SOD BLITZes 2023: Results & New SOD Management Recommendations

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U.C. Berkeley
Funding and acknowledgements

- United States Forest Service
  - State and Private Forestry: Phil Cannon

- Mid Pen Open Space

- Local Organizers and CNPS who make the Blitzes possible

- Local and State organizations: Save Mount Diablo, National Parks, SFPUC, Mid Pen Open Space, Santa Lucia Preserve, State Parks, the UCSC Bot Garden, East Bay Regional Parks, Calfire, Sonoma State University

- Doug Schmidt, U.C. Berkeley, Debbie Mendelson (Woodside), Kerry Winninger (UCCE Sonoma) and Kerri Frangioso (UC Davis). UC undergraduates and Lea Green
Donations can be done online at www.mattelab.org

Click the “Donate” link

Fully tax deductible
Sudden Oak Death

• Caused by the exotic pathogen *Phytophthora ramorum* introduced on infected ornamental plants in the 1980s

• Since the 1990s it has caused the mortality of tens of millions of oak species and of the related tanoak, but the disease affects a large number of native plants, some already threatened
  – Loss of native biodiversity, extirpation of entire tree populations
  – Declining and dead trees worsen fire hazard
  – SOD infected trees are at high risk of failing
  – Compromises the California Carbon offset program
  – Loss for native Californians
  – Loss of landscape trees
  – One of the worst tree epidemic in the world
SOD Blitzes: a unique citizen science program

• Yearly volunteer-based survey to track expansion and contraction of the pathogen’s range
• Volunteers collect over a weekend
• UC Berkeley tests all samples
• Early Fall, results of yearly blitz are available and made public
• Mid Fall, Blitz results added to SODmap
• SODmap mobile accesses data from SODmap:
  – App allows to identify sampled trees in the field
  – App calculates risk for oak infection at any location
SOD Blitzes vs. Other

UC Berkeley

The Public

Local Blitz Organizers

Citizen volunteer 1

Citizen volunteer 2

Volunteer

Organizer

Public

Volunteer
Citizen Science and Covid-19 (I)

• We have switched to online training and NO in person meetings will be organized. Everything you need to know is posted on www.sodblitz.org

• You still have to run your SOD survey on the weekend assigned to your community (see the BLITZES schedule online)

• Collection packets with all necessary materials are available in the left bin at the pick up/drop off Blitz station. Pick one or two packets, each one allows you to sample ten trees

• Blitz stations are at the venue published on the schedule. Their exact location will be posted on the doors of the venue
SOD Blitz station
SOD BLITZ Station
Online Training
BY mail
## SURVEY RESULTS

<table>
<thead>
<tr>
<th>Year</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>Survey Question</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.1 ± 1.0</td>
<td>3.2 ± 0.9</td>
<td>3.4 ± 1.0</td>
<td>3.1 ± 1.0</td>
<td>What do you consider your knowledge level to be on Sudden Oak Death (SOD)? (1-Low - 5-High)</td>
</tr>
<tr>
<td></td>
<td>4.3 ± 0.7</td>
<td>4.5 ± 0.7</td>
<td>4.5 ± 0.7</td>
<td>4.4 ± 0.8</td>
<td>How do you rate the overall quality of this SOD Blitz meeting and of the presentation? (1-Low - 5-High)</td>
</tr>
<tr>
<td></td>
<td>4.0 ± 1.1</td>
<td>4.3 ± 1.1</td>
<td>3.8 ± 1.4</td>
<td>3.9 ± 1.1</td>
<td>Are you likely to take action if the SOD Blitz shows there are infected trees in your neighborhood? (1-Low - 5-High)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>Number of years participating in the SOD Blitz survey</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>54</td>
<td>74.1</td>
<td>65.2</td>
<td>68.5</td>
<td>% of participant newcomers</td>
</tr>
<tr>
<td></td>
<td>9.0</td>
<td>8.3</td>
<td>13.5</td>
<td>5.6</td>
<td>% participating for &gt; 3 years</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>11</td>
<td>12.4</td>
<td>8.3</td>
<td>% participating for &gt; 5 years</td>
</tr>
</tbody>
</table>
RECONFIRMED THERE ARE TWO DISTINCT OUTBREAKS IN DEL NORTE COUNTY, 10 Km apart

1. NA1 lineage: Hiouchi
2. EU1 lineage: Fort Dick
Citizen Science Uncovers *Phytophthora ramorum* as a Threat to Several Rare or Endangered California Manzanita Species

Matteo Garbelotto,† Tina Popenuck,† Brett Hall, Wolfgang Schweigkofler, Francesco Dovana, Ruby Goldstein de Salazar, Doug Schmidt, and Laura Lee Sims

