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Pest Alert #6
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California Oak Mortality Task Force

Diagnosis and Monitoring of Sudden Oak Death

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The first step toward solving the Sudden Oak Death problem is to become familiar with diagnosis and monitoring. The knowledge base about this disease is evolving rapidly. Here are some facts:

- Sudden Oak Death is caused by a species of *Phytophthora ramorum* that was not previously known in California
- The pathogen attacks coast live oak, black oak, Shreve oak, tanoak, and other species. The host range is expected to increase
- On foliar hosts the pathogen rapidly produces spores on leaf surfaces
- The pathogen has been found in soil, rainwater, and downed wood
- No cure is currently available

Contents

SUDDEN OAK DEATH: Impacts of *Phytophthora ramorum*

Sudden Oak Death (SOD) is caused by the pathogen *Phytophthora ramorum,* which was recently identified in California for the first time. This pathogen was previously known to cause dieback of rhododendrons in Europe, and has been found to cause bark cankers in oaks and tanoaks as well as leaf and shoot infections on other plants in California. Sudden Oak Death is known to occur in ten of California's coastal counties: Alameda, Marin, Mendocino, Monterey, Napa, San Mateo, Santa Clara, Santa Cruz, Solano and Sonoma. It also occurs in Curry County in southern Oregon. Work on determining the full distribution of the pathogen is underway. Sampling has occurred throughout the state and it is very likely that more infested counties will be added.

SPECIES AFFECTED:

Phytophthora ramorum causes Sudden Oak Death in four tree species in the Fagaceae (beech family): coast live oak (*Quercus agrifolia*), black oak (*Quercus kelloggii*), Shreve oak (*Quercus parvula* var. *shrevei*) and tanoak (*Lithocarpus densiflorus*). In addition to causing bark cankers in tanoaks and several oak species, *P. ramorum* also causes infection on leaves and branches in at least 11 species from seven other plant families (**Table 1**). It is highly likely that this pathogen causes disease on many other hosts, but the type of disease and disease severity on other hosts will be variable.

Table 1: Host list for *Phytophthora ramorum* (as of January 2002)

Common name	Species	Family
Coast live oak	*Quercus agrifolia*	Fagaceae
Black oak	*Q. kelloggii*	Fagaceae
Shreve oak	*Q. parvula* var. *shrevei*	Fagaceae
Tanoak	*Lithocarpus densiflorus*	Fagaceae
Rhododendron	*R. macrophyllum*	Ericaceae
Evergreen huckleberry	*Vaccinium ovatum*	Ericaceae
Madrone	*Arbutus menziesii*	Ericaceae
California bay	*Umbellularia californica*	Lauraceae
California buckeye	*Aesculus californica*	Hippocastanaceae
Big leaf maple	*Acer macrophyllum*	Aceraceae
Viburnum*	*Viburnum bodnantense*	Caprifoliaceae
Common manzanita	*Arctostaphylos manzanita*	Ericaceae
California coffeeberry	*Rhamnus californica*	Rhamnaceae
Toyon	*Heteromeles arbutifolia*	Rosaceae
Hairy honeysuckle	*Lonicera hispidula*	Caprifoliaceae

* Only Europe, not in California


Fig. 1


Fig. 2

SIGNS AND SYMPTOMS:

Tree species

Similar symptoms occur on all the three oak species and tanoak with one notable exception. Spontaneous drooping or wilting of new growth (**Fig. 1)** may occur throughout the crown on tanoak prior to the appearance of bleeding cankers. On true oaks (*Quercus*) bleeding is the first visible symptom (**Fig. 2)**. Infected stems develop bleeding cankers that produce a reddish-brown to tar-black viscous seep. Cankers typically occur in the lower 10 ft of the stem and are restricted to above the soil line. Occasionally aerial cankers have been found up to 60 ft (tanoak). In advanced cases of the disease, bleeding may extend well up the main trunk and lateral branches. The pathogen also causes leaf spots and cankers on very small twigs of tanoaks. Some trees may survive a number of years after bleeding cankers appear.

Removal of the outer bark reveals a zone of necrotic tissue delimited from healthy tissue by a dark, resinous zone line (zone line, **Fig. 3**). Cankers are believed to cause mortality by eventually girdling trees. Controlled nursery studies indicate death in seedlings may occur within a few weeks of inoculation with the pathogen. The time from infection to death in mature trees is still unknown, but preliminary tests with artificial inoculations suggest that some, though not all, oaks die within one year.

When coast live oak is naturally infected, subtle foliage changes may become visible after bleeding begins (**Fig. 4**). In the advanced stages of decline, color changes rapidly from healthy green to chlorotic yellow and finally brown. It takes at least one growing season for an infected tree to die. Leaves may cling to branches for up to one year after tree death.

