



# 2006 Accomplishment Report

Aerial & Targeted Ground-Based Monitoring   
for Sudden Oak Death

# **2006 Accomplishment Report Aerial and Targeted Ground-Based Monitoring for Sudden Oak Death**

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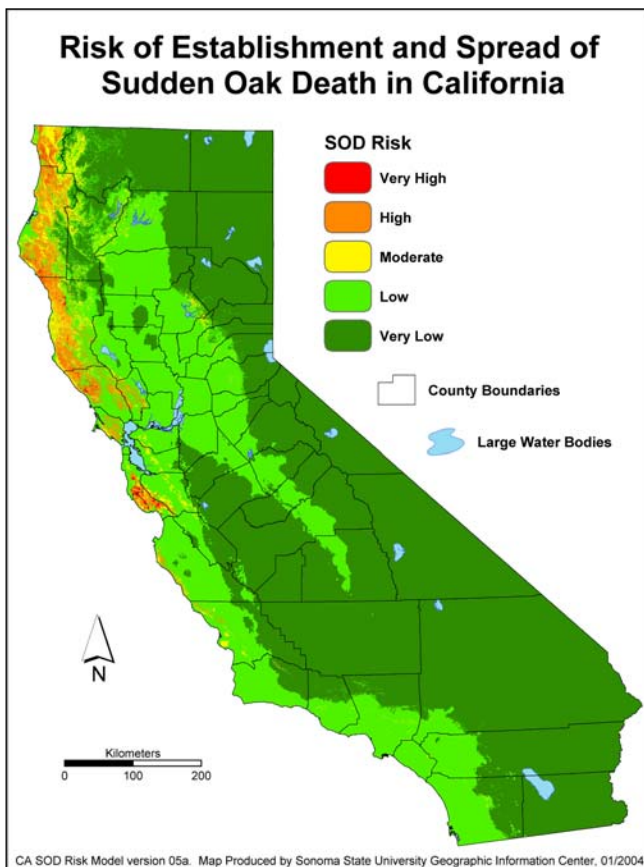
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**Cover photo:** 2005 National Agriculture Imagery Program (NAIP) photograph of southern Mendocino County southwest of Ukiah. A new SOD infestation was discovered in the bottom part of this photo in summer 2006 by Forest Service field crew.

## Introduction

Aerial surveys have been conducted over the past six years to map and monitor hardwood mortality and subsequently target ground-based surveys for the early detection of *Phytophthora ramorum*, the pathogen responsible for Sudden Oak Death (SOD). In 2006, aerial surveys covered approximately nine million acres across eleven counties and mapped recent hardwood mortality in habitat at-risk for the establishment and spread of SOD (Figure 1). Field visits were conducted based upon mortality sites identified during the aerial surveys. Ground surveys provide information about the spread of the disease within infested counties as well as tell us where the pathogen *was not* found.



**Figure 1.** California SOD Risk Map (Meentemeyer, 2004)

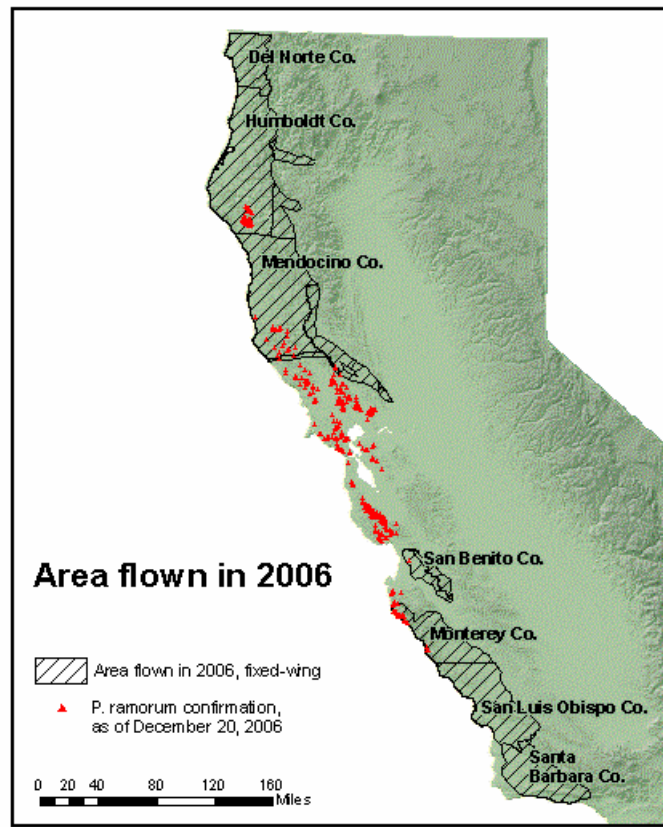
Results from the past five years have supported suppression management trials, outreach and education, and research efforts to understand the disease.

