DRAFT

Under Review by the Monitoring Committee

Survey Methods

General Guidelines for Conducting a Survey to Detect, Delineate, or Characterize Sudden Oak Death (SOD) within a given Area

No single survey methodology will meet the needs of all situations. There are many considerations to be taken in to account when designing a survey, such as the purpose, desired outputs and accuracy, attributes of the area to be surveyed, the data to be collected, time and personnel constraints, etc. Provided here are some general guidelines for conducting surveys on open-space lands with the purposes of 1) detection – determining presence or absence of SOD, 2) delineation – mapping disease distribution, and/or 3) characterization – providing various descriptors of the disease and its impacts. A survey may have more than one purpose and various methods may be used to achieve the desired outcomes. The methods described are intended to provide a general accounting of the disease situation on a given piece of land. They may be sufficient alone or may serve as a means of collecting baseline data that can be used for refining future surveys in the same or similar areas.

Basic Needs

- Familiarity with SOD recognition and sampling
- Map reading and orientation skills
- Map and aerial photo of the area to be surveyed – USGS 7.5 minute (1:24,000) topographic map and aerial photo of similar or larger scale.
- GPS Unit (use UTM NAD 83 coordinates) and compass
- Measuring tape or practice measuring distances by pacing
- Flagging, to mark the survey boundary, plots, routes of travel, etc.
- Data sheet
- binoculars
- Camera for documenting symptoms, samples, etc.
- Supplies for taking diagnostic samples
- Supplies for cleaning boots and tools that may become contaminated by the SOD pathogen

Preparation

- Describe survey's purpose
- Gather available information on the property – review maps and aerial photos, query the landowner and other sources of information
- Determine method(s) to be used and data to be collected
- Modify the data sheet, if necessary, to meet individual needs of the survey
- Prepare the map for field use – draw in the survey boundary, survey subunits, transect lines, plot locations, route of travel, etc.
- Prepare GPS for field use – load useful waypoints such as plot locations, boundary corners, endpoints of transect lines, etc.

Detection Survey

The purpose of a detection survey is to determine the presence of SOD in an area where the disease is not known to exist. As a prerequisite, it should be confirmed that no disease has been reported for the immediate area. Maps of the confirmed distribution of SOD are found on the SOD Monitoring website, which can be accessed via a link from http://www.suddenoakdeath.org/. It may also be possible to obtain SOD distribution information from the County Agricultural Commissioner's office and local offices of the University of California Cooperative Extension and California Department of Forestry and Fire Protection.

The best method for conducting a detection survey is to traverse the area following a series of parallel, evenly spaced transect lines (Fig. 1), continually looking for disease symptoms as you walk. In effect, the area being surveyed is a strip that extends outward a certain distance on either side of transect lines. All known hosts are visually scanned for symptoms, both to the right and left of the transect line, within the boundaries of the strip. All transects should be walked in the course of the survey, but the surveyor should be willing to make deviations from survey strips in order to further investigate areas of specific interest -- for example, areas with a concentration of symptoms, areas that that are suspected to have an abundance of hosts but are not within the boundaries of the survey strip, etc.

The intensity of the survey will determine the likelihood of finding SOD if it is present. Intensity can be measured as a percentage of the area that is visually inspected and will vary based on the width and spacing of survey strips. From a practical standpoint, the width of the strip is roughly estimated based on the distances to the right and left that a surveyor can effectively scan for symptoms. This obviously is not a precise measurement, but it does provide a means for determining the approximate area of land that has been visually surveyed. For small properties, e.g. less than 10 acres, it may be possible to survey close to 100% of the property. With larger properties this would be impractical. As a minimum standard for a **detection survey**, a 20% strip survey is recommended. Figure 1 illustrates how this could be achieved. Parallel transect lines are plotted on the map at 100m intervals. The surveyor uses a strip width of 20m (10m on either side of the transect line) and visually scans all hosts within the boundaries of the strip as the transects are walked. This example, i.e. 20m-wide parallel strips spaced at 100m, could be used with any size or configuration of land to achieve a 20% survey. The same width strips spaced at 50m intervals would achieve a 40% survey. Strip width can be varied to meet the preferences of the surveyor(s) or to better conform with site conditions, e.g. heavy vegetative cover may warrant narrower strips. If strip width is decreased, spacing between strips will also need to be decreased to maintain the same level of survey intensity. From a practical standpoint, 20m is about the maximum strip width that a single surveyor should consider using.

Topography can have significant influence on host and disease distribution. For this reason, it is generally best to plot transect lines roughly perpendicular to contour lines (up and down the slope) as was done in Figure 1. If lines are plotted parallel to contour lines, certain topographic features may be missed or poorly represented in the survey, i.e. ridgelines, stream bottoms, etc. It may not be necessary or practical to survey an entire property the same way. For larger properties in particular, the best approach may be to partition the property into more uniform subunits. Topographic maps, aerial photos, and other sources of information can aid in this process. Changes in topography may warrant changes in the orientation of transect lines. Changes in vegetative cover may warrant different survey intensities. Some areas may be devoid of hosts and be excluded from the survey, while other areas may be of lower or higher risk for disease based on the kinds and numbers of hosts present.

During the survey, closely inspect all symptomatic hosts to decide if a diagnostic sample is warranted. Determining the presence of *Phytophthora ramorum,* the cause of SOD, requires lab confirmation. This is essential when conducting a detection survey in an area where the pathogen's presence is uncertain. Keep a record of SOD hosts and symptoms encountered. Record the locations of symptomatic hosts and where diagnostic samples are taken, so that these areas can easily be returned to. Each sampling location should have a unique identifier.

