Sudden Oak Death:
Economic Impact Assessment

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Abbreviations

APHIS: **A**nimal and **P**lant **H**ealth **I**nspection **S**ervice

BLS: **B**ureau of **L**abor **S**tatistics

GIA: **G**enerally **I**nfested **A**rea

LEMMA: **L**andscape **E**cology, **M**odeling, **M**apping, and **A**nalysis

MBF: **Thousand B**oard **F**eet (timber volume unit)

MMBF: **Million B**oard **F**eet (timber volume unit)

ODA: **O**regon **D**epartment of **A**griculture

ODF: **O**regon **D**epartment of **F**orestry

OFRI: **O**regon **F**orest **R**esources **I**nstitute

Pr: ***P****hytophthora* ***r****amorum*, oomycete fungal pathogen responsible for causing SOD.

PoCB: **P**ort **o**f **C**oos **B**ay

QCEW: **Q**uarterly **C**ensus of **E**mployment and **W**ages

QZ: **Q**uarantine **Z**one

SOD: **S**udden **O**ak **D**eath

USDA: **U**nited **S**tates **D**epartment of **A**griculture

USFS: **U**nited **S**tates **F**orest **S**ervice

1.0 EXECUTIVE SUMMARY

This report estimates economic impacts of Sudden Oak Death (SOD) in southwest Oregon. The disease causes widespread mortality chiefly in tanoak (*Notholithocarpus densiflorus*). Through 2018, SOD has caused minor impacts on the regional economy:

- No current impact to annual timber harvest, export or log prices
- Inconsequential reduction in tanoak fiber shipments from Curry County
- SOD treatment funding of $1.5 million per year from federal and state funding sources
- Anecdotal loss of real estate transaction values in select instances
- No decline in recreation or tourism revenues attributable unequivocally to SOD

Potential impacts of SOD strike at core values that elude economic quantification, particularly tribal cultural values and the existence merits of tanoak-dominated forests. Cultural practices with great historic and traditional meaning—acorn gathering, materials for basket weaving, hunting—are already compromised by SOD, but lack a consensus value assessment in market terms. SOD may be an existential threat to tanoak and associated obligate species; while missing a clear monetary equivalent, these forests nonetheless have inherent existence value and may contribute ecosystem-level or biodiversity values unrecognized prior to extirpation.

Under current disease management, the SOD infestation will expand through Curry County between 0.5 and 4.5 miles per year. ODF's treatment regime should control the rate of expansion, while halting treatment would most likely accelerate infestation. Continued treatment may constrain SOD south of the Rogue River to 2028 and within Curry County to 2038. Without treatment, SOD could move north of the Rogue River by 2023 and to Coos County by 2028. Other disease models under development could provide alternative estimates of SOD expansion, including explicit climate change effects.

Alternative SOD management strategies may determine whether southwest Oregon can continue timber exports, maintain present ecosystem functions, ensure high quality of life for residents, and remain an attractive location for outdoor pursuits. If the ODF SOD treatment regime were terminated as of January 1st, 2019, serious economic impacts might occur as SOD expands to Coos County, which could happen as soon as 2028:

- Sanctions on southwest Oregon timber exports by China, Japan, and/or Korea
- Loss of 1,200 jobs related to timber export; $57.9 million in annual wages
- Reduction of timber harvest by 15%, with proportional loss of forest products harvest tax revenue, and forest sector jobs and wages
- Collapse of rural residential property value; loss of real estate transaction revenues
- Decline in recreation and tourism income out of proportion to the extent of SOD infestation; unfavorable public perceptions of the region take hold

We compared the preceding consequences of halted treatment to the likely outcome of continued SOD management. A treatment regime comparable to ODF's current procedures, giving equal priority to controlling either the NA1 or EU1 strain, could delay the spread of SOD north of the Rogue River until 2028, and prevent infestation of Coos County beyond 2038.

Funding SOD treatments for a total cost of $30 million over the next 20 years could offset loss of 1,200 jobs by 2028 and $580 million in wages from 2028 to 2038.

Regional economic impacts on the forest sector and non-timber concerns may be amplified by SOD, yet other factors could render SOD irrelevant. Loss of access to timber export markets in 2028 due to SOD could be precluded if international trade agreements break down over e.g. tariffs on US imports from China circa 2020. Impacts on property values or recreational industries may be overshadowed if SOD-infested forests and residential communities are destroyed by major wildfires. Ecosystem services provided by tanoak forests could be compromised by SOD, but the same functions could be more definitively impaired by climate change, wildfire, or development. We conclude that SOD may potentiate other regional trends already in motion—rural economic decline, wildfire frequency, climate change, biodiversity loss—but that only retrospectively may SOD be declared as the decisive cause of any economic impacts.

2.0 BACKGROUND

The purpose of this report is to estimate economic impact of Sudden Oak Death (SOD) disease in Oregon for the interval spanning 2001 through 2018, and to anticipate potential economic impacts of the ongoing epidemic through 2038. In Oregon, the disease infects principally tanoak (*Notholithocarpus densiflorus*), but also numerous other plant species, and economic impacts may be mediated through any of these species. We briefly review the literature on SOD's pathology and ecology to provide context, but it is not our objective to assemble a comprehensive review. For primary source material, we direct readers to appropriate citations.

Our assessment is divided along two axes, (1) current versus future impacts, and (2) timber or non-timber impacts. The current SOD outbreak is restricted to the southern half of Oregon's Curry County, having been introduced to Oregon from California ca. 2001 (Vaclavik, 2010). Any economic impacts that we classify as 'current' or 'through the present' are limited to this portion of Curry County and within the interval of time from 2001 to 2018. Forest pathologists predict that SOD could eventually infest the entire range of tanoak, given a likely set of unfavorable bioclimatic conditions (Vaclavik, 2010) and limited capability of management options to combat the pathogen. Quantitative assessment of current economic impacts can be reasonably well defined because the extent of infestation is geographically constrained, and the array of affected entities is still small enough that most groups or classes may be contacted directly and their concerns and experience may be documented. Accurate projection of future impact, in contrast, is subject to a complex interaction of rate of SOD expansion, sequences of contingent macroeconomic events, and regional processes of forest ecology, none of which may be known in advance.

The types of impacts are similarly divisible into a relatively clear set of timber industry impacts versus a less well-defined set of non-timber impacts. SOD may impact the timber industry differently for tanoak versus conifer volume. Impacts may be felt within or beyond the region of SOD infestation; either domestic or export markets may be impacted. In contrast, non-timber impacts include such diverse categories as tribal cultural concerns, real estate aesthetic valuation, hazard tree removal costs, recreation and tourism, and ecological impacts at multiple trophic levels. Moreover, certain non-timber ecological impacts are likely to have economic impacts only if they occur in particular geographic areas or under particular sets of economic conditions[1], neither guaranteed to occur in the necessary order to become problematic.

For the remainder of this section, we review the pathology and ecology of SOD, introduce a disease expansion model, cite relevant aspects of current Oregon Regulatory Statues, and further introduce the potential impacts of SOD on the Oregon timber industry, non-timber economic consequences, and the unique concerns of tribal organizations.

[1] E.g. recreational impacts to trail systems on USFS lands; property valuation after SOD infestation but only if wildfire events do not supersede; hunting impacts dependent on competing and contradictory habitat use by prey animals.

2.1 Pathology and Ecology

The pathogenic agent of Sudden Oak Death is *Phytophthora ramorum*, a fungus-like organism introduced to California on nursery stock from an unknown location ca. 1995, and first isolated from a canker on a coast live oak (*Quercus agrifolia*) (Grunwald, 2012). While tanoak experiences the most severe infection, resulting in mortality, SOD symptoms may appear in a range of host plants (Grunwald, 2012) including true oaks (*Quercus*), except Oregon white oak (*Quercus garryana*) and the families Ericaceae, Aceracea, Rosaceae, Lauraceae, and less frequently others (McPherson, 2002). Symptoms on tanoak are sometimes only apparent with secondary impacts like bark beetles and associated fungi, rather than *P. ramorum* being the sole cause of disease. The first recorded SOD infestation in Oregon occurred in Curry County in 2001, possibly though not certainly imported via nursery stock. The forest ecosystems originally infected in California share similar structure and species composition with southern Oregon forests.

Dispersal of SOD is influenced by climate, topography, spore abundance, and host vegetation susceptibility (Vaclavik, 2010). Most infection events occur as a result of local dispersal (<250 m), but long-distance dispersal events of many miles (Meentenmeyer *et al*. 2011), though rare, produce a disproportionate impact on containment efforts. Rainwater dispersal has been shown in California to facilitate dispersal up to 10 miles, and theoretically unlimited dispersal may occur via contaminated soil e.g. on soles of hiking boots after recreators walk through a SOD infestation (Davidson, 2005). Conditions most conducive to SOD expansion are convergence wet conditions with warm temperatures and extreme wind events. New infection events are less likely in areas where the vegetation composition features lower representation of suitable host species.

Molecular lab testing classified all SOD infestations in Oregon prior to 2016 as the NA1 strain (North American 1). The EU1 strain (European 1) emerged later in the 1990's in Europe, but was found in waterways in both California and Washington in 2013 (Frankel, 2014) In May 2015, this new strain was identified, based on gene sequencing, near Pistol River, Curry County, Oregon. This was the first report of the EU1 strain in US forests. The original forest infestation of the EU1 strain was treated (see §2.2), but EU1 nonetheless reappeared at new locations, and has shown ability to produce nearly an order of magnitude more spores than the more common NA1 strain (Pers. Comm., Ellen Goheen, Jared Leboldus). Although EU1 appears to function biologically via the same mechanisms as NA1, epidemiologically the infestation may accelerate because a dramatically higher spore production could increase the frequency with which infection or transmission occurs, and increase the coincidence of spore release with rare climate events conducive to long-distance dispersal.

2.2 Regulatory Environment

This report does not cover potential impacts from the nursery industry or attempt to model infestation events deriving from transport of SOD-infect nursery stock that may cause independent SOD infestation events in forestland.

