USDA Forest Service

Oregon Department of Forestry

Sudden Oak Death Management in Oregon Forests

Issue Paper

Options for Current Management Program
21 April 2017

SUMMARY

The purpose of this document is to summarize alternatives for the sudden oak death program for all forest lands in Oregon for the next five years. The Sudden Oak Death (SOD) Technical Task Force developed initial options for the function, funding and organizational structure of the sudden oak death program. The technical specialists (pathologists) convened the meetings to engage agency leaders with program leadership and planning. State and federal management teams responsible for the SOD program reviewed these options. Key components of those strategies were discussed and are presented here as a set of alternatives. The discussions did not lead to a recommendation for a fundamental change in the current SOD program, although the discussion recognized that continuing the current program is not sustainable as currently structured and funded.

ISSUE

The current slow-the-spread program uses early detection, monitoring and eradication treatment to reduce the rate of disease spread and slow disease intensification. The SOD technical team designed the program to treat infested sites outside of the generally-infested area (GIA), where the disease is commonly found. Eradication treatment priorities are set based on multiple factors including number of infested trees, location relative to quarantine boundaries, and available funds. Eradication treatments on non-federal lands range from cutting and burning an infected tree and its nearest neighbors (1/10 acre) to cutting and burning all host plants within a 300 foot treatment buffer (up to a maximum of 600 foot buffer). Expanding the GIA alleviates the obligation of non-federal landowners to treat infested sites in recognition of the high cost of doing so and the lack of available funds to cover these costs.

At the current pattern and rate of spread, the program does not have sufficient funds to treat sites that are of high priority for disease spread as proposed in the design of the slow-the-spread program. Currently, the minimum treatment option is being implemented due to insufficient funds to support the maximum treatment option. As the disease progresses, the slow-the-spread program will become more costly. Further, the inability to apply eradication treatments to infested sites on all land ownerships will increase disease intensification and spread and ultimately require expansion of the GIA. This trend also will increase the probability of spread of SOD into surrounding counties (Coos, Douglas and Josephine).

BACKGROUND

In 2001, Oregon discovered *Phytophthora ramorum*, the invasive non-native pathogen that causes the sudden oak death (SOD) disease in tanoak. *P. ramorum* spreads mostly by air when rain splashes the spores into the wind, which carries them to another host species; most likely the upper canopy of a tanoak. However, people can also spread the disease by transporting infected

plant material to uninfected areas. Besides tanoak, *P. ramorum* can infect many other species of trees and shrubs. In Oregon, the diseases on these other hosts do not lead to plant mortality.

When first discovered, the objective of Oregon's SOD program in forestland was elimination of the pathogen through eradication. Eradication treatment of an infested site consists of cutting, piling and burning all infected plant material and exposed host plant material within a specified radius (aka treatment buffer) surrounding infected plants. The species of exposed host plants that are treated varies from site to site based on infestation levels and could include Oregon myrtlewood, evergreen huckleberry, and rhododendron. The size of the treatment buffer varies depending on the level of infestation and the availability of funds to conduct the treatment; but efforts have shown that treatment within a 300 foot buffer conducted promptly following detection can successfully eliminate the pathogen from the site and slow spread. Eradication treatment can also include the application of herbicides to prevent sprouting of tanoak from stump material. Treatment is followed by reforestation by conifer or other non-host species that reduce the risk of disease recurrence or spread. Sites are monitored for persistence or recurrence of the pathogen with follow-up treatment to destroy residual or recurring infections.

Spread of *P. ramorum* is managed through the designation of a SOD quarantine area under the authorities of the Oregon Department of Agriculture (ORS 603-052-1230) and the U.S. Department of Agriculture Animal Plant Health Inspection Service (7 CFR 301-92). The state and federal quarantines regulate the intrastate and interstate movement of host plant material outside of the quarantine area. Oregon regulations require infested sites on state and private lands to undergo eradication treatment and sets forth requirements for disease free certification when moving uninfected host material to areas outside the quarantine. While federal land management agencies (U.S. Department of Interior Bureau of Land Management (BLM) and U.S. Department of Agriculture Forest Service (USFS)) are not required by federal regulations to eradicate *P. ramorum* from infested sites, federal land managers have conducted eradication treatments on all known infested sites on federal lands up to 2016.

