

Pacific Southwest Research Station



December 2002

Sudden Oak Death



Introduction

Sudden Oak Death is a growing threat to California and to forest trees, horticultural and agricultural plants, and the economy here and elsewhere. This emerging new disease, caused by the pathogen *Pythophthora ramorum*, is the subject of vigorous scientific investigation. In 2001-2002, the Pacific Southwest Research Station (PSW), USDA Forest Service, Albany, CA, secured and administered \$3.48 million for scientific investigation of Sudden Oak Death disease. Funds supported 22 projects with 12 university or other research partners addressing critical information needs. Projects were prioritized and selected to develop basic information on this new disease necessary to provide the scientific underpinnings for management and regulatory actions. Research projects addressed information needs in four areas:

- Pathogen Biology, Hosts, and Epidemiology
- Disease Management and Resource Utilization
- Disease Impacts on Ecosystem Components
- Economic and Social Impacts

Background and Funding

No additional research funds are budgeted for Sudden Oak Death at the PSW Research Station for 2003. While no *permanent* Forest Service Research and Development funds have been available, funds for 2001-2002 were secured from a variety of sources. Three million dollars came from USDA Forest Service, the Commodity Credit Corporation (an emergency authorization), and the U.S. Congress (2001 supplemental appropriation). The remaining \$480,000 came from the California Department of Forestry and Fire Protection.

The PSW Research Station Sudden Oak Death Research Program has been instrumental in planning, managing, coordinating, and funding research to meet the information needs of Sudden Oak Death. We look forward to continued partnerships in the future.

For projects supported by these funds, see the following pages.

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University of California, Berkeley, CA

Project Title Determination of population structure, phylogenetic placement, species state of *Phytophthora ramorum*, and development of a quick and accurate diagnostic methodology

Objectives (1) Determine the phylogenetic placement and evolutionary history of this new *Phytophthora*. (2) Develop methodologies for quick and accurate diagnosis of the new *Phytophthora*.

Funding \$446,770, for 3 years, from PSW Research Station

Dr. Matteo Garbelloto, Forest Plant Pathologist

Project Title Studies on treatment for prevention, management, and sanitation of Sudden Oak Death disease, with a particular emphasis on chemical treatments and composting

Objectives (1) Test various preventative treatments for protection from infection by Sudden Oak Death. (2) Test various treatments to retard the progression of Sudden Oak Death. (3) Test the efficacy of composting and heat treatments to reduce or eliminate pathogen viability.

Funding \$152,000, for 2 years, from PSW Research Station and California Department of Forestry and Fire Protection

Dr. Matteo Garbelloto, Forest Plant Pathologist

Project Title Detection and identification of decay and pathogen fungi directly from wood: A novel approach for the assessment of decay and disease in trees affected by Sudden Oak Death

Objective Develop a method to detect and identify the presence of associated decay organisms at all stages, from incipient to advanced, in urban and landscape trees infected with Sudden Oak Death disease.

Funding \$40,107, for 1 year, from PSW Research Station and California Department of Forestry and Fire Protection

Dr. Matteo Garbelloto, Forest Plant Pathologist

Project Title Identifying Sudden Oak Death resistant genotypes to susceptible species in coastal oak woodlands

Objectives (1) Assess genetic architecture of tanoak, coast live oak, California black oak and Shreve oak using AFLP [Amplified Fragment Length Polymorphism] molecular markers. (2) Look for correlated genetic markers and disease resistance in the four species. (3) Develop rapid methods of genetic fingerprinting for identifying resistant genotypes. (4) Determine whether populations with low genetic diversity are at higher risk of loss from disease. (5) Predict the risk of disease in populations not yet infected.

Funding \$135,922, for 2 years, from PSW Research Station

Dr. Richard Dodd, Professor of Forestry, Department of Forest Science

Project Title Continuation of Intensive Research Plot Monitoring Across the Range of Sudden Oak Death

Objectives (1) Detect newly infected trees in plots where year-2000 baseline conditions are known. (2) Place intensive monitoring plots in areas of infected forests in both the northern and southern limits. (3) Determine the sequence of symptom appearance for each tree species and the time from initial seeping-canker observation to the development of additional symptoms such as bark-beetle attack, appearance of fruiting bodies of *Hypoxyylon thouarsianum*, or foliage death. (4) Follow the physical breakdown of infected trees after death. (5) Correlate the infection status of trees determined through ground-level inspection with remote-sensed multi-spectral reflectance. (6) Develop predictive models for tree infection and mortality as a function of tree populations.