The starting point for the present impact assessment includes an extant quarantine zone (QZ) established by the Oregon Department of Agriculture (ODA) in Curry County, as authorized in ORS 561 and 570, and implemented in ORS 561.510 - 561.545, 570.105 - 570.190, & 570.990 - 570.995. This quarantine extends to several counties in California, though to date includes only the portion of Curry County in Oregon that is specified by vertices listed in (Appendix 8.1). Provisions exist for expansion of the quarantine in three mile buffered increments surrounding any detected SOD infestation. Regulations define an infested ***site*** as the area in a 50 foot radius around an infected ***tree***, and specify ***treatment*** for the site as requirement to "eliminate or reduce *P. ramorum* inoculum and source thereof". In general terms, this quarantine is currently established south of the Rogue River. Within the quarantine zone, an area designated the Generally Infested Area (GIA) is no longer prioritized for treatment because infestations are widespread. Rather, resources are focused on treatments in areas of the quarantine zone selected to minimize future expansion of the quarantine.

Ongoing treatments undertaken by the Oregon Department of Forestry (ODF) funded by the United States Forest Service (USFS) and the State of Oregon have, to this point, allowed the quarantine area to remain at a scale below the whole-county level, thereby preventing oversight of the QZ by USDA (United States Department of Agriculture) APHIS (Animal and Plant Health Inspection Service) from declaring all of Curry County under quarantine. In the event that the entirety of Curry County is declared under quarantine, then QZ management and regulatory definitions shift to APHIS, changing relevance of the quarantine definition cited in Appendix 8.1.

Programmatic response to SOD infestation includes a regional monitoring program and a treatment regime. Monitoring consists of aerial surveys combined with ground-based transect surveys and stream water surveys in which stream water is bio assayed using rhododendron leaves to detect SOD. Where detected in forests that have either tanoak or other host species, a SOD infestation treatment consists of cutting and burning all woody vegetation belonging to susceptible host species[2] within a 300' radius of the infestation site. Current protocol includes an initial herbicide application (via 'hack and squirt' method), followed by a period of time typically greater than 10 days to allow infected treated trees to die, then cutting the dead stems and burning at first appropriate opportunity. Some treatment sites have been replanted with non-susceptible species, but this activity is typically not funded under the standard treatment regime. The quarantine definition in Appendix 8.1 includes procedures relevant for nursery and forest infestation events; we reiterate that the current impact assessment does not examine SOD

[2] Treatment does not include cutting or burning of conifer species. Conifers are not considered susceptible hosts, and are allowed to continue growing within treated areas if originally present.

pertaining to nursery operations, and that the disease model (§2.3) underlying prediction of future economic impacts also does not include SOD infestation via nursery stock.

2.3 Treatment Progress

After initial detection, ODF implemented aggressive treatments from 2001 through 2012 that kept pace with disease expansion (Figure 1). Treatment from 2005 to 2012 averaged 650 acres per year, including some treatments that overlapped with commercial timber harvests. Over the last six years, however, an average of 295 acres have been treated annually, contending with larger acreage of new infestation. In 2012 treatment acreage continued to exceed new mortality acreage. However, through 2017, the cumulative infestation has outpaced treatment. Although 2016 and 2017 saw relatively low rates of new infestation, the rapid expansion of SOD in 2013 through 2015 left the region with more than 2,200 newly infested acres. The years 2014 and 2015 showed particularly rapid spread, coinciding with low funding levels (Figure 1).

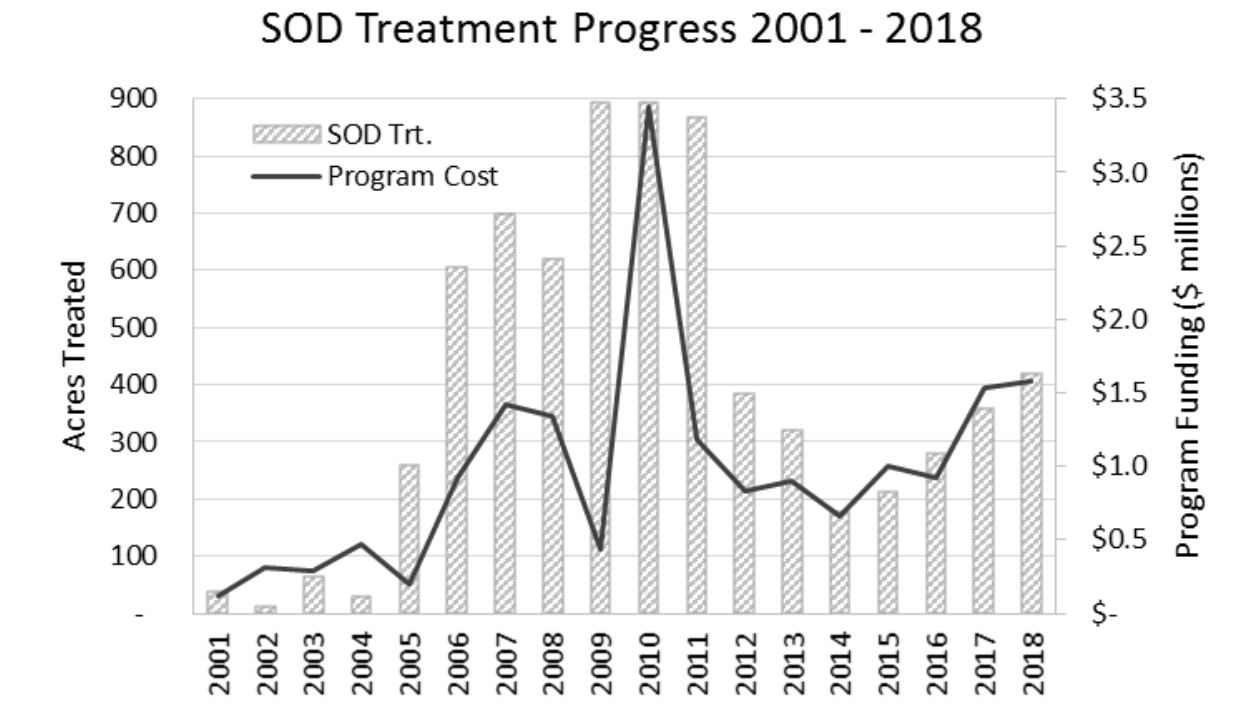

Figure 1. Progress on SOD treatment demonstrated by ODF from 2001 through 2018, showing acres treated (hatch bars) in comparison to total SOD treatment program costs (line, ODF fraction).

Treatment strategy has evolved in response to the SOD infestation. In the early stages, ODF sought to treat all infestation loci. The rate of spread within what is now the GIA surpassed treatment, leading to declaration of the GIA and a strategic shift toward treatments at the infestation periphery. Currently, treatment focuses on newly detected outbreak events along the north, east, and south edges of the infestation front inside the quarantined area. Appearance of the EU1 strain near the Pistol River in 2015 and 2016 caused a temporary strategy change emphasizing total eradication for EU1. Total EU1 eradication did not occur, and ODF now follows a combined strategy of prioritizing treatments where EU1 is detected, while continuing

treatment of NA1 along the SOD expansion envelope. This report will investigate impacts of the current treatment strategy, as well as alternatives where treatments are discontinued, or where solely EU1 strain is treated (see §3.1).

The GIA was established in 2012 (Figure 2), so area treated after 2012 corresponds only to treatments outside of the GIA, because treatments inside the GIA were suspended. The infested area after 2012 is tracked separately by ODF for inside the GIA (where treatment no longer occurs) versus in the QZ but outside the GIA, where treatment efforts have been focused since 2012. Although total treatment acres decreased after 2012, these are more targeted treatments applied to the edge of the SOD expansion front where treatment has maximum potential to halt disease dispersal.

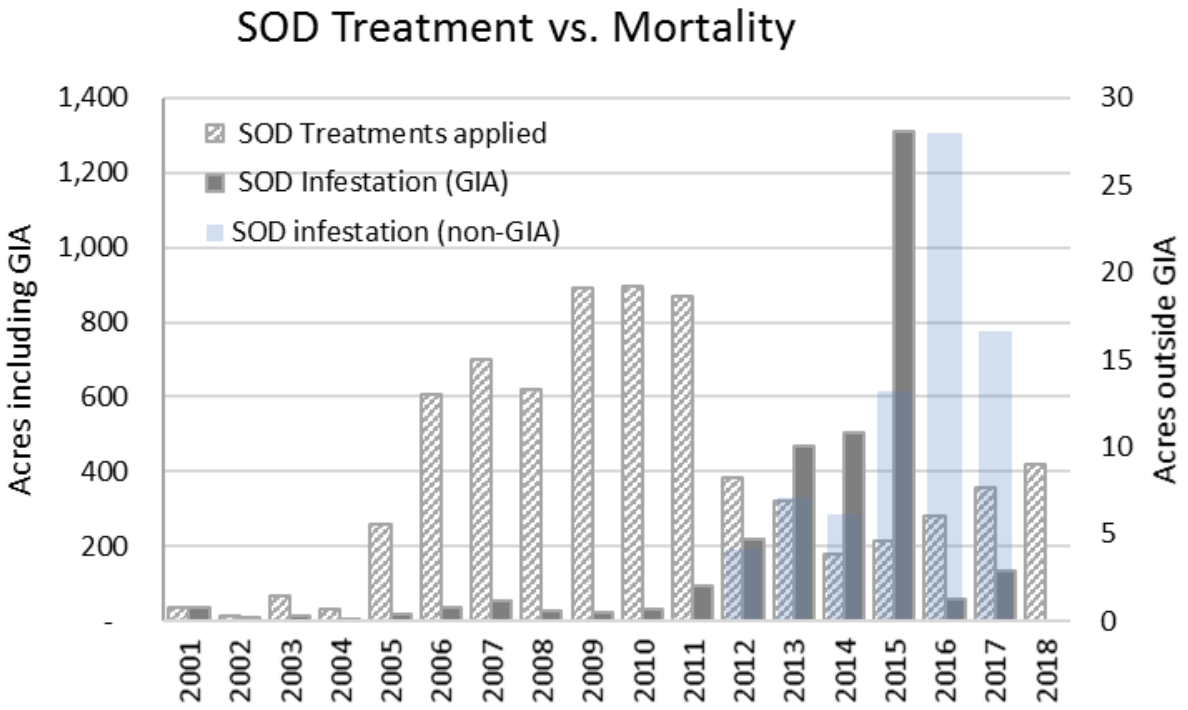

Figure 2. Through 2017, annually treated area outside the GIA has ranged from 179 to 358 acres, averaging 270 acres (hatched bar). The area infested by SOD in the QZ (including GIA and outside GIA) each year is highly variable, ranging from less than 100 acres in the earlier years to 1,311 acres in 2015 (grey bar). Treatments outside the GIA (blue fade bar) are only defined from 2012 onward, after the GIA was established. Note the second axis scale for outside-GIA treatments, the largest area treated was 28 acres in 2016.