By 2010, the quarantine area had expanded from its original 2001 size of nine square miles to 154 square miles and Oregon's SOD program on forestland transitioned from eradication to slowing the spread of *P. ramorum*. The 2010 SOD Quarantine also designated a Generally Infested Area (GIA) within the quarantine area where eradication treatment of infested sites is no longer required. Currently, federal land managers (BLM) are still conducting eradication treatments on infested sites within the GIA. The USFS has no lands within the current GIA. In contrast, treatment of non-federal sites within the GIA has mostly abated. The quarantine area expanded to 202 square miles in 2012; to 264 miles in 2013 and to 515 square miles in 2015. If SOD expands beyond the new 2015 quarantine boundary, the next quarantine area likely will be all of Curry County. The GIA now covers 58 square miles of disease establishment and intensification within the quarantine area; approximately 10 miles north-south and six miles east-west

DISEASE SPREAD

From the original infestations of 2001, SOD has spread 18 miles to the north and 8 miles to the east (Figure 1). The farthest of the infestations have received eradication treatments consisting of cutting, piling and burning of all host material within a 300 foot treatment buffer surrounding the infected trees. Many factors can affect rate of disease spread. These include climate, forest structure, host distribution, and disease abundance. Human assisted spread by moving infected

plant material can transmit the disease over long distances and is a wildcard factor in terms of predicting disease spread.

Current rates of spread are estimates made from the following:

Humboldt County, **California Infestation**: From 2003 to 2014 SOD had spread northward 39 miles (3.5 miles/year) from the initial infestation. There is no comprehensive control program in Humboldt County. Further, compared to Curry County, Oregon, the Humboldt County climate is less conducive to disease spread.

Curry County: Maximum distance of natural spread (no evidence of human assistance) in any given year appears to be 3 to 4 miles. From 2001 to 2016 the disease has spread northward 18 miles (average 1.4 miles/year) from the original 2001 infestations. Over the same time period spread to the northeast up the Chetco River was 8 miles (average 0.6 miles/year) from the original infestations. Human assisted spread by moving infected plant material, usually nursery stock, can transmit the disease over long distances and is a wildcard factor in terms of predicting disease spread. An example of this in Oregon is the 2010 infestation at Cape Sebastian State Park, which probably originated from nursery plants from as far away as California. Eradication treatments under the current slow-the-spread program now focus on new infested sites located outside of the GIA. The goal is to prevent these sites from becoming new sources of inoculum (or at least diminish their power); thus slowing disease spread.

Expected Spread Scenarios

While it is difficult to forecast an expected rate of spread, the following comparisons are informative.

Spread scenario assuming little or no eradication treatment to slow spread. This scenario assumes no human assisted spread, and natural spread northward at a rate of 3.5 mi/year, from the farthest north infestation (Hunter Creek). This spread rate is based on data for Humboldt County and for recent years in Oregon. Under this scenario, SOD reaches an adjacent county (most likely Coos) in ±12 years.

*Spread scenario under the current slow-the-spread program***.** This scenario also assumes no human assisted spread. It assumes the GIA expands northward at a rate of 2 mi/year (the rate of recent GIA expansion), with new infestations occurring no more than 12 miles north of it. All new infestations outside the GIA get some level of eradication treatment. Because of limited funding many sites will not be treated to the desired 300 foot treatment buffer. Under this scenario, SOD reaches an adjacent county (most likely Coos) in ±20 years.

Recent Trends in Disease Intensification and Spread (2014-2016)

Due to funding limits on the current slow-the-spread effort on non-federal lands and the establishment and expansion of the GIA (where there is no eradication effort on non-federal land), the amount of disease is increasing. This, along with favorable wet weather conditions for disease spread, has increased the number of new infestations at dispersal distances greater than 2.5 miles. It is reasonable to assume that rate of spread calculations that include the first 10 years of the eradication program will underestimate current and future spread.

In early 2015, another clonal lineage of *P. ramorum* (EU1) was detected on a single tanoak tree near the Pistol River on non-federal land. This is the first report of the European (EU1) lineage in US forests. Genetic analysis suggests a nearby private nursery (now closed) as the probable source. This finding is of particular concern because in Europe, the EU1 lineage kills or damages several conifer tree species and is considered more aggressive than the North American lineage (NA1). Furthermore, establishment of the EU1 lineage would create the potential for sexual reproduction and increased variability in the North American *P. ramorum* population. The EU1 infestation was cut and burned (13 acres) and has not been detected in post-treatment vegetation sampling in the vicinity. In 2016, the EU1 lineage was detected for a second time, ½ mile south of the one EU1-infested tanoak found in 2015. Of the 25 positive trees identified, two grand fir seedlings and 23 tanoaks are confirmed positive for EU1.The 2016 EU1 infestation is the top treatment priority and will include a 300-600 ft treatment buffer, resulting in a 50 acre treatment. Continued monitoring and ground surveys in the area have resulted in the detection of two additional infestations, one directly to the north of the 2016 eradication treatment and one a half mile north of the treatment. At this point, eradication of the EU1 linage is still possible, but funding and landowner cooperation have been challenges.