Objectives for the 2006 program were:

- To find any new infestations of *P. ramorum* within uninfested counties “with risk” at the northern and southern edges of infestation: Del Norte, San Benito, San Luis Obispo, and Santa Barbara Counties;
- To locate new infestations in Humboldt and Mendocino Counties outside of their very limited area of known infestation; and
- To provide aerial and ground support for site intensive projects in the Big Sur region and Humboldt County.

## Methods

Hardwood mortality was mapped from fixed-wing aircraft using a digital aerial sketch mapping system (DASM). Helicopter flights were conducted in some areas to more precisely map mortality. Ground crews conducted field visits to mortality sites to look for symptoms of SOD. If symptoms were found, a sampling plot was established and tissue samples from symptomatic vegetation were collected and sent to the California Department of Food and Agriculture (CDFA) Plant Pathology Laboratory or the D. Rizzo Plant Pathology Laboratory at the University of California, Davis, for diagnosis.



**Figure 2.** Area flown in 2006 aerial survey.

### Aerial Survey

Fixed-wing flights began May 15<sup>th</sup>, 2006 and were completed May 31<sup>st</sup>, 2006 for a total of 12 flight days over eleven counties (Figure 2). Aerial surveyors mapped mortality of SOD hardwood hosts, primarily tanoak and coast live oak. Using a DASM, the surveyor digitized directly onto a scrolling map displayed on a laptop screen creating information easily transferred to a geographic information system (GIS) environment.

Surveys with fixed-wing aircraft were conducted in:

- Areas of “low” to “very high” risk of establishment and spread in uninfested counties at the northern and southern boundaries of the pathogen (Figures 1 & 2);
- Infested counties, bordering uninfested counties, with limited areas of infestation including Humboldt and Mendocino Counties;
- Current infestations in the Big Sur Region and southern Humboldt County.

Nine million acres were surveyed by fixed-wing craft, 6,667 miles were flown, and nearly 21,000 acres with hardwood mortality were mapped. An “acre with mortality” is observed to have 0.5 or more dead trees per acre (Table 1).

County	Polygons mapped, fixed-wing	Additional polygons, mapped from helicopter	Polygons mapped by Oregon Dept. of Forestry (ODF)	Acres mapped with mortality
Del Norte	8	1	2	8
Humboldt	76	20	0	4,138
Lake	4	0	0	43
Mendocino	71	1	0	2,836
Monterey	42	1	0	13,530
San Benito	11	2	0	30
San Luis Obispo	42	5	0	152
Santa Barbara	21	2	0	60
Sonoma	5	0	0	42
Trinity	3	0	0	2
Yolo	1	0	0	1
<b>Subtotal</b>	<b>284</b>	<b>32</b>	<b>2</b>	<b>20,842</b>
<b>TOTAL</b>		<b>318 polygons mapped in 2006</b>		<b>20,841 acres</b>

**Table 1.** Mortality polygons mapped during 2006 aerial survey, by county.

A total of the 318 mortality polygons were mapped during the 2006 flights. The majority of the polygons, 284, were mapped from fixed-wing aircraft while 34 polygons were mapped using a helicopter. In an effort to better target field surveys helicopter flights occurred June 1<sup>st</sup> through 3<sup>rd</sup>, 2006 over San Benito, Monterey, San Luis Obispo and Santa Barbara Counties. Humboldt and Del Norte Counties were flown June 12<sup>th</sup> and 13<sup>th</sup>, 2006. The following factors determined which mortality polygons were mapped using a helicopter:

- Polygons in uninfested counties with “moderate” to “very high” risk,
- Higher numbers of dead trees in a polygon, e.g., greater than 10,
- Distance of newly mapped polygon from a *P. ramorum* confirmation, and
- Weather, flight time and distance from fuel.

### Ground Survey

Mapped mortality polygons were evaluated and prioritized for field visits in order to concentrate on those sites that had the most potential to be new *P. ramorum* infestations. The 318 polygons mapped in 2006 along with 174 unchecked polygons from 2005 (mapped but not visited in 2005) were evaluated. Greater priority was given to polygons meeting the following criteria:

- Polygons falling within very high, high, and moderate risk areas based on the Meentemeyer et al. (2004) risk map;
- High priority uninfested counties including Del Norte, San Benito, San Luis Obispo, and Santa Barbara;
- Polygons with large numbers of dead trees (greater than 10); and,
- Proximity to known SOD infestations, priority was given to polygons greater than 5,000 meters from a known infestation.

Risk for establishment and spread of *P. ramorum* has been identified as an important factor in determining where to target field efforts. Therefore, polygons falling within very high to moderate risk areas identified on the Meentemeyer risk map were given highest priority. Polygons with large numbers of dead trees as opposed to individual dead trees have also proven to be good indicators of areas to target on the ground. Finally, in an effort to concentrate on

finding *new* areas of infestation, mortality polygons **less** than 5,000 meters (3.1 miles) from a known infestation were not considered a priority and generally were not field-checked. This eliminated many polygons in southern Humboldt and southern Mendocino counties from the list for field visits. In Monterey County only the Willow Creek watershed was targeted for field visits. Trees in this watershed have been sampled regularly since a stream bait in Willow Creek tested positive for *P. ramorum* in 2005.

