




# Sudden Oak Death

Protecting America's Woodlands  
from *Phytophthora ramorum*





*This disease could have  
global economic  
implications for forest,  
horticultural, and  
agricultural industries.*





# Executive Summary

A newly identified nonnative pathogen, *Phytophthora ramorum*, threatens our Nation's oak woodlands, urban forests, and horticultural industries. It causes Sudden Oak Death, which kills coast live oak, tanoak, and California black oak trees. It also causes branch and twig dieback, as well as leaf blight in many other species.

Discovered in 2000, the pathogen has spread to 13 California counties, as well as to Curry County, in southwestern Oregon. *Phytophthora ramorum* has recently been found in nursery stock in 18 States, as well as nurseries and public gardens in Europe.

Sudden Oak Death affects ecosystem functions, increases fire and safety hazards, and reduces property values in developed areas. The initial outbreak occurred in the urban-wildland interface of central, coastal California, where over 7 million people live. In California, falling trees and increased fire risks threaten homes, buildings, power lines, roads, watercourses, and recreation areas.

This disease could have global economic implications for forest, horticultural, and agricultural industries. Seven nations, including the United States, have imposed emergency quarantines restricting the shipment of rhododendron and other horticultural host plants, logs, and other woody materials. In November 2002, the European Union issued a quarantine restricting import of susceptible plant species from the United States.

This report describes the U.S. Department of Agriculture (USDA) Forest Service's comprehensive, six-part strategy to allocate resources for managing Sudden Oak Death. The agency's objective is to minimize economic, ecological, and aesthetic damage to the Nation's oak woodlands. Strategy components include—

- **Prevention.** Provide support to the USDA Animal and Plant Health Inspection Service in developing quarantines to limit pathogen spread.
- **Early detection and rapid response.** Nationwide, detect outbreaks early, while they are still treatable. Intensify surveys.
- **Control, management, and restoration.** Carry out eradication and slow-the-spread projects to destroy new outbreaks. Conduct trials for pesticide treatments to develop methods to protect high-value vegetation.
- **Research and monitoring.** Conduct research to determine pathogen biology, epidemiology, distribution, and impacts. Enhance control measures. Track disease spread over time and maintain information in a national database.
- **International cooperation.** Foster cooperation between regulatory officials and researchers to protect forests and maintain a safe nursery trade for North America and Europe.
- **Public outreach and partnerships.** Work with other public and private land managers, State and community governments, public and private groups, and individuals to develop the infrastructure necessary to provide effective prevention, eradication, and slow-the-spread programs.

# Background

Discovered in 2000, *P. ramorum* is jeopardizing the Nation's oak woodlands, urban forests, and agricultural and horticultural industries. Known to be the cause of Sudden Oak Death, this virulent pathogen has spread to 18 California counties, as well Oregon's Curry County. It has also been found in European nurseries and public gardens. The pathogen has a broad host range, including hardwoods, such as coast live oak; landscape plants, such as camellia and rhododendron; herbaceous plants, such as western starflower; and softwoods, such as coast redwood. It has killed tens of thousands of coast

live oak, tanoak, and California black oak trees and causes branch and twig dieback in conifers and several shrubs, as well as leaf blight in mountain laurel, camellia, viburnum, and other species. In California, it has affected ecosystem functions, increased fire and safety hazards, and reduced property values in developed areas. Over 7 million people live where the initial outbreak occurred—the urban-wildland interface of central, coastal California. Neighborhoods were transformed within months; dead trees surrounded communities where green trees formerly thrived. Communities were overwhelmed as residential yards, parks, open space, and recreation areas were irreparably altered and in need of costly removal of hazardous trees. In Oregon, the pathogen was detected shortly after establishment, and eradication programs were initiated.



Canker on tanoak



Black or reddish ooze often bleeds or seeps from the canker





Symptoms on rhododendron

### Symptoms

On oaks and tanoaks, infection causes trunk wounds called cankers. Although cankered trees may survive for several years, cankers gradually expand until they girdle the tree, causing it to die. Black or reddish ooze often bleeds or seeps from the cankers. In the final disease stage, the leaves turn from green to brown within a few weeks. Because other diseases cause similar symptoms, laboratory confirmation is needed for accurate diagnosis.

On California bay laurel, rhododendron, and more than a dozen other plants, infection results in leaf spots and twig dieback. The pathogen reproduces readily on many of these plant leaves, so they serve as reservoirs of inoculum.

