Statewide Aerial and Ground Survey for Mapping and Monitoring the Distribution of Sudden Oak Death

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California's oaks are an essential part of our heritage and natural landscape. Since 1995, sudden oak death (SOD) has been confirmed in California from Humboldt County to Monterey County, as well as in Curry County, Oregon, and is particularly severe in Marin, Santa Cruz, and Monterey Counties in California. The actual current geographic range of the fungus that causes SOD, *Phytophthora ramorum*, is unknown. A team of USDA Forest Service, California State University (CSU), and University of California (UC) researchers was assembled to conduct a statewide survey to map and identify the fronts of infection and overall distribution of SOD on overstory hosts, including coast live oak (*Quercus agrifolia*), tanoak (*Lithocarpus densiflorus*), Shreve oak (*Quercus shrevii*), and California black oak (*Quercus kelloggii*). The 12 currently infested counties plus those counties south of San Francisco (San Benito, Fresno, San Luis Obispo, Kern, Santa Barbara, Ventura, and Los Angeles), and the Sierra Nevada foothill band of black oak were jointly surveyed. Additional counties including Solano, Yolo, Lake, Glenn, Tehama, Trinity, Shasta, Siskiyou, and Del Norte were also surveyed. Aerial surveys were conducted from May 29, 2002 through July 3, 2002 over 20 million acres of species susceptible to SOD. Approximately 14,500 miles of ground were flown and 450 polygons exhibiting oak mortality mapped. The area included in the polygons was approximately 148,800 acres, a nearly four-fold increase in the area mapped in the 2001 aerial survey. Ground surveys of a prioritized sample of the aerially surveyed polygons were checked primarily for new infestations and for infestations that expand the existing range of SOD. Field crews were provided with GPS coordinates to center points of a polygon, navigated to the center and determined if SOD symptoms were present in any one of the susceptible species. Established sampling protocols were followed and all samples were shipped to the laboratory for confirmation of SOD. Results from the entire aerial and ground survey were compiled and evaluated.

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Project Objectives: Conduct an aerial survey to map overstory mortality in hosts of SOD and identify, if possible, mortality that visually appears to be related to sudden oak death to:

- Determine if and where *P. ramorum* exists within currently (6/2002) un-infested counties, and
- Determine where within infested counties *P. ramorum* has spread or extended the range previously mapped.

Methods:
Faced with mapping the entire range of oak woodlands in the state of California, we designed an aerial and ground survey to be effective and efficient. The aerial portion of the survey covered all known infested and select un-infested counties (see Figure 1). Approximately 14,500miles were flown covering 43 counties.

The ground surveys focused on a prioritization of sites to sample for *P. ramorum* and determine the extent of *P. ramorum. The prioritization provided a way of* focusing on mapped mortality that could extend the current range of known infestations and determine new infestations in currently unregulated counties.

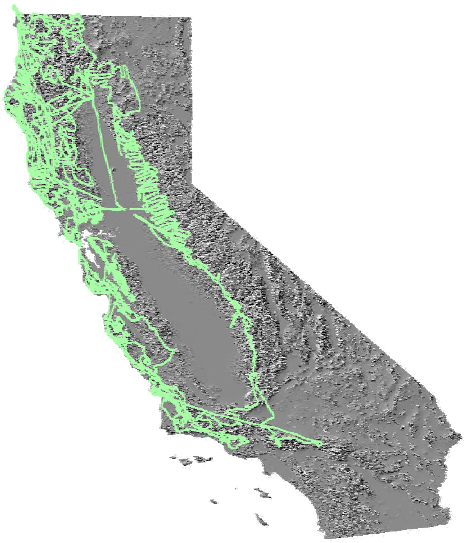


Figure 1. Aerial Survey Flight lines for 2002

The aerial survey was conducted to map areas (polygons) with mortality and other symptoms suspected to be associated with SOD. Areas to be flown were determined by utilizing SOD host maps. These maps were produced from a combination of data sources including the GAP and CalVeg vegetation data. Flight lines were laid out to maximize coverage of the areas of suitable host habitat. Flight elevation averaged between 500 and 2000 feet above the ground. Sketch mapping was done on a touch screen computer linked to a GPS. The background on the touch screen included previous survey data, confirmed SOD sites, topographic maps and county boundaries. Observers mapped the

location of the symptomatic trees and recorded data including species, percent of trees in the polygon exhibiting symptoms, and aspect. Oblique photos were taken using a 35 mm camera to provide images to aid the ground crews in locating the same trees. A contractor flying either a Cessna 206 or 210 aircraft conducted the flights.

Areas mapped from the aerial surveys were prioritized to create ground survey sample sites. Polygons were rated and given a high priority to ground survey if**:**

- the polygon fell within an un-infested county and,
- there were more than one dead tree in the polygon, or
- the polygon was within an infested county and had the potential to extend the current range of confirmed SOD sites, or
- the polygon was in close proximity to a nursery operation or composting facility.

Ground crews were trained and field survey protocols were presented (see Appendix A).

Unfortunately, due to funding limitations we were unable to ground survey all mapped areas and suspicious sites along the foothills of the Sierra Nevada's.

Results:

Approximately 14,500 miles were flown covering 43 counties in California. Suspected oak mortality covering about 148,800 acres was mapped totaling 450 polygons (areas containing oak mortality) and recorded into a database. Based on our prioritization criteria, 127 of 450 polygons were identified to be visited on the ground. Four two-person crews spread between the northern and central portion of the state visited 102 polygons, access was not obtained on 25 of the originally prioritized polygons. 81 polygons were visited in infested counties and 21 in un-infested counties.