Funding \$51,542, for 1 year, from PSW Research Station

Dr. Richard Standiford and Dr. N. Maggi Kelly, College of Natural Resources

Project Title Interactions of bark and ambrosia beetles with *Phytophthora ramorum* in coast live oaks and their role in tree failure

Objective (1) Determine the role(s) played by bark and ambrosia beetles in decline, death, and failure of coast live oaks infected with *P. ramorum*.

Funding \$75,000, for 2 years, from PSW Research Station and California Department of Forestry and Fire Protection

Drs. Richard Standiford, David Wood, Andrew Storer, Pavel Svihra, and Tjosvold

Project Title Ecological impacts of Sudden Oak Death on coast live oak and tanoak/redwood ecosystems

Objectives (1) Compare and contrast stand structure, species composition and environmental characteristics in coast live oak woodlands in infected and non-infected stands in Marin, Napa, Alameda, and Contra Costa counties; (2) Use historic Vegetation Type map data to locate additional plots to examine historic vegetation change in coast live oak communities; (3) Determine the relationship of spatial patterns of individual stems to patterns of disease spread. (4) Reconstruct height and diameter development of stands under various levels of infections. (5) Establish thinning and burning plots to assess the effect of alterations in stand structure on disease spread. (6) Determine if the composition and relative abundance of birds, mammals, and herpetofauna is affected by SOD and associated stand structure. (7) Determine the effects of a change in stand structure on the abundance, species composition, productivity, roosting, and foraging of secondary cavity nesting birds and predators of these birds. (8) Compare the diets of insectivorous birds in infected and non-infected areas. (9a) Determine how insect species of particular importance to the diet of secondary cavity-nesting birds respond in areas affected by SOD. (9b) Provide plant pathology capabilities for multiple Principal Investigators (an addendum to 9a, funded separately from 1-9a with \$35,000 jointly by PSW and CDF&FP.)

Funding \$534,734, for 3 years, from PSW Research Station and California Department of Forestry and Fire Protection)

Drs. Barbara Allen-Diaz, Donald Dahlsten, Kevin O'Hara, Scott Stephens, William Tietje
College of Natural Resources, Departments of Forest Science, Environmental Science, Policy and Management

University of California, Davis, CA

Project Title Studies to determine mechanisms of survival, spread, population structure, and other biological characteristics of *Phytophthora ramorum*

Objectives (1) Determine the mechanisms of survival, spread, and intensification of SOD. (2) Determine the population structure, mating genetics, and species status of the new *Phytophthora*. (3) Determine the susceptibility of host species within and beyond California.

Funding \$398,770, for 3 years, from PSW Research Station

Dr. David Rizzo, Associate Professor Plant Pathology

Project Title Epidemiology, biology, and impact of *Phytophthora ramorum* in the Sierra Nevada

Objectives (1) Determine the mechanisms of survival, spread, and intensification of *Phytophthora ramorum* in the Sierra Nevada mountains. (2) Determine the potential effects of the pathogen in those areas where the pathogen appears to be established.

Funding \$210,000, for 3 years, from PSW Research Station and California Department of Forestry and Fire Protection

Dr. David Rizzo, Associate Professor Plant Pathology

Project Title Disease progression and sporulation potential of *Phytophthora ramorum* on non-oak hosts

Objectives (1) Document symptoms and disease progression on all identified non-oak hosts of *P. ramorum*. (2) Determine the sporulation potential of the pathogen on these hosts. (3) Determine host range and symptom development of *P. "ilicis-like"* on non-oak species.