2.4 Disease Model

Future economic impact of SOD was to be estimated based on results of a raster-based disease spread model in the original Scope of Work. Challenges to modeling this extremely complex system arose, however, and these results will likely be available later in 2019. We present two disease model methods here, first a summary of the intended raster-based model, and second our construction of an empirical rate-of-spread model constructed in a regression framework. The raster model would have provided a thorough mechanistic reconstruction of future SOD infestations, addressing the complex interaction of forest management responses to the pathogen diffusion (§3.1). The spatial logistic regression approach can leverage only historic rates of spread. We infer e.g. dispersal rate of SOD in the absence of treatment for NA1 vs. EU1 strains derived from reconstructions from aerial photographs of SOD-induced mortality, or from ODF GIS records of SOD treatment. A comprehensive review of relative differences in operation and capability of these disease models is beyond the scope of this analysis. We provide a functional description here with content provided via Pers. Comm. Devon Gaydos, North Carolina State University, ca. 11/14/2018. Our discussion of the regression model follows.

Modeling disease progression at a fine spatial scale is important for projecting future impacts of SOD on economic phenomena that are area-dependent—for example, property values that are influenced both by the presence of SOD on a particular parcel, but also by the relative amount of nearby infestation and a critical degree of regional disease prevalence.

In contrast, other economic impacts are likely dependent on threshold events such as the point at which certain political boundaries are crossed. It would be sufficient to know within some tolerable uncertainty when SOD crosses one of these political or significant biophysical boundaries. Linear rates of spread may be estimated in terms of miles per year from the SOD dataset, either for Curry County or for California counties before SOD crossed the Oregon border. As of 2017, SOD averaged 1.4 miles per year northward spread in Curry County, Oregon, whereas in Humboldt County, California, the rate of spread was 3 to 4 miles per year[3]. Comparable spread rates may be derived from stochastic process-based models; indeed, part of the calibration these models involves checking linear rates for realistic behavior relative to measured rates.

We distinguish between detailed, fine-scale disease model outputs computed via stochastic models, and empirical rate-of-spread models reliant on distance per time calculations from observed SOD expansion. Complex, fine-scale models will be necessary for calculating area-based economic impacts, for example the acreage of private property upon which sale value may be negatively impacted by SOD, or the cost to municipalities and private individuals of hazard tree removal. In contrast, rate-of-spread models are suitable for calculating SOD impacts to the timber

[3] Association of Oregon Counties. 2017. Sudden Oak Death Task Force Strategic Action Plan. Pg. 20-21.

industry, which is unlikely to be severely affected by biological effects of SOD[4] or even its prevalence in tanoak-dominated stands that tend to be spatially separated from productive timberland. Instead, instant changes to industry practices may take effect, as would happen if the quarantine expands to encompass all of Curry County. The timing of these discrete events may be estimated either from applying past rates of spread to the future, or by deriving future rates of spread from fine-scale stochastic models.

2.4.1 Susceptible-infected-removed SOD expansion model

The raster-based model will be a stochastic geospatial susceptible-infected-removed (SIR) epidemiological construct which takes the effects of host density and weather conditions into account. It is a single-host model where tanoak is the sole driver of disease transmission and establishment. The model requires raster inputs of initial infection locations, host density, and weekly weather conditions. Host (tanoak) density is inferred from LEMMA data (https://lemma.forestry.oregonstate.edu/) using a density proportional to biomass assumption. Rate of SOD spread is governed by sporulation, spore dispersal, spore establishment, and tanoak mortality, with assessments occurring on weekly time steps and mortality inflicted on an annual time step. A management even step is assessed on an annual basis to reflect ODF SOD treatment in appropriate alternatives. The model is calibrated for pure NA1 or EU1 expansion, or observed combinations of the two strains.

2.4.2 Spatial regression SOD expansion model

Prior to availability of a calibrated SIR-type model, we constructed an empirical spatial regression model based on ODF SOD treatment and mortality data collected from 2012 through 2017, after the latest major acceleration of SOD dispersal. We parameterize four dispersal rate sub-models:

- Treated rate of NA1 dispersal, based on ODF SOD treatment polygons in the QZ but outside the GIA, with **two variants**, northward and eastward. **Used for Alternative A**.
- Untreated rate of either NA1 or EU1 dispersal, based on mortality monitored via aerial photography within the GIA. **Used for Alternative B**.
- Treated rate of EU1 dispersal, reflecting prioritized EU1 treatment, based on selected events near Pistol River ca 2014. **Used for Alternative C**.

Datasets for each model (Table 1) consists of the set of 300-m grid cells (corresponding to SIR grid cells) and their percent tanoak cover that exist between mortality or treatment polygons in the QZ or GIA, as defined in (1) through (3) above. Any mortality or treatment at time T_1 may be assigned up to three potential nearest-neighbor events at time T_n, where $n \geq 1$. That is, a dispersal event must be at least one year displaced from the source year, allowing for detection in the first year of mortality. The rate of spread from mortality point T_1 is evaluated across a range of

[4] Essentially all of the value realized by the timber industry in Curry, Coos, Douglas, and Josephine counties is from commercially harvest conifer species. Actual losses to harvest-age conifers from SOD have never been demonstrated. Loss of tanoak volume is a negligible fraction of annual industry revenues.

detection times, up to a two-year delay. We refer to literature values of observed historic dispersal to calibrate the models so that untreated dispersal rates are within a range from 1 to 4 miles per year. These models are not intended to capture stochastic long-distance dispersal.

Table 1. Empirical model names, purpose, and sample size. Sample size indicates number of discrete k-nearest neighbor events where k ≤ 3.

Model Name	Purpose	n
TRT_DN_NA1	Alternative A, Northern	13
TRT_DE	Alternative A, Eastern	46
NOTRT_DX	Alternative B	89
TRT_DN_EU1	Alternative C	29

Rate of SOD dispersal is quantified as years per mile (ypm), or the time (years) required for SOD to transit one mile under each of the model input assumptions. The ypm quantity is described as a nonlinear exponential decay function of tanoak percent. More sophisticated regression models could include slope, elevation, wind speed, or other spatially-associated variables in each 300-m grid cell, similar to the composition of the SIR calibration dataset. For the current report, we cite discussions with the SIR modeling group that identify tanoak percent cover as one of the most significant covariates of SOD dispersal rate in that framework. Models take the form:

$$ypm = \frac{b}{1 + TO\%^{c}}$$

Equation 1

where b and c are estimated parameters[5], ypm represents years per mile from spatial SOD dispersal data, and TO% corresponds to the averaged tanoak percent cover within each 300-m grid-cell aggregate consisting of 30-m grid cells from the LEMMA dataset, with tanoak percent cover in 2018 computed using FVS. To assure convergence, we replicated each dataset for a set of ypm values corresponding to the 95th percentile of the observed set, with percent tanoak set to 0.5%. This was necessary to anchor the near-zero portion of the exponential decay at a value within the observed rate range. Model parameters include b, c, and upper and lower 95% confidence intervals (CI) on those parameters (Table 2). Note that with the exponential decay function, the upper 95% CI produces a lower ypm output.

[5] Non-linear curve fit routine implemented with nls() package in R (R project for Statistical Computing, https://cran.r-project.org/)

Table 2. SOD dispersal model parameters, with upper and lower 95% confidence intervals. Model output computed for the mean parameter value at a range of tanoak percent cover points to provide a sense of years per mile under various assumptions. Note that the upper 95% CI parameter value yields an often dramatic reduction to the ypm rate (calculation not shown); we use both rates in a sensitivity analysis.

Model Name	Purpose	Parameter		95% Upper		95% Lower		Sample ypm by Tanoak %			
		b	c	b	c	b	c	10%	25%	50%	90%
NOTRT_DX	Alt. B	7.241	0.350	7.044	0.325	7.436	0.375	5.0	4.5	4.1	3.7
TRT_DE	Alt. A, East	15.171	0.294	14.594	0.265	15.747	0.326	10.1	9.1	8.4	7.7
TRT_DN_EU1	Alt. C	8.057	0.472	7.823	0.436	8.290	0.511	6.0	5.3	4.7	4.1
TRT_DN_NA1	Alt. A, North	15.400	0.272	13.342	0.171	17.455	0.402	10.0	9.1	8.4	7.8

Each model is evaluated along a vector pointing from either the northern-most or eastern-most major infestation as of 2017, such that the vector passes through notable decision point barriers (see §4.2) en route to the closest set of relevant borders (Figure 3). We identify first the Rogue River to the north and the QZ boundary to the east as elements that would trigger a whole-county quarantine for Curry County. The next barriers are county borders for Coos, Douglas, and Josephine Counties. Each model is evaluated by calculating the years per distance from the dispersal model required to cross the set of grid cells intersected by each vector (Figure 3).