### Spread

Spores are transported to new areas by windblown rain. Infected nursery stocks can also spread the disease. Other mechanisms for short- and long-range pathogen spread are under investigation (including transport in rivers and in soil by animals or hikers' shoes). Temperature and moisture conditions suitable for infection are also being studied.



Symptoms on bay laurel



## Current Distribution

In California, the pathogen is found from Monterey to Humboldt Counties in redwood/tanoak and coastal evergreen forests. The disease is widespread in Marin and Santa Cruz Counties, and in the Big Sur area of Monterey County. The infestations are concentrated in urban-wildland interface areas, but portions of wildlands are also heavily affected.

In Oregon, the pathogen was detected in 2001 via aerial survey. It was limited to a 9-square-mile area in Curry County near Brookings, OR, just north of the California border.

Within a 52-acre area, infected plants were identified and buffer zones surrounding them established. Immediately after detecting *P. ramorum*, Oregon landowners began cutting and burning host plants in the affected area. All identified sites were treated, and the eradication program required that the area be intensively monitored and found free of disease for at least 2 years. Several of the locations are close to reaching this goal.

## Distribution of Sudden Oak Death as of April 26, 2004

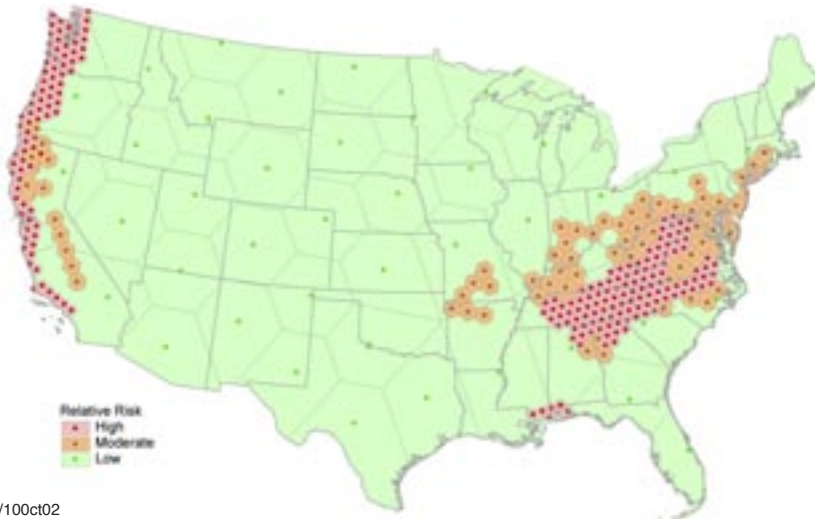


Map produced on 04/26/04 by UCD-CAMFER. <http://arbweb.berkeley.edu/SCD/monitoring/>  
 For more information about Sudden Oak Death, please visit the California Oak Mortality Task Force website at <http://www.suddenoakdeath.org/>





## Preliminary SOD Risk/Hazard Map



The USDA Forest Service constructed a preliminary risk map—integrating potential introduction pathways, susceptible plant species, and weather conditions favorable to *P. ramorum* survival and disease development—that guided cooperative pilot surveys in the spring of 2003. The risk analysis indicates that the Appalachian Mountains and coastal areas of Oregon and Washington are at greatest risk of acquiring the disease.

### Economic Implications

Sudden Oak Death could have major economic implications for forest, horticultural, and agricultural industries. Nursery stock has proven to be a pathway for dispersal of the pathogen, which has been found in garden centers and nurseries in 18 States and British Columbia. A different mating type of *P. ramorum* is present in hundreds of European nurseries. The U.S. nursery industry is valued at over \$13 billion annually, ranking as our Nation's third highest value crop. California is the industry's leading producer of horticultural plants, valued at \$2 billion a year. Oregon's industry is ranked fifth nationally and ranks second in the production of woody plants. The United States, Canada, the European Union, the Czech Republic, South Korea, Australia, and New Zealand have imposed

emergency quarantines for host plants and associated soil from infested areas. California and Oregon have also imposed internal quarantines. These quarantines restrict shipment of rhododendron and other horticultural host plants from areas where the pathogen is found.

Forest plants are also susceptible to *P. ramorum*. In addition to the culturally significant and aesthetically valued oak species, Coast redwood and Douglas-fir are susceptible. Although damage on these species appears to be limited to foliage and small branches, quarantines could result in a short-term loss of an estimated \$50 million a year for the redwood and Douglas-fir industry in California alone. The potential economic and ecological loss to Oregon's vast commercial Douglas-fir forest is even greater. Millions of acres of oak forests in the Eastern United States are also at risk. Lab tests show six eastern oak species are highly susceptible. An American native southern red oak, and a northern red oak, have been found infected in Europe. The oak hardwood forest is the largest forest type in the United States, and its potential vulnerability to this pathogen is a great economic and ecological concern.



