Sonoma County
Sudden Oak Death Strategic Response Plan

Western Sonoma County Tanoak Mortality

Prepared by the University of California Cooperative Extension, Sonoma County
and the Sonoma County Department of Emergency Services
January, 2008

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Strategic Response Plan

Executive Summary

Sudden Oak Death is a forest disease causing a major die-off of several species of oaks and tanoaks in California. It was first reported killing trees in Santa Cruz and Marin Counties in the mid-1990s. Currently Sonoma County is experiencing dramatic and large-scale mortality as hundreds of thousands of trees are dead and dying. Research and management trials strongly suggest that it is persistent, spreading, and it will not be eradicated. Therefore, it is a disease we have to learn to live with, a disease we need to manage. This document describes the impacts of the disease in Sonoma County and presents the needs of land management agencies. It is intended to be the foundation for a County-wide management plan that can be adjusted as unanswered questions about SOD spread, management, and fire risk are addressed by research.

Sudden Oak Death in Sonoma County

US Forest Service aerial surveys, which map the distribution of Sudden Oak Death (SOD), show 7.5% of the land in Sonoma County (75,000 acres) has been affected by SOD mortality in just the past three years. Currently, Sonoma County is California's hotspot for new SOD infestations and mortality; we have more than twice as many acres of new mortality than any other county in California (Z. Heath, USDA Forest Service, unpublished data).

Threats

Threats from SOD mortality include the following:

- Hazards from falling trees
- Potential increase in fire danger
- Loss of heritage and shade trees
- Loss of soil stability
- Loss of habitat & food for wildlife
- Aesthetic losses
- Economic losses
- Spread to new areas

The potential for increased fire danger is a complicated issue with many unanswered questions. There is considerable ongoing discussion about the fire risk that SOD poses to homes and forests.

Managing Sudden Oak Death

SOD management trials strongly suggest that this disease cannot be eradicated. Therefore, the goals of managing SOD are first to remove hazardous trees and dangerous fire fuels, and second, to minimize the number of spores produced by the pathogen in order to lower the rate of infection and spread. Management practices include cutting, thinning, burning, chipping, chemical treatment, and sanitation. Representatives from Sonoma County agencies and other land management entities within the County provided

information for this report on the impacts of SOD on their operations and their current and future management plans for dealing with the problem. This needs assessment makes up the bulk of this plan. In summary, the amount of land managed, its location and use dictate agency needs, which fall into several categories:

- Survey for extent of infestation
- Remove fire fuels & hazardous trees
- Educate residents and agency staff
- Develop protocols to manage SOD

Anticipated Needs, *Year 1*	**Estimated Costs**
Fire Fuels Reduction/Mitigation	$2,000,000
Tree Removal and Treatment/Forest Health	$867,110
Education and outreach	$313,090
Develop Fuel Model	$200,000
Hazardous and Infected Tree Survey	$614,200
Staff Training	$36,500
Develop SOD Protocols	$30,000
Fire Fuels Survey & Mitigation Plan	$30,000
Fire Department Funds	$16,156
Total	**$4,107,056**

Table 1. Summary of Needs and Costs, Year 1.

Anticipated Needs, *Subsequent Years*	**Estimated Costs**
Fire Fuels Reduction/Mitigation	$2,060,000
Education and Outreach	$296,090
Tree Removal and Treatment/Forest Health	$639,110
Hazardous and Infected Tree Survey	$122,583
Staff Training	$37,645
Fire department funds	$16,156
Total	**$3,171,584**

Table 2. Summary of Needs and Costs, Subsequent years.

Purposely

Cooperation among Agencies

Agency needs overlap in many areas, from hazardous tree surveys and the need for tree removals, to educational programs for staff and County residents. This is a challenge for any one agency, but it's an opportunity for agencies to share resources in order to accomplish their common goals of maintaining the safety and quality of the wild and urban environment in Sonoma County.

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Contents

Strategic Response Plan

Sonoma County Sudden Oak Death
Strategic Response Plan

Purpose of the Strategic Response Plan

The Sonoma County Sudden Oak Death Strategic Response Plan is a joint effort between the University of California Cooperative Extension and the Department of Emergency Services to summarize the impact of Sudden Oak Death (SOD) mortality on the County and present plans to address these impacts and threats. It was written in response to the increased tree mortality due to the SOD pathogen since 2005, and is intended to guide Sonoma County in setting priorities to manage the problems it causes for residents, agencies, and the environment.

There are many unanswered questions surrounding this recently emerged disease including: How does the disease spread?; How do we best manage it?; and, How much will increasing tree mortality affect fire behavior? Research is ongoing to address all of these issues, and more. Therefore, changes to this Strategic Response Plan will occur when research sheds light on these issues, or when new needs arise in the County.

Representatives from Sonoma County agencies and other affected organizations in Sonoma County were interviewed to determine the extent of SOD mortality on land they manage, how it is affecting operations, and what their current and future needs are for managing SOD. Interviews were conducted with planners, managers, and field staff from: the Water Agency, Transportation and Public Works, Agricultural Preservation and Open Space District, Regional Parks, Agricultural Commissioner's Office, Department of Emergency Services, University of California Cooperative Extension, Sonoma County's incorporated cities, California State Parks, and California Department of Forestry and Fire Protection.

The State of SOD in Sonoma County

Sudden Oak Death is a non-native forest disease caused by the plant pathogen *Phytophthora ramorum* (fy-TOFF-thor-uh ruh-MOR-um). Researchers believe it may be native to Asia and could have been introduced to California through ornamental plants (Goheen et al., 2006). The fungus-like pathogen requires warm (68°F is ideal) and wet weather to produce spores and spread infection. Infection occurs when spores land on the leaves or trunks of susceptible plants. On some plants, the pathogen simply causes minor dieback of leaves and twigs. But for these four tree species—tanoak, coast live oak, black oak, and Shreve's oak—the disease causes an often fatal inner bark infection.

There is a limited understanding of how the pathogen spreads to new areas to create infection. It probably travels in windblown rain, streams, in mud on boots and tires, in transported ornamental plants and in soil. Infection can spread from tree to tree in a landscape, but new infestations occasionally appear far from any known infestation.

University of California and Oregon State University scientists are researching the mechanism for this long-distance spread.

How much of Sonoma County is affected?

An estimate of the number of SOD-killed trees in the County is in the hundreds of thousands, distributed on over 75,000 acres. (Z. Heath, USDA Forest Service, unpublished data). These 75,000 acres represent just 17% of Sonoma County forests that are at-risk for Sudden Oak Death infestation (see Figure 1, Meentemeyer et al., 2004). It is reasonable to expect the remaining 73% to eventually become infested. The recent, dramatic increase in mortality is likely due to the pathogen-friendly wet springs of 2005 and 2006 that were favorable to establishment and spread of the disease.

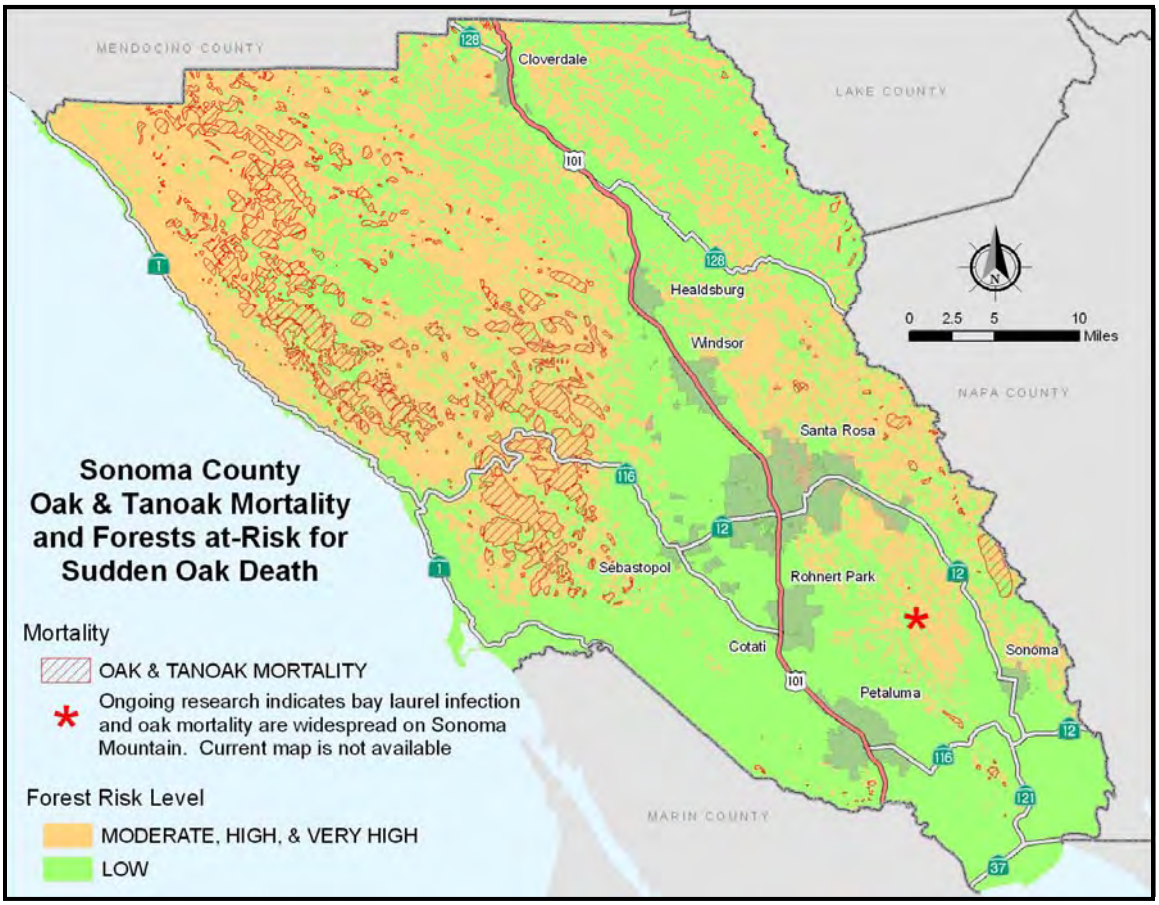

Figure 1. Currently there are at least 75,000 acres of Sonoma County affected by oak and tanoak mortality. The number of acres grows each year: 23,000 acres of mortality in 2005, another 23,000 acres in 2006, and an additional 29,000 acres of new mortality in 2007. In total, this is 23% of the Sonoma County forests that are at-risk for infection. Not yet included in this calculation is the Sonoma Mountain mortality. Much of Sonoma Mountain is infested, and has oak mortality; a map of that mortality will be available soon.

Data Sources: Aerial survey mortality data from USDA Forest Service, State and Private Forestry, http://www.fs.fed.us/r5/spf/fhp/fhm/aerial*). Forest risk level data from Meentemeyer et al. 2004.*

Distribution

The majority of SOD mortality is in western Sonoma County throughout the mountainous areas north of Occidental and west of Highway 101. This region contains some of the county's most impacted communities including Occidental, Camp Meeker, Forestville, Guerneville, Monte Rio, Cazadero, and Annapolis. Twenty, thirty, or more dead trees per acre in these infested areas is not uncommon. Tanoak, an important component of mixed hardwood forests common in the west County, has experienced especially high mortality; some researchers believe we may lose tanoak as a forest species.

In the eastern part of the county on Sonoma Mountain, tree mortality due to Sudden Oak Death has been documented since 2001. Infection on California bay laurel and coast live oak on Sonoma Mountain is described as ubiquitous and spreading (N. Rank, personal communication). Along Highway 12, the California Department of Forestry and Fire Protection has reported infection in the wildland areas west of the towns of Sonoma, Glen Ellen and Kenwood, and in forests along the Napa-Sonoma border.

While we do not know the precise extent of the pathogen in Sonoma County, we can get a very good idea of where it is by looking at the two maps in: Figure 1 which represents hardwood (oak and tanoak) mortality mapped by the US Forest Service during 2005-2007 aerial surveys; and Figure 2, which shows the distribution of SOD-infected trees confirmed by laboratory analysis. Figure 2 illustrates well the wide distribution of the pathogen on Sonoma Mountain.

The Santa Rosa plain and Valley of the Moon areas (including Highways 101 and 12 corridors) as well as much of the northeastern regions of Sonoma County are relatively free of SOD. Because conditions there are drier, forests are less dense, and important hosts that build up spore levels are less common (like California bay laurel and tanoak), SOD currently has less of an impact in these areas. However, SOD was recently identified in Santa Rosa's Doyle Park. Doyle Park has areas of heavy forest cover and host species at the confluence of two streams which creates suitable habitat for *P. ramorum.*

The number of acres currently affected by SOD in Sonoma County (about 75,000) may only represent the early stages of infection. An estimated 440,000 acres of Sonoma County are at *Medium to Very High Risk* for establishment of this disease (Meentemeyer et al., 2004). About 99% of the mortality is on private land and the rest is mainly in parks and roadways (Z. Heath, USDA Forest Service, unpublished data). Based on what we know from the short history of the pathogen in California, we can reasonably assume the established patterns of infection to continue. These patterns are: increased mortality one to two years after warm, wet springs; and patchy mortality throughout suitable habitat with large patches of tanoak succumbing quickly and individual coast live oaks and black oaks dying more slowly. We anticipate that private landowners and public agencies will need to manage the hazards and threats of SOD mortality for many years to come.

