

2009 RESEARCH ACCOMPLISHMENTS

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 (PSW) Research Station represents Forest Service Research and Development in California, Hawaii, and the Pacific Islands. The region has the lowest, driest desert in the country, the highest elevations within the 48 contiguous states, and wet tropical forests. It is the home of an abundant diversity of native plants and animals and nearly 50 percent of the Nation's threatened and endangered species. PSW Research Station has more than 50 scientists conducting a broad array of natural resources research to develop and communicate science needed to sustain forest ecosystems.

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A Message from the Station Director



It is my pleasure to present the 2009 PSW Research Station research highlights. This report shares key accomplishments and scientific advances and sheds a light on topics of national concern. Our discoveries and unbiased data assist a range of consumers making land management decisions regarding climate change, land use change, wildland fire issues, recreation needs, invasive species issues, and other forest and environmental health concerns. I am proud of our role in scientific research and delivery over the years and am delighted to present this accomplishment report.

My first year as PSW Research Station director began in 2009. During that year, I visited our laboratories and facilities in California and Hawaii to meet our scientists and staff. It is a new and exciting period of change for the station. We are redesigning our science programs, business operations, and communications to effectively target our station goals, facilitate greater integration of science, maximize strategic alliances, and leverage Forest Service Research and Development resources. This realignment enables us to strategically deliver our science to internal and external customers.

The redesign allows us to effectively tier our research to reflect and respond to the following Forest Service Research and Development strategic programs and emerging research areas:

Strategic Program Areas

- Wildland Fire and Fuels
- Invasive Species
- Outdoor Recreation
- Resource Management and Use
- Water, Air, and Soil
- Wildlife and Fish
- Inventory and Monitoring

Emerging Research Areas

- Climate Change
- Biomass and Bioenergy
- Urban Natural Resources Stewardship
- Nanotechnology
- Water Management and Restoration

For readers already familiar with PSW Research Station, this report provides updates on our recent work. For those learning about our station for the first time, this report provides an overview of the station and key research findings, research that could not be accomplished without our dedicated scientists, technicians, and support staff. Please contact me if you have questions or comments regarding this report. Thank you.

DEANNA J. STOUDER

DIRECTOR, PSW RESEARCH STATION
SEPTEMBER 2010

PSW Research Station Accomplishments Through Time

Several of the federally-funded research accomplishments and advances produced by PSW Research Station are listed below

1930s	Inventoried and mapped the vegetation of California
1940s	Pioneered work in forest genetics and tree breeding
1950s	Developed air tankers and fire retardants for firefighting Developed the rest-rotation grazing system
1960s	Developed the Incident Command System for firefighting Developed and tested alternatives to dichlorodiphenyltrichloroethane (DDT) for forest pest management Identified ozone as the cause of forest decline in the West
1970s	Developed electrophoresis (starch gel) genetic methods for forestry use Increased pine seed collection and tree planting by seed zone designation
1980s	Provided the scientific research findings that resulted in federal intervention to protect and recover the California condor Investigated the decline of the ohia lehua (flowering evergreen tree) in the Hawaiian islands Identified atmospheric nitrogen impacts on water quality in western ecosystems
1990s	Completed the California spotted owl technical assessment which assisted in land management planning related to this species of concern Completed the Sierra Nevada Ecosystem Project and final report providing guidance for long-term land management plans for the Sierra Nevada Mountains
2000s	Developed the first biocontrol agent for strawberry guava (small fruit-bearing tree), an invasive species in Hawaii Requested by Los Angeles city officials to identify sites throughout the city to plant 2.5 million trees; part of the city's plan to add more trees to city streets Participated in the genetic sequencing of black cottonwood, the first forest tree genome to be sequenced. Lead a multi-million-dollar Sudden Oak Death competitive grant program to prevent, treat, and eradicate this disease that kills oak trees throughout the United States Helped develop the first pheromone products to combat beetles that kill mountain pine and Douglas-fir trees

Research Theme:

Fire And Fuels

PSW Research Station has a rich history of fire research that addresses special fire management issues in California and in the Pacific Islands. Research findings address vegetation-restoration techniques, reducing catastrophic wildfires, invasive species management, and more. Fire research programs also focus on modeling fire behavior, creating decision-support tools for fire managers, and providing social science findings regarding the human aspect of fires (prevention, urban issues, etc.).