Funding \$210,000, for 3 years, from PSW Research Station and California Department of Forestry and Fire Protection

Dr. David Rizzo, Associate Professor Plant Pathology

University of California, Forest Products Laboratory, Richmond CA

Project Title Utilization and disposal of *Phytophthora ramorum* infected oak and coordination of the PSW Sudden Oak Death research program: An effort to retard the spread of Sudden Oak Death syndrome in the coastal habitat of California

Objectives (1) Analyze the technical feasibility of using *Phytophthora*-infected material for wood products, including composites, solid wood, and fuel and firewood (chips, firewood, and densified fuel). (2) Assess the risk of pathogen survival in processed products. (3) Test control methods for wood products including heat, chemical, and other typical wood pathogen control methods such as heat sterilization, and the effect of temperature and its correlation with wood thickness and moisture content and the effectiveness of sodium borates.

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Also, the Forest Products Laboratory will provide PSW with a SOD Research Program Coordinator whose responsibilities include (1) development of a program of research through partnerships with academia as well as the State and other public and private entities; (2) recruitment and negotiation of research agreements; (3) tracking progress of PSW funded research; (4) representing PSW at all appropriate local, regional, national, and international meetings concerning SOD; (5) providing assistance to the PSW management team to effectively utilize appropriated funds; (6) ensuring Forest Service recognition of research efforts; and (7) initiating and organizing meetings of research cooperators to coordinate research and utilization of research sites.

Funding \$216,000, for 3 years, from PSW Research Station

Dr. Frank Beall, Director

University of California Cooperative Extension, Watsonville, CA

Project Title Evaluation of fungicides for the control of *Phytophthora ramorum* infecting containerized plants

Objective Determine the efficacy (including residual properties) of fungicides that could be used by nurserymen to prevent infection by *Phytophthora ramorum* of containerized *Rhododendron* spp.

Funding \$18,000, for 1 year, from PSW Research Station

Dr. Steve Tjosvold

California State University-San Luis Obispo, CA

Project Title The effect of Sudden Oak Death on mortality, long term growth, and economic viability of coast live oak in three California counties

Objectives (1) Collect and analyze volume, growth, yield, and economic data from thinned and unthinned, permanent, oak-dominated plots established in 1984 in Monterey, San Luis Obispo, and Santa Clara counties (all counties with positive ID of SOD). (2) Starting this year these plots will also be assessed for the presence, incidence, and effect of SOD on thinned and unthinned plots throughout the study areas.

Funding \$52,000, for 3 years, from PSW Research Station

Dr. Norman Pillsbury, Natural Resources Management Department

Lewis and Clark College, Portland, OR

Project Title A cytological and histological study of *Lithocarpus* and *Quercus* spp. infected with *Phytophthora ramorum*

Objectives (1) Study the infection process of *P. ramorum* in *Lithocarpus densiflorus* and *Quercus* spp. (2) Gather cytological and histological data to facilitate discovering the portal of entry into the host and the sequence of tissue infection. Addendum to above project: provide laboratory assistance with sample preparation for electron microscopy.

Funding \$20,000, for 1 year, from PSW Research Station

Dr. Edwin R. Florance, Professor of Biology

Oregon State University, Corvallis, OR

Project Title Epidemiology of *Phytophthora ramorum* in Oregon forests

Objectives (1) Determine mating types and other measures of population structure of American and European isolates of *P. ramorum*. Also, with California colleagues, test hypothesis of origin of the pathogen, including (a) *P. ramorum* in Oregon is a recent introduction from California and (b) *P. ramorum* in California is a recent introduction from Europe. (2) Examine the mechanisms by which the pathogen infects, survives, and is dispersed under Oregon conditions, with emphasis on (a) susceptibility of common wild and cultivated Ericaceous shrubs, (b) epidemiology on susceptible plants growing beyond the range of susceptible tree species, and (c) the importance of soil- and water-borne inoculum in disease development and spread.

Funding \$218,009, for 2 years, from PSW Research Station

Dr. Everett Hansen, Department of Botany and Plant Pathology

Phytosphere Research, Vacaville, CA

Project Title Evaluation of water stress and other risk factors for *Phytophthora ramorum* canker in coast live oak and tanoak

Objectives (1) Remeasure stem-water potentials of symptomatic and non-symptomatic coast live oak and tanoak to document any changes in water stress over this period and assess the relationship between water stress and disease progress. (2) Reassess disease occurrence and severity of coast live oak and tanoak subject trees and plot trees 1 year after initial evaluations to document disease progression. (3) Collect data on additional selected plot and tree variables that may be related to disease. (4) Refine statistical models that relate disease risk with water stress and plot variables, and develop disease progress models.