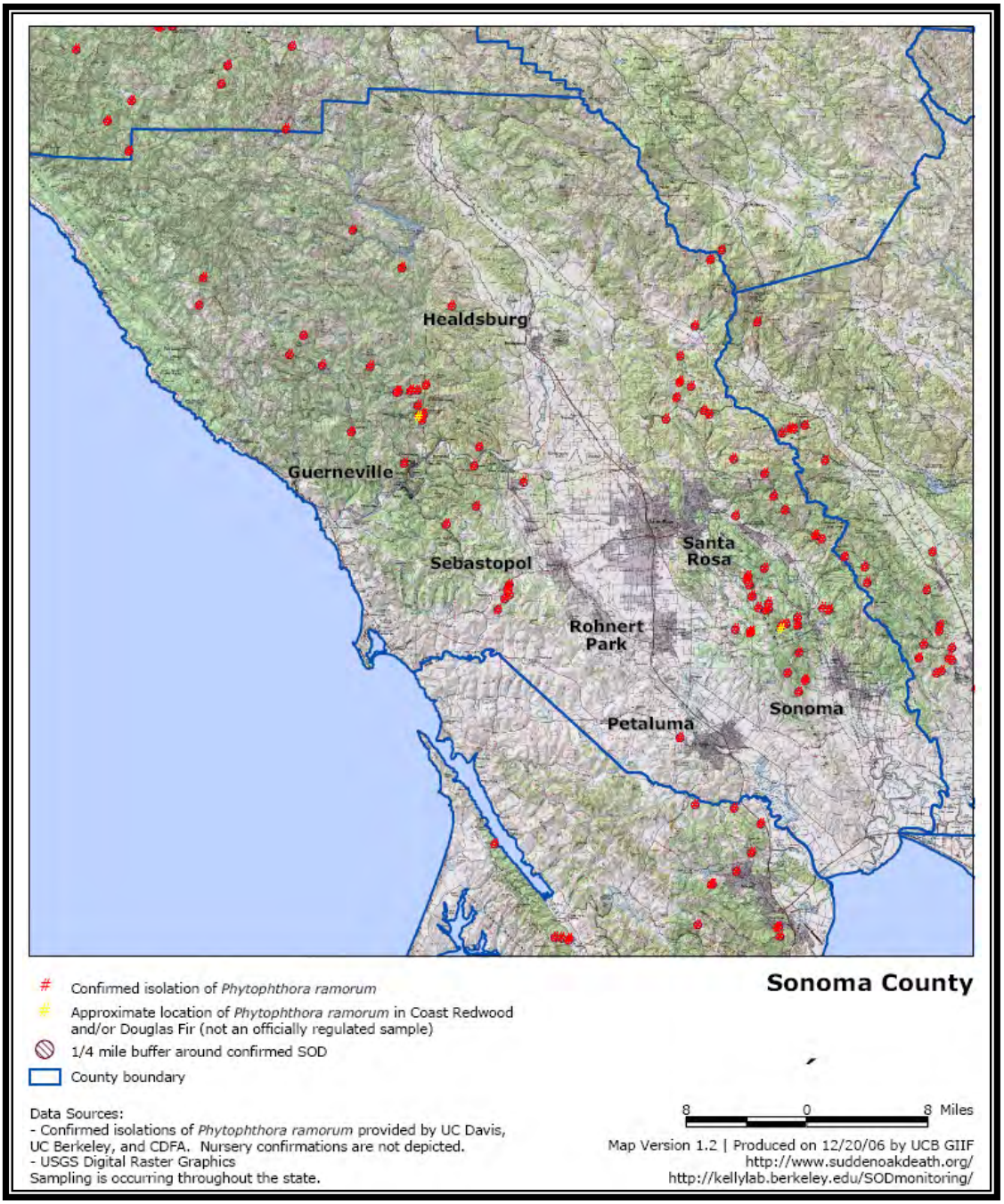

Figure 2. Distribution of laboratory confirmations of P. ramorum. Not every tree that is infected will appear on this map because not every symptomatic tree can be sampled and tested in a laboratory. However, this map illustrates the areas in the south and east part of the County that are infested and experiencing oak and tanoak mortality. The infestation in the west County is under-represented on this map, probably because the areas affected are more remote. http://kellylab.berkeley.edu/SODmonitoring/maps/PDF/Sonoma12-20-06page.pdf

Threats and effects of the disease

The large number of dead and dying trees presents significant, immediate and long-term risks to County residents. Immediate concerns include the threat of hazardous trees falling in roadways and on power lines, and the threat of disease spread to new areas. Concerns about the future include the types of vegetation that will replace the communities we are losing, and how the mortality and the new and unknown plant communities will affect our watersheds.

Hazardous trees are those trees that are likely to fall and cause injury, death and property damage. Trees affected by SOD are subsequently attacked by beetles and decay fungi which deteriorate affected stems, causing premature tree failure. Infected trees adjacent to power lines, roads, in campgrounds, and along public trails are especially dangerous. Landowners with several acres of forest may be forced to contend with dozens or hundreds of dead trees on their property.

Environmental impacts are not fully known because this disease has only been affecting California forests since the mid-1990s. However, it appears there will be a loss of food and habitat for wildlife species in the affected forests given the loss of hundreds of thousands of oaks and tanoaks that produce acorns. With a change in vegetation there is potential for changes in soil stability that could affect our watersheds, and for invasion of non-native species which could pose other problems.

Aesthetic losses include the loss of specimen or heritage trees and shade trees. This is especially true of the old coast live oaks. In the western part of the county, entire hillsides of tanoaks are being killed.

Total economic effects—losses by some, gains by others—are unknown. There are effects in the nursery and forest product industry, on tree-care workers and individuals who contract them, on the green-waste/compost industry, for utility companies, and on property values; costs have not been quantified.

Disease spread to other areas is a real concern for those parts of the country that have susceptible species. For example, a large area of the southeastern United States has the appropriate environment for the pathogen and oak trees (red oak and pin oak) that have been shown to get fatal infections when exposed to the pathogen in the laboratory. Though Federal regulations dictate movement of forest products and nursery plants, infected plants occasionally are found in nurseries in the southeast. There is a real possibility that this disease will reach the southeastern forests.

Wildfire Danger may increase with the growing number of dead trees in the county. Fire officials are concerned that increasing fuels could heighten fire conditions, and that they will not be able to put fires out quickly enough and keep them under control in moderate weather conditions. Fire modelers, however, point to factors that may mitigate the apparent dangers from SOD mortality. The issues surrounding fire and SOD are discussed in the next chapter, *Sudden Oak Death and Fire.*

Sudden Oak Death and Fire

The visual impact of Sudden Oak Death (SOD) mortality in Sonoma County's forests is striking; commonly the first response to that mortality is concern about the effect that all those dead trees will have on fire behavior. Yet fire modelers point out that the nature of the fire fuels that result from SOD may not have the devastating effects that we might first expect. Fire Officials from State and local agencies, on the other hand, uniformly express concerns about the increase in fire fuels and fire start risks resulting from oak mortality. Likewise, county residents in the SOD impacted areas express high levels of concern about both fire danger and the high costs of removing dead trees from their property.

Wildfire in Sonoma County

Climate, topography and wildfire history put much of Sonoma County at high risk for extreme fire behavior. Sonoma County has extensive Wildland Urban Interface and Intermix (WUI: areas where wildland type fuels and homes exist in close proximity); thus catastrophic wildfires have the potential to cause extensive structure and economic loss. Changing land use has increased both the population and the vegetative fuels in Sonoma County's Wildland Urban Interface. Additionally, because of efficient suppression, wildland fires, always a part of Sonoma County's ecology, no longer are serving to reduce fuels in vegetated areas. Even without tree mortality due to Sudden Oak Death (SOD), increasing vegetative fuel loads and increased population in Wildland Urban Intermix are of great concern for all area firefighters.

Sonoma County Firefighting Agencies

Responsibility for wildland fires in Sonoma County is divided into State Responsibility Areas (SRA) and Local Responsibility Areas (LRA). In the SRA, local agencies share firefighting responsibilities with Cal-Fire (formerly known as the California Department of Forestry or CDF). In the SRA, though local agencies may be first to arrive on the scene of a fire, Cal-Fire is automatically dispatched and has primary command of fires as soon as their units arrive on the scene. In LRA areas, local agencies have primary command, though in some cases, they may choose to request support from Cal-Fire.

Sonoma County is part of Cal-Fire's Sonoma-Lake-Napa Unit (abbreviated as LNU) which, covering 2.3 million acres, is the largest unit in the system. The LNU has the third largest population within a Cal-Fire Unit, and ranks third in average number of annual fires (*Sonoma Lake Napa Fire Management Plan*, 2005: p. 7). Sonoma County falls within the Unit's West Division, comprising 818,000, over half of which is classified as high or very high fire severity zone.

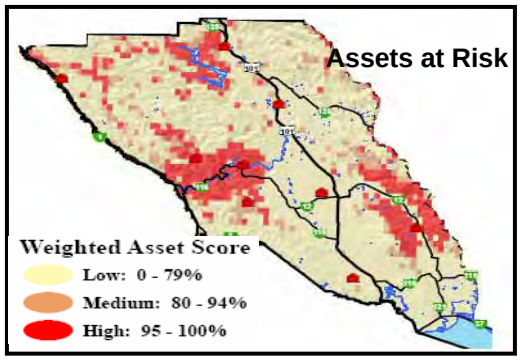

Figure 3. Cal-Fire West Division: Assets at Risk

Local Fire Agencies:

In Sonoma County there are 20 local fire agencies (indicated on figure 4 as Fire Protection Districts [FPD] or Community Services Districts [CSD]); six city fire departments; and the County Service Area #40 which consists of 15 all-volunteer rural fire companies under the direction of the Sonoma County Department of Emergency Services. Most of Sonoma County's WUI is located in the unincorporated areas of the county, and is almost entirely served by all volunteer fire departments, along with Cal-Fire. The strain of increasing call volume and heightened fire danger is especially difficult for financially strapped volunteer companies. Additionally, the *Fire Protection and Service Providers Review* (LAFCO, Sept. 2005; p.3) points out that the loss of resource based jobs, high housing prices and an aging population have reduced the ranks of volunteers in many communities, decreasing the chances for initial attack success in wildland fires.

Economic and Planning Systems

Figure 4. Sonoma County Fire Agencies

Wildfire History

The *LNU Fire Management Plan* notes that "most of the Unit has burned at least once since the beginning of organized fire protection" (p.19). In the West Division the Plan identifies four "historic wildfire corridors" (Fig. 5), where topography, fuels and weather have combined to channel large and damaging fires repeatedly in the past (*Sonoma Lake Napa Fire Management Plan*, p. 19). In all of those areas, the population has increased significantly in the last fifty years, straining local and state agencies' abilities to protect homes and property. Additionally one of those corridors, which follows the Coastal Ridges from the Russian River north to Annapolis, also has some of the worst SOD mortality in the County.

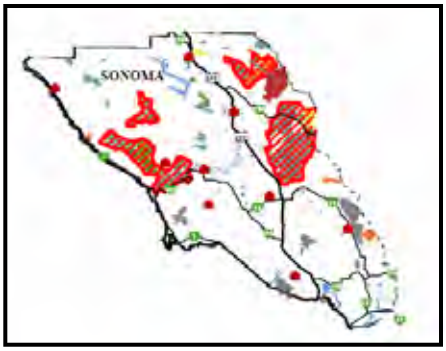

Figure 5. Wildfire Corridors

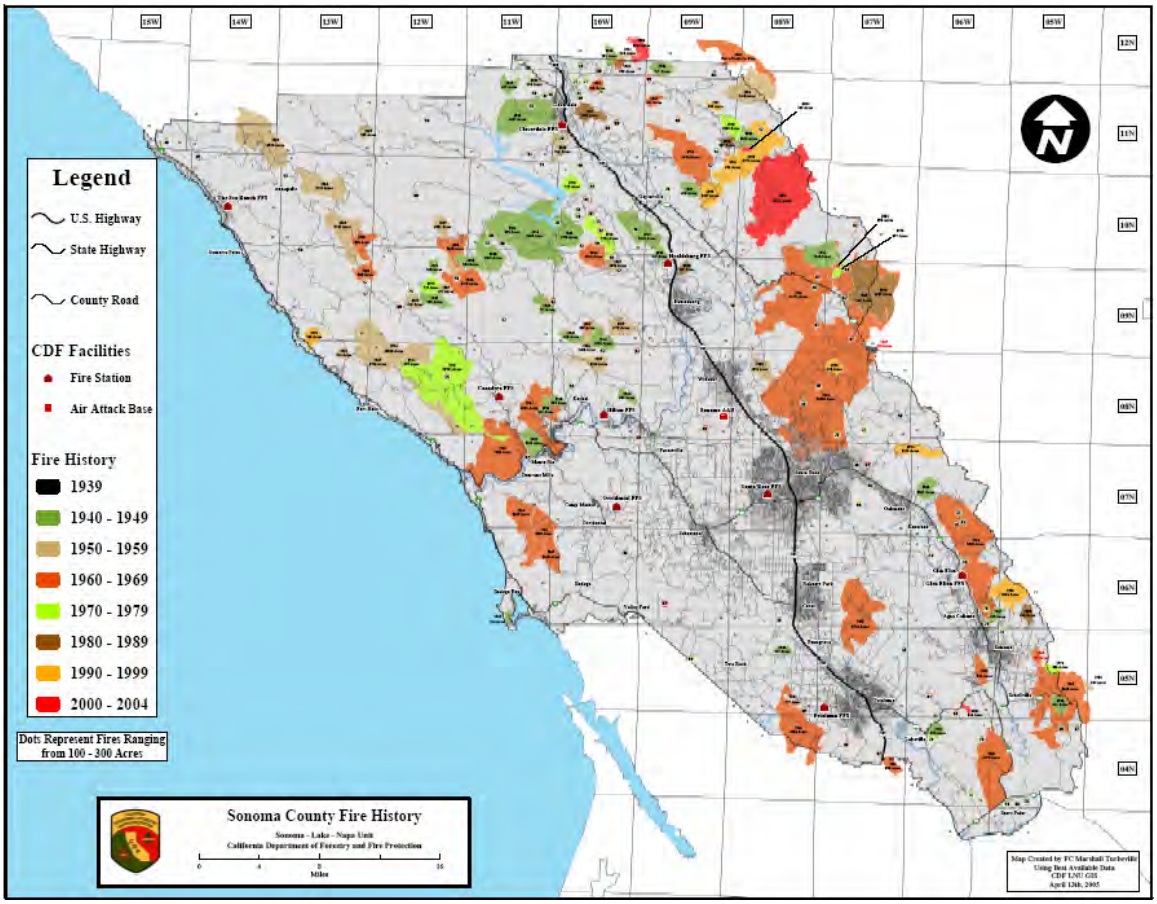

Figure 6. Sonoma County Wildfire History

Sudden Oak Death and Fire Behavior

There is some question about the extent to which SOD mortality will increase fire risk. Referring to SOD, the *LNU Fire Management Plan* asserts that:

> "This gross dieback of native vegetation at such a large level with no solution in sight will increase the fuel loading available to burn and dramatically increase fire behavior. Because the disease also weakens the trees, there is an increased danger to firefighters working under or near them." (p.38)

These concerns are echoed with varying degrees of severity by virtually all of the local fire Chiefs in SOD impacted areas, yet fire modelers point out that there are mitigating factors that could make SOD less of a fire risk than it might appear. This perception is generally based on the following points:

1) Because SOD mortality is spatially quite patchy in most affected areas, the mixture of dead to live trees in the landscape will not significantly affect fire behavior. Fire modelers estimate that as many as 20-40 dead trees per acre will not significantly affect fire behavior; this is especially true in mixed redwood forest ecosystem wherein tanoak is common. The redwood ecosystem typically is not a fire-prone landscape, and there are relatively few days per year that humidity and fuel moisture are sufficiently low to support sustained burning; on those days it will burn regardless of the presence or absence of up to 40 dead trees per acre.