1 Department of ESPM, University of California, Berkeley, CA 94720, U.S.A.

**Does weather explain natural infection in manzanita species?** To assess possible mechanisms explaining why these manzanita species had suddenly exhibited new symptoms, we analyzed relationships between rainfall and infestation intensity. Several studies have clearly shown a strong correlation between the amount of rainfall and the incidence of disease caused by *P. ramorum* (Eyre et al. 2013; Garbelotto et al. 2017); hence, we calculated average rainfall values for California as follows. Yearly precipitation data between 2008 and 2019 were collected from 28 National Oceanic and Atmospheric Administration (NOAA) weather stations (https: //

<table>
<thead>
<tr>
<th>Species sampled</th>
<th>Number of plants</th>
<th><em>P. ramorum</em> positive</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Arctostaphylos hookeri</em></td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><em>A. hooveri</em></td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><em>A. montereyensis</em></td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><em>A. morroensis</em></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><em>A. ohloneana</em></td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td><em>A. pilosula</em></td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><em>A. pumila</em></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><em>A. silvicola</em></td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td><em>Umbellularia californica</em></td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

![A and B images of manzanita plants showing symptoms](https://example.com/)

**Table 2.** Species tested at the University of Santa Cruz Arboretum and number of plants that were positive for the pathogen *Phytophthora ramorum*

**Fig. 2.** Ramorum blight can cause both a leaf blight and branch anthracnose. *A,* Underbark lesion and *B,* canopy mortality caused by *Phytophthora ramorum* on *Arctostaphylos silvicola* at the University of California-Santa Cruz Arboretum. Photos: Laura Sims
Citizen science making a difference for California

BY MATTEO GARBELLOTTO | SPECIAL TO THE DAILY CAL

The term “citizen science” has become increasingly popular among the public and the research community. Citizen science is any program in which nonscientists, mostly volunteers, are recruited and trained to participate in a scientific study. Despite its increasing popularity, scientists and funding agencies are still split on the true merits of citizen science. One side claims that citizen science is mostly just a way to engage and inform the public on a variety of issues. The other side further believes that citizen science is a
Department of Energy showcased our research and the SOD BLitzes.
Sodblitz.org

- Summary table of 2023 SOD Blitzes (you can turn on previous years’ data on sidebar)
- Google Earth map of 2023 SOD Blitzes
- Conversion excel file that allows blitzers to identify trees they sampled

Sodmap.org

- Google earth map of all SOD distribution data (updated when new blitz results come in)
- SOD heat maps
Sodmapmobile.org
- Companion file that explains in depth how to best use the free APP (Apple and Google Play)

SODmap mobile
- Video that shows how to use the APP SODmap mobile

Calinvasives by Calflora
- Allows to look at the data by quadrant, resolving the issue of data overcrowding
- Allows to compare pathogen and host distributions
- Allows to calculate disease incidence by site, county, host and year

Matteolab.org
- All other websites contained in it
- New recommendations to manage SOD
Unique feature of SODmap mobile

• Risk of oak infection where user is standing
Calinvasives

Map

Satellite

Start Year
End Year
Host
all hosts
only positives
Show cells
Show points
Cell Size
10 KM
Display
Outline
Print

California Plant Pest: Phytophthora ramorum

Export

matteo garbelotto
EDIT - SIGN OUT
Use TreeFAQs.org

• To let us know of wrong location of your samples on the SOD blitz map

• Please double check accuracy of sampled trees and provide us with feedback to improve quality
www.sodblitz.org
(TOP)

Google Map of Results

Results in Table format
Commentary on Results

Videos on what to do

Previous years results
Conversion file
To identify numerical code
For each tree

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Name</th>
<th>Gate</th>
<th>Time</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Measurements</th>
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<tbody>
<tr>
<td>A1</td>
<td>Sirocco</td>
<td>67</td>
<td>123</td>
<td>45.678</td>
<td>-12.345</td>
<td>measure1</td>
</tr>
<tr>
<td>B2</td>
<td>Eucalyptus</td>
<td>62</td>
<td>117</td>
<td>34.567</td>
<td>-23.456</td>
<td>measure2</td>
</tr>
<tr>
<td>C3</td>
<td>Oak</td>
<td>61</td>
<td>116</td>
<td>23.456</td>
<td>-34.567</td>
<td>measure3</td>
</tr>
<tr>
<td>D4</td>
<td>Pine</td>
<td>60</td>
<td>115</td>
<td>12.345</td>
<td>-45.678</td>
<td>measure4</td>
</tr>
</tbody>
</table>

Download (PDF) 1 Page

Note: The table contains hypothetical data for demonstration purposes.
Data flow chart

SPRING

SOD BLITZ DATA
(www.sodblitz.org)