# Strategy

The best defense against the establishment of *P. ramorum* in eastern oak forests is to prevent its introduction. Delineation of infested areas and aggressive containment of the pathogen in nurseries, and in natural areas in California and Oregon, through quarantine and eradication efforts are underway, but additional work in these areas is needed. Early detection and eradication from newly infested areas will be critical if the pathogen escapes containment. The USDA Forest Service is working with partners in USDA—Animal and Plant Health Inspection Service (APHIS); the Cooperative State Research, Education,

and Extension Service (CSREES); and the Agricultural Research Service—individual States, the California Oak Mortality Task Force, and university researchers to address Sudden Oak Death proactively. To manage *P. ramorum* to minimize financial, ecological, and aesthetic damage, the USDA Forest Service is implementing a comprehensive, six-part strategy that includes: (1) prevention; (2) early detection and rapid response; (3) control, management, and restoration; (4) research and monitoring; (5) international cooperation; and (6) public outreach and partnerships.



Quarantine Zone

*The oak hardwood forest is the largest forest type in the United States; its potential vulnerability is a great economic and ecological concern.*



## Prevention

**A**lthough pesticide tests are underway, only one pesticide treatment is currently approved for use on *P. ramorum*. This material must be painted on the trunks of trees as a preventative, and it has not been tested on hosts other than oak. In order to limit pathogen spread, quarantines are being implemented and enforced worldwide. In February 2001, APHIS issued an emergency rule on *P. ramorum* for interstate shipment of host plants and associated soil. California and Oregon have similar intrastate regulations. These regulations cover lumber, logs, mulch, wood chips, firewood, nursery plants, soil, yard waste,

florist materials, and many other commodities. Land managers are charged with enforcing the regulations on public lands; private landowners must also comply. In addition, best management recommendations are needed for firewood collection, Christmas tree cutting, timber sales, landslide repair, and road maintenance and construction to minimize the accidental spread of the pathogen. Federal and university personnel will develop literature to educate professionals and the public on symptom identification, sanitation measures, and quarantine compliance.



Rhododendron dieback







## Early Detection and Rapid Response

**M**onitoring is a critical component of Sudden Oak Death management. Using aerial and roadside surveys, forest inventory and monitoring plots, nursery surveys, and public employees trained to look for the disease during the course of their normal duties, the USDA Forest Service and its partners will work to detect new infestations early, facilitating containment or eradication. California and Oregon have more than 20 million acres of potential habitat for *P. ramorum*. Scientists identified 60 proven and suspected plant hosts and expect the known host range to increase as monitoring and detection methods improve. Aerial survey crews will monitor affected and adjacent regions; all suspect cases will be ground

checked and laboratory tested for *P. ramorum*. The Forest Health Monitoring program and its partners are conducting a national survey of forests at risk, focusing on the areas of high and moderate risk (see risk map), to determine whether the pathogen is present beyond California and Oregon. Federal, State, and county personnel will inspect nurseries located in areas where host species grow.

Records of pathogen distribution should be maintained in a national Web-accessible geographic information system database (<http://ceris.purdue.edu/napis>) and linked to California's database at <http://www.suddenoakdeath.org>. This resource will aid in economic analysis and prediction of the potential impact on natural resources.



Steps in the process of eradicating Sudden Oak Death in southwestern Oregon



## Control, Mangement, and Restoration

In areas considered generally infested, such as the central coast of California, only “slow-the-spread” projects are feasible. State and Federal personnel will work to educate the public to reduce the chances of accidental spread from these areas. We hope to be able to eradicate new infestations. Treating immediately after detection is considered essential. The current eradication methods are to outline areas with symptoms and add a 100-foot buffer zone; then cut, pile, and burn material; if possible, treat stumps to prevent resprouting; then broadcast burn to consume the litter layer. The Oregon Department of Agriculture and Oregon Department of Forestry worked with private land-

owners in Curry County to eradicate *P. ramorum*. They are conducting an intensive follow-up monitoring program, with retreatment where necessary. In some other areas, clear-cutting was not an option due to the value of trees or other considerations, so they removed infested California bay laurel or other foliar hosts that support pathogen reproduction to slow the spread of the pathogen. Eradication can only be successful if the disease is detected early and its distribution is limited. High-value areas can be replanted with resistant host ecotypes or nonsusceptible species to prevent exotic weed invasion and maintain recreational landscapes and visual beauty.