County	Polygons targeted for field visits
Del Norte	11
Humboldt	80
Lake	0
Mendocino	82
Monterey	2
San Benito	12
San Luis Obispo	46
Santa Barbara	23
Sonoma	0
Trinity	0
Yolo	0
<b>TOTAL</b>	<b>256</b>

**Table 2.** Polygons targeted for field visits, by county.

After evaluation, **256** polygons were targeted for ground surveys. In the northern project area a total of 173 polygons were targeted for field visits (88 polygons from the 2006 flights, 83 polygons from 2005, and 2 polygons from ODF). In the southern project area there were 83 polygons targeted for field visits, all mapped in 2006 (Table 2).

Field crews trained in SOD symptom recognition and field sampling protocol visited mortality polygons from June through September in seven counties. No polygons were visited without permission from a landowner and often the landowner or land manager accompanied the crew. Crews used topographic maps, National Agriculture Imagery Program photography (NAIP), photos taken from aircraft, and GPS coordinates to

navigate to the polygons. When the dead trees were located, the crew searched the area for symptoms of *P. ramorum* infection. If SOD symptoms were found, GPS coordinates were recorded and a center point for an L-shaped plot was established. The plots were 50 meters in the each direction and 10 meters wide. One arm was oriented upslope and the other oriented at a right angle to it, along the contour. Crews recorded host species and other forest data (see Appendix for field data collection protocol). If no SOD symptoms were found, crews did not establish a plot but recorded observations about the mortality. Occasionally, the crews came across symptomatic vegetation outside of a targeted field site. In these cases, a ‘pick-up plot’ was established using the same field plot protocol.

Crews inspected host species within the plot for symptoms of *P. ramorum* infection, sampling leaves, stems and trunk cankers of symptomatic live vegetation. Tanoak and California bay laurel were the primary species sampled in the northern counties. In the south, California bay, coast live oak, tanoak, and black oak were sampled. Usually more than one tissue sample was taken from a plot. Samples were sent to one of two laboratories for a *P. ramorum* positive or negative diagnosis; samples from uninfested counties went to the CDFG plant pathology lab and samples from infested counties went to the Rizzo lab at UC Davis. The Garbelotto lab at UC Berkeley did PCR work on samples from uninfested counties. The labs also reported if they found other *Phytophthoras* in the samples including *P. nemorosa* and *P. pseudosyringae*.

## Results & Discussion

Of the 256 polygons identified for field visits, 126 (49%) were successfully visited. An additional 16 sampling sites were created in the field when the crews came across symptoms outside of a mapped polygon, for a total of 142 sites. Symptomatic vegetation was observed and sampled at 38 of the 142 sites. There were 130 polygons *not* visited for a variety of reasons including denied access, no response from or unable to contact landowner, or site inaccessible due to road closures, fires, or for safety reasons (Table 3).

Northern Project Area			Southern Project Area	
	Private property, 82% of targeted sites	Public property, 18% of targeted sites	Private property, 75% of targeted sites	Public property, 25% of targeted sites
<b>Polygons visited</b>	66	22	23	15
<b>Access denied</b>	21	0	7	0
<b>Not visited due to logging or herbicide use</b>	3	0	0	0
<b>Inaccessible</b>	8	7	0	6
<b>No response or unable to contact</b>	29	0	32	0
<b>Unsafe to visit</b>	5	3	0	0
<b>Permission granted but site not visited</b>	9	0	0	0
<b>Pick-up plots created</b>	14	0	0	2
<b>Total sites visited in northern project area = 102</b>			<b>Total sites visited in southern project area = 40</b>	

**Table 3.** Summary of polygons visited and not visited.

Field visits resulted in ten *new P. ramorum* detections (Figure 3). Nine sites were in Mendocino County and one site was in Monterey County. The positive detection in southern Monterey County in the Willow Creek watershed is the farthest south the pathogen has been found to date. This watershed was targeted for field checks because a stream bait tested positive for *P. ramorum* in 2005.

The nine new SOD detections in Mendocino County expand the known infested area within the Navarro, Garcia, Gualala, and Russian River watersheds. The detection closest to Point Arena is the farthest from a previously known confirmation; it is 7.6 miles from confirmations at Hendy Woods State Park. The detection northeast of Boonville is just over a ridge from Robinson Creek drainage, a short stream that meets the Russian River at the south end of Ukiah. Currently, there are no confirmations this far up the Russian River.