FALL

SOD BLITZ MAP
(www.sodblitz.org)

FALL

OTHER DATA
(Government, Academia)

FALL

SOD MAP
(www.sodmap.org)

SODmap mobile APP
(Apple Store
Google Play)
www.sodmapmobile.org

CALINVASIVES
SOD Blitzes 2023: some statistics

- A total of 28 Blitzes from Oregon border to San Luis Obispo (was 24 in 2022)

- Del Norte (Oregon border) the Northernmost
- San Luis Obispo (Santa Barbara border), Southernmost

- 233 collectors, (was 254 in 2022), 408 participants (was 444 in 2022)

- Trees surveyed: 10,291 ( was 10,656 in 2022)
- Trees sampled: 1901 ( was 1805 in 2022)

- Statewide Rate of Positive trees 8.8% ( was 7.1% in 2022)
- Statewide True Infection rate: 2.7% ( was 2.9% in 2022)
- Oak mortality/symptoms 11.8% (was 14.3% in 2022)
1. TaqMan assay – ID of *P. ramorum* (ITS)
   - Extract DNA with ROSE extraction
   - RTPCR 2\textsuperscript{nd} round Taqman assay
   - Identify positives / “maybes” / negatives

2. Confirm positive assay 1 (COX1)
   - PCR the COX 1 gene
   - SYBR Green RTPCR assay melt curve
   - Confirm positives results for “maybes”

3. Culturing for Del Norte and San Luis Obispo
Phytophthora ramorum lineages

- Four different groups of variants (lineages) outside of Asia, where multiple, presumably native, lineages exist
- Each is different (mating type, virulence)
- BLITZ TESTS FOR LINEAGE!!!

Pathogenicity and infectivity of *Phytophthora ramorum* vary depending on host species, infected plant part, inoculum potential, pathogen genotype, and temperature

Matteo Garbelotto | Doug Schmidt | Tina Popenuck
3- SOD Blitz Lineage Test (PRNEST Cox 1 SNPs)

- PCR the PRNEST region of the COX 1 gene
- Sanger sequence PCR products
- Align and compare sequencing results

Key:
NA1 = T – T – T
NA2 = T – C - C
EU1 = C – T – T

The 3 locations in the COX1 gene that distinguish NA1, NA2, and EU1 are in bold (773bp, 788bp, and 834bp):
EU1 (European 1) strain identified by SOD Blitz in Del Norte County in 2020, 2021, 2022 and 2023. Only NA1 was present in California before this discovery.

EU1 lineage (Strain) is different from NA1 for all measurable metrics: this is a different threat!
NA1 was confirmed in 2023 in Del Norte Co., outbreak comparable in size to EU1.
Del Norte
(site 1)
Both % positives and true infection rates are still close to the lowest levels historically.

A total of 145,000 acres in 18 counties were surveyed!

False negative rate = 0%
False positive rate = 2.3%

<table>
<thead>
<tr>
<th>Year</th>
<th>Surveyed Trees</th>
<th>Symptomatic Oaks Nearby? (%)</th>
<th>Sampled Trees</th>
<th>SOD Positive sampled Trees %</th>
<th>Estimated True infection rate (%)</th>
<th>Symptomatic surveyed trees (%)</th>
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</thead>
<tbody>
<tr>
<td>2023</td>
<td>10291</td>
<td>11.8</td>
<td>1901</td>
<td>8.8</td>
<td>2.7</td>
<td>31.1</td>
</tr>
<tr>
<td>2022</td>
<td>10698</td>
<td>14.33</td>
<td>1805</td>
<td>7.1</td>
<td>2.9</td>
<td>43.8</td>
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<tr>
<td>2021</td>
<td>14804</td>
<td>10.6</td>
<td>2067</td>
<td>10.2</td>
<td>3.3</td>
<td>32.0</td>
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<tr>
<td>2020</td>
<td>21943</td>
<td>13.5</td>
<td>2030</td>
<td>21.5</td>
<td>7.4</td>
<td>34.3</td>
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<tr>
<td>2019</td>
<td>17287</td>
<td>12.4</td>
<td>1732</td>
<td>19.5</td>
<td>6.1</td>
<td>31.1</td>
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<td>2018</td>
<td>13504</td>
<td>12.2</td>
<td>2012</td>
<td>9.8</td>
<td>3.5</td>
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<td>2017</td>
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<td>2009</td>
<td>31.5</td>
<td>12.8</td>
<td>40.5</td>
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<tr>
<td>2016</td>
<td>14305</td>
<td>11.9</td>
<td>1878</td>
<td>16.1</td>
<td>5.7</td>
<td>35.7</td>
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</table>
Like 2020/2011 SOD may peak next year. Many blitzes in 2023 were done before. The warm rains.
SOD Blitz 2023 Sampling Week