CURRENT SOD SLOW-THE-SPREAD PROGRAM

The current slow-the-spread program uses early detection, monitoring and eradication treatment on sites outside the GIA to reduce the rate of disease spread and slow disease intensification. Survey, detection, and monitoring efforts compose of ground, aerial and stream bait surveys. Ground-based detection and delimitation surveys around infested sites are conducted year-round. Aerial surveys, both fixed winged and helicopter, are conducted four times per year; the main surveys occur in July and October when current-year mortality is most visible. Aerial surveys cover a cumulative area of at least 700,000 acres of forest; ground surveys cover 600 acres. The current program is incorporating the use of high resolution digital aerial imagery as a means to augment aerial surveys. High-risk streams within and outside of the SOD quarantine area are targeted for stream baiting; the practice of periodically submerging host plant materials in streams and then testing the material for the presence of *P. ramorum*. Additional streams near infested nurseries or other infested non-forest sites may also be baited. Stream baits are deployed and collected at two-week to one-month intervals for a minimum of 8-10 months, beginning in late April.

Once an infestation is detected from the survey efforts, eradication treatments are conducted on all infested sites outside the GIA to the desired 300 foot treatment buffer. Eradication treatment on non-federal land still complies with quarantine regulations for conducting treatment, but the level of treatment varies from site to site due to limitations on available funds. Federal land managers conduct eradication treatments to the desired 300 foot treatment buffer outside of the GIA, and in the case of BLM, also within the GIA.

Eradication treatments are most effective when conducted promptly and at the largest treatment buffer possible. However, if funds are not sufficient, the minimal treatment is better than no treatment but increases the likelihood of the disease showing up nearby in subsequent years.

- Minimal Treatment -- Cut and burn all host material within **20 to 50'** radius of infected tree (0.03 to 0.18 acres) and fell and lop remaining tanoak within 300' radius of the infected tree. Cost $1,500 per site.

- Desired Treatment – Hack and squirt all tanoak, then cut and burn all tanoak within **300'** radius of infected tree (6.5 acres). Cost would be $32,500 per site ($5,000 per acre). Sites that have a cluster of infected trees would be disproportionately higher in cost as the 300' radius for the buffer treatment is from the farthest tree out from center.
- Ideal Treatment – Hack and squirt all tanoak, then cut and burn all tanoak within **600'** radius of infected tree (26 acres). Cost would be $130,000 per site ($5,000 per acre). Sites that have a cluster of infected trees would be disproportionately higher in cost as the 600' radius for the buffer treatment is from the farthest tree out from center.

Program Structure

Essential program functions are shared among the following:

Oregon Department of Forestry (ODF) – Survey, detection and monitoring; planning and administration of eradication treatments on non-federal land; landowner education and assistance. Operations are managed by the statewide forest pathologist in Salem Private Forests Division plus two Coos Bay District SOD foresters located in Brookings.

Oregon Department of Agriculture (ODA) – Authority and administration of the SOD Quarantine. Authority and administration of the nursery SOD program. Coordinates with USDA Animal and Plant Health Inspection Service (APHIS). Operations managed out of Salem.

USDA Forest Service (USFS) – Planning and administration of eradication treatments on Rogue River-Siskiyou National Forest lands; assists ODF with aerial survey, conducts ground survey, detection and monitoring and technical assistance to federal land managers. Ground survey and treatment operations are managed by Southwest Oregon Forest Health Protection Service Center's zone forest pathologist in Central Point and SOD Forester in Gold Beach in conjunction with the Rogue River-Siskiyou National Forest. Aerial survey assistance provided by Pacific Northwest Region Forest Health Protection aerial survey program. Through grants provided to ODF & BLM and contracts with OSU the USFS provides program funding, technical support and assistance to entities engaged in SOD work.

USDI Bureau of Land Management (BLM) – Planning and administration of eradication treatments on Coos Bay District lands; conducts ground surveys and monitoring. Operations managed by BLM foresters in the Coos Bay District Office with program coordination by Oregon State Office in Portland.

Oregon State University (OSU) College of Forestry – Testing of sampled plant material for *P. ramorum* and related diagnostics. Everett Hansen Lab in Corvallis. Research into pathogenicity of NA1 and EU1 lineages of *P. ramorum*. Jared Leboldus Lab in Corvallis.

Oregon State University College of Agricultural Sciences/USDA Agricultural Research Service (ARS) Horticultural Crops Research Unit -- Genotyping of *P. ramorum* species and clonal lineages from sampled plant material. Nik Grünwald Lab in Corvallis.

Oregon State University Forestry and Natural Resource Extension Service – Outreach, education and assistance. Operations conducted by Forest Health Extension Specialist in Corvallis and the Coos and Curry Extension Forester in Myrtle Point.