High resolution model yields better predictions for the Hawaii Fire Danger Rating System



Weather in Hawaii is influenced by complex interactions between trade winds and the size, shape, topography, and location of each island relative to the other islands. These factors, which affect local circulation and precipitation on a much finer scale, make fire danger and behavior prediction difficult. PSW Research Station developed high-resolution computer models with a grid smaller than those commonly used in operational forecast models to simulate airflow and precipitation patterns. The model allows forecasters to see the terrain and other variations that affect fire behavior and helps fire managers make more accurate predictions when using the Hawaii Fire Danger Rating System.

Prescribed burning may minimize invasion of non-native plant species in chaparral

Fuel reduction in the wildland–urban interface is a good strategy to help reduce wildfires. But little is known about how different fire treatments affect the regeneration of non-native plants. To learn more, station scientists evaluated non-native and native plant responses to various fuel reduction methods in the northern California chaparral.

They used prescribed fire in the fall, winter, and spring; they also experimented with mastication (plants chewed or chipped). Mastication resulted in the regeneration of many non-native plants. The use of prescribed fire treatments in the winter and spring was the most successful treatment. Managers may consider using prescribed fire as a fuel reduction treatment on non-native grass. When prescribed fire is not feasible, mastication will exacerbate non-native grass production. Native plant seedbanks will flourish, however, if the site is undisturbed.

Post-fire restoration strategies summarized in new book

Pacific Southwest Research Station scientists contributed two chapters to the book, "Fire Effects on Soils and Restoration Strategies." One



Prescribed fire recovery, 3½ years post fire. Sprouting shrubs dominate with some perennial herbs in the understory.

chapter addresses post fire seeding and the other post fire rehabilitation treatments used in California. Post fire seeding helps stabilize burned slopes by increasing plant cover. This technique prevents the invasion of burned areas by noxious weeds, replaces weedy annual grasses on burned rangelands, and reestablishes desired vegetation. But grass seeding has a mixed record of success. In California, for example, post-fire rehabilitation treatments vary according to biophysical aspects of the landscape and societal practices regarding fire and landscape use. The book captures and describes those elements. The book also summarizes the latest research on soil fire effects and post-fire rehabilitation treatments. Burned Area Emergency Response teams and land managers should find the information in this book useful.



Dry forests in Hawaii are one of the most imperiled ecosystems in the world. Invasive grass species carry fires that degrade and destroy native forests.

Breaking the exotic grass wildfire cycle in tropical landscapes of Hawaii

A series of studies were completed by station scientists about how to use native species to reduce fine fuels, minimize risks associated with fires, and reduce the invasion of non-native species. Recent field studies focus on evaluating the seasonal and physiological characteristics of native and exotic plants common in sub-alpine ecosystems of Hawaii. These field measurements are essential to assess which species are prone or resistant to fire. The data provide clues about the roles of native and exotic species in facilitating or hindering the risk of catastrophic fires, and create a link between field measurements and remote observations. It is now possible to measure plant traits and fire fuels across large areas using airborne remote sensing, by examining light reflected at different

wavelengths, and how these patterns are influenced by physiological properties of plant tissues, enabling assessments of relative fire risk.



*The leeward coast of the Big Island of Hawaii has been converted from tropical dry forest to monotypic stands of fountain grass (*Pennisetum setaceum*).*

Research Theme:

Ecosystem Function and Health

Forests, watersheds, and landscapes are threatened by changing climate, past management practices, air quality, invasive species, human pressures, and land-use changes. PSW Research Station Forest Ecosystem Function and Health Program provides the scientific information to natural resource managers, policymakers and the public needed in order to preserve forest function, water, air, and soil resources.