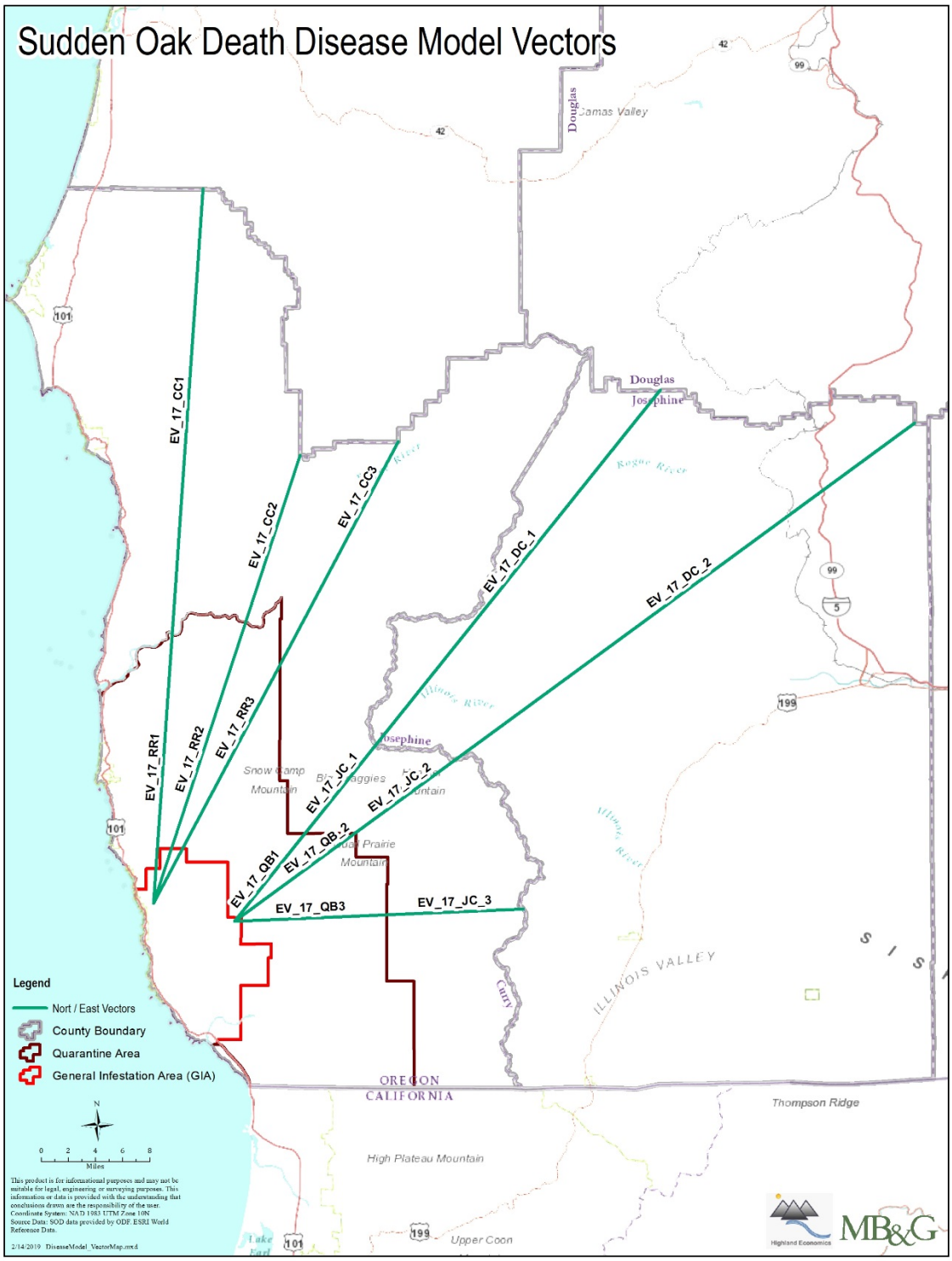

Figure 3. SOD dispersal vectors representing the most direct (linear) route from current north and east infestation concentrations through the most relevant decision point boundaries relating to SOD economic impacts. In particular, we focus on exiting the time at which major infestations escape the QZ, bypass the Rogue River, or enter Coos, Douglas, or Josephine Counties. Please refer to Appendix

2.5 Sources of timber industry information

We interviewed sources in the timber industry from southwest Oregon to establish expectations regarding cost of SOD treatment, cost of conforming to regulatory requirements imposed by quarantine rules, and as-yet unrealized effects of SOD quarantine including loss of access to international export markets. We estimated that current economic impacts from SOD are limited enough as to be ignored with the current quarantine definition.

In an effort to honor confidential information, we do not report quantitative data points for current timber impacts. Future economic impacts from SOD have the potential to range from levels that industry may easily accommodate, through impacts with substantial implications for the regional economy. Again to protect information provided to us in confidence, we do not report e.g. specific costs of operations that may have reported by industry contact, nor levels of employment, production figures, or logistical costs that could be traced back to individual companies. We do report publicly available figures, for example regional timber prices from 2001 through the present, corresponding timber harvest available via ODF, and timber export dispositions for the PoCB.

Current contribution of the timber industry in terms of jobs and wages was compiled from Bureau of Labor Statistics Quarterly Census of Employment and Wages[6] (QCEW), with an estimate of indirect and induced impacts derived from the Oregon Forest Resources Institute (OFRI) 2012 economic impact summary and OFRI's forthcoming 2017 impact summary. We do not pursue analysis of indirect and induced impacts separately in this report because (1) SOD has not yet caused measurable direct impacts on the timber industry that might be propagated through the broader economy, and (2) because future economic impacts of SOD are contingent on discrete outcomes at particular decision-making points. Rather than compute hypothetical effects on indirect and induced impacts, we estimate the hypothetical effect of SOD directly on the timber industry, and assume proportional influence on indirect and induced impacts.

2.6 Source of information for non-timber SOD impacts

We interviewed representatives of the Sudden Oak Death Task Force, whose contact information was provided to us by ODF. An effort was made to contact every member of the task force, first by physical mail and email, followed by phone calls. Where necessary, confidential information is withheld; any quantitative information presented in the relevant sections may be considered public knowledge and should not compromise any expectation of confidentiality.

[6] https://www.bls.gov/cew/datatoc.htm

3.0 SOD PROGRESSION

3.1 Current Extent

We define current impacts of SOD on the timber industry and on non-timber economic elements to cover the time period from 2001 to 2018 (Appendix 8.1). We do not attempt to match the extent of the SOD infestation to each successive year, rather, current in reference to time indicates the cumulative period through 2018, and current in reference to geography includes both the Generally Infested Area (GIA) and the present QZ (Figure 4, see next page).

3.1 Future Dispersal

The risk profile of infestation via nursery stock transport is outside the scope of this report. Conclusions in this report may be revised as rate of spread results become available from mechanistic epidemiological modeling research; such results may substantially alter SOD rate of spread projections.

3.1.1 Alternative A: Continue Current Management

Expand the quarantine as justified by disease presence, and continue with treatments. Quarantine expansion would proceed in two steps, (i) if SOD appears north of the Rogue River, then all of Curry County would become a quarantine zone (QTZ), and (ii) if SOD appears in any/each of Coos, Douglas, or Josephine Counties, then the geographic range of tanoak in the affected county or counties becomes the QTZ for that county. The quarantine expansion would occur only if SOD appears in the areas defined in (i) and (ii). Otherwise, treatments would proceed at the budgeted rate for the detected infestations closest to the edge of the core QTZ. While QTZ is at its current extent, treatments for the most likely infestations (either EU1 or NA1) would continue to be targeted toward areas closest to the northern edge of today's QTZ. Should condition (i) occur, then treatments would shift to the northern edge of Curry County in an effort to protect the southern portion of Coos County. If condition (ii) occurs in either Douglas or Josephine Counties, quarantine treatments would be prioritized in Curry County to protect Coos County, but if (ii) occurs in all counties, treatments would be prioritized by level of infestation.

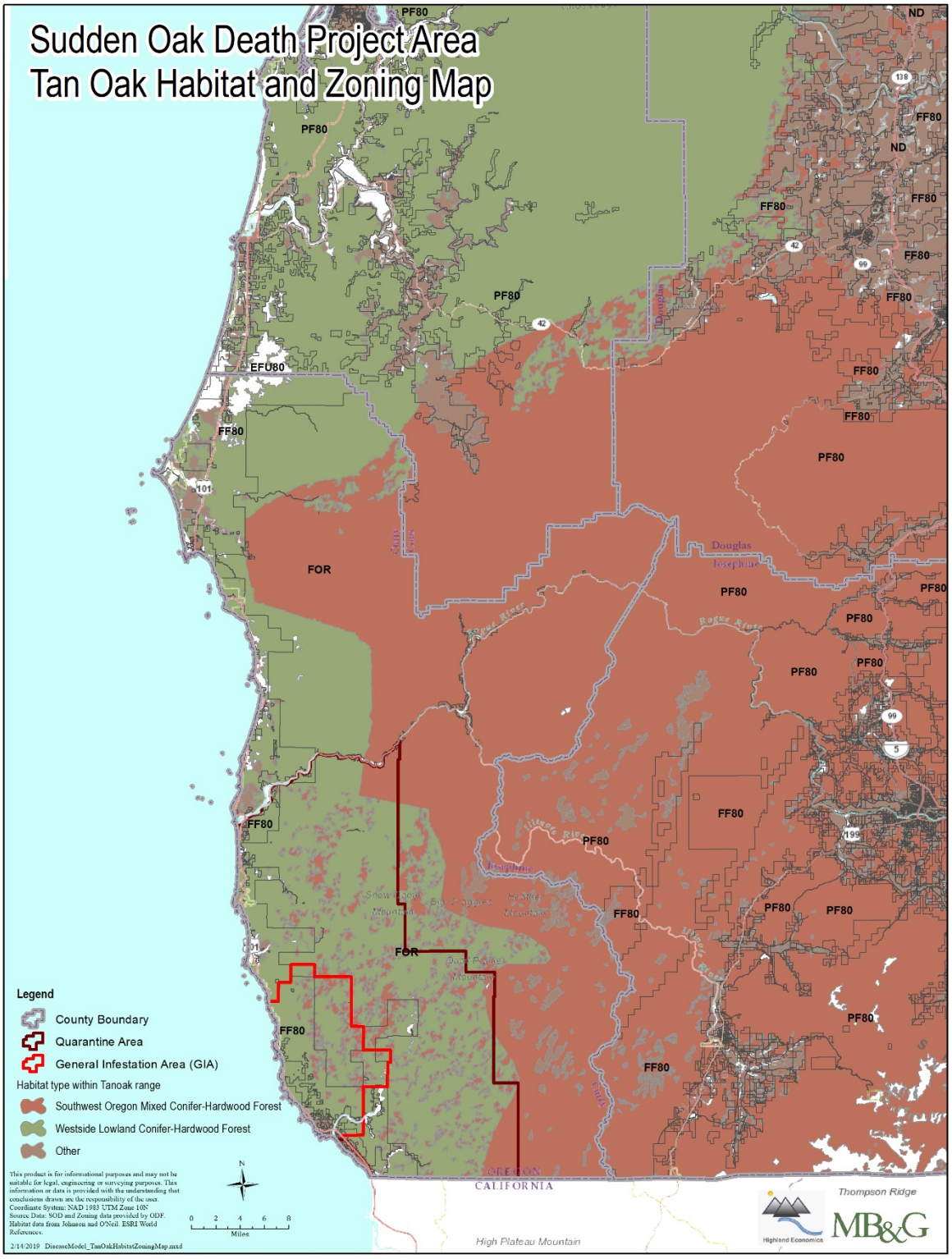

Figure 4. Map showing SOD quarantine zone (QZ, maroon) and generally infested area (GIA, red) in the southwest quadrant of Curry County. Map produced 2016, QZ boundary has not changed through the present.