Coordination of operations is conducted by the SOD Science Team: Ellen Goheen (Forest Pathologist, USDA Forest Service), Everett Hansen and Jared Leboldus (Forest Pathologists, OSU), Sarah Navarro (Forest Pathologist, ODF), and Helmuth Rogg (Plant Program Director, ODA). Communication among landowners, nurseries, other organizations, and other interested parties is conducted through monthly SOD Core Group conference calls hosted by Gary McAninch, Nursery and Christmas Tree Manager, ODA.

Current funding sources

All funding for the SOD program in forests is provided by agencies. The program also benefits from cooperation by private landowners.

USFS funds a pathologist that provides program oversight and expertise and a Gold Beach RD SOD forester positions which is focused on detection and treatment on National Forest lands. It also provides $150,000 per year for SOD diagnostics via a cost-reimbursable agreement with the Everett Hansen laboratory at OSU. USFS eradication treatments are funded internally through USFS budget processes on an annual basis. In FY2016, $265,000 was provided for treatments and their administration. USFS also funds grants to ODF annually which supports SOD surveys, monitoring, and eradication treatments. ODF receives $375,000 per year from USFS for SOD (which includes $35,000 from the forest health monitoring grant for stream baiting).

BLM funds eradication on their lands and related work through their internal budgeting process, and thru interagency grant programs which are approximately $250,000 per year from USFS.

ODF funds the pathologist and two foresters in Brookings, plus $75,000 per year for eradication. In 2016, in order to alleviate the eradication treatment funding shortage, ODF submitted a request to the Emergency Board for $250,000 of General Fund to the SOD program in May of 2016. The request was granted to ODF and the money was allocated in three parts: $100,000 to increase treatment of the leading edge of infested sites in or near the quarantine boundary; $100,000 will be used to create an emergency treatment fund that will be held by ODF for rapid treatment of any site outside of the quarantine area or an infestation of the EU1 lineage; and $50,000 was given as a block grant to the Association of Oregon Counties to convene and facilitate the SOD Task Force. Although the Emergency Board money helps to address the current backlog of funding, there is no guarantee the SOD slow the spread program will receive funding such as this in the future.

OSU receives funding for diagnostics and other lab support primarily from USFS, plus other agencies ($185,000 per year). The Grunwald Lab receives $15,000 per year from USDA APHIS for genetic lineage analysis.

Estimated Annual Program Expenditures- (funding source)

ODF-Brookings Field Office ($100,000 US Forest Service, $60,000 State General Fund)	$160,000
ODF-Salem Staff (State General Fund)	$90,000
ODF-Aerial Surveys (includes digital imaging) (US Forest Service)	$45,000
OSU-Hansen Lab (US Forest Service)	$185,000
OSU/USDA ARS-Grunwald lab (USDA APHIS)	$15,000
USDA Forest Service	$130,000
BLM-Coos Bay staff	$145,000
Subtotal	**$770,000**

*Excludes treatment costs for ODF Survey, detection, monitoring, and program administration costs are $325,000 per year.

Estimated Annual Eradication Treatment Expenditures

ODF ($75,000 State General Fund; $75,000 US Forest Service)	$150,000
USDA Forest Service	$250,000
BLM ($305,000 BLM and $250,000 US Forest Service)	$555,000
Subtotal	**$955,000**
TOTAL	**$1,725,000**

Cumulative Program Expenditures – 2001 through 2015

Cumulative Operating and Eradication Treatment Expenditures by Funding Source (excluding research)

USDA Forest Service	$10,195,700[1]
BLM	$3,901,000
ODF – State General Fund	$3,442,000
Oregon Department of Agriculture / USDA APHIS	$490,000
Private	$322,000
Other State Agency (Eradication Treatments)	$96,500
TOTAL	**$18,447,200**

[1] In 2010, the Oregon SOD Program received $2,692,000 from the American Recovery and Reinvestment Act through the US Forest Service.

ALTERNATIVES AND THEIR CONSEQUENCES

Alternative 1: Transition To Living With The Disease

Sudden oak death is here to stay and will be a forest health issue into the future. Under this alternative, the slow-the spread program (survey, detection, and eradication) would be halted. Federal funding for SOD would likely decrease and agencies would conduct SOD detection and monitoring surveys during their normal course of business. Through annual aerial surveys and imaging, small scale ground surveys, and possible citizen science programs, the disease spread could be monitored and provide data to researchers and graduate students. ODF could continue to provide technical assistance to landowners who want to know why their tanoaks are dying and what they can do about it, give advice on how to reduce hazards from fire and tree fall, assist in enforcing quarantine regulations, and promote best management practices for this forest health issue. In short, we would rely on educating people to mitigate the effects of the disease and prevent spread to other susceptible forests in adjacent counties. This scenario would be similar to what is happening in much of California.