Foliar hosts

In the non-oak hosts, a variety of symptoms are caused, including leaf-spots, and twig dieback (**Table 2**). Confirmation of *P. ramorum* infection can only be accomplished through laboratory diagnosis.

Table 2: Symptoms caused by *Phytophthora ramorum* on non-oak hosts

Host	Disease Symptoms
Rhododendron	Branch dieback, leaf spots
Evergreen huckleberry	Branch dieback
Madrone	Leaf spots, branch dieback
California bay	Leaf spots and brown leaf tips with chlorotic halo
California buckeye	Leaf spots, branch dieback
Big leaf maple	Leaf spots
Viburnum	Wilting of plant, discoloration at base
Common manzanita	Leaf spots, twig cankers and dieback
California coffeeberry	Leaf spots
Toyon	Leaf spots and branch dieback
Hairy honeysuckle	Leaf spots

ASSOCIATED ORGANISMS

The western oak bark beetle (*Pseudopityophthorus pubipennis*), oak ambrosia beetle (*Monarthrum scutellare*) and minor oak ambrosia beetle (*M. dentiger*) are common associates of trees infected with *P. ramorum*. These beetles are known to attack weakened, diseased or severely injured trees. Ambrosia beetles are 2 to 4 mm long, penetrate deep into the sapwood where they create two to four galleries, and produce conspicuous piles of light tan colored frass (boring dust) on the bark surface (**Fig. 5**). Western oak bark beetles are ~2 mm long, produce reddish-brown frass piles (arrow in Fig. 5), and egg galleries score the wood while larvae tunnel and develop in the inner bark. Initial attack is common in bleeding areas on true oaks, but may occur anywhere on the main stem of oaks and tanoaks. Mass attack can occur on the entire main stem and extend to the lateral branches. The activity of these small beetles is believed to hasten tree death.

Hypoxylon thouarsianum is another common associate of oaks in the later stages of decline (**Fig. 6**). This sapwood decayer may occur on living trees, on oak and tanoak infected with *P. ramorum,* as well as trees killed by other causes. It is important to note that presence of bark beetles and *Hypoxylon* does not clearly indicate Sudden Oak Death (**Fig. 24**). However, as frequent associates, they may serve as valuable identification tools.


Fig. 6

Sampling for *Phytophthora ramorum*

To confirm that a symptomatic oak tree has *P. ramorum*, the pathogen has to be cultured on a special agar medium from a sample of the inner bark of the tree. Sampled bark pieces are placed in petri dishes containing pimaricin-ampicillin-rifampicin-PCNB agar (PARP), a selective medium for *Phytophthora* species. Two protocols are presented here, the first for plating onto the PARP agar in the field prior to sending to the laboratory, and the second for sending samples to a laboratory for culturing.

If you are an official sampler, you can obtain PARP from, and send the sample to the State laboratory.

Equipment needs:

General:	Axe or hatchet
	Cleaning agent (70% ethanol, Lysol or 10% household bleach)
	Lighter or matches
	Pens for labeling samples
For plating:	Scalpel or sharp knife
	Forceps
	PARP selective media in petri dishes
	Tape to seal petri dishes
For sending samples:	Paper bags and plastic sandwich bags
For location information:	Handheld Global Positioning System (GPS) (e.g. Garmin)