P. ramorum Positives (%)
The SOD blitz regions
# Comparison between 2022 and 2023

= indicates infections on the rise

<table>
<thead>
<tr>
<th>Location</th>
<th>Number of Surveyed Trees</th>
<th>Symptomatic Oaks Nearby (%)</th>
<th>Number of Sampled Trees</th>
<th>SOD Positive Sampled Trees (%)</th>
<th>Estimated True Infection Rate (%)</th>
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<tbody>
<tr>
<td></td>
<td>2022</td>
<td>2023</td>
<td>2022</td>
<td>2023</td>
<td>2022</td>
</tr>
<tr>
<td>Big Sur</td>
<td>43</td>
<td>68</td>
<td>8.3</td>
<td>6.3</td>
<td>24</td>
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<tr>
<td>Carmel</td>
<td>278</td>
<td>303</td>
<td>4.1</td>
<td>9.9</td>
<td>218</td>
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<tr>
<td>Del Norte</td>
<td>8</td>
<td>46</td>
<td>0.0</td>
<td>7.4</td>
<td>8</td>
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<td>East Bay East</td>
<td>619</td>
<td>313</td>
<td>12.7</td>
<td>2.3</td>
<td>236</td>
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<tr>
<td>East Bay South</td>
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<td>50</td>
<td>0.0</td>
<td>0.0</td>
<td>13</td>
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<td>East Bay West</td>
<td>558</td>
<td>196</td>
<td>17.6</td>
<td>15.3</td>
<td>102</td>
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<td>Humboldt</td>
<td>74</td>
<td>730</td>
<td>0.0</td>
<td>1.6</td>
<td>21</td>
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<td>Lake</td>
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<td>45</td>
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<td>7</td>
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<td>83</td>
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<td>834</td>
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<td>0.9</td>
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<td>Santa Cruz</td>
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<td>0.0</td>
<td>14.8</td>
<td>24</td>
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<td>4269</td>
<td>762</td>
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<td>0.9</td>
<td>131</td>
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<td>44</td>
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<td>Sonoma West</td>
<td>257</td>
<td>541</td>
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<td>6.1</td>
<td>105</td>
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<tr>
<td>Trinity</td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>Total</td>
<td>10656</td>
<td>10291</td>
<td>14.3</td>
<td>11.8</td>
<td>1805</td>
</tr>
</tbody>
</table>
Note that:

• Probably only statewide % positives is easily comparable between years, due to “haphazard” sampling approach of SOD Blitzes

• If a region has few samples (<20) then calculations of true infection rate are “iffy”, results should be taken as +/-

• There are two main sampling/survey approaches:
  – Focusing on symptomatic trees whether extensively (one sample every 100 yards) or intensively (one sample every 10 yards)
  – Set up of sentinel trees to catch infection when it first arrives: Trinity, Mount Diablo, San Luis Obispo
Know that:

• Infection on bay laurel indicates arrival of the pathogen but oak infection may require several more years and one or two years with higher than average rainfall, however if bays have tested positive for SOD, that is the indication it may be necessary to preventatively protect your trees from the pathogen
• Google Earth Platform
• All colored icons were tested
• Red= has SOD
• Green= had symptoms but not SOD
• Circle means oaks dying but for any reason (e.g. drought)
Use these commands to:

- move around map
- enlarge it

Even when magnified, icons will stack. Click on one to see all icons in a so called spiderfy
Overall 2023 Results:

Number of positives is stable compared to that of 2022
Most Interesting Findings of 2023 Blitzes - I

• EU1 still present in Del Norte: outbreak about one mile in diameter. Appears to be spreading Northwards. All other California samples were NA1

• NA1 outbreak in Del Norte confirmed, also 1 mile in diameter

• Most areas in Trinity, Siskiyou, Mendocino, and North Sonoma, including tribal lands, were negative.

• Yorkville and Gualala positives. Both have been positive previously. Yorkville for a very long time. This is different from last year
Most Interesting Findings of 2023 Blitzes - II

• SOD on the rise in Sonoma countywide, but Geyserville and Cloverdale, which normally are positive in wet years, were not positive. Comparable to last year

• Napa was negative as it normally is in dry years. MidApril collection was before the warm late season rains. Comparable to last year

• South Marin positive, North and West Marin negative. Comparable to last year
Most Interesting Findings of 2023 Blitzes - III

• East Bay stable in terms of outbreaks, western slopes of the Berkeley-Oakland hills are more prone to infection even if more urbanized

• San Francisco and North Peninsula negative like last year

• Five nurseries/parks (GG, Presidio, UC Botanical Garden and Native Here Nursery, Filoli) are all negative.
Most Interesting Findings of 2023 Blitzes - IV

• Peninsula: Outbreaks undetectable away from the slopes of the Santa Cruz Mountains, as it normally happens in a dry year. Lower eastern slopes of the mountains are also negatives.