Without treatment the disease intensifies and rate of spread increases. Tanoak is rapidly being eliminated from infested areas in California and in the Oregon GIA. Oregon will lose tanoak in at least the western portion of its range. Birds, mammals, insects and fungi dependent on tanoak will migrate or die. Loss of tanoak will impact Native American culture; they have traditionally relied on tanoak acorns as a food source. Assuming no human spread, starting at the farthest north infestation (Hunter Creek), disease spreads northward 3.5 mi/yr. Disease reaches the Coos County line in 10-12 years.

The quarantine regulations would change soon to encompass all of Curry County, and eventually Coos and Douglas counties, potentially raising export and trade issues with species on the *P. ramorum* host list, including Douglas-fir, western hemlock, grand fir, and others. Forest, nursery, Christmas tree and other forest product operations that intend to ship material will need inspections and disease-free certifications, probably on a fee-for-service basis.

Alternative 2: Continue the Current Slow-The-Spread Program (with prioritized treatment sites – essentially status quo)

This alternative continues the current slow-the-spread program as funded today. In 2016, 65 new sites outside the GIA were confirmed; if these were treated with a 300 foot buffer the total treatment area would be 638 acres: 481 acres on privately owned land, 57 acres on BLM, and 100 acres on USFS (Figure 1). BLM is treating all infestations on their ownerships. USFS expects to treat all known sites to some extent; minimal treatment standards may need to be used based on available funds. The number of outlying sites in 2016 exceeded the program's capacity to treat all sites with 300 foot buffers. Thus, the program created treatment priority areas to identify where sites will receive 300 foot buffers, whiles other sites will receive treatment based on available funding. The establishment of the GIA has allowed the program to focus treatment efforts on high priority sites, however, the current budget does not allow for full treatments of all new infestations outside of the GIA.

The consequences of continuing the slow-the-spread program at current funding levels are becoming clear. In areas where treatments have stopped, disease intensifies dramatically and

kills most of the tanoaks in just a few years. As more inoculum is produced in the areas of uncontrolled disease, the leading edge of the main infestation expands northward and eastward, and the probability of human-assisted spread increases. Each year, outlier infestations become more numerous and occur farther from the leading edge. Funding for eradication treatments is not sufficient to treat all outliers effectively and will continue to be increasingly insufficient as the disease continues to intensify. Scaling treatment area size to importance of site allows the most important infestations to be cut and burned, which slows disease relative to no treatment.

Under this scenario, disease reaches the Coos County line in 20 years. The GIA would continue to expand northward 2 mi/year (rate of recent GIA expansion), with outliers occurring no more than 12 miles north of it and assuming no human assisted spread. At current funding levels, there is a risk that the rate of spread will increase over time and that risk of human spread also increases.

Additionally, Oregon State University would continue to conduct small scale research studies based on SOD program needs using existing funding from ODF and USFS.

Cost: $1,725,000/year

ODF-$225,000 for program admin/treatment on state & private
USFS-$380,000 for program admin/treatment on USFS land
USFS-$655,000 for support to others (ODF, OSU, BLM etc.)
USDA-APHIS-$15,000 to OSU
BLM-$450,000 for program admin/treatment on BLM land

Alternative 3: Continue the Current Slow-The-Spread Program, with Enhanced Funding to fully treat all sites

Assuming at least 638 acres requiring treatment per year on forestlands, implementing the desired treatment level (300 foot buffer) at an average $5,000 per acre would cost $3,190,000 per year. Expanding this number to $3,350,000 per year provides an eradication treatment budget that hedges that some sites may be larger because they encompass groups of infected trees and/or more costly due to difficult terrain or working in and around homes, power lines and other structures.

Currently, the annual operating budget for conducting eradication treatments on new sites on non-federal lands is $150,000 per year; $75,000 from the USDA Forest Service Forest Health Protection Program and $75,000 from the state general fund. The annual operating budget for conducting eradication treatments on USFS land is $250,000 and on BLM lands is $555,000. The current deficit for needed funds is an estimated $2,235,000 to treat new sites detected in 2016. Therefore, current funding only provides enough to treat approximately 107 acres on federal lands and 30 acres on non-federal lands to the desired level; or less than 22 percent of the anticipated need.

Under this alternative, the slow-the-spread program would need to secure increased funding for conducting eradication treatments on all lands by $2,395,000 per year for a total treatment of $3,350,000 per year. Unused funds should be allowed to be banked from year to year so as to take advantage of savings incurred in lower than average spread years to be available to address treatment needs in above average spread years. Mechanisms should be developed so funds can

also be used on all lands should their managers face the same financial limitation currently being incurred on non-federal lands to treat sites at the desired levels.