Adaptation tools developed for natural resource managers address the effects of climate change in Western forests

The Westwide Climate Initiative developed a set of strategic and tactical tools to assist managers as they incorporate climate change considerations in management and planning activities. The tools build and explore climate projection and climate impact models to facilitate the development of educational materials for resource managers. The initiative partners include the Pacific Northwest Research Station, Pacific Southwest Research Station, Rocky Mountain Research Station, several National Forests, and other organizations. Information collected by the initiative is shared through the Climate Change Resource Center at www.fs.fed.us/ccrc/.





Developing resilient ponderosa pine forests. Treatments include prescribed fire only (A), thin only (B), thin plus fire (C), and thin plus fire plus fertilize (D).

Developing resilient ponderosa pine forests using mechanical thinning and prescribed fire

Thinning and prescribed burning are common management practices for reducing fuel buildup in dry Ponderosa pine forests. However, it is not clear if both practices are necessary to lower fire risk in these kinds of forests. A research demonstration project in central Oregon using mechanical thinning techniques on Ponderosa pine forests proved effective. After thinning, some understory vegetation remained and helped sustain area wildlife. Prescribed fire alone was unsuccessful in restoring healthy forests or reducing wildfire risk. Thinning and repeated prescribed burns in this area reduced wildfire risk, but also eliminated the vegetation needed for wildlife. These findings offer land managers different fuel reduction options for Ponderosa pine forests, supports decisionmaking and helps create healthy, resilient, forests.

High-Resolution Forest Biomass Mapping in Hawaii: A Method for Mapping Tropical Carbon Stocks

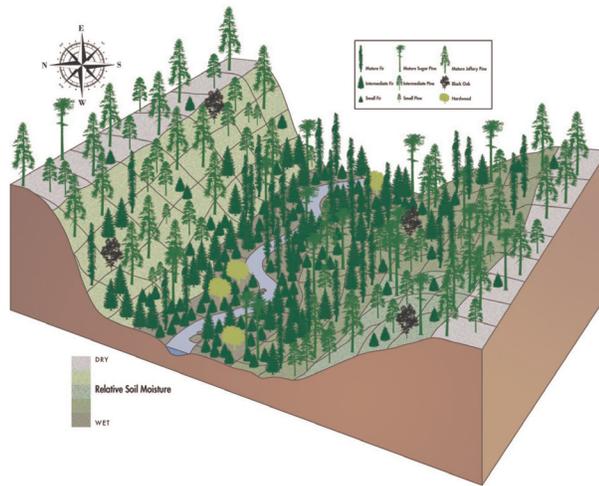
Large scale biomass mapping is essential to support the United Nations Framework Convention on Climate Change Program. The program helps to reduce emissions from deforestation and forest degradation. PSW Research Station scientists developed and tested an integrated satellite, airborne, and field based mapping approach to support high resolution biomass monitoring of tropical forest regions. The station tested this approach in Hawaii at a resolution of 0.1 hectare (¼ acre) making it the largest high resolution biomass mapping study of its kind. By combining free satellite monitoring technology with affordable light detection and ranging (LiDAR) mapping, the research findings demonstrate that high resolution forest carbon monitoring can be cost effective. This approach makes accurate, rapid biomass mapping a reality and helps improve the monitoring of carbon stocks, losses, and recovery in forests over time.