• SOD blitzes reveal a large number of SOD outbreaks on the Sant Cruz Mountains, involving several parks and open space lands: Huddart, Teague Hill, El Corte de Madera, La Honda and La Honda Creek, Los Trancos, Monte Bello, Skyline Ridge, Long Ridge, Upper Stevens Creek, Saratoga Gap, Portola Redwoods, Las Cumbres
Most Interesting Findings of 2020 Blitzes - V

• Santa Cruz County mostly negative, but poorly sampled. Summit Road area has positives

• Carmel valley: canyons on the slopes of the Santa Lucia Mountains remain positive and new outbreaks are discovered, but in patchy mixed oak woodlands it is absent. Disease incidence on the rise compared to last year

• Big Sur region confirmed as a constant hotspot. Disease incidence on the rise compared to last year, but some outbreaks are now negative

• San Luis Obispo still negative
North Coast
Mendocino County
Sonoma
Napa was negative
East Bay
San Francisco and North Peninsula were negative
South Peninsula and Santa Cruz
Carmel valley: higher disease incidence but no new outbreaks
Big Sur: San Carpoforo, once positive, was negative
San Luis Obispo was negative
What is driving Pram infections in mixed oak woodlands?

- Tree, stand, topography, bay density, rainfall

Landscape, disease, rainfall, temperature, bay density, urbanization

Bay laurel recovery
**SOD up**
- Eastern slopes
- Larger oaks
- High bay density
- High Oak-bay proximity+++ 
- High infection previous year
- High Rainfall

**SOD down**
- Low bay density+++ 
- Smaller oaks
- Larger bays
- High Tmax +++ 
- More urbanized

**RECOVERY OF over 50% of BAYS OCCURS**
- When temperatures are up (ave max >23 C)
- When rainfall is low (less than 500 mm)+++ 
- When terrain is flat
- Oakstep program was started because

- Confirmation of SOD on oak is important given that:

  - SOD infected oaks burn very hot
  - SOD infected oaks are likely to fail
  - Confirmation of SOD on one oak is the most pressing signal the landowner needs to protect other neighboring oaks
What is OakSTeP? Oak SOD Testing Program is a new program aimed at making a step in the right direction towards the detection and control of Sudden Oak Death (SOD). The other major program aimed at empowering communities in the fight against SOD is called “SOD Blitzes” and allows lay people to identify and confirm the presence of SOD on California Bay Laurel and Tanoak leaves, the two major vectors for the disease in California forests. OakSTeP is a new program launched by the U.C. Berkeley Forest Pathology Laboratory aimed at filling the gap of knowledge on SOD in oaks. Currently, oak testing for SOD is prohibitively expensive and too complex to perform, even for tree care specialists. OakSTeP facilitates the cooperation between professional tree care specialists, oak owners who are their clients, and U.C. scientists to provide a rapid and inexpensive diagnostic service on SOD infection on oaks. Although “SOD blitzes” remain key in protecting oaks from SOD, by identifying the disease in its major vectors (Bay Laurels and Tanoaks) before oaks are infected, early detection of SOD on an oak in any given property, may allow a tree care specialist to save that oak, or more realistically, it may allow her or him to save uninfected oaks that grow nearby.

How Does OakSTeP Work?

OakSTeP stands for “Oak SOD Testing Program”. It is a program directed at licensed tree care workers to provide them with all that is needed to sample symptomatic oaks at a fraction of the cost. By enrolling in the program, a licensed tree care worker will have access to the following:

1. Sets of Petri dishes and associated data forms directly delivered to them and to be used when sampling oaks.
2. Instructional Video and written instructions describing step by step all tools needed to sample oaks: when, where and how to sample oaks; where and how to send samples.
3. Analysis by the U.C. Berkeley state-of-the-art Diagnostic Lab
4. Easy to read diagnostic reports that may be shared with clients.

Special Event: An Evening to Support California Wild Lands and Native Forests
However: (II)

- Diagnosing SOD is the first step, but what about treatments to prevent disease spread? Only treatments will make a difference.

- SOD treatment has a cost but is easy, all treatment to be done in the Fall: 1) Identify high risk areas using SODmap mobile; 2) Remove bay laurels 15 - 30 feet around oaks you want to protect; 3) Treat oaks that have very high value with phosphites.