2) The dead trees fall quickly and finer fuel diameters (branches under 3"in diameter) decompose relatively quickly, within a couple of years (Max Moritz, personal communication 3/22/07). Fine fuels, including small diameter branches, twigs and dead or dry leaves, combust more readily than larger diameter fuels. Consequently, many fire modelers feel that once the trees loose their leaves (approximately one to three years, depending on conditions) they pose a lesser fire danger than when the trees are standing alive.

Data from SOD researcher Ted Swiecki, Phytosphere Research indicates that there is considerable variation in the amount of time it takes for SOD infected trees to fail with most but not all failure occurring within 4 years of tree mortality (*Phytophthora ramorum canker (Sudden Oak Death) in coast live oak and tanoak, 2000-2006: Factors affecting disease risk, disease progression, and failure potential;* Swiecki and Bernhardt, 2006*).* Swiecki also noted that defoliation of trees is highly variable, occurring in one to three years from mortality. Due to the spacing of disease and mortality over time and the subsequent variation in rates of defoliation and failure, one could expect that affected forests will have elevated levels of dead fine materials in the canopy and fresh slash on the ground for extended periods.

Arborist and Fire Ecologist Ray Moritz breaks the fire hazards of SOD mortality into five phases (*SOD Implications for Fire Ecology*, p.2):

1. **Initial infection stage:** In some trees, *P. ramorum* can cause reduced foliar moisture, thinning crowns, scattered dead leaves. Though SOD causes reduced fuel moisture, the relatively low flammability of oaks mean that the overall effects of early-stage infection on fire is low.

2. **Dead crowns with foliage attached:** The most hazardous phase for fire risk; torching is significantly more likely in this phase.

3. **Defoliated trees:** After the leaves have fallen, the open low density of live oak, tanoak and black oak canopies makes standing woody fuels unlikely to be ignited by a surface fire or to sustain a crown fire.

4. **Branch and trunk failures:** SOD related branch and tree failure may increase surface fuels and exacerbate fire behavior.

5. **Recolonization:** Plants that may move into areas following SOD mortality could include fire-prone plants like Douglas fir, coyote brush, brooms and grasses, exacerbating fuels problems.

The five phases listed in above are not necessarily sequential—for instance, failures can occur before the top dies, and may not involve the entire tree. Recruitment of understory trees can commence as soon as there is a significant canopy gap, which might occur before a tree has been killed. Conversely, it may not occur even after the tree is dead, especially in redwood forests with tanoak understory, where loss of the tanoak layer may not cause a canopy gap to develop. (Swiecki and Bernhardt, 2006*)*

Rate of Spread and Mortality:
The extent to which the pathogen will kill trees and the amount of time it will take to kill them is of great importance in anticipating what the risks will be in the future. Some researchers postulate that tanoak mortality will reach 80% to 100%. The risks posed will vary by the temporal distribution of mortality. If mortality increases rapidly, there will be a severe, though potentially short lived, increase in fire risk. If mortality progresses more slowly, the risk, and the costs associated with dealing with it, will be spread out over time. Because *P. ramorum* has been studied for a relatively short time, SOD pathologists find it difficult to make predictions about rate and extent of spread. As research into the pathogen continues, we hope that accurate predictions will be possible.

Overall, it might be said that when extreme fire conditions prevail, the presence or absence of dead SOD trees will not have a tremendous impact on how fires will burn: in extreme conditions, trees will burn dead or live. However, if a fire were to start in more moderate conditions, the presence of substantial SOD mortality, especially when trees are not defoliated, could intensify fire behavior as well as increase fire spread through ember transport, effectively increasing fire risks in moderate conditions.

Fuel Model:
A fuel model that addresses western hardwood forest in general and the impact of SOD in particular will be a tremendous help in understanding the real risks that SOD will pose in our forests now and in the future and be of great help to identify the means and costs of addressing risk. To date, few fires have burned in areas severely impacted by SOD mortality, making accurate predictions of fire behavior difficult. The development of a fuel model should be a high priority.

Fire Officials Concerns

Fire officials in SOD impacted areas were interviewed about their concerns about SOD; those concerns are cited below.

Unusually severe fire behavior in moderate weather conditions: Due to increased surface fuels and ember production potential, patches of SOD mortality have the potential to increase fire behavior and fire size in moderate conditions, making what normally would be small fires larger and more intense than they would be in the absence of SOD mortality.

SOD trees falling onto power lines: Pacific Gas and Electric Company (PG&E) is required to remove trees that are a hazard for falling onto high voltage power lines and starting fires. Despite an inspection program that patrols all lines in the county yearly, the fast progression of SOD mortality is making it difficult for PG&E to keep up with hazard trees (Greg Holquist, PG&E Regional Forester, Personal Communication 10/20/07). Lines that are inspected and cleared one month may potentially have newly dead trees impacting lines a few months later. Additionally, a SOD tree that is located far enough from lines not to pose a hazard will not be removed; however it is not uncommon for such a tree to fall, taking with it a healthy tree that itself contacts power lines. The potential for fire starts from SOD trees contacting wires is a great concern to Cal-Fire and local fire officials as well as PG&E.

Ember transport –Firebrands (burning embers) being transported ahead of a fire by the wind, by gravity (e.g. rolling downhill) or being carried aloft in the convection column or fire whirl and being deposited far in advance of the fire front cause spot fires. Dead plant materials have greater ember production potential than do live plants, thus we may anticipate that wildfires in areas heavily impacted by SOD will display increased ember transport. Research shows that most home loss in Wildland Interface fires is due to embers landing on flammable materials near the house walls or entering the structure itself through cracks in siding, vent covers in attics and foundations, etc. Some of the risk of ember ignition is preventable by homeowners reducing ignition sources on or near their homes; educating homeowners about how to reduce risk is of paramount importance.

Increased fuel load & ladder fuels: An increased surface load of dead and dying trees, even if partially decomposed, will provide a receptive fuel bed for embers. There is some debate about the likelihood that defoliated SOD trees or debris will increase crown fire potential (crown fires burn in the tree canopy and burn with great speed and intensity), but increasing surface fuel loads are a common concern of firefighters.

Inadequate defensible space and presence of SOD mortality within the defensible space zone (100' radius from structures) will cause increased structure loss during wildfires: It is crucial that homeowners be educated about the importance of creating and maintaining the defensible space that can save homes in the event of a wildfire.

Increased call volume and costs to fire departments due to down trees: SOD trees falling and blocking roadways will greatly increase the number of calls to which fire departments must respond. This is a particularly worrisome issue for all-volunteer fire

companies because, county-wide, a decreasing number of volunteers are responsible for an increasing number of calls. Costs to fire departments of "tree down" calls include fuel and maintenance for trucks, chainsaws and (for some departments) per-call stipends for firefighters. Additionally, a large number of calls put a tremendous strain on volunteers and can add to the volunteer companies' difficulties in retaining their volunteers. Tree down calls often come in the middle of the night during winter storms. When trees impact power lines, firefighters must wait for PG&E to send a unit before approaching lines; while waiting, firefighters are placed at risk from other trees falling on individuals or apparatus. During winter storms, PG&E's response time can be much delayed, leaving firefighters on scene for upwards of four hours. This can be a very difficult problem for volunteers, the vast majority of whom work during the day.

Mop up: Wildfires typically do not consume all of the trees and wood in a forest; they leave a considerable amount of smoldering and actively burning fuel in their wake. Mop up is the final extinguishment of a fire after it has been contained within the perimeter of the fire lines. Its purpose is to extinguish any burning or smoldering materials that may reignite the fire. The increase in surface fuel that will result from SOD mortality may significantly increase the time necessary for mop up operations.

Danger to firefighters from falling trees and tripping hazards: SOD trees fail quickly after or even before death. Firefighters in structure protection or wildland suppression or mop up modes will be at greater risk of injury due to falling trees. Additionally, fallen trees will hamper firefighters' mobility as well as increasing danger of tripping.

Flashy fuels build up on roadsides: The increase in dead trees along roadsides increases risk of accidental ignition due to carelessness (e.g. smoking) or due to car fires spreading into the wildland. Additionally, having flashy fuels along roadsides also increases dangers to homeowners attempting to evacuate and to firefighters accessing a fire.

Financial Resources for Mitigation: Firefighters are concerned about where the money is going to come from to contend with the increasing fuels and hazard trees.

Figure 7. Regrowth from dead tanoak, Cazadero

***Regrowth*:** In tanoak trees, infection by *Phytophthora ramorum* kills the stem and leaf crown of the tree, but does not kill the root structure. While this is a good thing from the standpoint of erosion, it could become problematic from a fire standpoint if the regrowth creates a tanoak chaparral fuel model. Because of the air-to-fine fuel mixture, chaparral fuel models have one of the greatest fire behavior potentials of any fuel type. Additionally, it is likely that in many areas, invasive and/or fire-prone plants such as Douglas Fir, coyote brush and broom may colonize areas SOD areas and further exacerbate fuel problems.

SOD Mortality and Fire Severity across Sonoma County

Thus far the most substantial mortality is to be found in the western portion of Sonoma county. This area encompasses the response areas of the following fire agencies: Cal-Fire Battalions 1410, 1413 and 1411; Local Fire agencies: Annapolis, Bodega, Camp Meeker, Forestville, Fort Ross, Gold Ridge, Graton, Monte Rio, Occidental, Sebastopol, Russian River, Timber Cove.

The eastern half of the county also has increasing SOD mortality. Mortality is present in Cal-Fire Battalion 1412; Glen Ellen, Kenwood, Rancho Adobe, Knight's Valley, Mountain, Rincon Valley, Bennett Valley, Mayacamas, Sonoma, Valley of the Moon. The patterns of SOD mortality and the presence of tanoak vary considerably across this county; consequently the fire risks and mitigation strategies also vary.

Generally, SOD mortality occurs in two distinct ecosystems: the redwood ecosystem and the dryer mixed hardwood and Douglas fir/mixed hardwood forests. At present in Sonoma County, the worst mortality is in tanoak, and some of the highest densities of tanoak are found in redwood forested areas. There is also considerable tanoak in the mixed hardwood and Douglas fir forests, especially along the coastal ridges north of the Russian River to the Mendocino County line. Mixed hardwood forests generally have hotter summer temperatures, and lower humidity than redwood environments and consequently higher fire risks.

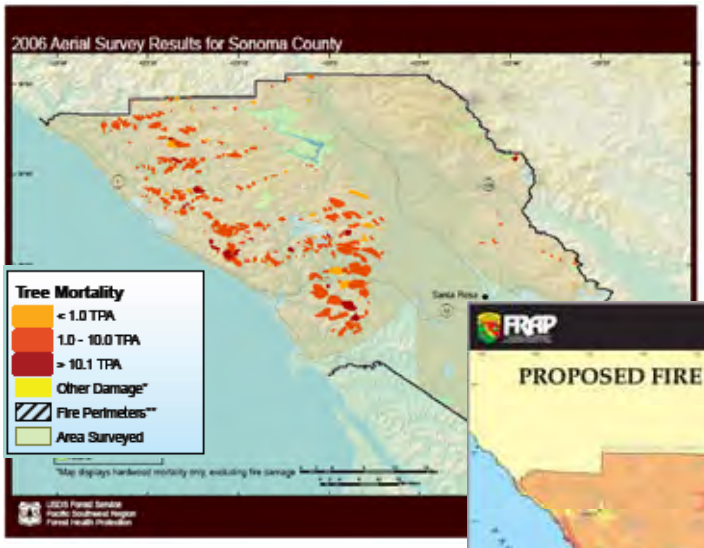

Figure 8. Aerial Survey of Tree Mortality: Approximately 99% SOD

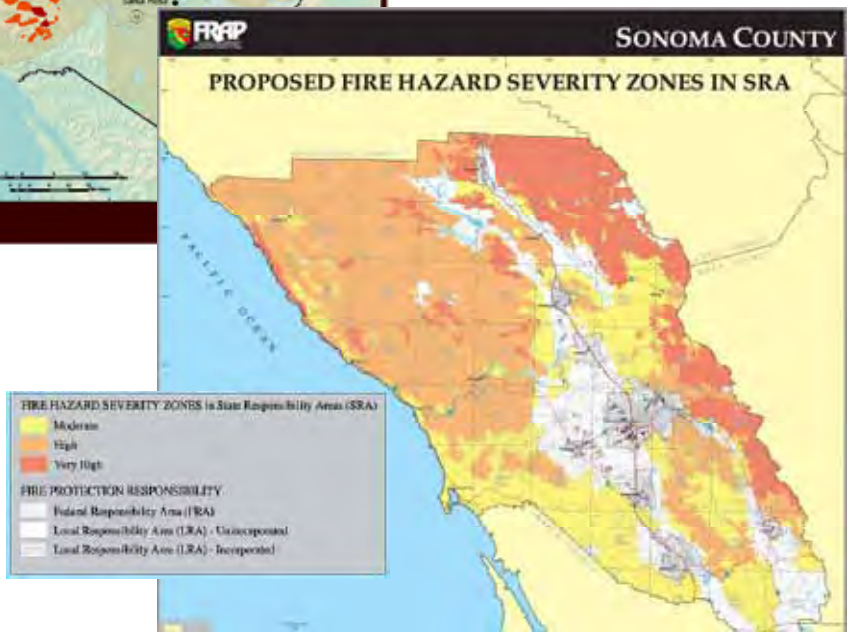

Figure 9. Fire Hazard Severity zones: SOD mortality is predominantly taking place in areas designated by Cal-Fire as high and very high fire severity zones.