Below is a summary of the samples taken from the 102 visited polygons. Not all polygons exhibited SOD symptoms and therefore were not sampled. A complete database is available at http://hilda.espm.berkeley.edu/OakMapper

Host	# Samples	Negative	Positive	Pending
CBL	27	20	7	
TOK	15	12	2	1
CLO	13	11		2
CBO	2	2		
CYN	2	2		
TOY	1	1		
INT	1	1		
SHO	2	2		
TOTAL	**63**	**51**	**9**	**3**

The majority of samples came from California Bay Laurel (CBL), which tends to be the best indicator of *P. ramorum* in an area. A total of 51 of the 63 samples were negative and only 9 were positive. Two of the 9 were located in Contra Costa County, which just after we began flying the surveys officially became an infested county. One of the samples identified as positive from Monterey County extended the northern range in that county.

Out of 21 polygons visited in un-infested counties 10 samples were taken, all tested negative for *P. ramorum.* The remainder of the polygons visited had no symptoms representative of SOD, so no samples were collected.

Summary:

We successfully created collaboration between FS and Cal Poly and improved coordination with local governments. Funding limitations and budget decreases created an opportunity to combine our survey efforts both aerial and ground. We were able to fly more miles and cover more ground by combining our funds.

More contact with local governments and local landowners helped to gain access, find sites and in general make the public more aware of the project and our objectives. While this year we believe me made much progress in reaching out to more of the local communities and governments, we will continue to improve our efforts.

We were able to confirm through ground checks that areas of mortality caused by *P. ramorum* can be successfully mapped by aerial survey techniques. We visited overstory mortality sites in un-infested counties and did not recover *P. ramorum* leading to the conclusion that the current distribution may be a good reflection of the disease in overstory hosts.

Data was provided to UC Berkeley for development of the Oakmapper tool accessible on the world-wide web. This tool is an interactive image site that enables users to create their own views of SOD surveys and views of current confirmations. There are many options and ways to use this tool. Visit the Aerial Survey Oakmapper site at: http://hilda.espm.berkeley.edu/OakMapper

Increased funding and digital sketchmapper technology greatly increased coverage and accuracy of the data compared to the 2001 survey. Better coordination with landowners, extension specialists, and county agriculture commissioners could make the ground check work more efficient Ground checking might yield more positive results if the checking could be completed earlier. Some sites that are suspicious but yielded negative results should be revisited, especially in the un-infested counties.

Finally, where do we go from here? Two options seem the most viable, (1) continue to provide aerial surveyed maps and follow with corresponding ground surveys to determine **where** the disease is located and the **area** of increase in the distribution; or (2) use a multiscale approach employing various technologies to identify areas of possible SOD-

related mortality. These technologies include satellite and airborne imagery, risk mapping, aerial and ground surveys.

Appendix A.

Ground Survey Methods: (Survey methods may be modified depending on polygon size) All polygons shall be located on a 7.5 minute quad map sheet and accompanied by a digital ortho quarter quad, if it exists, or aerial photo, where it exists. GPS waypoints calculated from the survey will be provided for each polygon to aid in locating the sketch mapped site. On the ground, crews shall conduct the following:

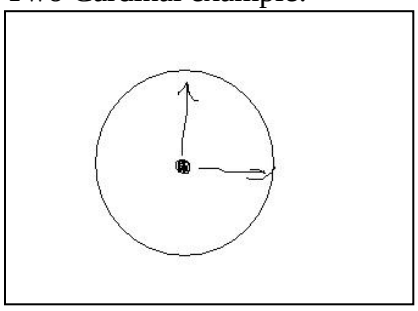
1. Navigate to plot center using GPS and monument all polygon center points.
    a. If the crew reaches plot center, and in walking to the center, SOD symptoms are identified, samples shall be collected and the polygon is complete.
    b. If crews reach plot center and on the way to the plot center SOD symptoms are not identified, a transect, as described below shall be conducted.

Lay out a transect in two cardinal directions, extending from center to edge of polygon, based on 35mm photography showing dead trees, the lay of the land, and host vegetation type.

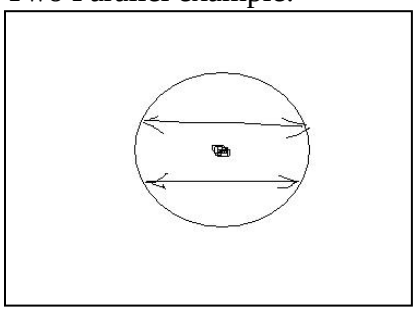
Or lay out two parallel transects. Transects extend the distance from edge to edge of the polygon as mapped.

Look for SOD hosts and symptomatic plants;
Collect symptomatic leaves and or bark from infected plants;
GPS ends of transects at point where edge of polygon is estimate on the ground.

Two Cardinal example:



Two Parallel example:



2. Polygons greater than 10 acres and up to 1000 acres in size:

a. Find center point using GPS and coordinate provided;
b. Conduct wander transects to find symptoms, e.g. ‘wander’ through the polygon systematically length wise from center looking for symptoms constantly;

c. Stop at a **minimum** of three points along the transects laid out, GPS and monument each location as “Wander Point 1, 2, or 3” and look for symptoms within a 100 foot radius;
d. Document compass reading for transects on a map representing the polygon;
e. GPS ends of transects at points where edge of polygon is estimated on the ground.

Crews shall complete all field data record forms contained in packets and properly submit SOD samples

Training for detecting SOD, SOD symptoms and appropriate SOD sampling procedures are provided by certified samplers. We also provide field packets containing aerial photos, digital ortho photos, and other map products necessary to locate areas to be surveyed and perform surveys; and field forms for recording field data.