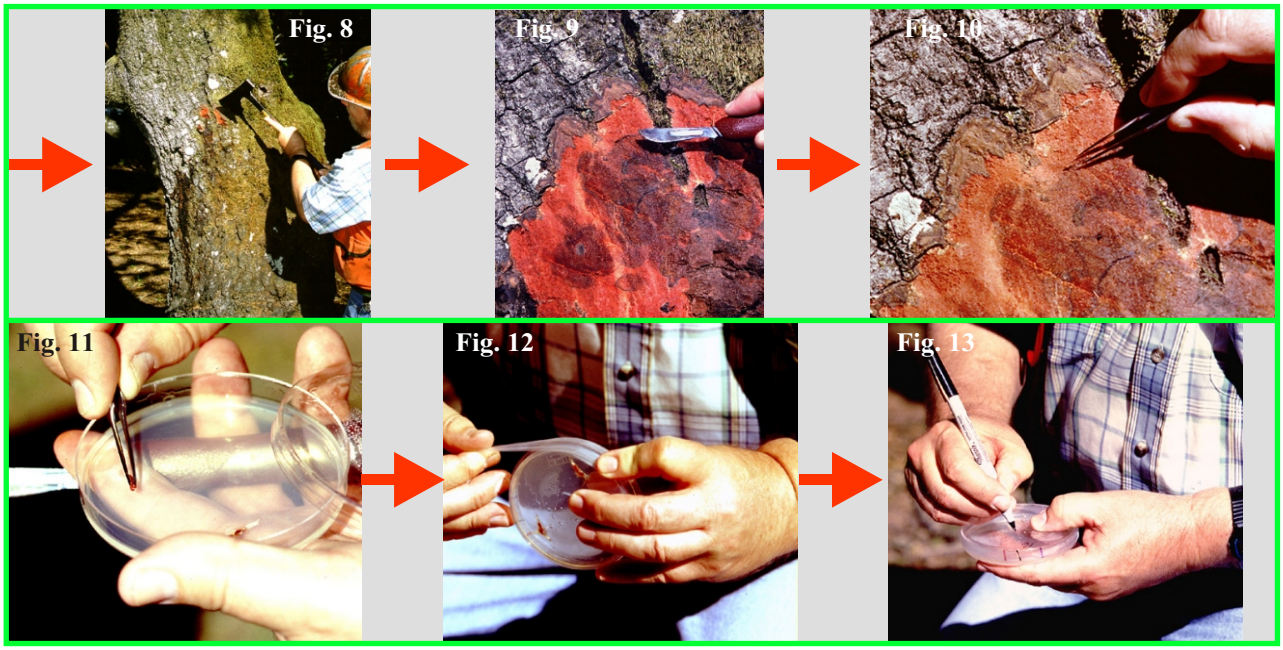

Fig. 7

Before you get started:

- Clean all tools (hatchets, knives, forceps, etc.) with one of the cleaning agents listed above.
- Flame each tool to kill any microbes that may be present on them. Hold the flame of a lighter so that it heats the edge of the hatchet blade, the knife and the forceps (**Fig. 7**). Take precautions against starting a fire by carrying out this work over an area where dead leaves and other duff have been removed.

For plating samples onto PARP medium in the field

1. Cut away the outer bark approximately 6" above or to the side of a seeping area (**Fig. 8).**
2. Shave away the bark in the area of the lesion until a canker margin (zone line) is evident.
3. Use the knife and forceps to excise small pieces (approx. ¼" x 1/16") of the phloem including both healthy and necrotic bark tissue on both sides of the zone line (**Fig. 9** and **10**).
4. Place each tissue piece on the medium and push down until it is covered by the medium (**Fig. 11**).
5. When you have three to five pieces of tissue inserted in the medium, seal the plate with tape and label it, including the date, location and identifying information for the tree sampled (**Fig. 12** and **13).**
6. Plates should be incubated in the dark at 20-22°C and examined by a laboratory within 7 days.
7. Send plates to a laboratory for incubation and identification of the fungus. Note: identification of the *P. ramorum* is carried out by pathologists, and may require DNA sequencing for confirmation.



For gathering GPS location

1. Collect GPS information while doing initial sampling, and note waypoint #, and actual location on sample notes.
2. Collect GPS information as near to sampled tree as possible. There may be degradation to the signal due to tree canopies, but usually with enough time (15min) you can acquire a signal. If you are having trouble getting GPS information, try moving around the tree, or moving to the nearest open area to acquire better signal reception. Some handheld GPS units are more effective than others under canopies. See http://camfer.cnr.berkeley.edu/oaks/GPSProtocol.html for more details.
3. Make sure you collect a 3-D location, and do not take the sample if you only have a 2-D location.
4. Collect information in UTM (preferred for data transfer), and if you can set the datum, collect NAD83 data.
5. If possible, record the accuracy of reading.

For collecting samples to send to a lab

1. Ensure that transportation and laboratory facilities have been arranged such that samples will be processed and plated within 48 hours of collection. Cut away the outer bark approximately 6" above or to the side of a seeping area.
2. Cut away the outer bark in the area of the lesion until a canker margin (zone line) is evident.
3. Use the hatchet to remove a piece of phloem approx. 2" x 1" x 1" that includes the margin between healthy and diseased tissue (**Fig. 14**).

4. Place the phloem piece in a paper bag. Label the bag with the date, location and identifying information for the tree sampled **(Fig. 15** and **16).**
5. Keep the samples cool while transporting them to the laboratory facility for isolation and identification of the fungus.

To sample leaves


Fig. 17

If there are oaks or tanoaks showing symptoms of *P. ramorum*, look for adjacent foliar hosts, such as rhododendron (for those in northern part of state) or California bay laurel trees. Then inspect the leaves for the following symptoms: dead leaf tip (the end of leaf which hangs down and away from twig), yellow halo on leaf directly above the dead tip, and often a few dark brown to black spots above the yellow halo on the green leaf portion (**Fig. 17**).

Pick the entire symptomatic leaf, place in fold/lock plastic sandwich bag with a slightly moist piece of paper towel, seal the bag. Make a paper label with your name, phone, county and location of sample (address if possible). Mail sample to the State laboratory.