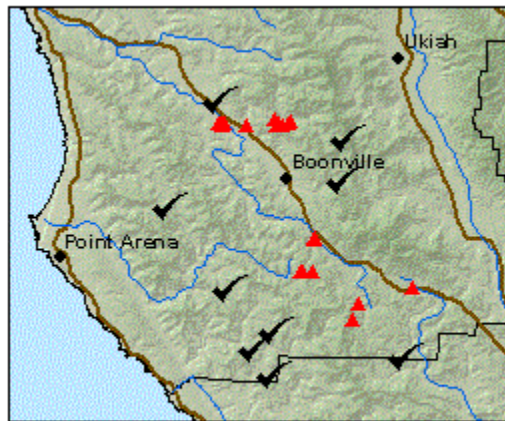
## *P. ramorum* Detections

2006 SOD Aerial & Targeted  
Ground Monitoring Survey

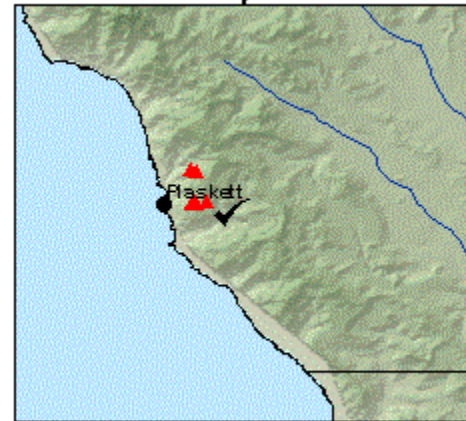
- ✓ *P. ramorum* positive, 2006
- ▲ Previously known confirmations
- Highway
- River



Southern Mendocino County



Southern Monterey County



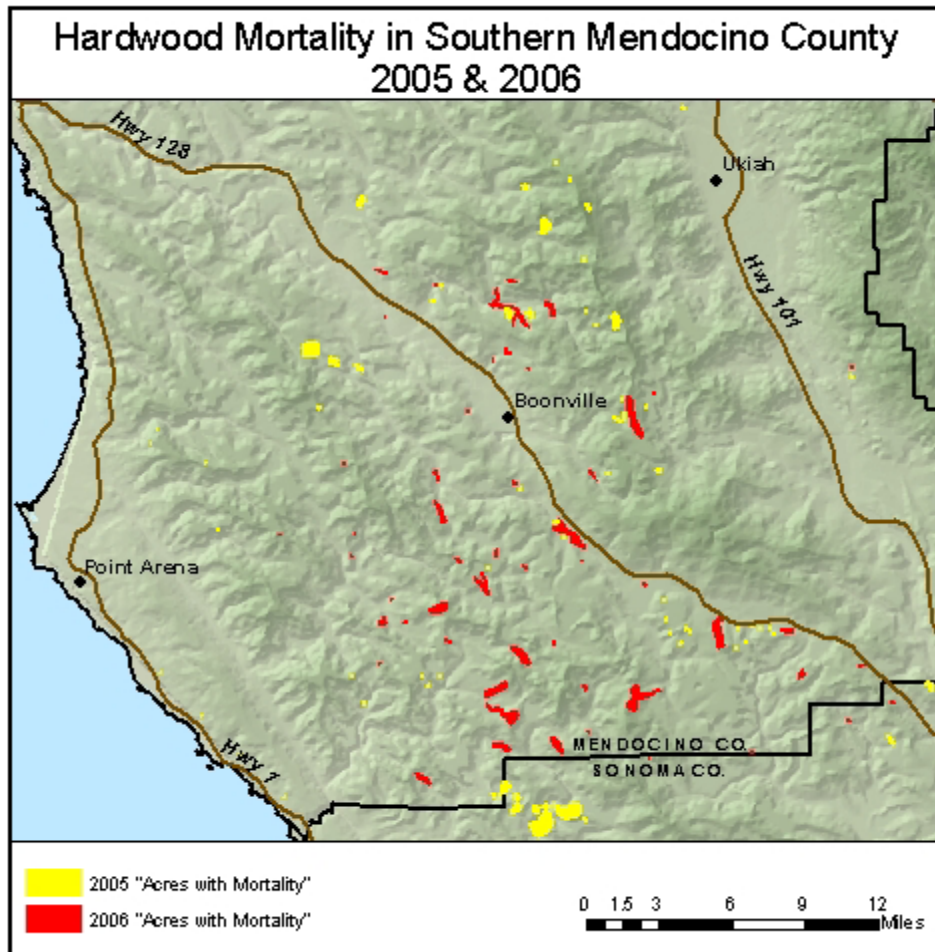
**Figure 3.** *Phytophthora ramorum* detections in 2006.

The largest increase in mortality observed this year was in Mendocino County. There was 54% more acreage with mortality mapped in 2006 than in 2005 (Figure 4). In 2005, 1,869 acres with mortality were mapped over 1,788 miles flown. In 2006, 2,836 acres with mortality were mapped over 1,354 miles flown. Several landowners and land managers in southern Mendocino County commented that in the spring and summer of 2006 they saw a large and sudden increase in tanoak mortality. As a result of this survey, at least two landowners with newly detected infestations in southern Mendocino County have contacted county and state agencies for help in managing the pathogen on their property.