Developing an Ecosystem Management Strategy for Sierra Nevada Mountains Mixed-Conifer Forests

PSW Research Station and collaborators completed a comprehensive literature review and synthesis to provide forest managers with the best available science for the management of the Sierra Nevada Mountains mixed conifer forests. The report considers forest structure, fire ecology, and the ecological needs of wildlife, and provides a scientific basis to help managers address multiple management objectives, particularly in the face of climate change. The report suggests that land managers produce different stand structures and densities across the landscape using topographic variables (i.e., slope shape, aspect, and slope position) as a template for varying treatments. For example, locally cool or moist areas, where fire may have historically burned less frequently, would have high density canopy cover, providing habitat for sensitive species. In contrast, upper, southern aspect slopes would have low densities of large fire-resistant trees. Thinning treatments should be on crown strata or age cohorts and species to mimic natural dynamics rather than on the uniform diameter limits used in standard forestry practices.

Evaluating the influence of bark absorption on rainfall interception

The effects of rainfall absorption by Redwood and Douglas-fir bark was evaluated at a stand scale. The results suggest that this process may contribute to the explanation for a seemingly anomalous finding from earlier rainfall interception studies: the proportion of rainfall intercepted remains relatively constant with increasing rainfall intensity. The results will allow



Landscape schematic of variable forest conditions produced by management treatments that differ by topographic factors such as slope, aspect, and slope position.

modeling of interception loss at a stand scale, eventually contributing to construction of a runoff model to predict the influences of logging on watershed hydrology under various scenarios of climatic change.

Management options for mitigating the effects of excess nitrogen in nitrogen-saturated mixed conifer forest in California

A study conducted by station scientists provides evidence that prescribed fire reduces nitrogen deposition and will lessen the impacts of excess nitrogen accumulation in mixed conifer forests of southern California. Atmospheric nitrogen pollution from fossil fuel use and agriculture practices in California is fertilizing many ecosystems in the state with excess nitrogen. Station researchers are using the Daycent biogeochemistry model to test for potential mitigation of the symptoms of nitrogen overload. Model simulations and a published literature review suggest that prescribed fire alone is not sufficient to reduce nitrogen overload and nitrogen deposited must be reduce in order to reduce below ground organic nitrogen stores.

Research Theme:

Conservation of Biological Diversity

In a continually changing environment, it is important to understand the responses of plants and animals to change so as to conserve populations, species, and their associated ecosystems. Ecologists in this program are working to assess biological diversity, determine the threats to that diversity, understand organism and ecosystem responses to those threats, and determine appropriate restoration and recovery techniques. Geneticists are performing genomics research as well as exploring the ability of plants to adapt to a changing environment. Invasive species biologists are exploring mechanisms to protect native biodiversity from exotic species as well as eradicate the invasive species.



Goldspotted oak borer (*Agrilus coxalis*) adults are about 10mm long and 2mm wide. They are bullet-shaped and can be identified by the six golden-yellow spots on the forewings.

Discovery of the goldspotted oak borer (*Agrilus coxalis*) in southern California

Many oak trees have been dying in eastern San Diego County since 2002. A PSW Research Station scientist and collaborator recently discovered that the goldspotted oak borer may be the cause of the oak tree mortality in the area. The team catalogued the beetle's biology and natural history and proposed the common name for the insect to the Entomological Society of America. This research has raised awareness of the pest to various regulatory agencies and allows land managers, homeowners, and foresters to take steps necessary to slow the spread of the insect and implement quarantine measures. This will eventually reduce coast live oak and California black oak mortality in the zone of infestation.



Tree injection protects ponderosa pine from mortality attributed to western pine beetle attack.

First demonstration establishing the effectiveness of a systemic insecticide for protecting a conifer from bark beetle attack in the western United States

PSW Research Station found emamectin benzoate effective when sprayed into the base of California conifers (prior to beetle colonization) in preventing tree mortality attributed to western pine beetle attack. Researchers have recently explored the effectiveness of injecting small quantities of systemic insecticides directly into trees to combat attack. This may be a safer treatment than conventional insecticide spray treatments with fewer impacts to the environment. Bark beetle attacks hasten tree mortality and also affect timber and fiber production, wildfire severity, water quality and quantity, recreation, biodiversity, and carbon storage.