3.1.2 Alternative B: Discontinue Management

Expand the quarantine as justified by disease presence, but discontinue treatments. The definitions of new QTZ are the same as Alternative A, but USDA APHIS quarantine rules come into effect because treatments have been discontinued. Immediately, all of Curry County would become QTZ, necessitating log washing of conifers within 300' of detected SOD, and certified disease-free condition for any county-line cross export of tanoak e.g. for chips. All harvest units must be surveyed for SOD prior to harvesting, which would become a fee service provided by ODA rather than a no-cost service performed by ODF, and would be a nominal incurred cost for all commercial harvest. As the disease model simulation proceeds, if condition (ii) occurs, then the entire county or counties where SOD is detected become QTZ. That is, if SOD appears in extreme southern Coos County, all of Coos County would become a QTZ. The ODA harvest unit inspection / SOD detection would be required for harvests across the entire county, necessitating the ODA fee service for all timber harvest activity regardless of whether tanoak is present. Likewise for Douglas and Josephine Counties. With multiple counties in quarantine, the State of Oregon is treated by APHIS like the State of California, requiring disease free certification prior to transporting any tanoak materials.

3.1.3 Alternative C: Emphasize EU1 Treatment

Expand quarantine as justified by disease presence, but prioritize treatment of EU1 infestations over NA1. All conditions of Alternative A apply, except that EU1 infestations are treated first, and if all EU1 is treated, then treatments would proceed with NA1 until the ODF treatment budget is exhausted. The acreage treated under Alternatives A and C would likely be the same, but the resulting rate of spread for SOD could be altered if there is a significant differential in large-scale rate of spread caused by suppression of EU1.

Under the original scope of this contract, alternatives were to be informed by results from a recursive, mechanistic implementation of a SIR-type model that would be able to explicitly simulate the effects of SOD treatments, including different approaches for EU1 versus NA1 infestations. Calibration of such a model is a complex task; work toward this goal is on-going and may be complete sometime in 2019. Supporting materials for the current report are structured so that SIR-type results, or indeed results from any rate-of-spread model, may be substituted for the model used here, and economic impacts automatically re-calculated based on modified input. It is expected that conclusions in this report can be modified by other SOD expansion model results, and that underlying economic forecasts may also be revised as new data become available. Area-based non-timber economic impacts are one exception to the preceding statement. A workflow has been developed to accommodate the areal extent of SOD beyond the current QZ and its impact on e.g. real estate valuations, but appropriate results are still pending, and the reporting framework (table structures, appropriate alternative comparison methods) would need to be developed later. The empirical rate of spread model that we used is suitable for estimating when SOD will expand beyond certain fixed points (Rogue River, Coos County border), but is not parameterized to estimate the probability of SOD infestation within single 30-

m forest type grid cells or cell aggregates at specific locations, and it is known that SOD does not necessarily infest 100% of the territory through which it disperses, even if suitable hosts are present.

We have explained that timber industry economic impacts from SOD may be evaluated for the time points at which certain critical boundaries are breached, and this is the task for which the current empirical model is suited. Non-timber impacts, in contrast, often depend on an estimate of the area infested by SOD. For current impacts, we can rely on the aerial survey data in the GIA and the treatment areas in the QZ to infer non-timber impacts. For future non-timber impacts, a probabilistic type of model output will be necessary for quantitative predictions of possible non-timber effects.

4.0 TIMBER INDUSTRY IMPACTS

4.1 Current Impacts

This report defines current impacts of SOD on the timber industry as any effect the disease may have had on industry operations, logistics, or profitability in the period from 2001 through the end of the calendar year 2018. Potential current impacts may be related to logging operations, logistical and administrative impacts for timber sale planning, or any detectable SOD-related change in harvest volume or timber export.

4.1.1 Timber harvest

SOD is unlikely to have had measurable negative impact on timber harvest in Curry County from 2001 through 2018. At the beginning of the SOD outbreak, commercial harvest from private land was stable, while harvest from public land increased until 2005 (Figure 5). Harvest from all landowners declined in the two years leading up to the 2009 recession.

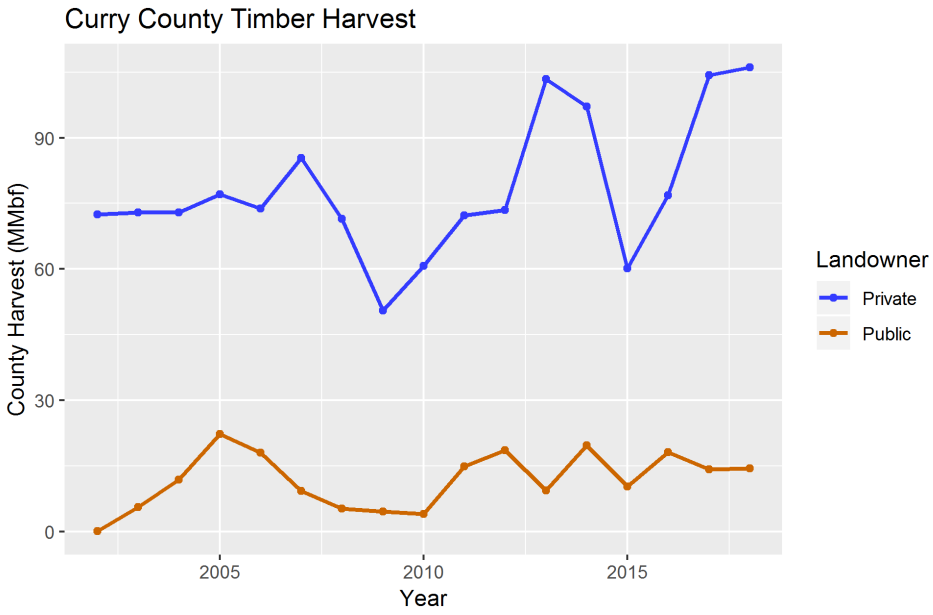

Figure 5. Timber harvest (MMbf) on public vs private land in Curry County, 2002 – 2018. This time span coincides with the SOD outbreak, but no discernible reduction in harvest volume can be detected. Rather, timber harvest levels broadly reflect log prices, which have been governed by market forces and seem uninfluenced by SOD.

After 2009, harvest on private land steadily increased through the present, aside from an export-related temporary decline in 2015 and 2016. Total harvests in 2017 and 2018 advanced to the highest levels in the last 15 years. We cannot conclude that SOD had any negative effect on commercial timber harvest rates in Curry County. The correlation between price signals (Figure 6) and harvest levels is stronger than any correlation with SOD infestation, and also provides a mechanism for influencing harvest, whereas SOD treatment protocols or secondary effects do not have a plausible mechanism for changing harvest to this degree. The average annual timber harvest in Curry County in the decade prior to appearance of SOD (1990 to 2000) was 83,558 MMbf/year, whereas average annual harvest from 2009 to 2018 was 91,764 MMbf/year, an increase of 9.8%.

Table 3. Timber harvest in the four study counties from prior to the 2009 recession, spanning a period of time when SOD was limited to the GIA (pre-2008) through its current extent in the QTZ.

Year	Total Annual Harvest (Mbf)				
	Coos	Curry	Douglas	Josephine	Total
2008	281,784	76,614	416,683	20,602	795,683
2009	195,669	55,007	384,233	19,299	654,208
2010	233,586	64,657	435,923	17,688	751,854
2011	274,633	87,060	468,819	18,900	849,412
2012	275,055	92,000	508,367	31,352	906,774
2013	309,928	112,730	567,187	38,770	1,028,615
2014	281,351	116,812	632,821	42,711	1,073,695
2015	266,593	70,377	559,062	32,868	928,900
2016	261,584	95,016	611,032	31,605	999,237
2017	220,954	118,538	588,767	31,847	960,106
2018	224,786	120,593	598,977	32,399	976,755

This increase was attributable primarily to increased harvest from private land, with insignificant harvest from public land (Figure 5, left). The harvest increase is most likely not a response to perceived threat from SOD, either biological or regulatory, rather it reflects a direct response to the sustained ascent of log prices following the 2009 recession (Figure 5, right). Note that initial infestation was followed by a period of elevated prices, while rapid expansion after 2012 showed both a price decline and a price increase. Together, these contradictory price signals suggest no causal relationship between timber prices and the current SOD infestation.

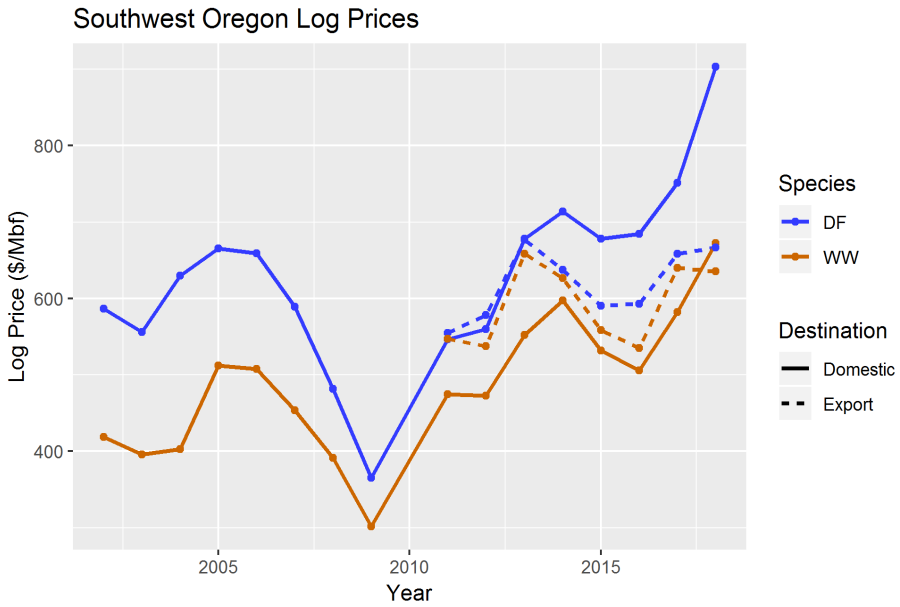

Figure 6. Southwest Oregon log prices for Douglas-fir (blue), whitewoods (orange) through 2018, spanning SOD outbreak period. Domestic prices (solid line) have exceeded export prices (dashed lines) after 2012 for Douglas-fir, but remain closely aligned for whitewoods.