Even with the most thorough survey, there is always the possibility the disease will not be detected when, in fact, it is present. It is also possible that symptoms will be found, but the pathogen cannot be isolated from samples submitted for lab analysis. The best time for symptom recognition and sample collection is during winter and spring. Also, the pathogen is more readily isolated from foliar samples, especially from California bay (Umbellularia californica), than from bark and wood. All samples should be kept cool and processed as quickly as possible. Survey and sample collection can occur at any time of year, but the aforementioned factors may influence the outcome of the survey. Follow-up surveys may be warranted.

Delineation Survey

A delineation survey has a different purpose than a detection survey, but the basic survey methodology is the same, i.e. traverse the area following a series of parallel, evenly spaced transect lines (Fig. 1) while visually scanning all known hosts within a certain distance, both to the right and left, of transect lines (refer to the discussion under detection survey). The purpose may simply be to map the area-wide distribution (presence or absence) of disease, but more than likely additional information will be desired -- on which hosts is the disease present? What are the relative levels of infestation (high, medium, low, or absent)? Diagnostic samples may not be necessary if there is good evidence that disease already exists in the general area, in which case disease presence or level of infestation is inferred from the symptoms observed.

The intensity of the survey will depend upon the desired accuracy and the relative abundance of disease. If a high level of resolution is desired and/or the disease is

believed to be relatively rare, a greater survey intensity is warranted, i.e. consider a strip survey of ≥ 20%. Also consider doing the survey in stages. For example, a 5-10% strip survey might be sufficient to establish the general disease distribution across the property. This could be followed by more intense surveys that are limited to particular areas of special interest. Meandering searches, i.e. those that do not follow transect lines, can be used to better define distribution patterns and their boundaries. As was described for the detection survey, the property can be partitioned in to more uniform subunits that are surveyed according to their particular attributes. A delineation survey need not follow a strict protocol, be flexible in designing a survey that best meets your needs.

Distribution data is best expressed as a continuum. A major advantage of a systematic strip survey is that it allows you to effectively sample a large area of land and to view conditions of interest as a continuum as you walk the property. If you are interested in a small amount of information, e.g. the distribution of symptomatic oak trees, it may be relatively easy to map the occurrence of each symptomatic and non-symptomatic oak within the boundaries of the strip survey. Collecting greater amounts of information, however, can be overwhelming and time consuming, e.g. attempting to map the occurrence of every symptomatic species of host plant. Keep in mind the purpose of the survey. Because you are doing a delineation survey, it is important that you continually observe conditions as you walk – this will enable you to better discern distribution patterns. Especially look for changes or unusual conditions and record them. Other, data, which provides details to your overall observations, need not be recorded on a continual basis. You may decide to collect detailed data only at given points along the transect. To avoid bias, it is best to predetermine how this will be done. For example, every 40m along the transect, stop and record data on conditions within a given distance of your position.

If SOD (caused by *P. ramorum*) is known to exist in the survey area, diagnostic samples should only be taken to confirm potentially new or unusual occurrences of disease, e.g. symptoms on an unusual portion of a host plant, suspicious symptoms on a non-host, etc. If diagnostic samples are taken, record each sampling location and provide it with a unique identifier. You may also consider taking samples to determine if other pathogens, such as *P. nemarosa,* are in the area.

Characterization Survey

The purpose of this type of survey is to estimate parameters that relate to SOD, e.g. what percentage of hosts are diseased, what percentage have been killed by the disease, what is the average age and diameter of diseased trees, etc. The procedure is to sample a subset of the population of interest and use the sample data to estimate population parameters. There are many different ways this can be done with no one best method for all situations. The sampling intensity, method used, and variability of the attributes being measured will influence the accuracy of the estimates. A discussion of these considerations is beyond the scope of this document. A text on forest or vegetation sampling should be consulted for further information.

What is suggested here is a line-plot sampling method. No attempt is made to determine the statistical accuracy of parameters that are estimated by this method, but sampling intensity, i.e. the percentage of the area that is sampled, can be used as a relative measure of accuracy. The first step is to decide upon a sampling intensity, e.g. 5, 10, 20, 40 %, etc. Guidelines are available to aid foresters in making this decision for timber stands when the approximate density and distribution of trees is known, but there are no appropriate guidelines for areas with SOD. If SOD is common and host distribution is fairly uniform across the area being sampled, a lower sampling intensity may be sufficient. Partitioning the area in to more uniform subunits can be helpful.

The next step involves deciding upon plot size and calculating the number of plots needed for a given sampling intensity. A common plot size used in forestry is one quarter of an acre (roughly 1/10th hectare). The number of plots needed equals **total area** multiplied by **% sapling intensity** divided by **plot size**. In Figure 2, the total area of interest is 100 hectares. If a 5% sample is chosen, then 50 1/10th hectare plots are needed, i.e. (100 X .05)/.01 = 50. As in the previous sampling methods, a series of parallel, evenly spaced transect lines are established. Plots are distributed evenly along these lines (Figure 2). The total length of the transect lines divided by the number of plots equals the distance between plot centers. If circular plots are used, a ¼ acre plot has a radius of 58.9 ft. and a 1/10th hectare plot has a radius of 17.84 m. All data is collected from within the plot boundaries.

Prepared by Donald R. Owen, March 2003