Funding \$33,924, for 1 year, from PSW Research Station

Dr. Tedmud J. Swiecki

Project Title *Phytophthora ramorum* (Sudden Oak Death) in coast live oak and tanoak: Factors affecting disease risk, disease progression, and failure potential

Objectives (1) Develop and refine statistical models that relate disease risk, disease progress, and mortality with tree factors and plot variables. (2) Assess how failure potential relates to SOD disease progress and mortality by observing tree failures over time and determining which factors observed prior to failure are most predictive of failure; (3) Document disease progress and new infections occurring within plots to provide information on disease phenology and initiation: (3) Determine how tree water status is affected by disease over time by documenting changes in water stress that develop as SOD symptoms progress.

Funding \$50,415, for 1 year; from PSW Research Station and California Department of Forestry and Fire Protection

Dr. Tedmud J. Swiecki

Project Title Relationship between tree failure potential and *Phytophthora ramorum* canker (Sudden Oak Death)

Objectives (1) Conduct field surveys to determine whether certain observable tree and stand factors are related to failure risk; (2) Statistically assess the relative importance of various agents and factors in predisposing trees to failure; (3) Compare field survey findings with data from the California Tree Failure Reporting Program database to determine whether differences exist in failure patterns in urban and wildland oaks; (4) Develop a protocol for assessment of failure potential in coast live oak affected by SOD based on previous findings.

Funding \$50,000, for 1 year, from PSW Research Station and California Department of Forestry and Fire Protection

Dr. Tedmud J. Swiecki

Pacific Southwest Research Station with Humboldt State University, Arcata, CA

Project Title Field evaluation to study a method of potential transmission of Sudden Oak Death (*Phytophthora ramorum*) by birds

Objectives (1) Establish a method of surveying for the presence of the pathogen on birds. (2) Determine the likely species involved, timing, and incidence rate of the pathogen.

Funding \$74,000, for 2 years, from PSW Research Station

Dr. C. J. Ralph, Redwood Sciences Laboratory Arcata

Dr. Erick S. Jules, Humboldt State University

Pacific Southwest Research Station, Davis, CA

Position: Post-Doctoral Plant Pathologist

The SOD program will provide operating funds for this position, starting with \$70,000; salary and overhead support will come from PSW research appropriations. The incumbent's primary research responsibility is to develop the necessary protocols for testing laboratory susceptibility and field infection rates of SOD on various species of oaks, both those native to California and those found elsewhere in the United States. The incumbent will be given a term appointment and housed in the laboratory of Dr. Rizzo, University of California, Davis because the lab has the necessary equipment and Dr. Rizzo the expertise to guide this research.

Funding \$70,000, for 1 year, from PSW Research Station

Wildlife Conservation Society, Santa Cruz, CA

Project Title A study to determine the role of vertebrate vectors (birds and small mammals) in spreading *Phytophthora ramorum*

Objectives (1) Determine whether wildlife can act as vectors of *P. ramorum*. (2) Determine taxa with potential to play a significant role in dispersal of inoculum. (3) Identify the means by which viable inoculum can be transported. (4) Map the potential inoculum shadows produced by potential vectors. (5) Develop management recommendations to reduce *P. ramorum* dispersal.

Funding \$45,000, for 1 year, from PSW Research Station and California Department of Forestry and Fire Protection

Drs. Keyt Fischer, Steve Zack,
Cheryl Blomquist, California Department of
Food and Agriculture; Eric Sanderson

International Research

Project title **Comparative aggressiveness of European and U.S. isolates of *Phytophthora ramorum* on *Quercus rubra***

Objectives (1) Determine the aggressiveness of European and USA isolates of SOD to infect red oak. (2) Determine the susceptibility of European and USA isolates of SOD to antifungal agents. (3) Determine the genetic differences of European and USA isolates of SOD.

Funding \$45,468

Dr. Clive Brasier, Pathology Branch, Forest Research Agency; Alice Holt Lodge, Dr. Sabine Werres, Phytopathologist and Mycologist, Federal Biological Research Center for Agriculture and Forestry, Braunschweig, Germany;
Dr. Willem A. Man, Dr. R. P. Baayen, Dutch Plant Protection Service, Wageningen, Netherlands.