SOD Impact in Redwood Ecosystems:

In redwood dominated forests on the lower Russian River and Occidental areas there is significant tanoak mortality. Fire is relatively rare in a redwood forest ecosystem, though like almost all California ecosystems, the redwood forest is adapted to fire. Logging activities in the late 19th and early 20th centuries and suppression of fire from the landscape have had a tremendous effect on what redwood ecosystems look like in Sonoma County today. Historically, in the redwood forest, low-intensity fires moved through the landscape on a twenty to fifty year cycle. Low intensity fires kill off small diameter trees thus reducing competition for water and nutrients; burn up ground litter which improves sanitation and makes minerals available to the trees; and reduce fire fuels so that the next fire too will burn with low intensity. Fire exclusion has increased the density of tree species like shade-tolerant tanoak that are intermixed in the forest and has caused considerable build up in the dead plant materials on the forest floor.

Sequoia sempervirens only thrives in temperate climates where frequent incursion of coastal fog keeps temperatures down and moisture levels up. Because of this, there are a relatively small number of days per year that redwood forests can sustain intense burning. Fire modelers postulate that, even if there are as many as 20-40 dead trees intermixed in a redwood ecosystem, their presence would not significantly affect fire behavior because, on the small number of days per years that fuel moistures are low enough to support a high intensity burn, it will burn regardless of the presence or absence of mortality.

Reasons for concern in the Urban Intermix redwood environment:

In the redwood forest along the Lower Russian River, many older summer homes have

Figure 10. Typical home with SOD mortality in Redwood / Urban interface

been converted to year round residency. Roads in these areas are commonly narrow and steep, and handle far more traffic and roadside parking than they can safely support, greatly impeding safe access for firefighters and egress for residents. Houses are often well over 50 years old, of fire-prone wood construction, and tucked into forest that has been growing without impediment since the end of the logging days. Redwood intermixes with tanoak, madrone and fir in these areas. Rio Nido and the areas around Camp Meeker and Green Valley/Pocket Canyon, Occidental and Cazadero have been particularly hard hit by SOD. A drive through these areas shows many dead tanoaks, many still bearing dry leaves, intermixing with other tree and shrub species. The potential for loss of life and property in wildland fire incidents in these areas is significant. Residents of the mixed redwood forests of Sonoma County are justifiably concerned about increasing likelihood of fire and fire behavior in their areas.

SOD Impact in Mixed Hardwood/Douglas Fir Ecosystems:
Tanoak and live oak forests have been heavily impacted by SOD. While the impacts of SOD are by no means limited to the western portion of the county, the higher incidence there of tanoak, which is more rapidly impacted by *P. ramorum*, has lead to significant patches of mortality. One of the legacies of repeated fires in the 20th Century, has been regrowth of dense, predominantly tanoak forest. The combination of a strong fire history and the predominantly tanoak fuel type makes this area a particular point of concern for firefighters who worry that the dead fuel load will further increase fire behavior and spotting (embers igniting fires beyond the fireline). Generally, mixed hardwood forests have higher temperatures and lower humidity than the redwood forest environment, and consequently have a stronger fire history and likelihood.

Figure 11. Spotty Mortality in dense tanoak forest, High Road, Cazadero 8/16/2006

Mortality varies considerably across the area. The degree of mortality that the tanoak forest will sustain, and the temporal distribution of mortality are of particular concern. Figure 11 shows spotty mortality in dense tan oak, while nearby Creighton ridge (Figure 12) shows extensive tanoak mortality. The lack of a fire model and the fact that no fires have yet burned in areas with similar SOD mortality, makes it difficult to make

Figure 12. Dense Mortality: Creighton Ridge, Cazadero, 8/12/07

accurate predictions about fire behavior. However, mortality such as seen on Creighton Ridge (which is repeated all along the coastal ridges) is of great concern to local firefighters.

Some researchers estimate that SOD mortality in tanoak will reach 80% to 100%. *P. Ramorum* has been studied for a relatively short time, and because spread of the pathogen is greatly dependent on winter and spring weather conditions, making predictions about the spread of mortality is very difficult. If trees die in relatively small numbers per year spread out over time, trees that die early in the infestation will drop their leaves and begin to decompose, making the risks less severe—though exactly how long it will take for defoliation and decomposition is an important question that does not yet have a definitive answer. If large numbers of trees die in a short time frame, the fire risks become more extreme.

The Coastal Ridges, though with a lower housing density than the lower Russian River area, have a mixture of small-lot and large-parcel subdivisions and residences along access roads and on larger ranches. Because the area is relatively remote and roads are narrow, curvy and often unpaved, access to most of this area is difficult, causing delayed response time for incoming fire apparatus. Water supply in some areas can be problematic or nonexistent with very low firefighting capacity during the peak fire season. Additionally, there has been significant growth in population as well as valuable assets—homes, businesses and agriculture—in the area, increasing risk of loss of life and property in the event of a significant wildland fire.

Mitigation Strategies:

In the following discussion about mitigation strategies, it is assumed that SOD mortality will increase fire risk and fire intensity, although clearly the degree to which that is true will be better determined in the future through research, modeling and the experience gained from fires occurring in areas with significant SOD mortality.
Mitigation strategies and procedures will differ between the areas covered by Public Resource Code 4291, which regulates fire fuels within 100′ of structures ("Defensible Space Zone") and the areas outside this perimeter ("Wildland Landscape Scale"). Strategies for these two scales will be covered separately.

Wildland Landscape Scale Mitigation Strategies:

Overall, landscape mitigation strategies should accomplish the following goals: abate fire risks; reduce fuel load; suppress establishment and spread of *P. ramorum* and create an overall improvement in forest health. Landscape mitigation strategies would address the issues caused by SOD mortality on a large-scale basis, removing dead and live trees in wildland areas beyond the 100′ Defensible Space zone required around structures. Removing trees from these areas would help to reduce intense fire behavior by removing fire fuels from the landscape, and also improve forest health by reducing crowding.

Landscape scale treatments would be regulated as follows: If the timber operation is not commercial (per PRC 4527), no permit is issued from Cal-Fire. Outside of the 100′ defensible space zone demanded by PRC 4290, timber may be commercially harvested under a 1038(b) Exemption if harvesting dead and dying (definitions in 14 CCR 895.1) in amounts less than 10% of the average volume per acre in the affected area (14 CCR 1038(b)). If the volume of dead and dying is greater than 10%, and a commercial harvest is to be conducted, then a harvest plan must be submitted.

Treatment could be carried out through mechanical means, with hand tools or by prescribed burn.

1. ***Mechanical:*** Using large machines like masticators, grinders and chippers, trees are taken down and chipped on site. Chips can be disposed of by broadcasting, or removing for disposal or reuse (firewood, chips for cogeneration, finished wood products, etc.) off site. Mechanical treatment can only be used when roads allow access to the site. Mechanical means of treatment range from $1,000-1,200 per acre, and cost of treatment will increase along with steepness and difficulty of access to terrain.

Figure 13. Masticator

2. Hand Tools: Chainsaws and other tools are used to cut trees and brush, either lopping-and- scattering or chipping debris in place or burning. Hand crews cost approximately $600 to $1,200 per acre, and cost of treatment will increase along with fuel density, difficulty of access and steepness of terrain.

Figure 14. California Conservation Corps Hand Crew

It is significant to note that California Department of Corrections inmate crews, who do a significant amount of fuels mitigation work in communities across California, cannot work in much of the western half of Sonoma County because of the amount of time it takes for them to commute from their home camps. Additionally, inmate crews typically do not work on private property.

3. Prescribed burning: Prescribed burning is the intentional introduction of fire into a landscape to accomplish predetermined management objectives and can protect trees from future fires, disease and insects, prepare a seedbed for the future forest, improve the habitat for many wildlife species and manage competing vegetation.

Fire can be an excellent management tool to deal with high surface fuel loads and dense conifer understories; however, in the SOD infested forest, the presence of a large number of dead trees may preclude prescription burning because of the high risk of escape. The window of opportunity for carrying out a prescribed burn is limited by weather, fuel conditions, air quality concerns, availability of Cal-Fire crews to monitor and potential mortality of high value trees. Sonoma County's Mediterranean Climate means very wet winters which make it difficult to burn, followed very quickly by very hot and dry conditions, which greatly increase the potential for out-of-control burns. While prescription burning has the potential to be a very cost effective and valuable tool for removing brush from the forest landscape, it is unlikely to be a viable method in Sonoma County's SOD landscapes. There is potential, however, to use prescription underburning to maintain treated acreage.

Figure 15. Prescribed burn with fuel break.

Defensible Space Zone:

Defensible Space is a radius 100 to 150 feet from structures in which vegetation has been modified to reduce the intensity of an oncoming wildfire. California Public

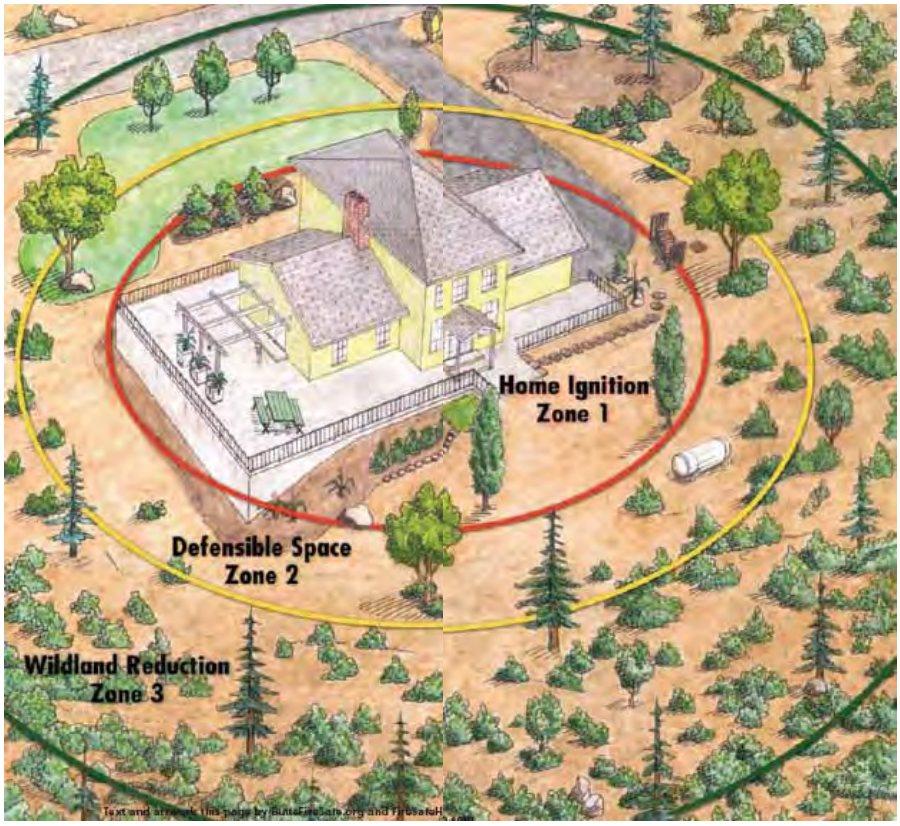

Figure 16. The fire risks of SOD dead trees must be addressed in the defensible space zone.

Resource Code 4291 demands that homeowners in Wildland Urban Interface areas create 100′ feet of defensible space. Sonoma County's building codes can increase this distance to 150′ and beyond where slope, topography or fuels increase risk. Defensible space is crucial for firefighter and homeowner life safety, for home loss prevention, and to keep fires that start in structures from escaping into the wildland.

Creation of 100′ of defensible space includes, removal of all dead materials, reduction the horizontal continuity of fuels so that fire can not move from plant to plant straight to structures, removal of the "ladder fuels" that fire can use to climb from the ground into the crowns of trees, and creation of a clean 10-30′ low fuel zone around structures. Homeowners interested in learning how to create defensible space can find information in Fire Safe Sonoma's publication, *Living with Fire in Sonoma County* and or consult with local firefighters.

If a landowner conducts a commercial timber operation whilst removing commercial

tree species from protection zones around homes to comply with PRC 4291, a 1038(c) Exemption permit from CDF must first be submitted. No permits are required if there is no commercial sale of timber (unless local ordinances restrict tree cutting, such as in the City of Santa Rosa).

Creation and maintenance of Defensible Space is the homeowner's responsibility; homeowner education about the importance of defensible space is critical. There is also a need for increased inspections to insure compliance. In Sonoma County's State Responsibility Areas (where Cal-Fire has primary jurisdiction over wildfire), Cal-Fire is responsible for carrying out those inspections. Cal-Fire will be using some of their extra staffing to do property inspections and also are training their Volunteers in Prevention (VIP) to carry out inspections.

Additionally, Fire Safe Sonoma along with neighborhood fire safe councils are an excellent resource for helping inform residents about the importance of defensible space. Fire Safe Sonoma is a 501(c)(3) non-profit whose mission is to increase awareness of wildfire issues throughout the county and has been the recipient of numerous grants that have funded both public education and fuels mitigation projects. Fire Safe Sonoma's non-profit status and organizational structure enable it to cost-effectively enact and coordinate educational and fuels reduction projects.

Costs of creating defensible space: Creation of defensible space can be a very expensive prospect for homeowners, especially those who live in forest environments. Adding to the expense, continuing mortality can force homeowners to do the same work year after year as more and more trees die. For some homeowners, compliance can be an extreme economic hardship. Typically, a five person crew with a 15" chipper costs about $2,250 per day. While one day with a crew can be enough to clear defensible space, costs can far exceed this if large trees and/or large numbers of trees need to be removed. Because of the instability of SOD trees, tree surgeons must take extra safety precautions and removal of a single large tree can easily cost upwards of $2,000 depending on the tree and its proximity to structures.

In mountainous regions of San Bernardino, Riverside, San Diego and Los Angeles Counties, hundreds of thousands of trees, weakened by years of drought, are dead or dying due to widespread infestation by bark beetles. By 2005, the governor had proclaimed a state of emergency in the four affected counties. These disaster declarations helped pave the way to federal funds for mitigation programs. To date, some 250 million dollars has been spent on fuels reduction projects in affected forests. Projects have been focused on increasing safety for communities, homes and evacuation routes as well as forest health. Funds have been administered through a combination of Federal, State, and local fire agencies, as well as non-profit fire safe councils. One of those programs, the Forest Care Program, has been able to effectively reduce fire fuel loads on privately owned land for approximately $2,700 per parcel.