Research is needed to improve our ability to combat sudden oak death, especially given the introduction of the EU1 lineage in Oregon's forests. A cooperative, competitive research program is proposed to improve early detection and silvicultural control methods, as well as compare aggressiveness and host range for the NA1 lineage versus EU1 lineage. Studies are also needed to describe the ecological and economic impacts of sudden oak death in Oregon. The program would be administered through the US Forest Service, Pacific Southwest Research Station, and would require an annual budget of $1.2 million for 2018 and $1.7 million for the following 3 years.

Cost: $5,320,000/year

ODF-$225,000 for program admin/treatment on state & private
USFS-$380,000 for program admin/treatment on USFS land
USFS-$3,050,000 for support to others/additional treatment on USFS (ODF, OSU, BLM)
USDA-APHIS-$15,000 to OSU
USFS $1,200,000 for research thru Pacific Southwest Research Station
BLM-$450,000 for program admin/treatment on BLM land

Alternative 4: Contain To Curry County For As Long As Possible

Alternative 4 focuses on preventing sudden oak death from entering the adjacent counties, Coos, Douglas, and Josephine, for as long as possible. This alternative increases the chance to protect important tanoak ecosystems, and provide long term conservation and adaptation of tanoak genes. Alternative 4 builds on alternatives 2 and 3 because continuing to slow the spread in the southern portion of Curry County is essential for containment farther north.

There is strong interest in avoiding a county wide SOD Quarantine for Curry County as well as avoiding the spread of SOD into neighboring counties. A means of ensuring aggressive eradication of human assisted or other unanticipated infestations would be to establish an Emergency Fund held in reserve and available to rapidly respond to new infestations in an action zone adjacent to neighboring counties (Figure 2); or for sites detected in the neighboring counties themselves.

This opportunity also requires an expansion of survey, detection and monitoring capacity due to the need to survey the action zone and the area between the action zone and quarantine area at intensities currently reserved for within the quarantine area and areas proximately surrounding its boundary. From the Emergency Board allocation in 2016, $100,000 has been placed into an emergency treatment fund to be used on any new infestation outside of the current quarantine or a new infestation of the EU1 lineage. Given the cost of an ideal eradication treatment (600 foot radius, 26 acres), this emergency treatment money would be spent down in order to cover one infestation. An emergency eradication treatment fund totaling $500,000 would potentially treat five new sites (or 100 acres) at the ideal treatment level; this would relieve the burden of finding continued funding on potentially an annual basis.

Alternative 4 requires increased survey effort in the 6 mile wide action zone between Curry, Coos and Douglas Counties (Figure 2). The additional survey effort would include 20-30 stream baits and two aerial surveys of 250,000 acres each near the county line. Intensive delimitation

surveys are conducted whenever a new infestation is found. This alternative will likely require an increase in field staff. The cost of this increase in aerial surveys, field technician time, and lab diagnostics is estimated at $100,000 /year.

Additionally, the program must be able to mobilize eradication crews quickly and sometimes simultaneously within days or weeks of detection to prevent additional spread, especially in the action zone. Contractor response time has been problematic due to fire danger and contractor availability. We will need to review and secure contracts to ensure acceptable response or train a local workforce to conduct eradication work.

Alternative 4 is designed primarily to ensure that SOD does not move into Coos, Douglas, or Josephine Counties, and it should succeed at doing that for at least 10 years, probably longer. Cutting and burning isolated individual infestations can stop intensification and spread, provided delimitation and treatments are done properly. Based on current observations, it is unlikely that the disease will naturally spread across the 6 mile wide action zone without detection and an opportunity for eradication, provided continued diligence with detection surveys. Host removal in disease pathways leading to the action zone should improve the chance of containment in Curry County. The GIA likely will expand slowly, the rate of which will depend in part on our capacity to treat infestations beyond its leading edge to the north, but short of the action zone.

Cost: $5,920,000/year

ODF-$225,000 for program admin/treatment on state & private
USFS-$380,000 for program admin/treatment on USFS land
USFS-$3,650,000 for support to others/additional treatment on USFS (ODF, OSU, BLM)
USDA-APHIS-$15,000 to OSU
USFS $1,200,000 for research thru Pacific Southwest Research Station
BLM-$450,000 for program admin/treatment on BLM land

Other Options that can be done simultaneously with alternatives.
Finding and developing disease-resistant tanoaks is a long-term proposition with an unknown probability of success. Preservation of important tanoak ecosystems (refuges) seems possible if located away from the highest disease risk areas.

- **Tanoak Refugia**: Protection of important tanoak ecosystems (refugia) is possible if located away from the current distribution of SOD as well as away from the highest disease risk areas as shown in Figure 2. Areas of tanoak with high ecological and/or cultural value would be identified. Protection would involve intensive early detection, strict limits on human access and ideally eradication within 2-3 miles of each identified refuge. These areas likely will be located on federal land and will be selected by land managers and interested parties. These areas also could be part of a larger tanoak gene conservation effort. **Cost: $130,000/year-** $30,000 for additional aerial and ground surveys at 3 areas ($10,000 per area) and $100,000 to expand scope of Emergency SOD Treatment Fund to include treatment needs around designated refuges.