The following points should be taken into consideration when interpreting results that come back to you from the lab:

- Approximately 60% of all samples from symptomatic trees test negative for *P. ramorum* and may require a re-sampling (i.e., false negatives).
- Other *Phytophthora* species often cause bleeding lesions and have identical zone lines in the bark.
- *P. ramorum* has been found almost exclusively in mixed oak forests, woodlands, or urban-forest interface type situations, mainly on shady hillsides and ridges, in relatively natural stands of mixed hardwoods or hardwoods and conifers.
- A few positive samples have been collected in urban situations where a residential backyard tree is a remnant of a previously natural stand (e.g., Miwok Park in Marin Co.).
- None of the samples in residential or other urban locations (generally single trees or planted rows along streets or engineered creeks) has been positive for *P. ramorum*, although some have had *P. cinnamomi*, or other unidentified *Phytophthora* spp.

Disposal and Hygiene

In General:

Restrict forestry and arboricultural activities in oak woodlands and gardens during the fall and winter when there is a high risk of infection. Avoid movement of potentially infected material away from infested areas. This includes movement of host plants (from nurseries), all plant material from known hosts, especially leaves and branches of foliar hosts, and soil. Below are proposed hygienic procedures that minimize the spread of *P. ramorum* and might prevent its introduction into healthy areas.

Tree Removal:

- The best time to remove Sudden Oak Death killed trees is during the hot summer months when the *P. ramorum* and beetles are least active.
- Leave felled trees on site if possible.
- Chip branches and scatter on site.

- Do not leave wood near roads where it may be taken out of infested areas and used as firewood.
- Infected wood may be used as firewood as long as it is used locally and not transported out of the infested area.
- Keep wood piles as far away from susceptible hosts as possible. Leave wood uncovered in a sunny area to promote drying. This will discourage growth of *P. ramorum*, which requires moisture.
- Clean/disinfect all equipment used on infected trees before using on healthy trees or traveling to an uninfested area. Pruning, cutting and chipping tools can be cleaned with Lysol, 70% alcohol solution or 10% household bleach solution.
- Wash mud from all vehicles, machinery and boots before leaving infested areas to prevent dispersal of the pathogen-contaminated soil.

Wood disposal:

All host materials in known infested counties are regulated under State and Federal quarantines. Prior to moving any materials off-site, contact your County Agricultural Commissioner. Agricultural Commissioner staff can advise on safe disposal options. All materials are potentially infectious and should not be moved off-site without consultation.

Common Oak Pests That Can Cause Symptoms Similar to Sudden Oak Death

Symptoms are the visual clues indicating changes in the normal growth and/or appearance of a tree in response to insects, pathogens, environmental factors and horticultural practices. Signs are evidence of the cause, e.g., the pest itself, or pest produced materials or structures left behind.

Sudden Oak Death is characterized by seeping cankers on the lower trunk of infected oaks and tanoaks, and a relatively rapid decline in the crown of the tree. Insects and other diseases can mimic these symptoms, making diagnosis difficult. Symptoms that are commonly seen in native oaks that might be mistaken for Sudden Oak Death are listed below. The most likely insect pests or disease pathogens causing these symptoms are included. These pests commonly occur on a wide range of oak species.

SYMPTOMS:

1. Tree died suddenly or appears to be declining, e.g. sparse foliage, premature leaf-drop, branch dieback, undersized and chlorotic leaves, bleeding, etc.


Fig. 18

Probable causes:

- OAK ROOT FUNGUS (*Armillaria mellea)* - often causes a general decline in oaks, characterized by sparse, off colored foliage. Healthy appearing trees may die suddenly after foliage wilts and fades. A resinous, gummy or liquid exudate may be seen on the lower trunk of affected trees. A common problem of landscape oaks in irrigated settings (**Fig. 18**).


Fig. 19

- PHYTOPHTHORA ROOT DISEASE (*Phytophthora cinnamomi*) - is characterized by general decline, twig and branch dieback, small, yellow and sparse foliage, premature leaf-drop, and lesions on the lower trunk and root flare (**Fig. 19**). Typically there is bleeding or oozing through bark cracks near root-crown, often appearing as black to rusty streaking. Wood and inner-bark appear discolored. Frequent irrigation, poor drainage and poor soil aeration favor this pest.
- ROOT LOSS INJURY - caused by root pruning, excavation, soil compaction and/or

trenching within the dripline.

2. Foliage partially or totally missing (defoliation)

Most likely pest causing this type of injury:

- CALIFORNIA OAK MOTH (*Phryganidia californica*) - a common defoliator of coast live oak. Caterpillars are black with longitudinal, yellow to olive stripes, and up to 1 1/4" long. Adults are silvery to tan moths with prominent wing veins. There are 2 or more generations per year, and the last generation larvae overwinter on the foliage. Deciduous oaks are seldom defoliated as the eggs are shed with the foliage.

3. Leaves or portions thereof dead and brown, symptoms distributed fairly uniformly throughout tree or portions of the canopy, some leaves or portions appear unaffected.