Where the pathogen was *not* found in this survey is as important as where it *was* found. Results from the 2006 ground survey indicate that the pathogen is still not in San Luis Obispo or Del Norte Counties. These counties are the next most likely areas for the pathogen to become established based on host type, climate and proximity to currently infested areas. *P. ramorum* also has not been found in San Benito or Santa Barbara Counties. The northern parts of



Mendocino and Humboldt Counties have a great deal of at-risk habitat, yet no *P. ramorum* was detected during this survey.



**Figure 4.** Mapped mortality in Mendocino County increased 54% from 2005 to 2006.

Other *Phytophthora* damage agents, *P. pseudosyringae* and *P. nemorosa*, were diagnosed from tissue samples. *P. pseudosyringae* was recovered from one location in San Luis Obispo County, and *P. nemorosa* was recovered from two sites in Mendocino County and one in Humboldt County. Table 4 below provides a summary of field visits by county.

The past six years of aerial surveys and targeted-ground surveys have provided land managers with a way to track the disease over time. These data have also been useful for planning research projects and to target funding for other projects.

County	Ground checks, 2005 polygons	Ground checks, 2006 polygons	Pick-up plots	Number of sites sampled	Sites testing Positive	Sites testing Positive	Sites testing Positive
					<i>P. ramorum</i>	<i>P. nemorosa</i>	<i>P. pseudo-syringae</i>
Del Norte	0	6	0	0	0	0	0
Humboldt	13	30	4	11	0	1	0
Lake	0	0	0	0	0	0	0
Mendocino	26	13	10	20	9	2	0
Monterey	0	2	0	2	1	0	0
San Benito	0	5	0	0	0	0	0
San Luis Obispo	0	23	2	3	0	0	1
Santa Barbara	0	8	0	2	0	0	0
Sonoma	0	0	0	0	0	0	0
Trinity	0	0	0	0	0	0	0
Yolo	0	0	0	0	0	0	0
<b>TOTAL</b>	<b>39</b>	<b>87</b>	<b>16</b>	<b>38</b>	<b>10</b>	<b>3</b>	<b>1</b>

**Table 4.** Summary of field visits and sampling results, by county.

## References

1. Alexander, J., in *2006 Forest Pest Conditions Report*, California Forest Pest Council
2. Meentemeyer, R., D. Rizzo, W. Mark, E. Lotz. 2004. Mapping the risk of establishment and spread of sudden oak death in California. *Forest Ecology and Management*, v. 200, pp 195-214.
3. USDA Forest Service, State and Private Forestry, Forest Health Protection, Region 5. *2005 Accomplishment Report: Cooperative Monitoring Program for Early Detection of Sudden Oak Death (Phytophthora ramorum) Aerial and Ground Surveys*, <http://www.fs.fed.us/r5/spf/fhp/fhm/sod/index.shtml>

## Acknowledgments

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## Appendix

Field protocol provided by R. Meentemeyer and B. Anacker

### *Phytophthora ramorum* Ground Survey 2006 Field Protocol

#### Introduction

This protocol describes how to sample research plots for the 2006 statewide survey for Sudden Oak Death in Del Norte, Humboldt, Mendocino, Monterey, San Benito, San Luis Obispo, Santa Barbara, and Trinity Counties.

#### Field Protocol

- I. Secure access permission: Coordinate with project coordinator (Lisa Bell for private) to see what needs to be done to get access permission for the points you want to visit in advance.
  
- II. Navigate to Plot
  1. Use waypoints provided in Garmin GPS and maps to navigate to the point.
  2. Offsetting a point: If GPS point lands outside of host type vegetation,
    - a. offset the point up to 200m so that both transects land within the vegetation type and within the same land ownership, if possible
    - b. else, the plot is thrown out. Fill out a datasheet explaining why the plot was thrown out and document the host species present.
  3. Marking a new point: It is ok to establish new points in suitable host vegetation when necessary, ie, when you can't offset with the distance criteria above. See naming convention for these points below.
  4. If you see a symptomatic tree in an uninfested area, you can establish a new plot, run a transect and mark the waypoint, with initials, county code and plot number starting at 500 (as stated below)
  5. If you are unable to navigate to a primary point, you may replace it with a secondary point that is nearby the abandoned primary. There is no need to match risk level or vegetation type, but it must be more than 500 meters from any other plot.