- **Resistance Breeding for Tanoak**[2]: Begin long-term program of locating and developing tanoaks that can grow and reproduce in the presence of *P. ramorum*. Partner with Dorena Genetic Resource Center and OSU. **Cost: $30,000/year.**

- **Tanoak Removal in Strategic Areas:** Identify areas on the landscape that are likely pathways for aerial dispersal of *P. ramorum* into adjacent counties and remove or destroy tanoak in advance of the disease. The location of these areas will be determined by recent dispersal patterns, land forms, the amount and distribution of tanoak, and risk modeling. Private landowners will need incentives to do this. Incentive programs may be available to encourage landowners to remove tanoak and establish conifers or other non-host species. Increase market opportunities to utilize tanoak so as to cover the cost of removal within the quarantine area to encourage projects. **Cost: $650,000/year** to treat 1,000 acres/year; 50% hack and squirt treatment at $300/acre; 50% slash and burn treatment at $1,000/acre. This opportunity is scalable depending on the amount of funding secured.

- **Stakeholder Cooperative:** Coordinate detection and control among all landowners in SW Oregon. If stakeholders, especially private industry, do not want SOD to enter Coos and Douglas Counties, they should begin action and investment now.

[2] Finding and developing disease-resistant tanoaks is a long-term proposition with an unknown probability of success.