Survival, dispersal, and detection of *Phytophthora ramorum* in various media

Several species of trees throughout California have died after being infected by the pathogen that causes the Sudden Oak Death disease. Many new discoveries have been made by station

scientists regarding the pathogen causing Sudden Oak Death (*P. ramorum*). Scientists have learned that the pathogen may survive up to 49 weeks in forest soil but is suppressed in dry soil. Its presence in wet seasons causes foliar infections due to splash dispersal. In a study on nursery plants maintained under greenhouse and field conditions, foliar infections were present after rain, but absent in drip-irrigated plants, and accelerated in

sprinkler irrigation. Green fluorescent protein marker stains have been developed to improve early detection survey and inspection methods. This work is being used to develop effective quarantines for the pathogen.

Innovative Web applications to compile, archive, access, and analyze bird monitoring data throughout the Americas

PSW Research Station scientists developed web based tools that allow multiple partner contribution and access to bird census and capture data throughout North America, Mexico, and Central America. Researchers will have more than 1 million records from all partners posted by 2010. This database allows for predicting population changes under various habitat, landscape, and climate change scenarios. Bird monitoring census and capture data in a single, high quality, multifaceted database allows researchers to use the data more efficiently and ensures data quality, security, and consistency.

Estimation of detection probabilities for Pacific fishers using standard non-invasive protocols

The Pacific fisher, a member of the weasel family often found in the Sierra Nevada Mountains, is a species of concern to conservation biologists and land managers. PSW Research Station researchers developed new methods to analyze data collected throughout the range of the fisher that more accurately estimate the probability of detection. The analysis assesses how well the protocols detect fishers and provides recommendations on how to improve survey protocols to increase confidence in fisher detection. The analysis also addresses how field complications (e.g., bears rendering survey equipment unusable) affect detection probability and how practitioners can compensate to ensure a high level of confidence in detection. An occupancy survey devised in the 1990s was the standard protocol but it had never been analyzed or evaluated.

Evaluating risk of scour in salmon spawning areas

Trout, salmon, and related species (salmonids), bury their eggs in river gravel. The eggs incubate for months before the young fish emerge. During incubation, high water flow may scour the river bed and remove incubating embryos or smother the bed with a new layer of sediment.



An experimental unit with unembedded substrate where all fish survived.

A study in the Trinity River in northwestern California led by PSW Research Station was the first to evaluate the risk of scouring, which can decrease the population of a cohort of salmon fry. Results

show that scour-prone areas can be predicted; and fish generally avoid these areas. This study showed how variable changes in rivers can influence salmonid survival during this key life history stage. Knowledge gained from this study can be used to evaluate the risk of scour and fill on salmonid embryos to improve salmonid management and reduce mortality in regulated rivers.

However, fish are still vulnerable to widespread fill resulting from high flow events.

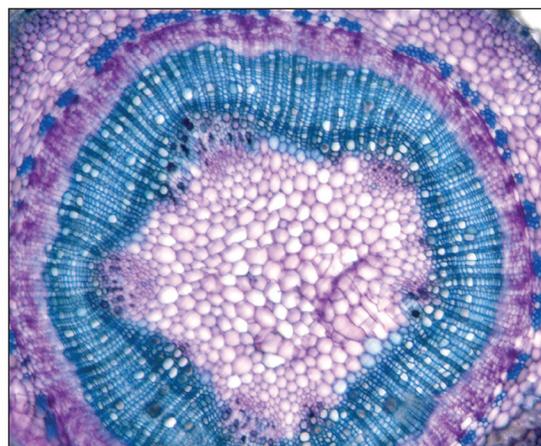


Image shows a cross section of a poplar stem stained to show the lignified, wood tissues.