SOD has not been detected in Coos, Douglas, or Josephine counties, so its occurrence cannot have impacted historic harvests in those counties, which experienced, decline (Coos County), increase (Douglas County), or stasis (Josephine County) during the SOD episode (Figure 6).

4.1.2 Jobs, Wages, and Tax Revenue

The timber industry is a major employer and source of regional wages and tax revenue. Current impacts from SOD to the timber industry are not detectable in terms of harvest, historic price signals, or direct effects on timber harvest. In this section, we report the current contribution of the timber industry to the economies of Coos, Curry, Douglas, and Josephine counties. While SOD has no current economic impact on the timber industry, there are scenarios under which SOD could impact the timber industry in the future. We report economic contributions from 2017[7] as a baseline assessment of the timber industry's economic importance.

Employment and wages data are available from the Bureau of Labor Statistics (BLS) Quarterly Survey of Employment and Wages (QCEW), separated by North American Industry Classification System (NAICS) codes. The OFRI[8] identifies NAICS codes that constitute the timber industry (Table 4). Corresponding jobs and wages from BLS are calculated for 2017, implementing some adjustments following OFRI methods.

Table 4. Forest industry subsectors and constituent NAICS codes, as defined by OFRI 2012, 2017.

Forestry Subsector	NAICS Code	NAICS Description
Primary forest products	321212	Softwood veneer, plywood
	3211	Sawmills and wood preservation
	321213	Engineered wood products
	321211	Hardwood veneer, plywood
	321214	Truss manufacturing
	321219	Reconstituted wood products
Forestry support activities	1133	Logging
	11531	Support activities for forestry
	333243	Sawmill, woodworking, machinery
	1132	Forest nursery and gathering
Secondary forest products	33711	Wood kitchen cabinets
	32191	Millwork
	321999	Miscellaneous wood products
	32192	Wood containers and pallets
	337212	Custom architectural woodwork
	337122	Nonupholstered furniture
Forestry Management	1131	Timber tract operations
	924120	Administration of conservation
	551114	Corporate office management
	6113	Colleges, universities, research
	9211	County foresters and support
Maritime, port, transporation	488320	Marine cargo handling
	488210	Support activities for rail
Forestry-dependent industries	42331	Lumber, plywood, etc. wholesalers
	42413	Industrial paper wholesalers
Other forest industries	425120	Wholesale trade agents
	541511	Custom computer services

[7] 2017 is the most recent complete year for which BLS QCEW data are available.
[8] Oregon Forest Resources Institute; Economic Impact Summary 2012; 2017 forthcoming.

We have aggregated forestry-related NAICS codes into industry subsectors again following methodology consistent with the OFRI. Subsectors include primary forest products, forestry support activities, secondary forest products, forest management, forestry-related port activities, indirect industries, and assorted other industries (Table 4). The most important contributors to forest sector employment (Table 5) and wages (Table 6) in the four focal counties are primary forest products, forestry support activities, forest management, and forestry-related port activities.

Table 5. Cumulative 2017 forest industry jobs for 2017 by subsector for Coos, Curry, Douglas, and Josephine Counties.

Forest Sector	BLS 2017 Forest Sector Jobs				
Subsector† | County	**Coos**	**Curry**	**Douglas**	**Josephine**	**Regional**
Primary forest products	676	405	2,861	387	4,329
Forestry support activities	692	154	1,546	342	2,734
Secondary forest products	77	18	428	303	826
Forest management	152	53	381	124	710
Forestry Related Port Activity‡	105	-	37	-	142
Indirect forest industries	14	-	-	17	31
Other forest industries	-	2	1	3	6
BLS QCEW Totals:	**1,716**	**632**	**5,254**	**1,176**	**8,778**
OFRI 2017 Total Employment*:	2,031	673	5,592	1,611	9,907
Inferred Port Related Emp.‹	420	41	375	-	1,271
Reconciled Total Employment:	**2,031**	**673**	**5,592**	**1,611**	**9,907**

† BLS QCEW summary data source unless otherwise noted
‡ BLS QCEW omits port-related employment for establishments in Coos, Curry, and Douglas Counties
* County total employment from forthcoming OFRI 2017 report
‹ Josephine County reports 0 port-related transportation establishments; infer 0 jobs

Table 6. Cumulative 2017 forest industry wages by subsector in Coos, Curry, Douglas, and Josephine Counties.

Forest Sector	BLS 2017 Forest Sector Wages (thousands)				
Subsector† | County	**Coos**	**Curry**	**Douglas**	**Josephine**	**Regional**
Primary forest products	$ 34,760	$ 20,148	$ 150,806	$ 19,437	$ 225,152
Forestry support activities	$ 31,922	$ 6,726	$ 72,645	$ 15,760	$ 127,052
Secondary forest products	$ 2,966	$ 638	$ 15,801	$ 12,180	$ 31,584
Forest management	$ 11,765	$ 3,566	$ 26,163	$ 9,020	$ 50,514
Forestry Related Port Activity‡	$ 3,226	$ -	$ 1,768	$ -	$ 4,994
Indirect forest industries	$ 810	$ -	$ -	$ 1,365	$ 2,175
Other forest industries	$ -	$ 179	$ 90	$ 269	$ 538
BLS QCEW Totals:	**$ 85,449**	**$ 31,258**	**$ 267,272**	**$ 58,030**	**$ 442,009**
OFRI 2017 Total Wages*:	$ 103,080	$ 35,898	$ 289,951	$ 68,665	$ 497,594
Inferred Port Related Wages	$ 20,857	$ 4,640	$ 24,447	-	$ 60,579
Reconciled Total Wages:	**$ 103,080**	**$ 35,898**	**$ 289,951**	**$ 68,665**	**$ 497,594**

† BLS QCEW summary data source unless otherwise noted
‡ BLS QCEW omits port-related employment for establishments in Coos, Curry, and Douglas Counties
* County total wages from forthcoming OFRI 2017 report
‹ Josephine County reports 0 port-related transportation establishments; infer 0 wages

Employment and compensation data provided by the BLS QCEW are not yet available for calendar year 2018, so we report quantities from the complete year 2017. At the county level, statistics are not reported by BLS when industries have so few establishments that inferring jobs and wages for specific companies would become possible. For Coos, Curry, and Douglas Counties, there are single establishments that constitute the forestry related port activity in each county. We also respect the confidentiality of single establishments: here, we report an *inferred port related employment* or an *inferred port related wages* quantity. This value is computed as:

$$\text{Inf. port quantity} = (\text{OFRI County Subsector}) - (\text{BLS County Subsector})$$

Equation 2

with the exception of Josephine County, which has zero port related forestry establishments, in which case we adopt the OFRI county level employment and wages quantities. This inference of county forestry related port activity relies on publicly available data to estimate the subsector employment and wages. To respect confidentiality, we cannot report jobs and wage data for the entities in question. These estimates serve as an approximation of the economic contribution of the port subsector. For more precise data regarding port traffic volume and value, we refer the reader to (§4.1.6), which provides a sense of the relative importance of e.g. the Port of Coos Bay (PoCB) in terms of total timber exports from ports in the State of Oregon.

The primary forest industry also impacts the regional economy via the Forest Products Harvest Tax[9] (FPHT), which is applied to timber harvested from any land in Oregon, with the exception of most tribally owned lands. The FPHT applies equally to timber harvested from private or government-owned land, with exemption for the first 25 Mbf of timber harvested annually by each land owner. The FPHT applies to logs or chips, including sawtimber or utility grade, whether sold by volume or weight, except for chip wood designated for hog fuel. The FPHT rate for 2017 was $3.7487 / Mbf, for 2018 was $4.2311 / Mbf, and the preliminary 2019 rate is $4.2811 / Mbf. As most industrial timber volume is produced from forest cover types that are predominantly conifer, the impact of SOD via FPHT would be negligible.

Forest land owners are also taxed in the form of property taxes, which vary by location and timber production potential, but apply to forests with at least minimum stocking levels as defined by the Oregon Forest Practices Act. Forest land may be held in Timber Deferral, with different rates assessed for small forest tracts. SOD could potentially impact forest land tax rates, if the level of stocking of forest land falls below OFPA regulations, affected acreage could fail to qualify as forest land, and could be taxed at higher rates. This outcome likely would have minimal impact for industrial timber land owners, or for small woodlot owners who can produce volume that counts toward industrial production. Such landowners with SOD-impacted forest stands would likely remove infested areas and replant with conifer species, or divest the land holdings if tax rates were unfavorable versus production opportunities. Risks for SOD to impact the timber industry

[9] https://www.oregon.gov/DOR/programs/property/Pages/timber-forest-harvest.aspx

via property tax rate changes are likely limited to small landowners with constrained ability to replant or sell affected stands. We do not consider SOD-related losses to FPHT *current direct revenue* or forest property tax revenue to be of significant impact.

Total state tax income from the forest industry in 2017 was $306 million (Table 7), with $76.3 million from Coos, Curry, Douglas and Josephine Counties. The major tax contributor was Douglas County, at $46.8 million, followed by Coos County, at $17.6 million. As with timber harvest and log prices, no detectable signal exists for an impact of SOD on tax revenues. In the worst revenue years since SOD detection, 2010 and 2011, low revenues are attributable to the 2009 recession and its after effects. In the rapid SOD expansion years of 2013 through 2015, tax revenues increased in Curry County by almost $2 million (Table 7). We view this as scant evidence for an impact of SOD on tax revenues derived from timber industry activities.

Table 7. Historic through 2017 Oregon and county-specific forest industry tax revenues. Totals consist of forest products harvest tax, industrial and forest land property taxes, fire protection fees, corporate income taxes, and transport operations taxes. County quantities computed as a proportion of annual harvest.