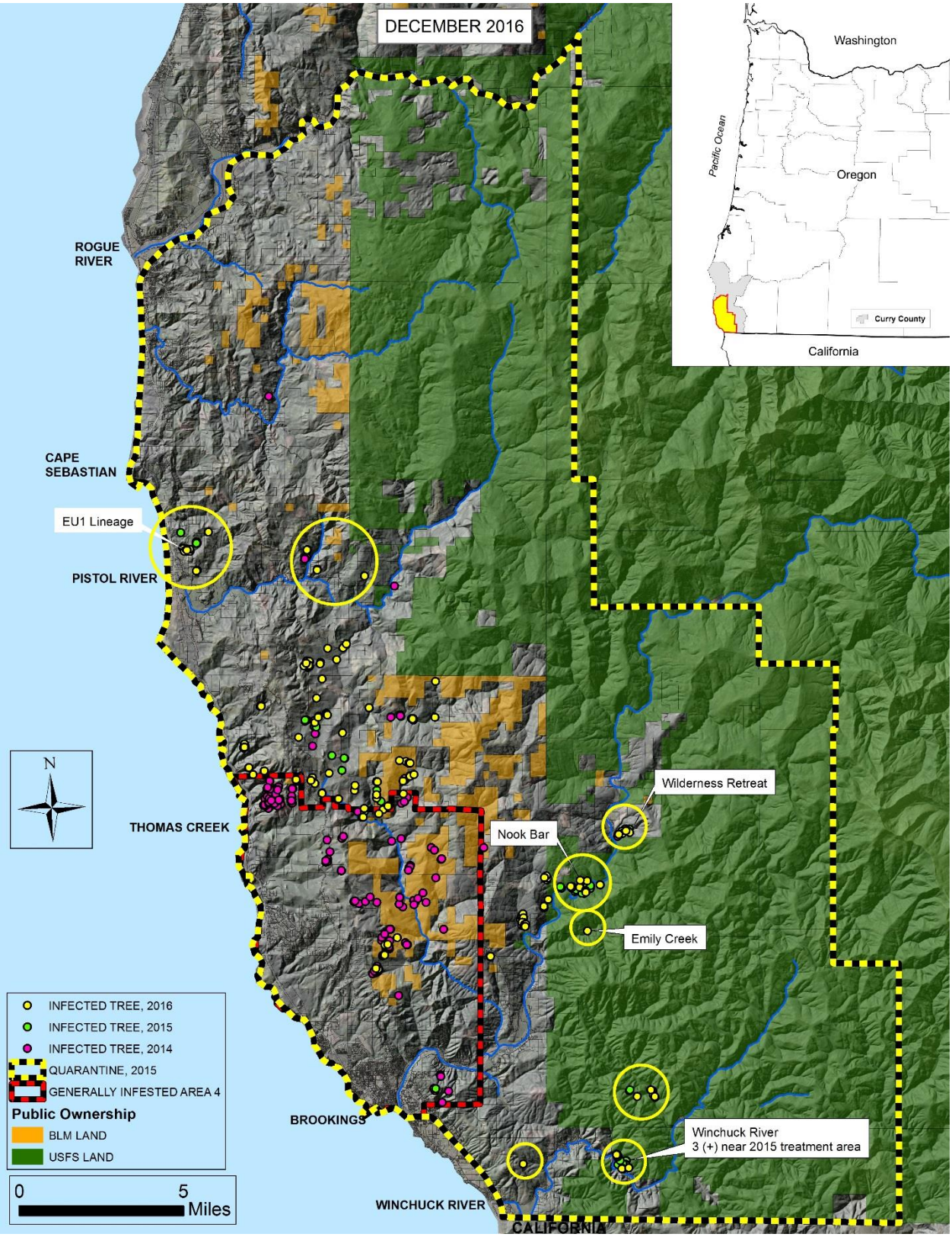

Figure 1. Location of sites infested with *Phytophthora ramorum* in southwest Oregon that were discovered in 2014-2016. All 2015 infestations have receive some level of eradication treatment. Yellow circles designate 2016 infestations have been prioritized for treatment.

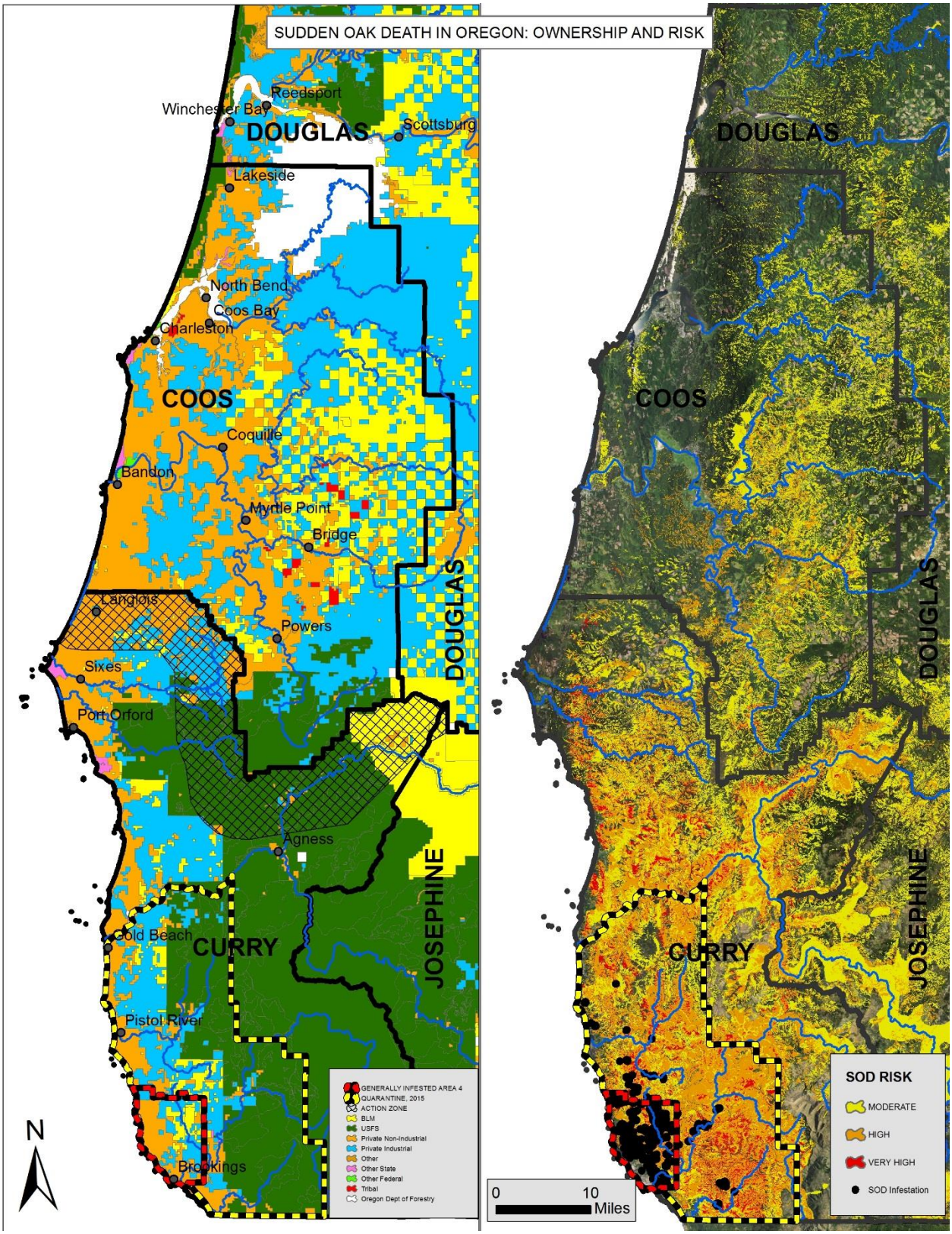

Figure 2. Sudden oak death action zone, major land ownership, and potential distribution in southwestern Oregon.