- Fill in the extended Treatment form record included in your collection packet. THIS WILL CREATE A DATABASE OF HOW MUCH CALIFORNIANS ARE WILLING TO INVEST TO STOP SOD AND TO GET POLICY MAKERS TO INVEST MORE ON SOD.
Fill in form inside packet or go to www.sodquest.org

Sudden Oak Death (SOD) TREATMENT SURVEY

Date: Full Name:
Zip code: Email:

Your position, circle one:
Owner Manager Renter Arborist or similar

Year when SOD was first officially diagnosed in property:

How was it diagnosed, circle all that applies:
SOD Blitz results
Ag commissioner/CDFA
Professional Arborist/private lab

Circle all tree species present in property:
Coast live oak Shreve’s oak Black oak
Canyon live oak Tanoak California bay laurel

What actions have you taken to control SOD, circle all the apply:
Removed bay laurels around oaks

your contribution will remain anonymous
SODQUEST Survey 2023 Results

- 64 Responses
- 6,878 Trees were protected
- 715 Acres
- Average success rate 88% : Range 10-100%
- Average cost per tree $56
Five steps to control SOD

• Use the APP Sodmap mobile to determine whether the location you are at is at risk of SOD infection (moderate or high)

• In the Fall, remove bay laurels if their foliage is closer than 30 feet to oak stems or large branches. Need to treat stumps with herbicides

• For high value trees: broadcast anhydrous gypsum around the base of trunk (do not let the gypsum touch the trunk. Use 3-5 lbs per tree depending on tree size). 1-2 weeks later apply phosphonates as sprays with Pentrabark (trees under 25 inches diameter) or injections (trees with diameter > 25 inches)

• If bays regrow, they need to be recut. Phosphite treatment every two year, however if your neighborhood was well sampled two years in a row with no positive in both year you can skip a year

• Do major pruning and yard work in the late Summer early to mid Fall
EARLY DETECTION: SOD BLITZES

SOD on oak
CONFIRMATION
OakSTeP.org

Two-way Communication:
Treefaqs.org

SOD Treatments:
Do and report them
In SOD treatment survey
Donations can be done online at www.matteolab.org

Click the “Donate” link

Fully tax deductible
This is the “whole enchilada” to protect our oaks

• Thanks to NSF, Gordon and Betty Moore Foundation, PG&E Foundation, MidPen Open Space and USFS State and Private Forestry
Important websites

• [www.sodblitz.org](http://www.sodblitz.org)  SOD blitzes 2020 & soon 2021

• [www.sodmap.org](http://www.sodmap.org)  all data on SOD

• Sodmap mobile (App) all data on SOD plus risk calculator

• [www.oaskstep.org](http://www.oaskstep.org)  how to diagnose oaks with SOD

• [www.sodquest.org](http://www.sodquest.org)  let us know what you have done to control SOD
Sudden Oak Death

New disease caused by an exotic pathogen introduced in CA in the late 80s probably from Asia through infested ornamental plants. Oaks are completely susceptible (up to 100% mortality)

Spreads by itself aerially by wind & rain during mild wet season (but only a few hundred yards)

Risk for oak infection only when pathogen is within 200 yards

Need to have a fine-scale map of pathogen distribution
Infectious hosts in CA forests

• CA Bay Laurel
  Only leaves, highly infectious

• Tanoaks
  Leaves, petioles, twigs=infected
  (Branches, trunks=not infectious)
Bay/Oak association (not tanoak-oak)

Yearly, in spring, bay laurels

Coast Live Oak (no sporulation)

Canker margin in phloem

Wave years

Bleeding canker

Soil/Water
More on bay-oak transmission

• Oaks and bay have to be within 60 feet

• Rainfall needs to be exceptionally high 6 weeks prior to infection (this has happened only in 2000/2001; 2005/2006; 2010/2011; 2017)

• Temperatures need to rise to 70 F for infection to occur. Early rain is too cold.
Disease Management: 1\textsuperscript{st} step

• Do I live in an area at risk for SOD?
• Are there California Bay Laurels and/or tanoaks where I live?
• Are my oak species:
  – California Coast Live Oak
  – California Black oak
  – Shreve’s oak (Santa Cruz to Santa Barbara)
  – Canyon Live Oak
  – Tanoak
SODmap Mobile:

SODMAP Mobile

U.C. Berkeley
Forest Pathology
and Mycology
Laboratory
Enlarge screen view using your Index and thumb fingers

Red pins = SOD positive, tap to find out date and number
Risk at current physical location

Insufficient Sampling Data

Insufficient Sampling Data to Assess Risk

Current Location:

37.911949° x -122.300286°

Tap on risk icon

Risk where you are physically standing
When assessing risk at a second location, remember to tap SODMAP button and then Risk button, in order to reset, otherwise you may get same warning as in the previous location.