Forest Industry Tax Revenues (Total $)					
Year	Statewide	Coos County	Curry County	Douglas County	Josephine County
2001	$ 264,126,650	$ 18,738,528	$ 4,025,178	$ 31,506,898	$ 1,710,476
2002	$ 275,651,636	$ 23,490,094	$ 5,099,230	$ 31,243,828	$ 1,850,183
2003	$ 286,027,180	$ 23,320,423	$ 5,606,874	$ 33,234,411	$ 3,113,492
2004	$ 312,007,336	$ 25,004,354	$ 5,939,095	$ 34,801,628	$ 3,622,028
2005	$ 335,647,094	$ 27,128,702	$ 7,559,658	$ 36,255,195	$ 4,279,142
2006	$ 327,557,668	$ 27,536,935	$ 6,944,501	$ 37,313,853	$ 2,299,797
2007	$ 313,659,860	$ 25,051,310	$ 7,818,884	$ 39,577,639	$ 1,849,811
2008	$ 278,855,124	$ 22,832,813	$ 6,207,993	$ 33,763,610	$ 1,669,370
2009	$ 239,004,561	$ 17,015,150	$ 4,783,345	$ 33,412,458	$ 1,678,219
2010	$ 241,568,963	$ 17,488,379	$ 4,840,813	$ 32,637,172	$ 1,324,285
2011	$ 247,646,771	$ 18,637,859	$ 5,908,292	$ 31,816,214	$ 1,282,641
2012	$ 255,914,253	$ 18,776,863	$ 6,280,454	$ 34,704,134	$ 2,140,238
2013	$ 271,849,013	$ 20,064,198	$ 7,297,944	$ 36,718,697	$ 2,509,902
2014	$ 286,361,218	$ 19,528,762	$ 8,107,999	$ 43,924,530	$ 2,964,599
2015	$ 296,556,853	$ 20,870,892	$ 5,509,637	$ 43,767,550	$ 2,573,153
2016	$ 301,413,681	$ 20,277,248	$ 7,365,370	$ 47,365,463	$ 2,449,930
2017	$ 306,080,802	$ 17,561,441	$ 9,421,410	$ 46,795,247	$ 2,531,202

Historic timber industry tax revenues are cited by revenue stream and by county in (Appendix 8.4). County taxation is closely in proportion to relative timber harvest rates. Forest products harvest tax is nearly directly proportional, whereas tax revenue from timberland ownership may be slightly decoupled from harvest levels because of productivity differences, particularly in Eastern Oregon. As this region is primarily Western Oregon, we proceed with these proportions.

4.1.3 Indirect and Induced Impacts

Discrete industry sectors impact regional economies in ways that are classified as direct, indirect or induced (DII). Indirect impacts include the jobs and wages that result from supplying or servicing component industries in the subsector. For example, a veneer mill will purchase logs, a direct impact, but also industrial machinery, an indirect impact. Induced impacts occur when persons employed directly in the forest sector spend their income in the larger community, for example a logging contractor purchasing personal items.

The causal link between SOD and economic impacts to industry is mediated by at least one tier of policy- or decision-based outcomes, so we apply industry-level impact factors derived from published reports (OFRI 2012) to county-level direct jobs and wages. The purpose of this economic impact assessment is to classify the potential effects of SOD on the timber industry, not to develop a detailed assessment of DII impacts. Current timber industry impacts from SOD are virtually zero, and future impacts are highly uncertain.

As a proximal causative agent of losses to the timber industry, SOD with its current epidemiological profile has limited potential to alter most of the value-generating industrial forest management currently practiced in the four study counties. In the future, SOD may become an important factor in export market access (see §4.2.4), but this outcome could easily be overshadowed by policy-based economic impacts that have both earlier and more decisive impacts, or by regional scale mitigating events such as wildfire or prolonged drought. It is beyond the scope of this report to develop a quantitative risk profile for stochastic events of major consequence, whether these are policy outcomes or natural events.

We present DII employment and wages as estimates based on a combination of ratios from past OFRI economic reports (2012, forthcoming 2017) and the most recent full year of BLS QCEW data (2017). These ratios will be most accurate for the industry as a whole, and reasonably accurate for the main subsectors. We would not expect accuracy for individual NAICS code industries, so we limit the estimates here to subsectors.

Table 8. Estimated Direct, Indirect, and Induced forest industry employment in the focal counties. Ratios computed from 2017 BLS data and informed by OFRI Type II IMPLAN ratio, per forthcoming 2017 OFRI report.

	2017 Forest Sector DII Jobs				
Subsector | County	**Coos**	**Curry**	**Douglas**	**Josephine**	**Regional**
Primary forest products	1,375	824	5,818	787	8,803
Forestry support activities	1,407	313	3,144	695	5,560
Secondary forest products	157	37	870	616	1,680
Forest management	309	108	775	252	1,444
Forestry Related Port Activity	854	83	763	-	2,585
Indirect forest industries	28	-	-	35	63
Other forest industries	-	4	2	6	12
Total DII Employment:	**4,130**	**1,369**	**11,371**	**2,391**	**20,146**

Table 9. Estimated Direct, Indirect, and Induced forest industry wages for 2017 in the focal counties.

2017 Forest Sector DII Wages (thousands)					
Subsector | County	**Coos**	**Curry**	**Douglas**	**Josephine**	**Regional**
Primary forest products	$ 67,970	$ 39,398	$ 294,887	$ 38,007	$ 440,261
Forestry support activities	$ 62,419	$ 13,152	$ 142,049	$ 30,816	$ 248,437
Secondary forest products	$ 5,799	$ 1,248	$ 30,897	$ 23,816	$ 61,760
Forest management	$ 23,005	$ 6,972	$ 51,159	$ 17,638	$ 98,775
Forestry Related Port Activity	$ 201,563	$ 70,195	$ 566,970	$ 134,268	$ 972,995
Indirect forest industries	$ 1,585	$ -	$ -	$ 2,669	$ 4,254
Other forest industries	$ -	$ 351	$ 175	$ 526	$ 1,052
Total DII Wages	**$ 362,341**	**$ 131,316**	**$ 1,086,137**	**$ 247,740**	**$ 1,827,534**

4.1.4 Logging and Transport Logistics

Impacts of SOD on commercial timber harvest to date register differently for conifer versus hardwood markets. Impacts on conifer harvest have been negligible, and limited to a few instances of individual log washing on a handful of timber sales within the GIA and QZ. The number of these instances is too small either to use as data for estimating procedural costs or to track the cost through to delivered log price. Maintaining confidentiality, essentially all of the conifer timber harvested in Curry County within the GIA is either processed into lumber at facilities also inside GIA, or hauled to the PoCB for international export. In no instances are we aware of harvested conifer volume incurring a SOD-related cost penalty substantial enough to have been reported by industry contacts. The few instances where conifer logs needed to be washed because they were cut within SOD treatment circles were dealt with using water and equipment already on site, and did not divert enough labor resource or machine time to justify cost tracking.

SOD has impacted hardwood markets specifically for tanoak, although not with effects that influence entities' costs of doing business. No tanoak cut from an area impacted by SOD may be transported either within or outside the GIA or QZ[10]. Tanoak harvested within the QZ but outside of SOD treatment circles must be shipped with ODA inspection vouchers indicating its disease-free status. In our investigation, industry did not report appreciable volume losses of tanoak from SOD treatment areas for most timber sales. Moreover, tanoak typically commands a break-even price when delivered to the PoCB and nearby facilities to be chipped. Inability to haul minor fractions of tanoak on a commercial basis out of the QZ does not impact commercial operations as reduced employment, sales, or profits. Indeed, removal of tanoak is principally a biomass reduction strategy so that the material does not need to be burned in harvest units, reducing regional smoke contamination and mitigating wildfire risk related to forest operations.

[10] ODA quarantine guidelines Appendix 8.1

In its current configuration, the SOD infestation has not had a level of impact on commercial timber activities that rises to losses in employment or reduction in revenue. The negligible reduction in commercially harvested tanoak chip volume from SOD infested treatment circles has decreased to a very limited extent the chip volume hauled from Curry County. This change has not reduced harvest receipts, and the volume reduction has not impacted operations in the Coos County destination facilities, either intermediate chip facilities or the PoCB.

4.1.5 Sale administration

Completing a timber sale inside the Curry County QZ requires several regulatory steps that are unnecessary elsewhere, but which to date have not resulted in any additional costs. The current protocol requires checking with ODF regarding location of timber harvest unit, ODF checks SOD infestation maps, dispatches personnel to conduct on-the-ground or aerial monitoring, including looking for diseased trees, as well as stream monitoring. If there is no SOD detected in the sale unit, the harvest may proceed without further ODF input. If SOD is detected, sale administration costs may go up, but *at this time* ODF conducts all of the SOD treatment activity and manages the SOD treatment contractors.

For sales with tanoak volume intended for commercial sale, that volume can only be shipped if there is no SOD detected in the harvest unit, in which case ODA provides certificates of disease free status and the tanoak may be transported. If a harvest unit is impacted by SOD, then tanoak may not be transported for commercial purposes, and ODA does not issue a transport permit. In either case, as of 2018 these outcomes require no additional expenditures toward sale administration, and the requirement for transporting tanoak with permits does not translate to extra logistical costs for hauling companies.

4.1.6 Export

Virtually all of the timber export activity in Curry, Coos, Douglas, or Josephine Counties is channeled through the PoCB. Both direct communication with the port and publicly available timber export data confirm that no current reduction in volume can be attributed to SOD. Over the course of the SOD infestation, export through PoCB increased from approximately $80 million to more than $150 million in 2018. Brief detours to lower or higher trade levels occurred with global economic events, for example the 2009 recession with only $62 million in exports, or the peak of the export volume market in 2011 ($217 million in total exports). Note that essentially all of the value transiting PoCB is in the form of timber, never less than 91% of the port's total, and running at 100% every year since 2016 (Table 10).

SOD was first detected in Oregon in 2001. Here we show timber export statistics from 2003 through the present because it is unlikely that SOD could have had any impact except via choice of market participation on the part of foreign importers. Rather than seeing a decrease in exports, as would be expected if foreign importers were becoming uninterested in the risk associated with importing from a region infected with SOD, we instead see fluctuations both positive and negative in the annual value transiting the port. Port traffic is less tied to US macroeconomic

trends than to international trends, although it was impacted by the 2009 recession, which had global effect. Overall, we cannot identify any impact of SOD on timber exports through 2018 because exports increased during several of the more extensive SOD expansion years, e.g. 2013 and 2014. Prior to 2018, it does not seem likely that temporarily high export levels occurred because importers were trying to capture this volume before SOD becomes a problem. Nor were exporters trying to sell off as much volume as possible for the same reason. Importers have numerous other options for sourcing volume (New Zealand, Russia), so SOD unlikely to influence their decision making. Export declines in 2018 are most likely an effect of declining prices and uncertainty around the implications of tariffs.

Table 10. Total and timber exports from PoCB, 2003 to 2018; values in USD (2018) and tons.