Common pests may cause these symptoms:

- TWIG BLIGHT (*Cryptocline cinerescens*) - causes dieback of leaves and twigs of current year's growth, dead leaves are scattered throughout much of the mid-to lower canopy (**Fig. 20**). Trees under stress are most susceptible. This disease is more prevalent during wet years.
- OAK ANTHRACNOSE (*Apiognomonia quercina,*) - causes irregular brown, dead areas or small spots on leaves, entire canopy may be affected and fall prematurely (**Fig. 21**). *Sepotoria quercicola* and *Cylindrosporium kelloggii* have been implicated as causing leaf spotting associated with oak anthracnose.
- LIVE OAK GALL (Hymenoptera: Cynipidae) - leaf tips and margins appear dead and brown. One species, *Dryocosmus dubiosa*, forms small, slightly oval galls with two horn-like projections, one at each end, on the undersides of affected leaves along the leaf veins. A tiny pumpkin-shaped gall is formed by another gall-wasp


Fig. 20


Fig. 21


Fig. 22

(*Dryocosma minisculus*). Species within the black oak group are affected (**Fig. 22**).

4. Bark on lower trunk dead, cracked, missing, loosened, sunken or darkly stained by a thick exudate or fluid-like discharge. "Bleeding" may be described as wet and copious or as dark, thick droplets oozing through small bark fissures. In some cases, the exudate has dried, leaving behind a light to rusty colored residue. Lesions or cankers (dead, often sunken areas of the bark) may be elliptical, elongate, pyramidal or irregularly shaped. Some cankers show strong callusing along the margins.

Possible causes:

- CANKER-ROT PATHOGENS - these pathogens cause a white rot of heart and sapwood, leading to branch and trunk failure. Canker-rots are unique in that they move from the heartwood into the sapwood and cambium, causing branch and trunk cankers. Bleeding may occur as the pathogen kills the bark. Some produce elliptical,

concentrically ringed target-like cankers at branch stubs. Other cankers are elongate with strong callusing along the margins. The pathogen enters through dead branch stubs and broken branches and wounds.

- BACTERIAL WETWOOD- is characterized by a copious, wet discharge (fermented sap) flowing from a narrow lesion or crack in the bark. The exudate, which is initially clear, gradually darkens and thickens or becomes slimy. Upon drying, the exudate leaves a conspicuous, whitish to brown crust-like residue on the bark below the lesion. Lesions typically dry and close with time (**Fig. 23)**.
- OAK ROOT FUNGUS - may cause lesions and occasionally bleeding from the soil-line to several feet above. (see 5 below.)
- PHYTOPHTHORA ROOT DISEASE - is characterized by lesions on lower trunk and root-crown, typically with dark staining and oozing of a dark, tar-like exudate on lower trunk. Bleeding may also appear as nearly black to rusty colored streaking down the lower trunk.


Fig. 23

- BORERS - boring injury caused by the carpenterworm (**Fig. 25)**, Pacific flatheaded borer, western sycamore borer (**Fig. 26**) and oak bark beetle may cause bleeding on the bark (see 6 below.)

5. Root-flare with lesions - areas of dead, sunken, cracked, missing or loosened bark, usually accompanied by bleeding (seeping or oozing) through small, bark fissures. Vigorous callusing may be seen at lesion margins, sometimes with adventitious roots growing from the callus to the soil.

Most probable pests:

- OAK ROOT FUNGUS - distinctive thin, white fans of fungal material growing between bark and wood, smells like common edible mushrooms, bark nearby is often dead, loose or missing, light brown mushrooms may appear at the tree's base in winter. Although this disease is often characterized by decline, canopy symptoms may be lacking.
- PHYTOPHTHORA ROOT DISEASE (CROWN ROT) - is characterized by general decline, twig dieback, small, yellow and sparse foliage, premature leaf-drop, and wounds on lower trunk and root crown, often with black to rusty colored bleeding or streaking on trunk.

Note: root diseases caused by *Armillaria* spp. (oak root fungus) and *Phytophthora* spp., are associated with frequent irrigation, poor drainage, restricted soil aeration and/or raised soil grade around tree.

6. Scattered holes in bark, coarse or powdery sawdust-like boring material (frass) in bark crevices and on ground, bark appears riddled in patches, wet/frothy spots or dark brown to black bleeding on bark.


Fig. 24

Common pests causing this type of injury:

- OAK BARK BEETLES (*Pseudopityophthorus* spp.) - white, legless grubs under bark, are up to 0.1 inch long. Adults are dark brown and shiny. Extensive tunneling etches the wood, leaving horizontal and vertical grooves in a grid-like pattern (**Fig. 24)** . Tunneling commonly causes some bleeding or a foamy/frothy exudate. Look for reddish frass to help ID pest.
- OAK AMBROSIA BEETLES (*Monarthrum* spp.) - adults bore into the sapwood and heartwood of severely stressed, dying, or recently dead trees; windfall; broken branches and cut firewood. Look for small, cone-shaped piles of fine, light-colored boring dust on the bark surface or accumulations

of frass around the tree's base. Black-stained tunnels can be found in the wood and 'pin holes' can be seen in the bark.