A two-digit number in this line gives you more confidence.

Number > 4 in this line gives you more confidence.

Precise location and coordinates of user: You can record if needed.

Stay alert but no need to do anything.
Moderate Risk Level

1 Positive trees between 200m - 1km
39 Negative trees within 1km, 37Trees sampled post 2009

Current Location:
37.868105° x -122.270557°

May want to do something

High Risk Level

1 Positive trees within 200m
2 Positive trees within 1km, 168 treessampled post 2009

Current Location:
37.872738° x -122.262817°

Urgent to do something if you haveOaks and bays growing together
What to do and when to act

• Insufficient data or low risk
  — Keep monitoring your bay trees for infection, by participating in one of the many SOD blitzes in the Spring of each year. For info and details go to www.sodblitz.org

• Moderate or high risk
  — Do most of the significant yard work (e.g. pruning, grading, cutting dead trees) in the late summer or fall
  — Selectively remove “key” bay laurel trees in Summer and Fall
  — Apply a preventive phosphonate treatment to oaks at risk in the late Fall (after Halloween and before Xmas)
2\textsuperscript{nd} What to do

- Oaks are infected by spores produced on leaves of California Bay laurels
  - Selectively remove bay laurels around high value oaks

- Reduce overall bay density in property
Symptomatic CA bay laurel

+ rainfall (over 400 mm) = oak infection
Choose line depending on size of your oak. Risk should be no more than 0.2. Draw horizontal line from 0.2 until it intersects the line you picked based on size of oak. Draw vertical line at intersection point. On x axis is the minimum buffer zone where you should remove bay laurels.
Risk acceptable, varies subjectively, but let's say 10%.
Oak is 60 cm in diameter (purple line): remove bays for 10 m.
Oak is 40 cm in diameter (dark blue): remove bays for 5 m.
These are minimum values: we tested 10 and 20 m.
Drip-line to trunk distance (DTD)

DTD 10 yards (or 15-20 for large oaks)

If on a slope, or bay is upwind, increase distance 10 or 20%
Reducing overall bay density beneficial (red line infection rate when it rains a lot; black line infection levels when dry)
Which bays should I remove?

- Only up to 20” diameter, only if slope not too steep, and only if tree further than 10 yards from a stream
- Remove bays whose canopy drip line is within 10 yards of oak trunk if oak diameter is 35” or less, for larger oaks try to remove bays in a buffer area up to 15-20 yards from oak trunk
- Remove bays that are SOD infected after long drought (i.e. SOD positive in 2014 blitz) if frequency of positives 20% or lower
Preventive treatments with phosphites aka phosphonates (I)

• Water soluble, neutral pH, systemically absorbed by plant they increase natural defenses of trees. If dosage is right, no significant side effects

• Treatments need to be applied on healthy trees in areas with confirmed SOD between Halloween and Christmas
Preventive treatments with phosphites aka phosphonates (II)

• Injections
• Multiple per tree but can use same injector
• Only diluted phosphonate
• Once every two years in Fall
• Trees of all sizes

• Bark application
• Need to combine with Pentrabrak
• Once every year (unless soil was amended with gypsum)
• Trees with DBH under 45 cm (20 inches)
Injections using 40 mL and 35 PSI (Moderate Pressure)
20 mL and 20 PSI (low pressure)
NEW!!!

Table 1. New recommended phosphonate injection dosages.

- Label Dose = 1 part chemical + 2 parts water = 1:3 delivered in 10ml dose (discontinued).
- Dilution #1 = 1 part chemical + 29 parts water = 1:30 delivered in 20ml dose (Chemjet injector).
- Dilution #2 = 1 part chemical + 59 parts water = 1:60 delivered in 40ml dose with higher pressure (Arborjet injector).

Treatment once every two years
Injected Phosphonate Efficacy

Cankers produced on Coast Live Oak saplings infected with *P. ramorum*.

Prob>F: <0.0001

df=4

n=48

Tukey’s HSD

Columns with different letters are significantly different P<0.05

Figure 1. Efficacy of labeled dose vs updated dilution ratios. Smaller lesions = higher efficacy.
Phosphonate Damage to Wood

Damage produced on Coast Live Oak saplings injected with phosphonates

Prob>F: <0.0001
df=3
n=40
Tukey’s HSD
Columns with different letters are significantly different P<0.05

Figure 2. Injection damage caused by labeled dose vs updated dilution ratios. Note that updated dosage damage is indistinguishable from damage caused by only injecting water.
Topical Treatment
Injection treatments require additional equipment in the form of spring-loaded, hydraulic, or air pressure injectors that maintain a positive pressure required for introducing the diluted product into the tree. The injections are made through holes drilled into the trunk and use relatively small amount of chemical usually about 50-200ml (1.5 – 7oz), to treat a tree.