Aftermath of Sudden Oak Death in California



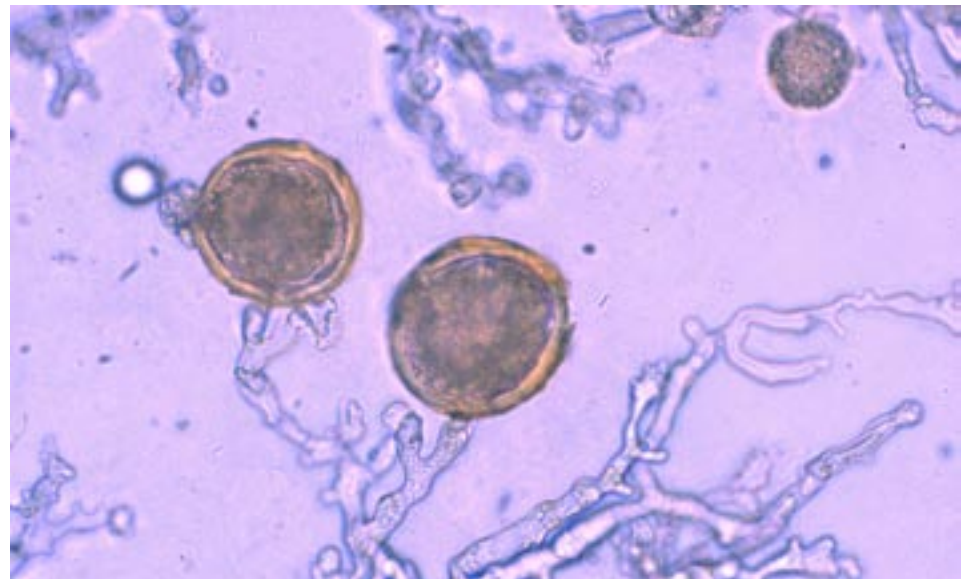




## Research and Monitoring

Effective regulations, treatment methods, resource utilization and best management practices for professionals and the general public all depend on research. Since *P. ramorum* is a pathogen new to science, researchers need to learn about the pathogen biology, disease epidemiology, and pathways of spread—as well as host and geographic ranges—in order to develop integrated management programs. We need to refine

diagnostic techniques and test management options. Finding the origin of the pathogen could yield important clues to its management. We need to determine and track pathogen distribution and impacts on ecosystem components. In order to prioritize control efforts, we need to assess impacts and balance management options with risk and social factors.



Resting spores permit long-term survival of *Phytophthora ramorum*

*The pathogen spreads through spores in soil, water, plants, and plant debris.*



## International Cooperation

The pathogen has been found in many European nurseries and a few public gardens on ornamental plants. In response, the European Union developed a system of plant passports that enables tracking nursery stock from first producer to the retail market. The United Kingdom is devoting considerable resources to developing sensitive field diagnostic kits. Researchers and regulatory officials worldwide are developing appropriate and standardized

regulations and inspection procedures in order to maintain trade and protect oak woodlands. These regulations must balance the needs of the forestry, horticultural, and agricultural industries. USDA APHIS frequently updates its regulations, as new hosts are identified. Their inspectors are trained in symptom recognition and kept up-to-date on susceptible plants to inspect. The USDA Forest Service updates its risk assessment for *P. ramorum* annually and provides it to U.S. trading partners.

*Researchers and regulatory officials worldwide are developing inspection procedures and detection methods to stop the spread of nonnative invasive pests like Phytophthora ramorum.*