Sonoma County GIS estimates that some 13,043 homes are located within one mile of SOD infected areas. Using the Forest Care Program per-home cost estimate, some $35,216,100 would be required to completely clear defensible space around these

homes. However, many of these homeowners are physically and financially capable of doing the work themselves. To help those in financial need, or help communities work together to clear common access roads, a tremendous amount could be accomplished with $2,000,000. These funds could be administered by a combination of local agencies and non-profits such as Fire Safe Sonoma to greatly improve the fire safety of many county residents. With a $147,884 grant from the Bureau of Land Management, Fire Safe Sonoma is currently administering a program for SOD impacted areas that is based on the Forest Care model.

Fire Safe Sonoma's Sudden Oak Death Fuels Mitigation Project preliminarily funded by the Bureau of Land Management for the 2007-2008 grant cycle ($147,884)* is an example of how funds can be channeled to those most in need to create their defensible space. The program will provide grants to individual homeowners to help defray the costs of creating defensible space and also will provide funds to homeowners groups or associations so that they can hire a chipper to chip debris on a neighborhood scale. It is anticipated that demand for funds will far outstrip those available for the project. More programs such as this one will be a great help reducing county residents' fire risks.

*Just before this document went to press, Fire Safe Sonoma was informed that the funding for this project had been decreased from $147,884 to $18,000. At this writing, it is unclear whether the project will take place. This bad news highlights the funding challenges we are facing for SOD mitigation in our County.

Grant Funding Challenges for Sonoma County

Most fuels mitigation grant programs are funded by federal agencies to help protect communities that are at risk to fires originating on federal lands. Because Sonoma County has very little federal land, our access to federal fuels mitigation programs is severely restricted. The Bureau of Land Management has generously funded Fire Safe Sonoma's SOD Mitigation Program as well as several other important grant projects despite the lack of real nexus. We hope that the success of the SOD Mitigation program will help encourage BLM to continue to fund projects in our county, but the fact remains that the grant funds to which we have access is very shallow.

In addition, the closure of Sonoma County's sole California Department of Corrections Conservation Camp has had an impact on fuels management projects. Inmate crews are no longer available for projects in the West County, which not only makes it very difficult to tackle large-scale mitigation projects, it also removes crucial grant matching fund potential. The number of calls received by Sonoma County's fire agencies, SOD Coordinators, and Fire Safe Sonoma indicates that residents are truly concerned by the number of dead trees in their communities, and that they need help to deal with the problem. Our local, state and federal leaders' awareness of the magnitude of the problem, the costs of addressing it (and alternately the potential costs of NOT addressing it) will be a crucial element in deepening the resources available to aid county residents and agencies

Components of the Strategic Plan

Managing the spread and hazards associated with Sudden Oak Death in Sonoma County will require the following actions, each discussed in more detail below:

1) Manage the hazardous trees in order to avoid injury and loss of life, and damage to property;
2) Slow the spread of the disease. Hazardous tree removal and practices that may slow the spread of the disease are used minimally in Sonoma County currently, mainly because of lack awareness and lack of funds;
3) Educate agencies and residents to keep them current with research about SOD, forest health, fire dangers, and management techniques;
4) Reduce fire fuels in the wildland urban intermix.

1. Manage for Hazardous Trees

The large numbers of dead trees on public and private property pose a significant risk for residents. The greatest dangers are associated with the effects of hazardous trees and potential for wildfire. Agencies and homeowners need to remove trees that have died or are dying when they pose a hazard—when they could potentially fall and kill or injure people, cause property damage, or hit power lines.

Figure 17. This dead tanoak next to a road, power line and person is a hazard to all three, and needs to be removed.

Hazards on individual properties pose risks for the entire community. Many homeowners and agencies lack the means, financial or otherwise, to remove dead trees and fire prone vegetation from around homes and vulnerable structures. The rapid spread of SOD often makes it difficult for property owners, utility companies, and land managers to simply keep inventory of trees that need to come down, and makes tree removal an unending activity—if it can be afforded. Local fire officials are increasingly alarmed about the risk of catastrophic fire and structure loss in Sudden Oak Death impacted areas. Federal and State funding for these activities is needed.

2. Slow the Spread of Infection

Current research and results from in-the-field management trials in Humboldt County, California and Curry County, Oregon are what we rely on in choosing suitable and effective management tools for use in Sonoma County. Slowing the spread of the pathogen requires attack on three fronts: preventing spread of the pathogen into areas

where it is not already present; lowering the level of spores in the landscape; and trying to reduce the susceptibility of hosts. The techniques are used in a variety of combinations (less of one, more of another, etc.) according to land management goals, social acceptability, and cost, among other factors. An aggressive management plan to slow the spread of the pathogen requires removal of all host trees in an infested area coupled with burning, applying herbicide to stumps, and replanting with non-hosts species. A less aggressive plan would be less than this, for example, using fewer management tools and/or working on a smaller scale.

Figure 18. Humboldt County SOD management site where tanoak and bay laurel trees were removed and small diameter material burned. Photo by Yana Valachovic.

Cutting down, or thinning out host trees in a forest creates a less suitable habitat for the pathogen should it reach an area. The fewer host trees there are, the fewer spores that get produced, and therefore the fewer infections that can get started. California bay laurel and tanoak are the main host trees that would be targeted in this technique. Herbiciding stumps to prevent re-sprouting and subsequent re-infection of sprouts often accompanies this technique. Broadcast burning and pile burning which destroys the pathogen in the plant material and soil also can accompany this technique which aims to lower the level of spores on host trees and in the landscape.

Clearing around individual high-value trees is a technique used to try to preserve individual, high-value trees. Research reveals that spores on a bay leaf easily travel a couple of meters in wind and rain. Therefore pruning and thinning California bay laurel and tanoak within 2.5 to 5 meters from a high-value oak tree should reduce the amount of pathogen the oak is exposed to (Sweicki et al., 2007).

Sanitation & slow-the-spread BMPs (best management practices) are practical measures to prevent the spread of SOD based on what we have learned from SOD research and management trials. The techniques are probably not widely practiced by land owners, tree trimming services, and County agencies, because they are not yet widely known. Some of the practices that help slow or prevent spread of SOD are:

- Clean equipment after working in the forest, including chainsaws, boots and truck tires (spray with a 10% bleach solution or Lysol, then rinse);
- Avoid or minimize pruning oaks in wet weather;

- Work in forests in the dry season instead the warm, wet seasons when spores are being produced and infections are starting;
- Select SOD and fire-resistant species for landscape plantings;
- Keep an eye out for symptoms, for two months, on nursery-purchased host plants before planting them in the ground—especially rhododendrons and camellias;
- Keep potentially infected downed trees on your property instead of transporting the material to an uninfected area.

Chemical treatment with the systemic fungicide Agri-Fos: This a very low toxicity spray-on or injected phosphonate compound that has been shown in trials to help a tree protect itself from infection (M Garbelotto et al., 2007). It has been approved for this use on susceptible oak and tanoak trees only since 2003, so it's efficacy in the field is largely unknown. It is not a forest-wide treatment because it is labor intensive and costly to apply; it is used instead on high-value oaks and tanoaks.

Figure 19. Agri-fos can be sprayed onto a trunk, as shown here. It can also be injected into the trunk of an oak or tanoak.

Replanting with native, non-host species may be a way to lower the pathogen in the landscape (by not providing host species to infect) as well as a way to discourage colonization by non-native weed species which may cause other problems in the future.

Other management strategies can be explored through creating, participating in, and encouraging SOD management and research projects in Sonoma County. UCCE and DES personnel are currently formulating management projects in order to find effective and feasible treatments appropriate for Sonoma County SOD and fire conditions.

3. Educate Residents and Staff

Because SOD is a disease only recently affecting our forests, there is a lack of understanding at every level from the general public to government agency officials. Presenting information about disease spread, symptoms, hazards, fire danger and defensible space to residents and agencies enables them to take personal responsibility for forest health and fire fuels reduction. Currently, the Sonoma County UC Cooperative Extension and the Department of Emergency Services provides educational programs addressing the growing threats from SOD. After seventeen Sudden Oak Death community information meetings in the past ten months it is clear that residents are very interested in recognizing disease symptoms and preventing spread, using treatment for infected trees, funding for tree removal, recognizing fire hazards, and creating defensible space.

Figure 20. Mark Stanley, Chair, California Oak Mortality Task Force, speaks at a community SOD meeting in Guerneville. Outreach and education personnel at DES and UCCE provide indoor and in-the-field educational programs for Sonoma County

A consistent education effort gives Sonoma County agencies and residents some of the tools they need to act on their interests, to care for their trees, forests, and their own safety. Continuing this outreach and education program would allow us to reach more residents, work with more agencies, and carry-on efforts to provide information on SOD, forest health, and fire safe practices. Additionally, education and outreach ensures that funding opportunities are well publicized and understood by homeowners and public and private agencies.

4. Reduce Fire Fuels & Make Accurate Assessments of Sod Fire Risks

Reduction of fire fuels build-up that results from SOD mortality, particularly in the 100' defensible space zone around structures, is crucial. (The complicated issue of SOD fire risks is discussed in detail in the *Sudden Oak Death and Fire* chapter of this document.) Crucial elements for improving fire safety in SOD areas are: educating homeowners about the importance of defensible space and how to create it; increasing inspections for compliance to Public Resource Code 4291, which demands defensible space; and providing financial aid programs for fuels mitigation work for those in the SOD affected areas.

Creation of a fuel model that addresses the western hardwood forest in general and the SOD impacted landscape in particular is a crucial need to make more accurate predictions about how fire will behave in the SOD devastated landscape.

SOD Impact in Sonoma County: Agency Responses and Needs

Current and Future Needs

Sonoma County agencies and other organizations within the County that manage land were interviewed to determine the extent of SOD mortality on land they manage, how it is affecting operations, and their current and future needs are for managing SOD mortality. Interviews were conducted with planners, managers, and field staff from: the Water Agency; Transportation and Public Works; Agricultural Preservation and Open Space District; Regional Parks; Agricultural Commissioner's Office; Department of Emergency Services; University of California Cooperative Extension; Sonoma County's incorporated cities; California State Parks; and California Department of Forestry and Fire Protection.

The programs they would like to implement are mainly a reaction to the disease once it hits. No agency is planning a dramatic response (for example, they are not planning to attempt to eradicate the disease), their reactions are more along the lines of trying to keep their heads above water in dealing with the hazards and costs of SOD mortality. Below are the approaches to managing the disease and its consequences.

Surveys for infected and hazardous trees

Surveys determine the extent of SOD and hazardous trees and can target management activities. Aerial and ground surveys that confirm mortality caused by the pathogen lets land managers know the extent of the problem, where to look for hazard trees, where to expect a change in fire behavior, and where to manage for slowing the spread of the disease. Ground surveys are particularly important in park campgrounds and along hiking trails, along roads and power lines, and in areas with homes built in the forest. All agencies need to know where the disease is in order to focus management activities making this a good candidate for cost-sharing among the agencies.

Tree removal

The decision to cut down a tree is made on a tree-by-tree basis. Trees are removed if they are a hazard or if their removal will slow the spread of the disease. In some situations it is best to cut down diseased or susceptible trees and dispose of the wood, for example, by chipping. This can be very expensive because of equipment and labor costs. Many agencies can remove small trees with their own equipment and staff, but outside experts need to be hired for larger trees, trees on steep slopes, and in areas with extensive tree mortality.

Public Education Programs and Staff Training

Education is needed on several fronts in managing SOD. Agencies would like to provide in-house training to keep current with SOD research, protocol, and threats. County

residents and park visitors want to learn what they can do to lower the impact of SOD in their neighborhoods, forests, and parks. Landowners need to know how SOD influences their forest, the potential for forest fires, and how to create and manage defensible space around their homes. Outreach programming would be geared toward managing mortality, slowing the spread of the pathogen, and fire awareness.

Protocols for Identification, Tree Removal, Disposal, and Sanitation

Protocols for identification of symptoms, tree removal, disposal and transportation of infected biomass are needed to guide County agencies through the proper procedures, or Best Management Practices (BMPs), for dealing with SOD. Many BMPs are already available; these could be tailored to Sonoma County resources. Since all agencies need procedures and BMPs, this is a good opportunity to pool resources and create protocols for the entire county, with the necessary minor changes made for individual agencies.

Fuel Model

A fire fuel model for the Western Hardwood Forest that is being heavily impacted by SOD in Sonoma County does not exist. A model that accurately describes fire behavior in this type of forest, with reference to the ramifications of SOD mortality is crucial to understanding what fire behavior will be like in SOD impacted areas, and how fuels management plans and programs can best address risk reduction.

Fire Fuels Reduction, Planning and Funding

Public agencies and private landowners are concerned about the costs of removing dead trees from roadways and around homes. Because of the instability of SOD trees, removal can be difficult and costs can be high. This is especially true in areas where mortality is spread out over time, forcing large expenditures year after year.

Aid for Fire Fighting Agencies impacted by downed trees

Fire Agencies in SOD impacted areas are frequently called out to deal with SOD trees that take down power lines and block roadways. Funds to help them contend with the extra costs of SOD tree calls would moderate financial impact and help them to recompense volunteer firefighters.

The tables below summarize the costs by agency. It does not take into consideration the shared-cost opportunities presented by the overlapping tasks, for example in survey, education, and protocol development; nor does it include Cal-Fire’s increased staffing.