#### III. Record Plot Information

1. Plot ID
  - a. For pre-established *risk* plots:  
Plot ID = initials + 3 char county + three digit plot number  
e.g., BA-HUM-001 for Brian Anacker, Humboldt Co., point number 001  
For new *risk* plots (ie., "pick-up plots")  
initials + 3 char county + plot number starting at 500  
e.g., BA-HUM-500 for Brian Anacker's first pick-up plot, Humboldt Co., point number 500
  - b. For pre-established *aerial* survey plots:  
Plot ID = initials + 3 digit plot number + 3 char county + 2 digit year  
e.g., JM-896-HUM-06 for Jeff Mai, point number 896, Humboldt Co., year 2006  
For new *aerial* survey plots:

initials + plot number in the series assigned to you (e.g., 2001, or 3001) + 3 char  
county + 2 digit year  
e.g., JM-3001-HUM-06 for Jeff Mai's first pick-up plot, point number 3001,  
Humboldt Co., year 2006

2. Date
  - a. Date plot visited
  - b. Date format = ddmmmyyyy; e.g., 31May2005
3. Crew
  - a. Initials of crew members conducting survey
4. County
  - a. Enter County Code:
    - i. HUM Humboldt
    - ii. DNT Del Norte
    - iii. MEN Mendocino
    - iv. LAK Lake
    - v. Et cetera
5. Landowner
6. Vegetation Alliance (Given on spreadsheet)
  - a. Based on CALVEG vegetation database
7. Risk level (Given on spreadsheet)
  - a. Place Risk level in the space provided
  - b. Very High = V, High = H, Medium = M, Low = L

#### IV. Record Actual Location

1. Mark a waypoint following plot name format above –see Appendix I for Garmin protocol
2. Record accuracy of GPS instrument (located on GPS screen)
3. Write down coordinates
4. Record offset distance, if applicable
5. Record offset direction, if applicable

#### V. Record Basal Area

1. Basal area is defined as “Cross-sectional area of tree composition at breast height (4.5 ft)”
2. Take basal area from plot center using a 10 factor Cruz-all
3. Hold the Cruz-all gauge 2 feet from your head at eye level. Maintain this spacing while using the gauge by stretching a string of the appropriate length between your eye and the gauge.
4. Aim the gauge at each tree trunk 4.5 ft above the ground (only consider live trees larger than 5 inches in diameter.
5. Turning 360 degrees, count and record the species of all tree species that look wider than the gauge.
6. These trees are “in”, tree trunks narrower than the gauge are “out”

#### VI. Run Transects

1. Run two 50 x 10 m perpendicular transects sharing the same origin, resulting in an “L” shape. Run the first transect upslope from plot center and the second at 90°

#### VII. Record Transect Information

1. Record transect length in meters

2. Record compass bearing of transect. e.g., 13° or 272°
3. Observe and record host relative cover and number of symptomatic individuals in both the overstory and understory, by walking the length of each transect
  - a. Species codes are pre-recorded; Code reflects first two letters of the *scientific name* of both genus and species
  - b. Enter visual estimate of relative percent cover of each species 0-100%.
  - c. Estimates should be in increments of 1% (e..g. 66% QuAg; 35% UmCa).
  - d. Species that are present but significantly less than 5% should be recorded as 1%.
  - e. Sum must equal 100%
  - f. Tally number of all symptomatic individuals by species
4. Samples are to be taken from symptomatic host plants as follows
  - a. Collect from up to 10 symptomatic individuals.
  - b. Collect up to 10 symptomatic leaves per individual.
  - c. Prioritize collection from bay first, tan oak second, all other species third
  - d. For each individual, place samples into a separate bag and complete a unique pdr.
  - e. Important: See Appendix II for collection protocol and scenarios

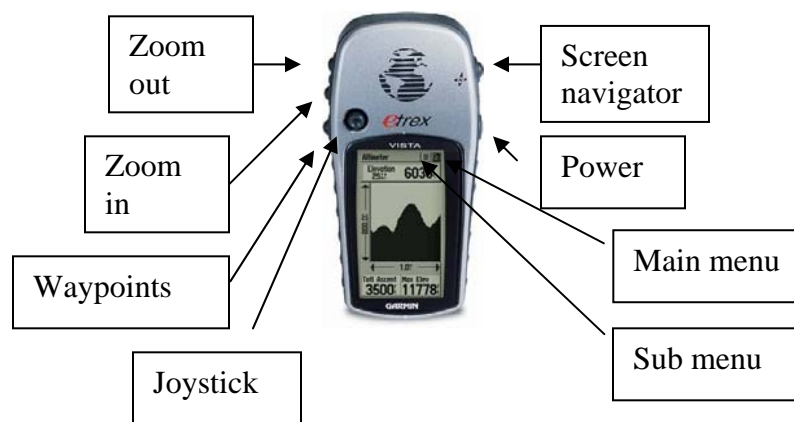
#### VIII. Notes

1. Record notes, tree damage, plot particulars, etc.

#### IX. Leaving an area

1. Gather all supplies, leave no waste behind.
2. Disinfect all tools and footwear using Lysol® or a 10% bleach solution.
3. Wash vehicle tires ASAP after visiting each plot.