Identification of genes regulating wood formation in poplar

There is a growing interest in using genetic information to improve selection in breeding programs for wood quantity and quality for bioenergy applications. PSW Research Station researchers have identified a gene that regulates cell differentiation during wood formation in poplar. This research is part of a larger effort to understand the genetic regulation of wood formation. The gene under investigation regulates the expression of enzymes responsible for the synthesis of cell walls. Altering the expression of this regulatory gene results in marked changes in the lignin and cellulose content of wood. Lignin and cellulose are the primary polymers responsible for the mechanical properties of wood, and are also key in determining the end use of wood for lumber, fiber, or biofuels.

Research Theme:

Urban Connections and Social Dynamics

With an expanding wildland-urban interface, our Nation's natural resources are becoming closely entwined with urban centers. Researchers in urban connections and social dynamics work to bring the natural world to urban areas by greening city landscapes while simultaneously facilitating the public's ability to interact with adjacent forests and rangelands.

Publication of the lower Midwest community tree guide

The Lower Midwest Community Tree Guide is a recent PSW Research Station publication about how urban forests can improve air quality, conserve energy, filter storm water, and reduce carbon dioxide. It answers questions about the environmental and aesthetic benefits that trees provide, and how trees help to conserve energy while adding value to homes and communities. It also answers questions about how to select tree types to minimize conflicts with power lines, sidewalks, and buildings. The guide was used as a training tool at a recent conference of the Indiana Urban Forests Council. State urban and community forestry coordinators from Kansas, Oklahoma, Missouri, Arkansas, Illinois, Indiana, Kentucky, and Ohio distributed copies to their communities to improve urban forestry.

Tree carbon calculator for urban forestry projects

PSW Research Station developed and released the Tree Carbon Calculator, a free Microsoft Excel spreadsheet that provides carbon related information for individual trees in one of 16 climate zones in the United States. It is the only tool approved by the Climate Action Reserve, a national offsets program working to ensure integrity, transparency and financial value in the United States carbon market, for quantifying carbon dioxide sequestration from tree planting projects in urban areas. The program estimates how much carbon dioxide individual trees sequester in a year and in their lifetime. In addition to quantifying carbon benefits, the calculator quantifies annual per-tree energy savings for planted trees. Tree planting increases energy conservation because urban trees reduce

the demand for energy needed to heat and cool adjacent homes and buildings. The tool is used by the city of Santa Monica in its pilot greenhouse gas tree project and the Sacramento Tree Foundation in estimating green house gas reductions associated with tree planting.

Learning how technology can be used to attract children to the outdoors

An exploratory study (Youth Day) to determine if technology attracts kids to outdoor activities consisted of activities offered to 38 youth ages 6 to 17. Two activities were dependent on technology (camera safari and geocaching) and two activities were not (paper etching or rubbings of natural surfaces and a nature scavenger hunt). The technology dependent activities were favored by all of the participants. The study results (based on votes by the youth and observations by adults) suggest that technology, particularly digital cameras and global positioning system units, can be used effectively to get youth outdoors. A guidebook was developed describing how to plan and implement youth days. This may be helpful to managers and others working to get youth involved in outdoor activities. The Youth Day was held in 2007 in Griffith Park, Los Angeles, California.



Children engaged in etching and rubbing activities of natural elements.

Synthesis of recreation visitor research that emphasizes diversity

PSW Research Station scientists compiled and coauthored, "Recreation Visitor Research: Studies of Diversity." This publication includes 16 papers about international studies, syntheses, management, environmental belief, communication, and measurement. Results from the international papers indicate how cultural values produce significant differences on visitor constraints and use of public lands. The papers on environmental beliefs indicate the importance of managing natural areas for regulatory (i.e., protecting water quality) and cultural (i.e., outdoor recreation locations) uses. Recreation managers, academicians, and researchers will find this compilation useful in understanding diverse visitors and public land issues.