The topical application, on the other hand, uses commonly available liquid spray equipment and does not leave holes in the tree. The topical method however requires considerably more product (2-15L, 0.5-4gal) and overspray may damage surrounding vegetation, including moss and lichens.
Phosphonate Application Materials and Supplies

- Disinfectant
- Measuring
- Gloves
- Injectors
- Pentra-bark Surfactant
- Water
- Phosphonate
- Mixing Bucket
- Drill Bit
- Drill
- Spray Rig
- Face Shield
- Drill Bit
NEW

• Injection dosages changed, one injection every two years between Halloween and Christmas

• Topical treatment unchanged, one treatment in the Fall each year, but with Gypsum amendment one topical treatment every two years may be reasonable

• Soil amendment with Gypsum highly recommended but only if treating with phosphites and in soil that are not too rich in calcium
Gypsum amendments

(Anhydrous Calcium Sulfate)

- 3-5 lbs of granular Gypsum per tree, depending on tree size
- Mix with top layer, an area with radius of about 3 feet around trunk
- Apply possibly one two two weeks before phosphonate treatment, or at the latest at the same time as treatment
- Increases efficiency of both injections and bark treatments
- Bark treatments plus gypsum can be applied once every two years rather than yearly

About 3 feet around trunk
Gypsum amendment OK if color is not yellow to red

https://casoilresource.lawr.ucdavis.edu/ca-soil-properties/
SCRIBING

• Can we excise cankers from oaks stems, if we catch them early on
  – Run experiment during dry 2012-2014 period in 3 sites
  – Results show that during drought 75% of oaks are not easily infected
  – Using the remaining 25% we can say with strong statistical support that:
• *P. ramorum* was detected in an equal number of scribed vs. non scribed trees
• Positive, yes *P. ram* DNA
• Negative, no *P. ram* DNA
• **Summary**
  
  n=68
  Scribing positives= 14; negatives 54
  Untreated positives= 12; negatives 56
  P=0.66
SOD Canker Scribing Experiments
Positive control (infected but not scribed) lesion

≈ 1cm
Infected/scribed lesion

New lesions outside scribed area? Maybe

≈ 1cm

Initial infection site
Scribing

- Based on our results we cannot recommend scribing
Final additional recommendations

• Green waste and live infected plants the most dangerous ways to spread SOD

• Tools not very effective in spreading SOD: however if tool looks clean then SOD will not be spread

• Mulch could harbor SOD, fine grain commercial compost does not harbor it

• Dead trees or plants: grind and disperse locally: do not pile or cover. Infected material needs to dry fast
- [www.TreeFAQs.org](http://www.TreeFAQs.org)
- **Tree Health Answers & Questions**
- Good or new questions are published and help create a database of important issues in CA
Important URLs

• Matteolab.org
• SuddenOakDeath.org
• Sodblitz.org
• Sodmap.org
• Treefaqs.org
Drought and oaks

• Water deficiency due to prolonged diminished precipitation and increasing temperatures
• Physiological changes:
  – Direct effects such as thinner canopy, leaf abscission, stunted growth
  – Indirect effects: secondary pathogens and pests
• Some effects reversible: direct physiological changes, branch and foliage issues, stem decay
• Some effects irreversible: stem issues, some root rots
Stunted growth
Fungal twig dieback
Cryptocline
Fungal branch dieback
Diplodia
Twig girdlers
Agrilicus
Foliar insects, oak pit scale
Stem cankers & terminal secondary decay fungi
Trunk insects & associated fungi
Root rots, Armillaria
Soilborne Phytophthora
Root rots, Hymenochaetales
Canker rots, Hymenochaetales
Managing drought (I, short term))

- Ameliorate conditions to avoid onset of irreversible symptoms, normally done during drought:
  - Place ground cover around (not on) tree base to lower evaporation and increase absorption
  - In case of prolonged drought and onset of symptoms, water deeply (12 inches) once a month, November to June, only
  - Within a tree species, there is variable resistance to drought among individuals this is both genetic and site dependent. Learn to speak “tree”, to understand which ones need help
  - When irreversible symptoms are obvious; there is nothing you can do except for making sure windthrows will not cause damages or fatalities
Managing drought (ii, Long Term)

- South aspect, shallow sandy or rocky soils, midslope are most impacted by drought
- Maintain a density appropriate for the site: thin, thin, thin: but do so before or after drought
- Make sure canopy is pruned back, important when trees are isolated or in low density stands
- When landscaping, avoid planting under trees. Also when making compositions use species with comparable drought resistance
- Individual trees growing in drier sites are more drought tolerant: saplings growing in these sites may be more drought tolerant.