



Figure 6—Employees from the Maryland Department of Agriculture's Plant Protection and Weed Management Division (left) and APHIS' Plant Protection and Quarantine program collect leaf samples from rhododendrons during a national survey for *P. ramorum* in nurseries. (APHIS photo by R. Anson Eaglin.)

most likely to experience *P. ramorum* damage and then expanded the agency's efforts to detect the pathogen in the areas of greatest risk.

By the end of 2004, west coast nurseries had shipped more than 2.3 million exposed or "at-risk" plants to every State except Hawaii. Inspectors found infected plants at 171 nurseries in 21 States. Early in December 2004, APHIS began restricting the movement of nursery stock from California, Oregon, and Washington. At the time these restrictions were established, these three States appeared to present the greatest risk of moving *P. ramorum* in nursery stock shipments.



Figure 7—An APHIS plant health safeguarding specialist flags sampled rhododendrons for destruction should they prove positive for *P. ramorum*. (APHIS photo by R. Anson Eaglin.)

Nurseries in those three States that ship *P. ramorum* host and associated host plants interstate must have their nursery stock inspected, sampled, and tested by State officials before those plants can be transported across State lines. APHIS verifies the results of these tests. Nurseries that ship nonhost plants interstate must undergo a visual inspection to ensure that those plants are not exhibiting *P. ramorum* symptoms before interstate shipment.

Although quarantines are in place in 14 northern California counties and 1 county in Oregon (where the pathogen exists in the environment), eradication



Figure 8—Agricultural officials survey for the pathogen in areas surrounding nurseries. Here, leaf and branch samples are collected from a maple tree. (APHIS photo by R. Anson Eaglin.)

of the pathogen from nurseries is the best defense against long-distance spread. The goal of APHIS is to determine the distribution of infected plant material in the United States and to limit the human-caused spread beyond the infected areas through quarantines and a public education program.

APHIS is working with other Federal agencies, the States, conservationists, and industry to accomplish this important goal. If you suspect that trees or plants are infected with *P. ramorum*, contact your State department of agriculture or your local extension specialist. To locate an extension specialist near you, consult the blue pages of the telephone book under "U.S. Department of Agriculture, Cooperative State Research, Education, and Extension Service." ■



United States Department of Agriculture  
Animal and Plant Health Inspection Service

## Phytophthora ramorum: Stopping the Spread

Program Aid No. 1842

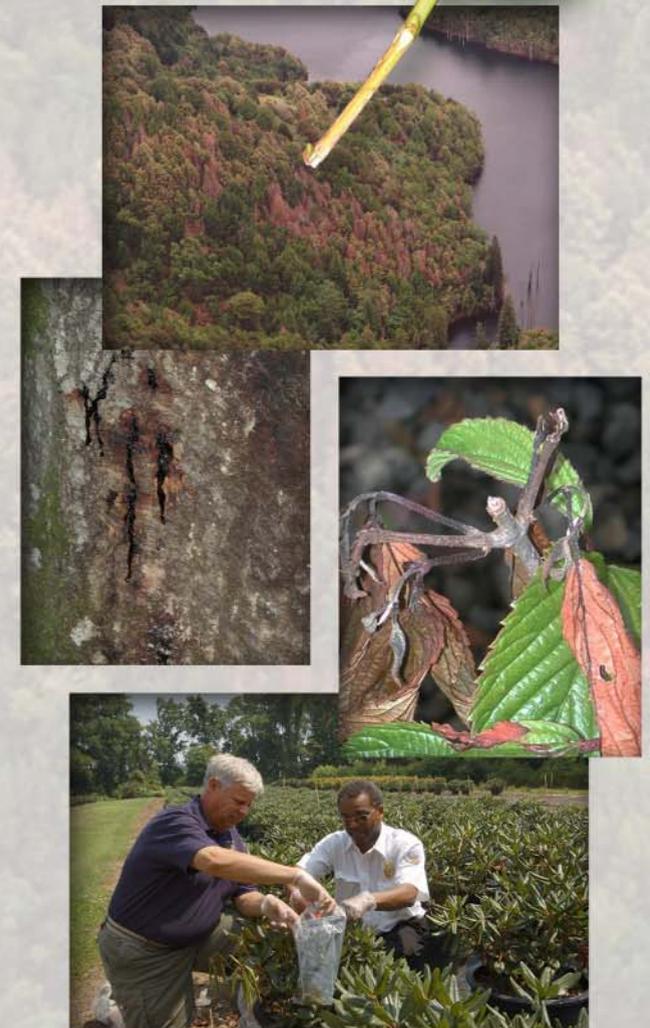


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Cover photos [top to bottom]: An aerial view of Kent Lake, CA, woodlands infected with the sudden oak death pathogen, *Phytophthora ramorum*. The trunk of this infected live oak exhibits bleeding cankers caused by *P. ramorum* infection. Viburnum, a popular nursery shrub, is susceptible to sudden oak death. (APHIS photo by R. Anson Eaglin.) Federal and State cooperators survey for evidence of *P. ramorum* nationwide. Camellias are also susceptible to *P. ramorum* infection.