Agency	Year 1 Costs	Subsequent Year Costs
Sonoma County Department of Emergency Services	$335,246	$135,246
Sonoma County UC Cooperative Extension	$165,000	$155,000
Sonoma County Transportation and Public Works	$119,000	$114,000
Sonoma County Regional Parks	$695,560	$266,288
Agricultural Preservation and Open Space Dist.	$72,100	$41,000
Sonoma County Agricultural Commissioner	0	unknown
Sonoma County Water Agency	0	unknown
Sonoma County Agencies: Subtotal	*$1,386,906*	*$711,534*
Fuels Mitigation Funds (Agencies TBA)	$2,000,000	$2,000,000
Incorporated Cities	$449,300	$196,300
Cal-Fire/California Forest Improvement Program	$150,000	$150,000
State Agencies: CA Dept. Parks & Recreation	$120,850	$113,750
Total	**$4,107,056**	**$3,171,584**

Table 3. Summary of Costs of Agency Needs

Fuels Mitigation Programs

Sonoma County's SOD coordinators have presented more than twenty 20 SOD Workshops and make daily contact with residents of the SOD impacted areas of the County. Overwhelmingly, they have found that residents are very concerned about the effect that SOD dead trees have on fire risk in forest areas. The public clearly perceives that SOD mortality presents a danger to their homes and they will continue to look to local officials to help mitigate the problem. It is clear that there is a need for funds to aid homeowners and agencies concerned with hazard trees and fuels risks.

Sonoma County GIS estimates that approximately 11,500 homes are in areas likely to be affected by SOD. Using Southern California's Forest Care Program's $2,700 per-home cost estimate for clearing defensible space, $31,050,000 would be required to completely clear defensible space around these homes. As a starting point, we estimate $2,000,000 is a manageable amount that could have a tremendous impact on reducing fire risks and hazard trees in the county. Priority projects could target trees that are in the 100' defensible space zone around homes or hazard trees that pose a falling risk to roads, trails structures or people.

Where mitigation funds will come from and how they will be managed and distributed are issues still up to question. Funds could be administered by State Agencies, Local Government Agencies, non-profit organizations such as Fire Safe Councils or a combination of all three. Obviously, this issue will require considerable discussion if and when funds become available.

Grant Funding Challenges for Sonoma County

Most fuels mitigation grant programs are funded by federal agencies to help protect communities that are at risk to fires originating on federal lands. Because Sonoma County has very little federal land, our access to federal fuels mitigation programs is severely restricted. Though the Bureau of Land Management (BLM) had preliminarily funded Fire Safe Sonoma's SOD Mitigation Program despite our lack of federal nexus, their ability to fund the project is now in question (see Fire Safe Sonoma, below). It is clear that we are severely limited in fuels mitigation funds.

In addition, the closure of Sonoma County's sole California Department of Corrections Conservation Camp has had an impact on fuels management projects. Because of the distance from their home camps, inmate crews are no longer available for projects in much of the West County. This makes it very difficult to cost-effectively implement large-scale mitigation projects and removes crucial grant matching fund potential.

Our local, state and federal leaders' awareness of the magnitude of the problem, the costs of addressing it (and alternately, the potential costs of *not* addressing it) will be a crucial element in expanding the resources available to aid county residents and agencies. The inclusion of SOD issues in this year's Leglislative Agenda is a great step forward.

Fire Safe Sonoma

Fire Safe Sonoma is a non-profit fire safe council, whose mission is to increase awareness of fire safety issues in our county and encourage fuels reduction projects and education. Fire Safe Sonoma's Board of Directors and Executive Director have considerable experience in administering fuels mitigation projects. This year, Fire Safe Sonoma's Sudden Oak Death Fuels Mitigation Project was preliminarily funded by the Bureau of Land Management ($147,884)*. Currently in early implementation, the grant project will run from November 2007 to May 2008. At this writing, there have been some 50 individual homeowners and homeowners groups that have submitted notice of their interest in participating in the project.

* Unfortunately, in mid-December, Fire Safe Sonoma was informed that funding for this project had been reduced from $147,884 to $18,000. At the time of this writing, it is uncertain if the SOD Fuels Mitigation Project will take place.

The Sudden Oak Death Fuels Mitigation Project is based on the Southern California's Forest Care model; Fire Safe Sonoma will provide funds ($2,000-$4,000) to help homeowners either hire a contractor to take down hazard trees or hire a chipper to dispose of debris on a neighborhood level; there is a 10% cost share for participants which can be fulfilled with in-kind labor. $100,000 of the grant funds will go directly to help homeowners reduce fuels in the defensible space zone; if grant awards average $2,000, we can treat 50 properties. A number of neighborhood project proposals have been submitted. Because neighborhood efforts will make great use of volunteer labor in conjunction with contractors, it is anticipated that work carried out will exceed goals. This project will serve not only to reduce fuels risks in the defensible space zone for County residents, it will also serve as a model for future fuels mitigation projects.

Fuels Mitigation:

Total Cost: $2,000,000

Impact, Response, and Needs:
Sonoma County Agencies

Sonoma County agencies and other organizations within the County that manage land were interviewed to determine the extent of SOD mortality on land they manage, how it is affecting operations, and what their current and future needs are for managing SOD mortality. Interviews were conducted with planners, managers, and field staff from: the Water Agency; Transportation and Public Works; Agricultural Preservation and Open Space District; Regional Parks; Agricultural Commissioner's Office; Department of Emergency Services; University of California Cooperative Extension; Sonoma County's incorporated cities; California State Parks; California Department of Forestry and Fire Protection; and PG&E.

Sonoma County Department of Emergency Services & County Fire Fighting Agencies

Sonoma County Department of Emergency Services
Contact: Vernon Losh III, Director

Administrative Offices:
2300 County Center Drive, 221A, Santa Rosa, CA 95403
(707) 565-1152
http://www.sonoma-county.org/des/

Agency Overview:

In Sonoma County there are 20 local fire agencies, six city fire departments and the County Service Area #40 which consists of 15 all-volunteer rural fire companies under the direction of the Sonoma County Department of Emergency Services (see fig. 3, Fire Section). Generally, the problems that SOD causes for fire agencies are similar, with areas more heavily impacted faced with more problems and greater costs.

The Sonoma County Department of Emergency Services (SCDES), which consists of Emergency Services, Hazardous Materials, Administrative and Fire Divisions, has taken a lead role in dealing with the issues pertaining to SOD. Many of the fifteen rural fire companies of the CSA #40 are in areas already severely impacted by SOD and most of the rest are in areas that are at high risk of showing greater infection in the future. The SCDES's administrative structure, experience in writing and directing grant projects, and the availability of staff that specializes in Wildland/Urban Interface fire issues and public education puts them in an ideal position to plan and administer SOD related projects.

In 2006, DES was the lead agency in a grant program funded by the US Forest Service. With grant funds, DES hired a part time SOD Outreach Coordinator/Fire Prevention

Specialist to provide outreach to residents about the fire risks associated with SOD mortality and how to make their homes more fire safe. For this document, the SOD Outreach Coordinator conducted interviews with personnel from fire agencies that are in areas severely impacted by SOD. The recommendations and concerns they expressed are more completely outlined in the Fire Section of this Strategic Response Plan.

The SOD Outreach Coordinator/Fire Prevention Specialist works closely with the SOD Coordinator at the Sonoma County UCCE, whose expertise is in the management of the pathogen.

Activities of SOD Outreach Coordinator/Fire Prevention Specialist include:

• Coordinating and creating educational programs for residents

• Creating strategic plan for County

• Participating in trainings with other State and local agencies

• Consulting with homeowners and agencies about fire risks of SOD mortality

• Press and Media relations

• Research local management options

• Stay current with SOD research

Recommended Action

• **Education, Outreach, Research**

Education for homeowners and firefighters: Education is a crucial element for increasing county residents' awareness of the risk that SOD poses to their property and what they can do to mitigate it. A fire outreach coordinator with experience in fire and knowledge about Defensible Space who is available to help all County residents is a critical need. In addition to educating residents about the importance of defensible space, fire outreach coordinator can serve an important educational role for all fire safety issues; while it is true that SOD mortality poses risks to structures, it is also true that because of extensive mortality, house fires have a greater likelihood of spreading to the wildland. Continuing education about how to prevent and keep families safe from both home and wildland fires has far reaching positive benefits for our residents.

Cost: Full time: $96,364/year;

Supervision: $ 22,726;

Total Cost: $119,090

Fuel Model: A fuel model that addresses western hardwood forests impacted by SOD would greatly enhance our ability to understand how SOD affects fire behavior, and aid fire professionals to better anticipate threats and develop response plans. It is estimated that a practical fuels model could be completed in approximately four years at a cost of $200,000 (Susan Frankel, personal communication, 2007). Additionally, Cal-Fire has indicated that their fuels modeler could develop a basic fuel model for SOD impacted forest in far less than four year, pending his availability for the project.

Total cost: $200,000

Provide Funds for Fire Departments impacted by SOD responses: Funds could be used to maintain or purchase new equipment used in down tree calls down trees and provided a stipend to firefighters for tree down calls. This stipend would be a good incentive, especially for volunteer fire companies for whom tree down calls pose a difficult burden. Basing costs on an average number of down tree calls of 156, with an average per firefighter stipend of $17.00 x 3 responders per call: $7,956: Equipment and tool allowance: $400 per 13 SOD impacted department=$5,200

Total cost: $16,156

Sonoma County Department of Emergency Services, Local Fire Agencies and Fire Safety Groups:

Anticipated Needs Year One	**Estimated Costs**
Education	$119,090
Fuel model	$200,000
Fire Department Funds	$16,156
Total	**$335,246**

Table 4: Fire Agency Needs, Year 1

Anticipated Needs Subsequent Years	**Estimated Costs**
Education	$119,090
Fire Department Funds	$16,156
Total	**$135,246**

Table 5: Fire Agency Needs, Year 2

Sonoma County
University of California Cooperative Extension

Contact: Lisa Bell
SOD Program Coordinator
lkbell@ucdavis.edu

Administrative Office:
133 Aviation Boulevard, Suite 109 Santa Rosa, CA 95403
(707) 565-2621
http://cesonoma.ucdavis.edu/

Agency Overview

The Sonoma County, University of California Cooperative Extension (UCCE) provides agricultural, natural resources, and home advisor services through an agreement between Sonoma County and the University of California. UCCE conducts research and educational programs for local agricultural industries and disseminates information to the community at large. Services provided by UC staff include assistance for the dairy, poultry, horticulture, viticulture, seafood, and livestock industries. In addition, UC and County support staff, along with trained volunteers, provide information to the community on integrated pest management, gardening, natural resources, nutrition education, youth development, and home economics.

Agency Response to SOD

In 2002, UCCE in Sonoma County had a Sudden Oak Death Coordinator who conducted local research and an educational outreach program. This one-year position was funded by the Sonoma County Fish and Wildlife Advisory Board. The SOD Coordinator was a resource for information delivery to professional arborists and homeowners, was involved in local research on the disease, performed survey work to determine the location and spread of the problem, and worked on diseased vegetation disposal alternatives.

A SOD Program Coordinator position was re-funded in late 2006 by the US Forest Service. The primary objectives of the SOD Program Coordinator are: to develop a County Strategic Response Plan; to provide SOD educational programs to County residents; and to conduct local research on SOD management techniques. The Program Coordinator's goal is to manage the effects of SOD infestations through workshops, community presentations, and one-on-one contact with residents, and local research.

The Sudden Oak Death Program Coordinator currently provides outreach and education to residents and agencies, facilitates SOD research in the county, and keeps the county up-to-date on SOD research and best management practices. The UCCE Sonoma SOD Program Coordinator works closely with a Fire Management Specialist at Sonoma

County DES, and SOD Coordinators at the UCCE Marin and Humboldt offices, and the California Oak Mortality Task Force.

Activities of Sudden Oak Death Program Coordinator include:

- Holding educational programs for residents
- Creating strategic plan for County
- Participate in trainings for arborists
- Consult with homeowners and agencies about SOD mortality
- Research local management options
- Stay current with SOD research

Recommended Actions

- **Education, Outreach, Research**
- **Develop County-wide Protocols**

Education, Outreach, Research

A full-time Sudden Oak Death Program Coordinator at Sonoma County UCCE would continue to provide outreach and education to people and agencies within Sonoma County, facilitate SOD research in Sonoma County, and keep the county up-to-date on SOD research and Best Management Practices. As Sudden Oak Death continues to spread in the County, greater resources are needed to respond to residents' and agencies' needs. The SOD Program Coordinator will continue to work with residents, industry, and public agencies to slow pathogen spread, and minimize the effects of mortality.

Develop County-wide Protocols

Several agencies reported the need for a document describing protocols to follow when dealing with Sudden Oak Death. Protocols would describe the options for identification of hazardous and infected trees, their removal and disposal, and sanitation in SOD-impacted forests. This guide would draw on research and respond to changing conditions. The SOD Program Coordinator will work with County agencies, the California Oak Mortality Task Force, industry, SOD researchers, foresters, and arborists to develop protocols to effectively deal with the spread of the pathogen and the tree mortality it causes. Protocols would be developed for the following areas:

- How to detect and monitor for SOD
- How to manage SOD, Best Management Practices
    - What do you do with an infected tree, remove it or not
    - What to do with the downed material
    - How and when to treat individual trees with Agri-fos
    - Thinning trees in a stand
    - Prescribed burns
    - Herbicide use
    - Sanitation
- State Regulations
- Resources for residents and agencies

Anticipated Needs	Estimated Costs
SOD Program Coordinator (salary, benefits, office support, travel)	$155,000
Develop County-wide Protocols (Determine effective procedures)	$10,000
Total	**$165,000**

Table 6. U.C. Cooperative Extension Needs, Year 1

Anticipated Needs	Estimated Costs
SOD Program Coordinator (salary, benefits, office support, travel)	$155,000
Total	**$155,000**

Table 7. U.C. Cooperative Extension Needs, Subsequent years

Sonoma County Transportation and Public Works

Contact: Ken Giovannetti
Engineering Manager, Maintenance Division
manken@sonoma-county.org

Administrative Office:
2300 County Center Drive, Suite B100, Santa Rosa, CA 95403
(707) 545-2231
www.sonoma-county.org

Overview of Agency

The Sonoma County Transportation and Public Works Department provides road construction and maintenance services, and directly provides or administers contracts for various public utility services. The roads are primarily on private lands within right-of-way easements. The Transportation and Public Works Department is not responsible for the management of the surrounding land except when conditions directly affect or threaten road operations.

Impact of Sudden Oak Death on the Agency

Very few SOD-killed trees have been recorded as interfering with roadway operations; therefore, Public Works has not yet been significantly impacted by SOD. But mortality can be seen along many county roads, and an analysis by Public Works determined there are currently 30 miles of road in areas of significant tree mortality. It follows that as more trees die, the number of dead trees creating a hazard to roads will increase. Particularly vulnerable roads in the west county include Green Valley Road, Joy Road, Coleman Valley Road, Bittner Road, Mays Canyon Road, and the Bohemian Highway. In the heavily impacted northwestern part of the county, impacted roads include Tin Barn Road, Hauser Bridge Road, Fort Ross Road, and Stewarts Point Skaggs Spring Road.