## Public Outreach and Partnerships

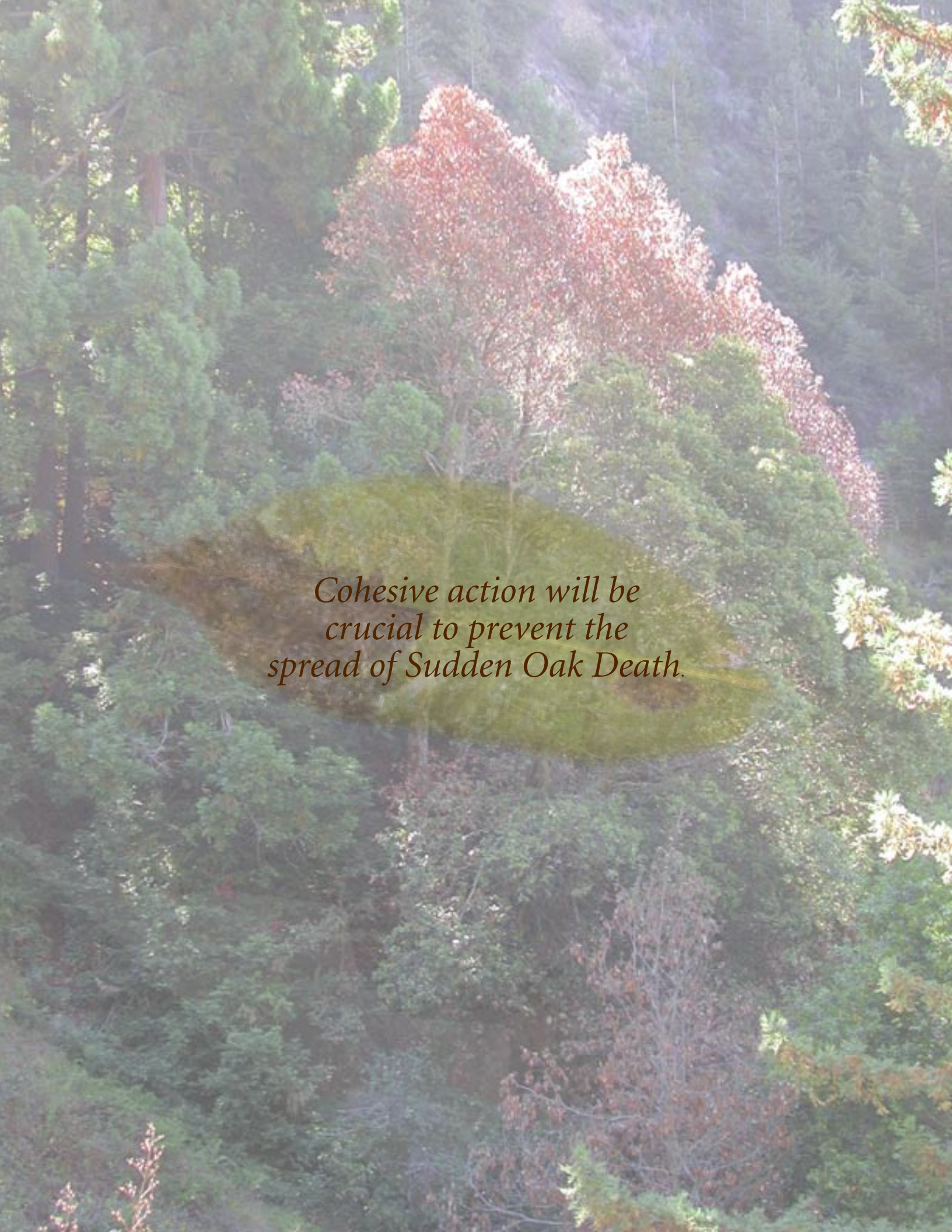
Sudden Oak Death is receiving national and international media coverage, and the public is looking for strong management and policy to protect natural resources. To achieve effective adaptive management of the disease, Federal and State personnel must devote resources to outreach activities for partners, organizations, Tribes, and communities on Sudden Oak Death. Cohesive action will be crucial to prevent pathogen spread. *Phytophthora ramorum* is found on land of multiple ownerships, making coordination essential between all levels of government, nonprofit organizations, industries, and private landowners. Good coordination will ensure that funds are spent efficiently and program efforts are not duplicated. Land managers from affected agencies must jointly develop effective

prevention, eradication, and slow-the-spread programs, because no single agency has the technical expertise, authority, or financial resources to address the issue independently.

Longstanding cooperation between organizations provides the necessary basis for launching a successful rapid response to the threat of Sudden Oak Death. Collaborations such as that fostered by the California Oak Mortality Task Force provide prime opportunities to pool resources for research, to learn more about the disease and how to control it, and for management activities to implement what is learned. Oak ecosystems are a priceless resource, and they require a rapid, effective response to the threat of Sudden Oak Death.







*Cohesive action will be  
crucial to prevent the  
spread of Sudden Oak Death.*



## For more information contact:

**USDA Forest Service  
State and Private Forestry  
Forest Health Protection**

1601 North Kent Street  
RPC, 7th Floor (FHP)  
Arlington, VA 22209

Phone: 703-605-5352

FHP Web site: <http://www.fs.fed.us/foresthealth>



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