#### Garmin User Manual



#### I. Setup

1. Units
  - a. position format: UTM UPS
  - b. map datum: WGS 84
  - c. distance/speed: Metric
  - d. elevation: Feet or meters

2. System
  - a. GPS: Normal
  - b. WAAS: Disabled
  - c. Compass: On
  - d. Battery: Alkaline
3. Owner Information
  - a. Your Name; 1801 E. Cotati Ave., Rohnert Park, CA, 94928-3609; Your phone number; lab number 707-664-3067

## II. Collaborating the compass

1. The compass needs to be calibrated
  - a. After each time you change the batteries
  - b. Whenever the garmin is giving you erroneous readings
2. Go to the navigation screen
3. Click on the submenu
4. Select “calibrate compass”
5. Follow the on-screen instructions

## III. Marking a waypoint

1. Go to the satellite screen
2. Wait until the screen does not display “Wait...Tracking Satellites”
3. note the gps accuracy on the datasheet
4. Go to the main menu screen
5. Select “mark”
  - a. Push down on the joystick 3 times
  - b. Press enter on the joystick
  - c. Change the name of the point to match the plot id
  - d. Hit “ok”
  - e. Note the coordinates on the datasheet
  - f. Hit “ok” again

## IV. Navigating to a waypoint

1. Hit the waypoint button
2. Select “nearest” or “by name”
3. Find the waypoint of interest in the list, enter
4. Select “go to”

## Sampling

1. Each individual gets a unique bag and PDR form
2. Samples are to be placed in air tight Ziplock® bags, write plot id, date, species, and collectors initials on bag. (Use permanent marker) PDR id sticker must also be place on bag
3. Place samples inside ice chest as soon as possible. **DO NOT** include a damp paper towel in each collection bag.
4. Disinfect all tools and footwear using Lysol® or a 10% bleach solution.
5. Fill out a PDR for each bagged collection
6. Place the PDR number or PDR sticker on the data sheet along with the species id. Include the white top sheet of PDR form with the sample bags for overnight delivery. Place in water tight bag to prevent PDR forms from getting wet.
7. Samples must be mailed/FEDEX (Overnight) ASAP to appropriate lab for analysis; use billable stamps provided. (addresses below) **DO NOT** send after final pick up on Thursday afternoons (usually around 4pm, will say on drop box) as the samples will sit unrefrigerated all weekend
8. If a copy machine is accessible (most grocery stores will have one) make copies of data sheets and mail them to the GIC when making a fedex drop.

Send to: Stevenson 3032, Geography Dept. 1801 East Cotati Ave, Rohnert Park Ca 94928, ATTN Brian Anacker, or fax to 707-664-3332

**Infested County**

Plant Pest Diagnostic Center  
Plant Health & Prevention Services  
3294 Meadowview Road  
Sacramento, CA 95832-1448  
Ph: 916.262.1870

**Uninfested County**

Rizzo Lab, Plant Pathology Dept  
Attn: John Bienapfl  
1 Shields Ave, Hutchinson Hall  
Davis, CA 95616  
Ph: 530.754.9894

Note, “infested” and “uninfested” refers to counties, not ROI and ED. Infested counties include: Alameda, Contra Costa, Humboldt, Lake, Marin, Mendocino, Monterey, Napa, Solano(?), San Mateo, Santa Clara, Santa Cruz, Sonoma  
Uninfested counties include: All others

**Leaf collection scenarios**

*scenario 1*

11 symptomatic umca  
15 symptomatic lide  
10 symptomatic vaov  
collect 10 leaves from 10 umca, bag all 10 separately; do not collect from lide or vaov;

*scenario 2*

7 symptomatic umca  
9 symptomatic lide  
collected 10 leaves from 7 umca; collect 5 leaf/branches from 3 lide; bag all 10 separately

*scenario 3*

4 symptomatic lide  
2 symptomatic umca  
2 symptomatic sese  
1 symptomatic vaov  
collect 10 leaves/samples from all individuals; bag all 9 separately

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### **Equipment List**

- Garmin, with waypoints
- aa batteries
- backpack
- orange vests
- pencils
- sharpies
- clipboard
  - field protocol
  - maps
  - datasheets
  - contact information / emergency information



- dash placard
- permits
- CalVeg Alliance
- first AID kit and snakebite kit
- metric measuring tape, 50 or 100 m
- cooler with ice pack/ice
- 4x4 vehicle
- cell phone
- fed ex envelopes and billable stamps
- water jug
- Lysol/brush
- leaf collection bags – multiple sizes (quart and gallon)
- cruz all  
available from Forestry suppliers Inc.  
[http://www.forestry-suppliers.com/product\\_pages/View\\_Catalog\\_Page.asp?mi=1395](http://www.forestry-suppliers.com/product_pages/View_Catalog_Page.asp?mi=1395)  
Item number 59795
- Paper towels
- technu
- orange flagging
- compass
- pdr book(s)
- camping gear