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## Background

In 1995, a mysterious and sometimes lethal plant pathogen was detected for the first time in the woodland environment of Marin County, CA. Over the next several years, foresters, conservationists, plant pathologists, and the general public noticed that trees were dying in large numbers in coastal northern California. Initially observed in a limited number of oak species, the organism infected and eventually killed thousands of tanoaks, as well as coast live oaks, California black oaks, canyon live



Figure 1—This aerial view shows tree death in Kent Lake, CA, woodlands infested with the sudden oak death pathogen, *Phytophthora ramorum*. (Photo supplied by the Oregon Department of Agriculture and reproduced by permission.)



Figure 2—The trunk of this *P. ramorum*-infected coast live oak exhibits the bleeding cankers associated with sudden oak death. (Photo by Bruce Moltzan, Missouri Department of Conservation, on assignment.)

oaks, and Shreve oaks. The pathogen also infected, but did not kill, a number of other plants.

Through extensive study and cooperative research, scientists identified the pathogen in 2000 as a water mold called *Phytophthora ramorum*. It is now known to be the cause of several plant diseases, including ramorum leaf blight, ramorum die-back, and *Phytophthora* canker diseases, but the most widely known of these is sudden oak death.

First discovered in Germany and the Netherlands in 1993, the pathogen has now turned up in 15 countries, including England, Belgium, Poland, Spain, and the Canadian province of British Columbia.

*P. ramorum* has a broad range of hosts, including hardwoods (e.g., coast live oak), softwoods (e.g., coast redwood), landscape plants (e.g., camellia and rhododendron), and herbaceous plants (e.g., western starflower). To date, more than 75 plant species and cultivars representing more than 45 genera can either be infected by *P. ramorum* or facilitate its spread.



Figure 3—Rhododendron, a common nursery plant, is one of more than 70 plant species and cultivars susceptible to *P. ramorum*. (Photo by Jennifer Parke, Oregon State University; reproduced by permission.)

## Plants Naturally Infected With *Phytophthora ramorum*

Plants in the following genera are highly susceptible to infection by *P. ramorum*:

- *Camellia*,
- *Rhododendron*,
- *Viburnum*,
- *Pieris*,
- *Syringa* (lilac),
- *Kalmia* (mountain laurel),
- *Quercus* (oak), and
- *Umbellularia* (California bay laurel).

To learn more about other plants susceptible to *P. ramorum*, please visit the APHIS Web site at: <<http://www.aphis.usda.gov/ppq/ispmp/pramorom>>.



Figure 4—These camellia leaves show *P. ramorum*-induced leaf spot. (Photo by Cheryl Blomquist, California Department of Agriculture; reproduced by permission.)

## Movement and Infection in Plants

*Phytophthora ramorum* thrives in cool, wet climates, but significant infections can occur in nurseries with microclimates that favor disease. The organism is known to spread through wind-blown rain, contaminated irrigation water, and infected plants, and it may spread in ways not yet discovered. Movement of the pathogen in soil or potting mix is also possible.

Depending on the plant species, *P. ramorum* infections may occur on the trunk, branches, and/or leaves. Infections that result in tissue death and callus response on the woody portions of a tree are referred to as cankers. In foliar and twig hosts, symptoms can range from leaf spots to twig die-back, but these hosts rarely die from the infection.

Symptoms caused by *P. ramorum* are difficult to differentiate from those caused by other pathogens. For this reason, laboratory analysis is necessary to confirm the presence of *P. ramorum*.

## *P. ramorum* Makes Its Way Into the U.S. Nursery System

During spring 2004, the California Department of Food and Agriculture confirmed the presence of *P. ramorum*, the sudden oak death pathogen, on several varieties of camellia plants at two large California wholesale production nurseries. Investigation of shipping records revealed that these facilities had shipped large quantities of several varieties of common household garden plants nationwide.



Figure 5—Nurseries can be a pathway for the spread of *P. ramorum*. (APHIS photo by Jim Writer.)

## Stopping the Spread

Immediately following that discovery, the Secretary of Agriculture transferred to APHIS \$15.5 million from the USDA Commodity Credit Corporation to prevent further spread of sudden oak death and to detect and eradicate *P. ramorum* from nurseries that had received the infected stock. APHIS launched a massive program to track the shipments of potentially infected host plants, test plants for *P. ramorum*, destroy infected plant material, inform nursery owners about disease management practices, and help nurseries and affected States recover from this event. APHIS used computer-generated models to predict which areas of the country were