- PACIFIC FLATHEADED BORER (*Chrysobothris mali*) - larvae are off-white with flattened, amber colored heads. They are up to ¾" long and found under bark and in the wood of dead and dying branches and tree trunk. Larval tunnels, primarily in the inner-bark, are shallow, oval and packed with coarse boring dust (frass). Saplings, branches and large areas of the bark may be killed (girdled) by meandering tunnels.
- CARPENTERWORM (*Prionoxystus robiniae*) - a wood-boring moth. Larvae are dirty-white and up to 2 ½" long. They tunnel in inner-bark and wood. The bark is sometimes missing in patches or may appear roughened, and the underlying wood is riddled with tunnels (**Fig. 25**). Abundant boring dust is expelled through ½" exit holes. Empty pupal cases may be found protruding from exit holes.
- WESTERN SYCAMORE BORER (*Synanthedon resplendens*) - a wood-boring moth (**Fig. 26**). The larvae are pink, and up to ¾" long. Their tunneling riddles the bark, giving it a roughened appearance and often causes

Fig. 25

Fig. 26

bleeding. The larvae seldom damage the cambium or bore in the wood. Reddish frass can be seen accumulating in bark crevices below or on the ground. Larval cases can sometimes be found protruding through ⅛" wide exit holes.

7. Clear, sticky fluid dripping from acorns, or large, sticky droplets falling from tree (acorns), creating a nuisance.

Probable cause:

- DRIPPY ACORN (NUT) DISEASE - a bacterial disease that invades insect wounds, causing profuse clear and sticky bleeding from acorns. Often associated with filbertworm and acorn weevil, a cynipid gall wasp (perhaps *Callirhytis flora* - the summer generation), and another cynipid gall wasp (*Drycosma minusulis*) that lays its eggs on the upper leaf surface in spring, causing a clear fluid to drip.

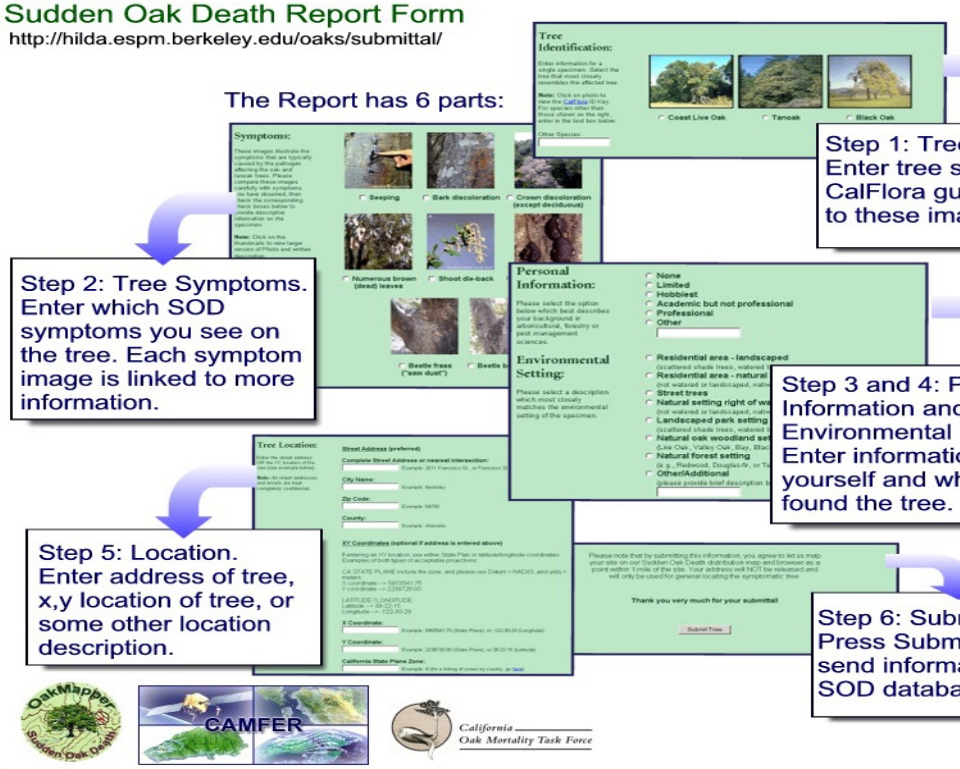
Sudden Oak Death Monitoring Strategy

The University of California's Center for the Assessment and Monitoring of Forest and Environmental Resources (CAMFER), along with the California Oak Mortality Task Force (COMTF), have developed a strategy for monitoring incidences of Sudden Oak Death that involves gathering reports of the disease with spatial information (ideally a GPS), followed by sampling of reported trees. California Department of Food and Agriculture samples trees within the infested areas, and UC Davis samples outside of those areas. To report Sudden Oak Death symptoms, contact the County Agricultural Commissioner's Office or UC Cooperative Extension (CE) Office in the County where you find the tree. You can also submit information directly to the Sudden Oak Death spatial database via the OakMapper website.