Using ethnic media to provide recreation information to diverse audiences

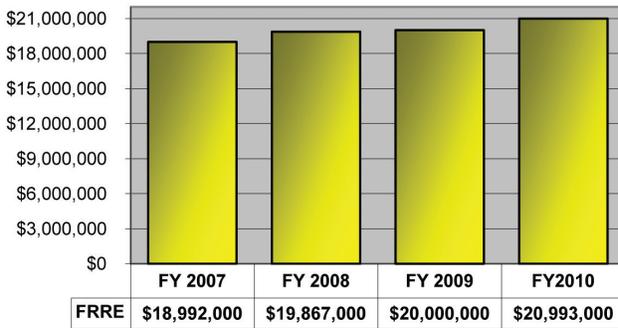


Recreation in an urban natural area of California.

A lack of information about outdoor recreation opportunities is often cited as a barrier by land managers when reaching out to communities of color. A PSW Research Station review of media use and reliance measures the value of ethnic media for outreach. Ethnic media is a trusted information source when paired with key contacts within ethnic communities. Beyond providing information to an audience that otherwise may not learn about national forests, ethnic media helps increase awareness among ethnic populations about the issues and benefits of natural resources. Managers can use these findings when developing outreach and communication strategies.

Pacific Southwest Research Station by the Numbers

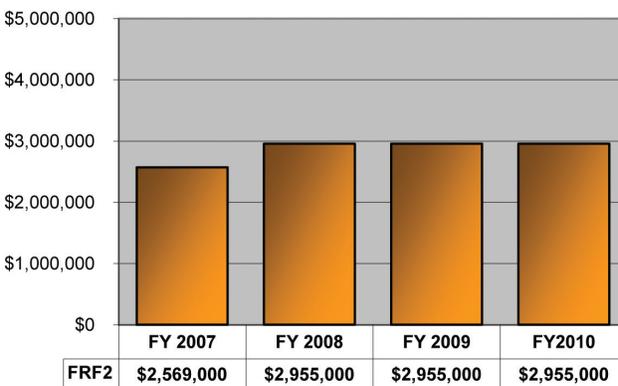
Forest and Rangeland Research Funds (FRRE)



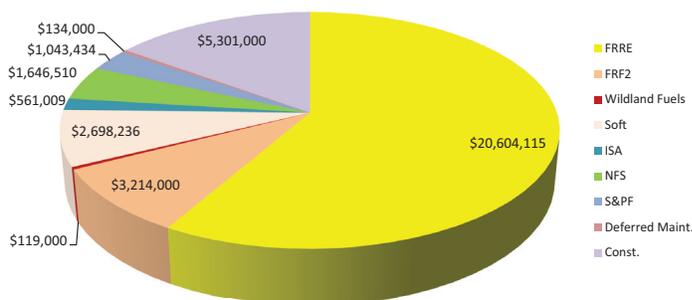
Budget

The majority of PSW Research Station's appropriated dollars are provided under the Forest and Rangeland Research Appropriation (FRRE funds). Other appropriated Research funds are provided under the Wildland Fire Management Appropriation, as part of the National Fire Plan (FRF2 funds).

National Fire Plan Research Funds (FRF2)



PSW RESEARCH STATION FY 2009 Total Budget



In addition, PSW Research Station scientists engage in many partnerships and collaborations with the USDA Forest Service National Forest System, and State and Private Forestry, universities, other federal agencies, and nonprofit agencies. The Station's total budget, as a result, represents a mixture of appropriated Forest Service research funds, as well as 'soft' funds obtained through grants and agreements.

Workforce

PSW Research Station employs 161 permanent employees; 53 of these employees are research grade scientists, with an additional 108 permanent employees providing science and administrative support.

<i>State/Lab Location</i>	<i>Permanent Employees</i>		
	Scientists	Support	Total
California Total	46	99	145
Albany	4	22	26
Arcata	6	19	25
Davis	11	13	24
Fresno	2	5	7
Placerville	1	9	10
Redding	5	11	16
Riverside	17	20	37
Hawaii Total	7	9	16
Hilo	7	9	16
Grand Totals	53	108	161

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