Recommended Actions

- **Survey**
- **Hazardous Tree Mitigation**
- **Training**
- **Identification, Disposal, and Sanitation Protocols**

Survey

SOD infection, or even dead trees near roadways, does not mean that the trees pose a direct hazard to road operations. A ground survey could determine the extent of SOD-killed trees that are hazardous. It would take approximately 80 hours to complete a survey of the roads, including analysis and reporting. Using a conservative estimate of $100 per hour for a private arborist, the survey would cost $8,000. Surveys should be conducted annually as SOD is projected to spread and intensify in the coming years.

Hazardous Tree Removal
The Department of Transportation and Public Works currently has the staff and equipment necessary to remove and dispose of smaller SOD-killed trees and downed branches. However, larger trees killed by SOD can be difficult and dangerous to remove, and may require outside contractors. It is estimated that $100,000 would be needed annually for tree removal.

Training
The Department of Transportation and Public works has a full-time vegetation and herbicide management crew responsible for monitoring and removing hazardous vegetation. In addition, there is a road crew does large-scale roadside vegetation removal. Once the protocol is completed, the field staff would require annual training on Best Management Practices (BMPs). Trainings could be completed for $6,000, and would provide instruction to eight field foremen and eight lead workers. It should be completed annually to ensure that BMPs reflect the most current research and management strategies.

Identification, Disposal, and Sanitation Protocols
Transportation and Public Woks require protocols for the identification of infected and hazardous trees, and recommendations on removal, disposal, sanitation, and transportation of SOD infected biomass.

Anticipated Needs	**Estimated Costs**
Hazardous Tree Survey (ground surveys by arborists)	$8,000
Tree Removal (in-house and contracted)	$100,000
Staff Time for Sudden Oak Death Trainings (on BMPs)	$6,000
Identification, Disposal, and Sanitation Protocols	$5,000
Total	**$119,000**

Table 8. Transportation and Public Works Needs, First year

Anticipated Needs	**Estimated Costs**
Hazardous Tree Survey (ground surveys by arborists)	$8,000
Tree Removal (in-house and contracted)	$100,000
Staff Time for Sudden Oak Death Trainings (on BMPs)	$6,000
Total	**$114,000**

Table 9. Transportation and Public Works Needs, Subsequent years

Sonoma County Regional Parks

Contacts:
Allan Darrimon
Parks and Grounds Maintenance Manager
adarrimo@sonoma-county.org

Ken Krout
Parks and Grounds Maintenance Worker II
Kkrout@sonoma-county.org

Administrative Office:
2300 County Center Dr., Ste 120A, Santa Rosa, CA 95403
(707) 565-2041
http://www.sonoma-county.org/parks/

Agency overview

The Sonoma County Regional Parks Department oversees 43 parks. Their mission is to enhance the quality of life in Sonoma County by providing recreational, social and cultural opportunities for the public; and leading in the preservation, conservation, restoration and promotion of the natural, scenic, and historical resources in Sonoma County.

Impact of SOD on Agency

SOD mortality was first confirmed at Mt. Hood Regional Park in 2003. The number of acres affected is less than two (California Oak Mortality Task Force, OakMapper; lab confirmation – State of California 2003). SOD has also been confirmed at Spring Hill School Cemetery (California Department of Food and Agriculture, May 2007), where three trees are SOD confirmed and 37 more showing symptoms are subject to lab confirmation. In addition, suspected specimens at Spring Lake Regional Park are being surveyed, but are not yet confirmed.

While the total current confirmed impact of SOD in the Regional Parks might appear limited, the Department is assessing greater potential affects. All park sites will be surveyed and potential outbreaks will be identified and mapped.

Recommended Actions

- **Survey for hazardous and infected trees**
- **Hazardous tree removal**
- **Staff training**
- **Education and outreach**
- **Identification, Removal, Disposal, and Sanitation Protocols**

Survey

Currently, the extent of SOD infestation in the Regional Parks is unknown. Aerial and ground surveys are valuable options to provide any information about the boundaries of the potential infestation. An initial SOD survey of the entire park system, performed by staff, would take approximately 600 person hours and require GPS equipment and specialized vehicles; with an estimated cost of $456,000. The Regional Parks Department

may consider sponsoring students from Sonoma State University, the University of California, or Santa Rosa Junior college to carry out the survey, which could lower costs substantially. Annual follow-up surveys are estimated at $12,500.

Hazardous Tree Removal
There are a few infested acres in the Regional Parks. The greatest concentration of infected trees is at the Spring Hill School Cemetery (about 40). The removal of 40 infected trees at this particular site is estimated at $50,000.

If infection spreads to other areas within the parks, the department may remove more hazardous trees. Regional Parks estimates that they may remove 80% of dead and diseased trees using in-house staff. The remaining 20% would require the more specialized removal techniques of outside contractors.

Staff Training
Regional Parks' field staff currently attend regular pesticide and pest management training. This training would be expanded to include SOD field identification, best management practices, and Agri-Fos application. The Department is interested in the use of Agri-Fos to prevent infection in healthy heritage trees. It is anticipated that the University of California Cooperative Extension staff and University of California researchers could provide SOD training. Annual, eight-hour training sessions for key supervisory staff would cost $7,920 (15 staff members @ $66/hour) and annual four hour training sessions for maintenance field staff would cost $6,425 (30 maintenance staff @ $53.54/hour).

Outreach and Education
In an effort to slow the spread of SOD, visitors could be informed of what they could do to prevent the spread of the pathogen. Signage could be placed at trailheads in areas of known SOD infestation, and at trailheads in high-risk areas. A brochure could be made available to visitors at ranger stations and public kiosks. Field staff and tree crews could also benefit from field diagnostic guides. These guides could serve as a complement to staff training. A focused outreach campaign is estimated at $10,000 for materials and staff time the first year and $1,000 annually for subsequent years.

Identification, Removal, Disposal, and Sanitation Protocols
Protocols will be formed for the identification of infected and hazardous trees, and recommendations on removal, disposal, sanitation, and transportation of SOD infected plant materials.

Anticipated Needs	**Estimated Start-up Costs**
Survey for Hazardous and Infected Trees (staff time and equipment)	$456,000
Hazardous Tree Removal of 80 trees (contracted labor)	$211,360
Staff Training for key staff and maintenance staff	$13,200
Outreach Materials (signs, brochures, diagnostic guides)	$10,000
Identification, Removal, Disposal, and Sanitation Protocols	$5,000
Total	**$695,560**

Table 10. Regional Parks Department Needs, First year

Anticipated Needs (Estimates are subject to 10% annual increases)	**Estimated Annual Costs**
Staff assessing outbreaks	$12,850
Mapping of infected, dead, hazard trees	$17,133
Administrative Assistant to input mapping data into system.	$1,600
Removal of 80 Hazardous trees (contracted)	$211,360
Laboratory Services for determining SOD Infection	$8,000
Staff Training (on Agri-fos treatment and BMPs)	$14,345
Outreach Materials (signs, brochures, diagnostic guides)	$1,000
Total	**$266,288**

Table 11. Regional Parks Department Needs, Subsequent years

Agricultural Preservation and Open Space District

Contact: Leslie Lew
Open Space Planner
llew@sonoma-county.org

Administrative Office:
747 Mendocino Avenue, Suite 100,
Santa Rosa, CA 95401
(707) 565-7360
http://www.sonomaopenspace.org

Agency Overview

The Sonoma County Agricultural Preservation and Open Space District permanently preserves the diverse agricultural, natural resource, and scenic open space lands of Sonoma County for future generations through land purchases and conservation easements. The District conserves greenbelts between cities, farmland, biological resources, wildlife habitat, and land for public recreation (Sonoma County Agricultural Preservation and Open Space District website, 2007).

Impact of SOD on the Agency

The District protects 70,700 acres of lands in Sonoma County. Roughly 640 acres is affected by SOD mortality. This is about one percent of the District's land interests. SOD has been detected on District-protected fee lands at Calabazas Creek, Taylor Mountain, and Jacobs Ranch Open Space Preserves and probably affects other District fee lands as well. Various properties protected by District-held conservation easements such as the Moon Ranch, Sonoma Development Center #1 (part of Jack London State Park), and Camp Gualala, among other properties, have also been affected by SOD.

Agency Response to SOD

District personnel have attended Sudden Oak Death informational meetings and have had one-on-one meetings with SOD experts. In an effort to proactively address SOD, the District has opened up Jacobs Ranch, Calabazas Creek, and Taylor Mountain to research projects focused on managing the pathogen's spread, and they will continue to incorporate the research and its findings into their management plans. While the total impact of SOD on the District is relatively minor, the District is concerned about the potential for future outbreaks of SOD and the effects of oak mortality, including potential fire hazard and the creation of hazard trees. High incidence of tree mortality would likely require costly tree removal.

Recommended Actions

- **Survey for hazardous and infected trees**
- **Hazardous tree removal**
- **Treatment of infected trees**

- **Staff training**
- **Education and outreach**
- **Identification, removal, Disposal, and sanitation protocols**

Survey for Hazardous and Infected Trees
A comprehensive aerial survey of District land followed by on-the-ground inspections would be essential to determine the full extent of SOD on district lands. An estimate for initial aerial and ground surveys is $42,100. Ground surveys will be needed in subsequent years to determine the spread of the pathogen. Additional ground surveys are estimated to cost $20,000 annually.

Treatment of Infected Trees
Should it be determined that any trees affected by SOD should be treated, the District would hire a contractor to treat affected trees by trimming host plants and/or applying phosphonate (Agri-fos). This activity is expected to cost $6,000 annually.

Hazardous Tree Removal
If the District identifies trees that require removal to reduce the potential hazard, to decrease fire danger, and/or to prevent pathogen spread, the District would retain a contractor to conduct tree removal. This activity is expected to cost $10,000 annually.

Staff Training
District planners, land acquisition personnel, technicians, and stewardship coordinators would benefit from annual SOD training in order to recognize, manage, and slow the spread of SOD. Trainings would be conducted by UCCE staff and focus on current best management practices, the latest findings on pathogen biology and transmission, and field diagnostics. Trainings would run approximately eight hours and would occur annually. The estimated cost is $4,000/year.

Education and Outreach
In an effort to slow the spread of SOD, the District would develop materials to inform visitors of how they can prevent the spread of the pathogen. Signage would be placed at trailheads in areas of known SOD infestation, and at trailheads in high-risk areas. A brochure could be made available to visitors at public kiosks. The cost of this activity is expected to cost $5,000 for the first year and $1,000 annually for subsequent years.

Identification, Removal, Disposal, and Sanitation Protocols
The District needs to develop protocols for the identification of infected and hazardous trees, and recommendations on removal, disposal, sanitation, and transportation of SOD infected biomass.

Anticipated Needs	Estimated Cost
Aerial Survey	
Flight Time	$2,500
GIS Mapping Equipment	$10,000
Mapping Software	$1,600
Staff Time	$4,000
Ground Survey	$20,000
Survey Analysis and Report	$4,000
Treatment of Infected Trees (pruning, removing, Agri-fos treatment)	$6,000
Hazardous Tree Removal (contracted labor)	$10,000
Sudden Oak Death Trainings (staff time)	$4,000
Education and Outreach (signs, brochures)	$5,000
Protocol Development	$5,000
Total	**$72,100**

Table 12. Agricultural Preservation and Open Space District Needs, First year

Anticipated Needs	Estimated Cost
SOD Ground Surveys	$20,000
Treatment of Infected Trees	$6,000
Hazardous Tree Removal (contracted labor)	$10,000
Education and Outreach (signs, brochures)	$1,000
Sudden Oak Death Trainings (staff time)	$4,000
Total	**$41,000**

Table 13. Agricultural and Open Space District Needs, Subsequent years

Sonoma County Agricultural Commissioner

Contact:
Stefan Parnay
Chief Deputy Commissioner
sparnay@sonoma-county.org

OR

Cree Morgan
Ag Biologist/Standards Specialist
cmorgan@sonoma-county.org

Administrative Office:
133 Aviation Boulevard, Suite 110
Santa Rosa, CA 95403
(707) 565-2371

Agency overview

The Agricultural Commissioner's office provides regulatory oversight in the areas of agriculture, weights and measures, and animal care and control. The Agricultural division is charged with environmental protection through pesticide regulations and agriculture hazardous materials programs; agriculture worker health and safety; pest prevention, exclusion, detection, and eradication; consumer protection; compilation of an annual crop report; and also provides information to other county agencies and the general public on a variety of pest control issues.

Agency Response to Sudden Oak Death

The Agricultural Commissioner's Office enforces State and Federal regulations concerning the movement of forest products and nursery plants, which are intended to protect our natural resources and prevent the spread of the disease. Agricultural Biologists inspect each nursery shipment of SOD-susceptible plants that is shipped out of the fourteen California counties for SOD symptoms. Nurseries that ship non-SOD host material outside of California are inspected on an annual basis. All nurseries shipping outside of the fourteen quarantined counties are required to have a compliance agreement with their Agricultural Commissioner's Office.

Additionally, as part of their general pest monitoring efforts, the Agricultural Commissioner's Office is responsible for enforcing nursery stock cleanliness standards for production nurseries on an annual basis.

Recommended Actions

The Commissioner's office currently has adequate resources to perform inspections of nurseries and regulate the movement of SOD hosts. They perform these regulated activities with funding from California Department of Food and Agriculture. If additional responsibilities are placed on the Office, further funding will be required.

Sonoma County Water Agency

Contact: Jon Niehaus
Senior Environmental Specialist
Sonoma County Water Agency
jon@scwa.ca.gov

Administrative Office:
404 Aviation Boulevard, Santa Rosa, CA 95403
(707) 526-5370 or (707) 547-1900

Agency Overview

The Sonoma County Water Agency was created as a special district in 1949 by the California Legislature to provide flood protection and water supply services to portions of Sonoma and Marin counties. Legislation enacted in 1995 added the treatment and disposal of wastewater to the Agency's responsibilities. The Sonoma County Board of Supervisors acts as the Agency's Board of Directors. The Agency is a separate legal entity created by State law, having specific limited purposes and powers, and separate sources of funding.