OakMapper
Sudden Oak Death Report Form

http://hilda.espm.berkeley.edu/oaks/submittal/

The Report has 6 parts:



Step 1: Tree Species. Enter tree species. CalFlora guide is linked to these images.

Step 2: Tree Symptoms. Enter which SOD symptoms you see on the tree. Each symptom image is linked to more information.

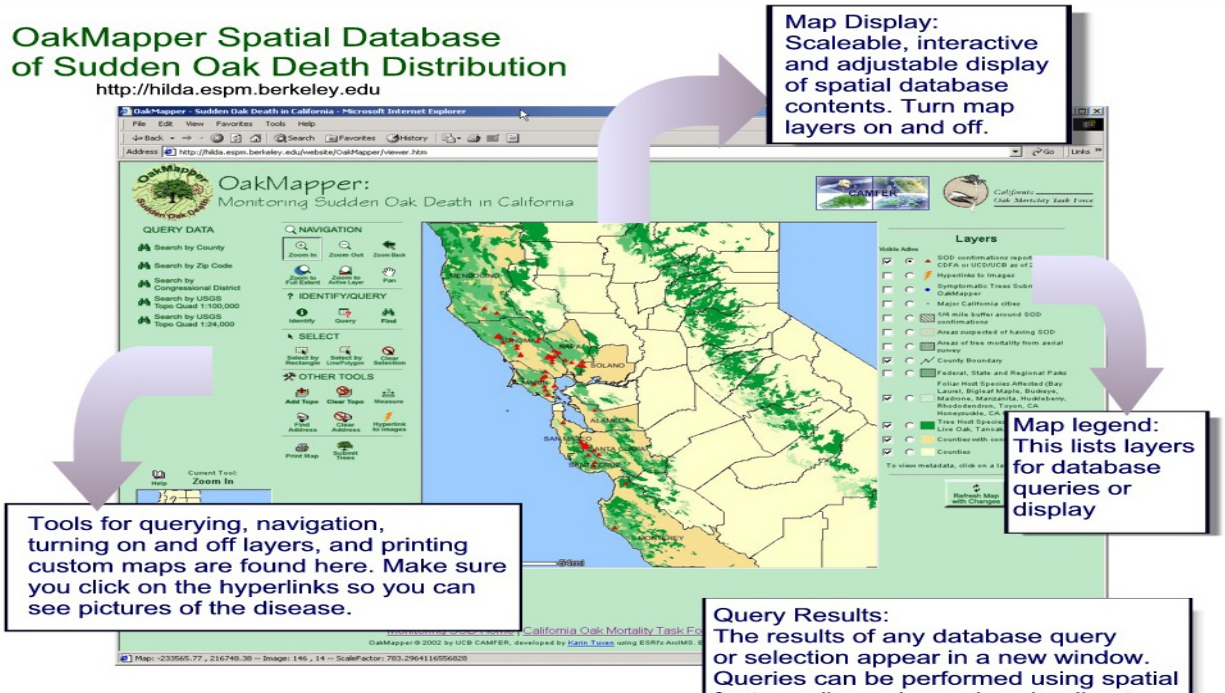
Step 3 and 4: Personal Information and Environmental Information. Enter information about yourself and where you found the tree.

Step 5: Location. Enter address of tree, x,y location of tree, or some other location description.

Step 6: Submit Report. Press Submit button to send information to the SOD database.

OakMapper Spatial Database of Sudden Oak Death Distribution

http://hilda.espm.berkeley.edu



Map Display: Scaleable, interactive and adjustable display of spatial database contents. Turn map layers on and off.

Map legend: This lists layers for database queries or display

Tools for querying, navigation, turning on and off layers, and printing custom maps are found here. Make sure you click on the hyperlinks so you can see pictures of the disease.

Query Results: The results of any database query or selection appear in a new window. Queries can be performed using spatial features (i.e. polygons), or by direct query of the database (i.e. by County, by zipcode etc.)

To find contact information for the County Ag. Commissioner's Office or County CE office, go to:

www.suddenoakdeath.org and click on: 'County Contacts'.

OakMapper website information and tools:

To use the Individual Tree Report on the OakMapper website:

Go to the OakMapper at http://hilda.espm.berkeley.edu/ .