## SOD Host list

Regulated Hosts	
Scientific Name	Common Name
1 * <i>Acer macrophyllum</i>	Bigleaf maple
2 * <i>Aesculus californica</i>	California buckeye
3 * <i>Arbutus menziesii</i>	Madrone
4 * <i>Arctostaphylos manzanita</i>	Manzanita
5 <i>Camellia spp.</i>	Camellia - all species, hybrids, and cultivars
6 <i>Calluna vulgaris</i>	Scotch heather
7 <i>Hamamelis virginiana</i>	Witch hazel
8 * <i>Heteromeles arbutifolia</i>	Toyon
9 * <i>Lithocarpus densiflora</i>	Tanoak
10 * <i>Lonicera hispidula</i>	California honeysuckle
<i>Maianthemum racemosum</i> (formerly	
11 <i>Smilacina racemosa</i> )	False Solomon's seal
12 <i>Photinia fraseri</i>	Red tip or Fraser's Photinia
13 <i>Pieris formosa</i>	Himalaya pieris
14 <i>Pieris formosa x japonica</i>	Pieris 'Forest Flame'
15 <i>Pieris floribunda x japonica</i>	Pieris 'Brouwer's Beauty'
16 <i>Pieris japonica</i>	Japanese pieris
17 * <i>Pseudotsuga menziesii var.menziesii</i>	Douglas fir
18 * <i>Quercus agrifolia</i>	Coast live oak
19 * <i>Quercus chrysolepis</i>	Canyon live oak

20 *	<i>Quercus kelloggii</i>	California black oak
21 *	<i>Quercus parvula v. shrevei</i>	Shreve oak
22 *	<i>Rhamnus californica</i>	California coffeeberry
23	<i>Rhododendron spp</i>	Rhododendron (including azaleas) - all species
24	<i>Rosa gymnocarpa</i>	Wood rose
25 *	<i>Sequoia sempervirens</i>	Coast redwood
26	<i>Trientalis latifolia</i>	Western starflower
27 *	<i>Umbellularia californica</i>	California bay laurel/Oregon myrtle/pepperwood
28 *	<i>Vaccinium ovatum</i>	Evergreen huckleberry
29	<i>Viburnum x bodnantense</i>	Bodnant Viburnum
30	<i>Viburnum plicatum var. tomentosum</i>	Doublefile Viburnum
31	<i>Viburnum tinus</i>	Laurustinus

### Associated Hosts

	Scientific Name	Common Name
1	<i>Abies grandis</i>	Grand fir
2	<i>Aesculus hippocastanum</i>	Horse-chestnut
3	<i>Arbutus unedo</i>	Strawberry tree
4	<i>Castanea sativa</i>	Sweet Chestnut
5	<i>Clintonia andrewsiana</i>	Andrew's clintonia bead lily
6 *	<i>Corylus cornuta</i>	California hazelnut
7	<i>Drimys winteri</i>	Winter's bark
8	<i>Dryopteris arguta</i>	California wood fern
9	<i>Fagus sylvatica</i>	European Beech
10	<i>Fraxinus excelsior</i>	European ash
11	<i>Griselinia littoralis</i>	New Zealand Privet
12	<i>Hamamelis mollis</i>	Chinese witch-hazel
13	<i>Kalmia latifolia</i>	Mountain laurel
14	<i>Laurus nobilis</i>	Sweet bay laurel
15	<i>Leucothoe fontanesiana</i>	Drooping leucothoe
16	<i>Magnolia stellata</i>	Star magnolia
17	<i>Magnolia x loebneri</i>	Loebner magnolia
18	<i>Magnolia x soulangeana</i>	Saucer magnolia
19	<i>Nothofagus oblique</i>	Southern or Roble beech
20	<i>Parrotia persica</i>	Persian Parrotia
21	<i>Pieris formosa var. forrestii</i>	Chinese Pieris
22	<i>Pieris formosa var. forrestii x Pieris japonica</i>	Pieris
23	<i>Pittosporum undulatum</i>	Victorian box
24	<i>Pyracantha koidzumii</i>	Formosa firethorn
25	<i>Quercus sativa</i>	European turkey oak
26	<i>Quercus falcata</i>	Southern red oak
27	<i>Quercus ilex</i>	Holm oak
28	<i>Quercus rubra</i>	Northern red oak
29	<i>Rhamnus purshiana</i>	Cascara
30	<i>Rubus spectabilis</i>	Salmonberry
31	<i>Salix caprea</i>	Goat willow
32	<i>Syringa vulgaris</i>	Lilac
33	<i>Taxus baccata</i>	European yew

34	<i>Taxus brevifolia</i>	Pacific yew
35	* <i>Toxicodendron diversiloba</i>	Poison oak
36	<i>Viburnum davidii</i>	David Viburnum
37	<i>Viburnum farreri</i>	Fragrant Viburnum
38	<i>Viburnum lantana</i>	Wayfairingtree Viburnum
39	<i>Viburnum opulus</i>	European cranberrybush Viburnum
40	<i>Viburnum x burkwoodii</i>	Burkwood Viburnum
41	<i>Viburnum x carlcephalum x V. utile</i>	Viburnum
42	<i>Viburnum x pragense</i>	Prague Viburnum
43	<i>Viburnum x rhytidophylloides</i>	Alleghany or Willowood Viburnum

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\* denotes a common species

**Figure 1: ROI transect layout**