Impact of SOD on the Agency

The Sonoma County Water Agency owns small parcels of highly managed land primarily as sites for their pump stations and holding tanks. At this point, there has been no impact on the agency from SOD mortality. The Water Agency properties that would have the greatest potential for SOD are those near Wohler and Mirabel, and its property surrounding the Spring Lake and Matanzas flood control reservoir. The majority of its holdings associated with the water and wastewater collection and distribution system, and its flood control facilities, are in the urban corridors where conditions are less suitable for widespread SOD infection.

Agency Response to SOD

The Agency's properties are regularly inspected by staff. There is sufficient staff to monitor for SOD. Staff could sample symptomatic trees and use best management practices for dealing with an infestation in accordance with County protocol.

Recommended Actions

At this time no additional actions or resources are needed. The Water Agency is not significantly impacted by SOD. They have limited land holdings and have sufficient staff and equipment to address any vegetation management concerns on their land.

Sonoma County Cities

The threats presented by SOD mortality and (*P. ramorum*) blight in urban environments are the same threats faced by wildlands: increased number of hazard trees, increase in fire fuels, loss of species and wildlife resources, loss of shade trees and aesthetics, and diminished health of susceptible plants in the landscape. Although Sonoma County's cities are at lower-risk for heavy SOD infestation because they generally have lower densities of important host species (such as California bay laurel and tanoak), there has been a SOD confirmation in Santa Rosa's Doyle Park. For this report, arborists were consulted for each of the nine incorporated cities in Sonoma County.

City of Santa Rosa

Contact: Lisa Grant
Parks Superintendent, Santa Rosa Recreation and Parks Department
lgrant@ci.santa-rosa.ca.us

Administrative Office:
55 Stony Point Rd, Santa Rosa, CA 95401
(707) 543-3774
http://ci.santarosa.ca.us

The City of Santa Rosa is primarily composed of urban and suburban habitats, most of which lack the necessary conditions for significant SOD infection. However, many of the city parks, as well as nearby Annadel State Park and Spring Lake Regional Park have habitat more favorable to the development and spread of SOD. This spring, Sudden Oak Death was confirmed in Doyle Park, SOD is also present in Annadel Park. The city manages 765 acres in 57 parks.

The Recreation and Parks Department of the City of Santa Rosa maintains street trees and takes care of the trees surrounding city owned buildings and facilities. Neighborhoods such as Fountaingrove, Montecito, Bennett Ridge, Bennett Valley, Annadel Heights and Fairway View Estates contain great densities of susceptible hosts, therefore, they are at higher risk for the establishment and spread of SOD. A sudden increase in mortality caused by SOD may heighten fire danger in these already fire prone areas—the north and northeastern ridges around Santa Rosa are already identified as high severity fire zones.

Impact of SOD in Santa Rosa

Sudden Oak Death symptoms were detected on oaks and bay laurel trees at Doyle Park in 2006. Hidden Valley Park, Howarth Park, Dan Galvin Park, the parkland around Fountaingrove Lake, and the Bennett Valley Golf Course are suspected areas of SOD infection (H. Wilson, personal communication).

The City of Santa Rosa Recreation and Parks Department is concerned about the spread of SOD throughout the city's parks. Not only will infestation mean threats to park users because of hazard trees, but, city parkland could serve as a source of the pathogen allowing the spread of SOD into urban and suburban areas. In Marin County , for example, the disease was first observed in wildland areas but quickly moved into the cities, posing a significant threat to homeowners and businesses.

Recommended Actions

- **Survey for Infected and Hazardous Trees**
- **Hazardous and Infected Tree Removal**
- **Outreach and Education**
- **Staff Training**
- **Identification, Disposal, and Sanitation Protocols:**

Survey for Infected and Hazardous Trees

The first stage in addressing SOD in Santa Rosa would be to conduct a city-wide survey. The survey would initially focus on areas of known infection and high-risk parklands. Doyle Park, Howarth Park, Daniel Galvin Park, Bennett Valley Golf Course, Spring Lake Regional Park, and Annadel State Park could be surveyed in 240-person hours. While Annadel and Spring Lake fall outside of the city's boundaries, they are included in the survey because they can serve as sources of inoculum. Depending on available funding, survey efforts could then be expanded to include lower-risk street trees. Using a conservative rate for a contract arborist ($100/hour), the cost to survey the city and create a report (20 hours) would cost approximately $26,000, plus the laboratory costs of processing samples (approximately $1,000/year). After the initial survey, follow-up surveys would be completed annually in 100-person hours.

Hazardous and Infected Tree Removal

The only known infestation within the City of Santa Rosa is at Doyle Park. Best management practices in this situation, in order to slow the spread of the pathogen is to remove select California bay trees and infected oak and tanoak. About 50 trees need to be removed. Eradication efforts may also be needed at Hidden Valley Park. If disease incidents at Hidden Valley Park are comparable to Doyle Park then an additional 50 trees will need to be removed. At $1,600 per tree (Marin County Sudden Oak Death Response Program, 2001), the cost of contract tree removal for Doyle and Hidden Valley Park is estimated to be $160,000. "Slow the spread" efforts need regular maintenance to be affective, therefore, an estimated $100,000 per year could be used for contracting tree removal as SOD continues to pose hazards in Santa Rosa.

In addition to contracted work, the Santa Rosa Recreation and Parks Department could do in-house tree removal as needed. Parks staff would need a bucket truck ($130,000) and wood chipper ($38,000) for this work. In-house tree removal is billed at $70/hour. With an estimate of 400 person hours per year to address SOD in city parks and streets, the total cost of in-house tree removal would be $196,000 the first year (equipment purchase and staff time), followed by $28,000 (staff time and machine maintenance) in subsequent years for hazardous tree removal.

Mitigation and replanting costs could be reduced by the use of Supervised Adult Convict (SAC) crews. SAC crews are contracted through the Sonoma County Probation Department. SAC crews typically consist of 10 people and cost approximately $1,000 per day. The expanded use of SAC crews could be a cost effective way to remove small hazardous trees and SOD infected material in Santa Rosa's urban parks.

Outreach and Education
An outreach and education effort will inform city residents and park users about SOD. Education efforts would focus on familiarizing residents with the disease, the fire and hazard tree dangers, as well as things each of us can do to slow the spread of the pathogen when visiting areas that are potentially infested. Approximately 120 person-hours would be needed for outreach efforts per year. It is estimated that $9,000 per year would cover the cost of staff time and $5,000 would pay for creation and printing of outreach materials appropriate for the City. After the initial development of outreach materials, they could be updated and printed for $1,000/year.

Training
Training field staff is essential in order to monitor the parks for SOD and to educate park visitors. Trainings could be provided by University of California Cooperative Extension and Department of Emergency Services personnel, and would focus on disease biology, pathogen transmission, field diagnostics, fire threats, and best management practices. Trainings would run approximately six hours for 10 staff members and would be completed annually. The estimated cost for staff training is $4,500 including materials.

Identification, Disposal, and Sanitation Protocols:
The City Parks require protocols for the identification of infected and hazardous trees, and recommendations on removal, disposal, sanitation, and transportation of SOD infected biomass.

Anticipated Needs	**Estimated Costs**
Survey (contracted arborist time, lab costs)	$27,000
Tree Removal (contracted)	$160,000
Bucket Truck	$130,000
Wood Chipper	$38,000
Tree Removal (in-house)	$28,000
Outreach and Education (staff time, educational materials)	$14,000
Staff Training (recognizing symptoms, BMPs)	$4,500
Identification, Disposal, and Sanitation Protocols	$5,000
Total	**$406,500**

Table 14. Recreation and Parks Department Needs, Year 1

Anticipated Needs	Estimated Costs
Follow-up Surveys (contracted arborist time, lab costs)	$11,000
Tree Removal (contracted)	$100,000
Tree Removal (in-house: staff time, machine maintenance)	$28,000
Outreach and Education (educational materials, staff time)	$10,000
Staff Training (recognizing symptoms, BMPs)	$4,500
Total	**$153,500**

Table 15. Recreation and Parks Department Needs, Subsequent Years

Other Sonoma County Incorporated Cities

Cloverdale, Cotati, Healdsburg, Petaluma,
Rohnert Park, Sebastopol, Sonoma, and Windsor

Impact

There have been no SOD confirmations in these cities.

Recommended Actions

- **Survey**
- **Training**

Survey

The cost to complete comprehensive surveys of the incorporated cities in Sonoma County (excluding Santa Rosa) is outlined in Table 6.

City	Number of hours needed to survey	Cost per hour for survey	Cost of survey with report
Cloverdale	24	$75	$3,000
Cotati	32	$120	$5,000
Healdsburg	30	$75	$3,000
Petaluma	30	$100	$4,000
Rohnert Park	30	$100	$4,000
Sebastopol	32	$120	$5,000
Sonoma	32	$120	$5,000
Windsor	50	$100	$5,000
Total			**$34,000**

Table 16. Sonoma County Cities Survey Costs

Training

The incorporated cities either employ arborists, or contract with certified arborists to monitor and manage city trees. While the city arborists are familiar with Sudden Oak Death, additional training is required to keep professionals up-to-date on research and Best Management Practices. SOD specialists at UCCE could administer trainings and present research updates. County SOD specialists are billed out at approximately $50 per hour. Trainings for city arborists could be completed annually. The cost for trainings, including materials and staff time, would be approximately $4,000. The billing cost for an arborist from each of the incorporated cities (not including Santa Rosa) to attend a six hour training course, at $100/ hour, is approximately $4,800. Total cost for city staff and SOD specialists is $8,800.

Anticipated needs, *Yearly*	**Estimated Costs**
Arborist survey for eight of the incorporated cities	$34,000
SOD trainings for eight of the incorporated cities	$8,800
Total	**$42,800**

Table 17. Funding Needed for Incorporated Cities (except Santa Rosa)

Impacts, Response and Needs: California State Agencies

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Agency overview

The California Department of Forestry & Fire Protection (Cal-Fire) has primary fire protection responsibility for 794,000 acres of wildland (approximately 1,240 square miles) in Sonoma County. These areas of the county are referred to as "State Responsibility Area" (SRA) and consist of timber, brush, and grasslands that are generally outside of incorporated cities and developed areas. SRA lands in Sonoma County include over 28,000 houses and a population of approximately 59,000. Cal-Fire's resources available for the wildland fire protection mission in Sonoma County include 14 fire engines, 2 bulldozers, and 3 aircraft located at 10 separate facilities in the County. To ensure a quick response to all types of emergencies from the closest resource, Cal-Fire maintains auto-aid agreements with numerous fire protection jurisdictions in the County. Additionally, as part of the larger Sonoma – Lake – Napa Administrative Unit, other personnel and equipment are also available if needed to respond to wildland fires in Sonoma County. This additional equipment includes fire engines and bulldozers, 11 inmate fire crews, and a water-dropping helicopter with crew. Cal-Fire's stations are fully staffed during the fire season, typically from late May to late October. Fire station staffing is reduced in the non-fire season, with three Cal-Fire stations staffed in the County under contractual agreements during this time.

In addition its primary fire protection mission, Cal-Fire also regulates numerous activities pertaining to forest health on commercial and private timberlands in the County.

Impact of SOD on the Agency

Though numerous tree species can be adversely impacted by SOD, tanoak *(Lithocarpus densiflorus)* in western Sonoma County appears to be the species with the highest level of mortality in the county to date. While tanoak is widely distributed throughout the county, Cal-Fire's SOD-related fire protection concerns are focused on the western portion of the county at this time.

Within the western portion of the county where tanoak mortality is high, there are two distinct areas of concern:

a) North of the Russian River within 10 - 12 miles of the coast. In this area tanoak is often found in pure dense stands up to several hundred acres in size. tanoak mortality here can be seen in patches up to 10 - 15 acres in size where 100% of the trees have died.
b) The Highway 116 and Bohemian Highway corridors. Here tanoak is typically a minor component in the forest canopy made up of predominantly redwood and Douglas fir. In these areas tanoak mortality is still highly noticeable in the understory, but consists of fewer trees per acre.

Potential SOD-Related Wildland Fire Protection Impacts to SRA in Sonoma County

- SOD-killed trees in close proximity to structures, power-lines, and highways present an increased risk to those improvements.
- Extensive areas of continuous SOD-killed trees will likely alter wildland fire behavior. Wildland fires in these areas will likely require more resources to successfully contain, particularly during periods of severe fire weather. This condition may also adversely impact wildland firefighter safety.
    - SOD-killed trees with dead leaves still attached present an increased chance for carrying burning embers, possibly increasing the rate of spread of the fire.
    - Without leaves attached (approximately 18 months after death), SOD-killed trees which have fallen over will impede the progress of ground crews fighting a wildland fire.
    - Standing SOD-killed trees also present a safety hazard from falling rotten limbs, particularly when water and retardant-dropping aircraft are working a fire.

Agency Response

- Annual aerial survey in the west county to monitor potential fire protection impacts
- Assist SOD Task Force
- Renewed focus on defensible space inspections for structures in the SRA
- Increased power-line inspections in the SRA
- Public education targeted to increase defensible space and fire-safe awareness
- Conduct Vegetation Management Plan (VMP) controlled burning where feasible to reduce fuel buildup and improve wildlife habitat
- Increased preparedness (increase fire protection staffing) during periods of predicted severe fire weather
- Update auto-aid agreements with neighboring fire protection jurisdictions

Agency Needs

- Dedicated staffing for defensible space inspections.
- Enhanced public education program.
- Improved fire detection systems, particularly on days of severe fire weather
- Improved infrastructure for weather data collection (remote weather stations)

- **The California Forest Improvement Program** (run through the Cal-Fire Regional Office) assists property owners with management plans and tree removals outside of the 100' defensible space zone on properties of 25 acres or more. Cost: $150,000 / year.

Cal-Fire

Anticipated Needs	**Estimated Costs**
California Forest Improvement Program (CFIP)	$150,000
Total	**$150,000**

Table 18. Cal Fire Needs, Year 1

Anticipated Needs	**Estimated Costs**
California Forest Improvement Program (CFIP)	$150,000
Total	**$150,000**

Table 19. Cal Fire Needs, Subsequent Years

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