OakMapper website can be used for:

- Logging occurrence of trees with possible Sudden Oak Death;
- Educating the public on symptoms and hosts;
- Scalable viewing of current distribution coverages;
- Performing simple geographic queries such as: Where are confirmed cases of Sudden Oak Death in my county, zipcode, congressional district, etc.

COMTF Monitoring Committee Information: http://www.suddenoakdeath.org and click on COMTF Information Page.

Research and Resources

Information about Sudden Oak Death is rapidly developing as a result of continuing research efforts. One challenge facing professionals is keeping up-to-date with the latest information about the disease. Whenever reviewing information about Sudden Oak Death, pay close attention to the date that the information was reported. The best source for new information is the Internet. The California Oak Mortality Task Force website is at www.suddenoakdeath.org . This website has links to other relevant websites including research and monitoring websites. It also has contact information for the Co-chairs of the Committees of the Task Force, including the Biomass, Education, Fire, Funding, Management, Monitoring, Regulations, and Research Committees. Participation in the activities of one of these committees, or in full task force meetings that are held every few months, provides access to up-to-date information, and the opportunity to have questions answered. New information coming from research will be reported in as timely a manner as possible.

Some important research questions have been answered:

- The pathogen's spores may be dispersed in rain splash and other forms of moist air. Spores build up rapidly on the leaf surfaces of foliar hosts, such as bay trees, and this is a source of innoculum for infecting nearby oaks.
- Composting may kill the pathogen in plant material if kept at 55^{o}C (131^{o}F) for two weeks. Composting guidelines are in the process of being developed.

Research questions currently being investigated that are of importance to professionals include:

Are some individual hosts resistant to the pathogen?

What other plant species can harbor the pathogen?

How should we manage Sudden Oak Death in areas with other herbaceous hosts such as huckleberry?

Do insects play a role in the spread of the pathogen?

Do ambrosia beetles lower the structural integrity of the tree, resulting in higher likelihood of tree failure?

Are there fungicide treatments that may be useful in managing Sudden Oak Death in some situations?

Do insecticide treatments prolong tree life, and how might this impact disease progression?

Recommendations for management of sudden oak death will change as new research findings are made. The Task Force will maintain up-to-date management guidelines, but complete answers to all management questions will be a long time in coming. Maintaining the vigor of oak trees, and being aware of the pathogen and other organisms associated with

Sudden Oak Death will help managers to make pertinent recommendations to their clients.

Treatment and Management

(cemarin.ucdavis.edu/treatment.html)

Trees Without Symptoms of Sudden Oak Death

The best defense against a range of plant pathogens and insect pests is to promote tree health. The following are some general guidelines.

Irrigation - Avoid frequent irrigation of oak trees. Oaks are adapted to the dry Mediterranean climate that prevails in central coastal California and most established oaks do not require supplemental irrigation except under severe drought conditions.

Root zone management - The root zone, the area under the crown + 1/3, is the most vulnerable part of oaks and should be treated as a ZONE OF NO DISTURBANCE. Do not damage the roots by activities such as paving and soil compaction. Apply a 4 - 6 inch deep layer of coarse wood chips under the tree canopy or 1 - 2 inch thin layer of leaf or small particle-size mulch. Make sure that the mulch is at least two feet away from the root crown.

Pruning - If possible, only prune dead and dying branches, or others needed to maintain a safe canopy structure, in the dry summer months (June - September) when activity of both fungus and insects is at a minimum.

Fertilization - Fertilize if the tree shows external symptoms of deficiency, such as yellowing of leaves, and the deficiency is confirmed by a laboratory test.

Injury - Protect the stem and lower limbs from injury.

Symptomatic Individual Trees in a Garden Setting

The following discussion of treatment recommendations is for individual trees in garden and landscape conditions with a managed understory and does not apply to woodland trees. Monitor oaks in urban settings for the bleeding symptom year round. If the bleeding symptom is detected, seek confirmation that the cause is *P. ramorum*.

CAUTION Not all bleeding on oak stems and limbs is indicative of Sudden Oak Death. Other causal agents such as *Phytophthora cinnamomi*, wet wood, sycamore borer, or carpenter worm, may be responsible. If you see *Hypoxylon* fruiting bodies on the stem, tree should be checked for structural stability.

At this time there is no known cure for trees with symptoms of Sudden Oak Death; however, if the new *Phytophthora* species is confirmed in a tree in an urban setting, a number of treatment options are available that may extend its life. It must be stressed that tests yielding conclusive data regarding the effectiveness of these treatments have not been completed at the current time. Options may include the use of fungicides that are registered for, and useful in, the management of other *Phytophthora* caused diseases. In addition, registered insecticides that target the beetles, but not the underlying causal fungus, are registered for use against oak bark beetles. Insecticide treatments should be avoided from mid-October to mid-March when beetles are not active. All pesticides must be used in accordance with their labels.

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