Export Year	Total Exports			Timber Exports			Timber Fraction
	$	tons	Mbf	$	tons	Mbf	(% of $)
2003	$ 84,663,995	1,299,029	228,372	$ 81,339,385	1,298,712	228,317	96%
2004	$ 89,344,891	1,346,248	236,674	$ 88,605,529	1,341,438	235,828	99%
2005	$ 93,442,893	1,610,538	283,137	$ 89,375,934	1,593,473	280,136	96%
2006	$ 77,417,777	1,356,146	238,414	$ 76,407,562	1,356,136	238,412	99%
2007	$ 103,892,781	1,363,753	239,751	$ 103,338,945	1,363,734	239,748	99%
2008	$ 118,528,241	1,344,307	236,332	$ 109,118,590	1,341,054	235,761	92%
2009	$ 62,162,172	1,017,566	178,891	$ 56,707,057	1,017,321	178,848	91%
2010	$ 107,036,048	1,730,190	304,172	$ 106,848,583	1,730,182	304,170	100%
2011	$ 217,241,484	2,201,611	387,048	$ 216,997,413	2,201,407	387,013	100%
2012	$ 156,640,712	1,777,035	312,407	$ 151,477,511	1,760,890	309,569	97%
2013	$ 170,406,096	1,981,015	348,267	$ 169,738,360	1,975,241	347,252	100%
2014	$ 139,974,390	1,850,423	325,309	$ 139,475,416	1,850,422	325,309	100%
2015	$ 131,153,511	1,590,968	279,696	$ 122,159,245	1,590,968	279,696	93%
2016	$ 142,797,119	1,935,711	340,303	$ 142,731,229	1,935,711	340,303	100%
2017	$ 137,350,884	1,939,255	340,926	$ 137,172,304	1,939,255	340,926	100%
2018	$ 150,409,487	1,652,027	290,430	$ 150,360,685	1,652,027	290,430	100%

The PoCB is the only maritime cargo handling entity in Coos County, and support activities for PoCB are the only export-related activities in the remaining study counties. The BLS QCEW does not report employment or wages for relevant NAICS codes for Coos County due to confidentiality. In an effort to respect confidentiality to the same degree as BLS, we shall not attempt to directly quantify in this report the employment and wages impact of PoCB in any of the study counties. Please refer to §4.1.2 for relevant NAICS codes and an assessment of statewide employment and wages for maritime and other forestry transport.

We are at liberty to report the total value of forestry-related goods exported from Oregon ports in the Columbia-Snake Customs District[11], as these are publicly available data and cannot be used to infer PoCB employment levels. Other notable ports in Oregon include Astoria and Portland, responsible for 24% and 1%, respectively, of annual timber exports. Note these ports are within

[11] https://usatrade.census.gov/

the Columbia-Snake Customs District, and the Total Oregon export level (Table 11) consists only of Oregon ports, not of any Washington or Idaho ports that are reported by USA Trade. While PoCB transports proportionally more timber, it is exclusively a timber port, unlike the others.

Table 11. The PoCB is responsible for 75% of the timber products exported from Oregon, value basis.

Timber NAICS group; ($US)	Columbia-Snake District			
	Total Oregon	Astoria	Coos Bay	Portland
44 Wood And Articles Of Wood; Wood Charcoal	$ 182,035,662	$43,479,762	$ 137,172,304	$1,383,596
47 Wood Pulp Etc; Recovd (waste & Scrap) ppr & pprbd	$ 326,700			$ 326,700
48 Paper & Paperboard & Articles (inc Papr Pulp Artl)	$ 4,564			$ 4,564
Timber Subtotal by Port:	$ 182,366,926	$43,479,762	$ 137,172,304	$1,714,860
Timber Percent by Port:		24%	75%	1%

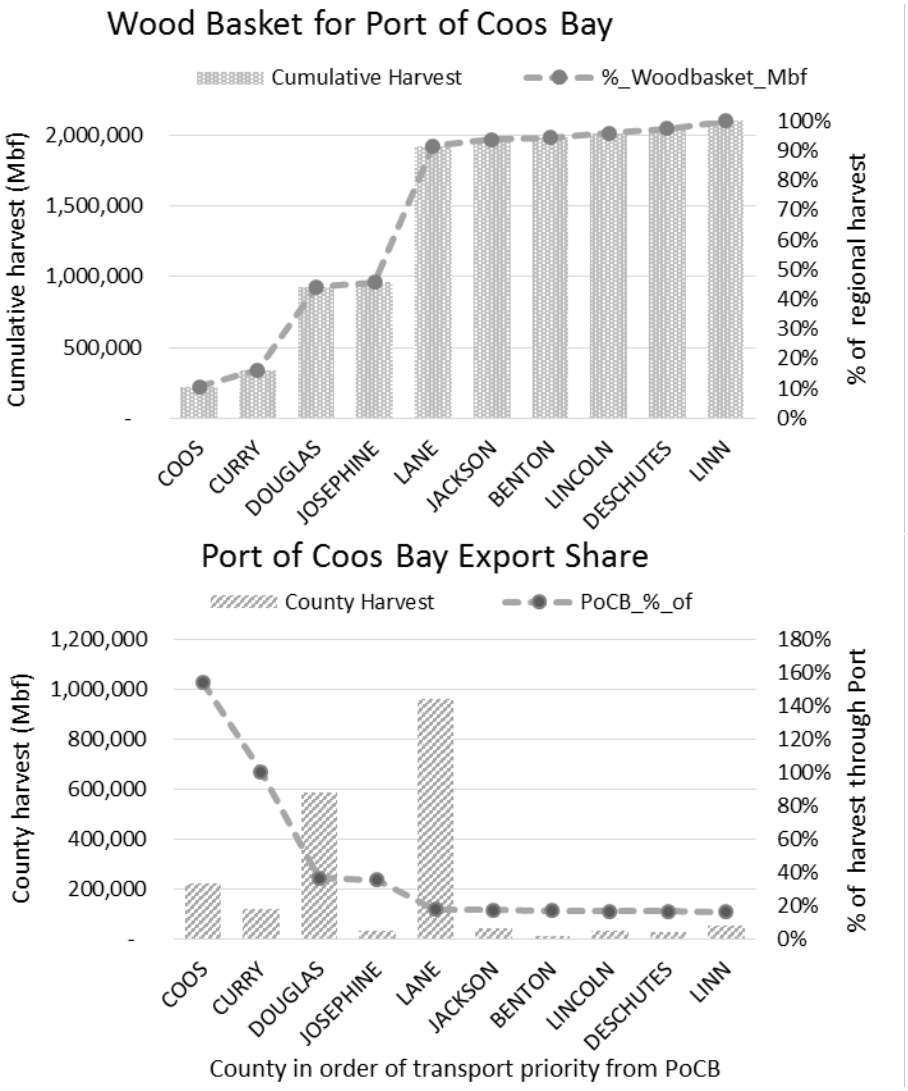

Figure 7. The wood basket for PoCB extends north into Linn and Benton Counties, but is primarily driven by Coos, Douglas, and Lane harvest levels (top). Accumulating harvest across the source counties (bottom), we estimate up to 15% of the regional volume has been exported through PoCB.

Through 2018, we see no discernible impact on export levels that could be reasonably attributed to SOD effects. There has been a limited reduction in tanoak fiber export from Curry County, particularly since 2012, but the value of this fiber volume is low, fluctuating from negative to positive and averaging around zero. The impact of regulations requiring a transport permit from harvest units near a known SOD infestation has been limited, and any reductions would have applied to tanoak chip export from Curry County.

PoCB is most likely to export timber from the four counties that are the focus of this economic impact assessment (Coos, Curry, Douglas, and Josephine), but also from counties to the north. With a total wood basket of just over 2 billion board feet annual harvest, PoCB export accounts for around 16% of the harvested volume (Figure 7). This percentage value is strongly dependent on the conversion ratio of tons to Mbf, and may be ±8% over the likely range of possible conversion factors. The lower end of this range, 8% per year, aligns with statewide average exports from Coos Bay through 2014 (Pers. Comm. B. Kaetzel 2018). Given the range of possible annual export through PoCB, we conclude that a range of 8% - 15% of the annual harvest from Coos, Curry, Douglas, and Josephine Counties, **collectively**, may be exported each year. Current impact of SOD on exports is undetectable. Future potential impacts will be based on this fraction (see §4.2.4).

4.1.7 Aggregate Current SOD Impacts

We do not identify any measurable negative impacts of SOD on the current state of the regional timber industry in Curry County, the only county that could potentially be directly affected by SOD. In surrounding counties with economic ties, we cannot identify any current impacts to the industry. As of ending calendar year 2018, SOD impacts to the timber industry are:

- Undetectable job losses: regional forest sector employment (2017) at 9,907 jobs.
- Modest employment gains: approximately 30 jobs in Curry County derived from SOD treatment; wages commensurate with ODF SOD treatment funding.
- Undetectable wage losses: regional forest sector wages (2017) at $497.6 million.
- Undetectable impact to total direct, indirect, and induced employment: regional forest sector DII (2017) at 20,145 jobs.
- Undetectable impact to total direct, indirect, and induced wages: regional forest sector DII (2017) at $1.83 billion.
- Undetectable impact to timber export value via PoCB: ranging from 8% - 15% of harvest in the focal counties, valued at $43.5 million per year, and counting for 1,271 jobs (12.8%) of regional direct sector employment.

The current economic impact of SOD is mediated largely through impacts outside of the timber industry, please refer to (§5.0) for detailed discussion of non-timber impacts.

4.2 Future Impacts

Future economic impact of SOD on timber harvest will result from a cascading set of decisions that may be made as industry and agencies respond to disease progression (Figure 8). It is not possible to know whether one or indeed any of these outcomes will occur, but we can assert with a high degree of certainty that if SOD expands beyond Curry County, quarantine zones will shift from sub-county (as has been the case from 2001 to 2018) to the whole of Curry County, and possibly to other whole or fractional counties as well (Table 12). If—and likely when—that shift occurs, we are informed (Pers. Comm. ODF, S. Navarro) that quarantine regulations would be governed by USDA-APHIS, represented by ODA. If SOD treatment efforts continue, then new quarantined counties may follow the Curry County model, beginning with partial quarantine that expands. If SOD treatment efforts are terminated, we are informed that any incursion into new counties would be met with quarantine of the whole county from the outset, rather than going through the sub-county QZ process that Curry County has followed to date.

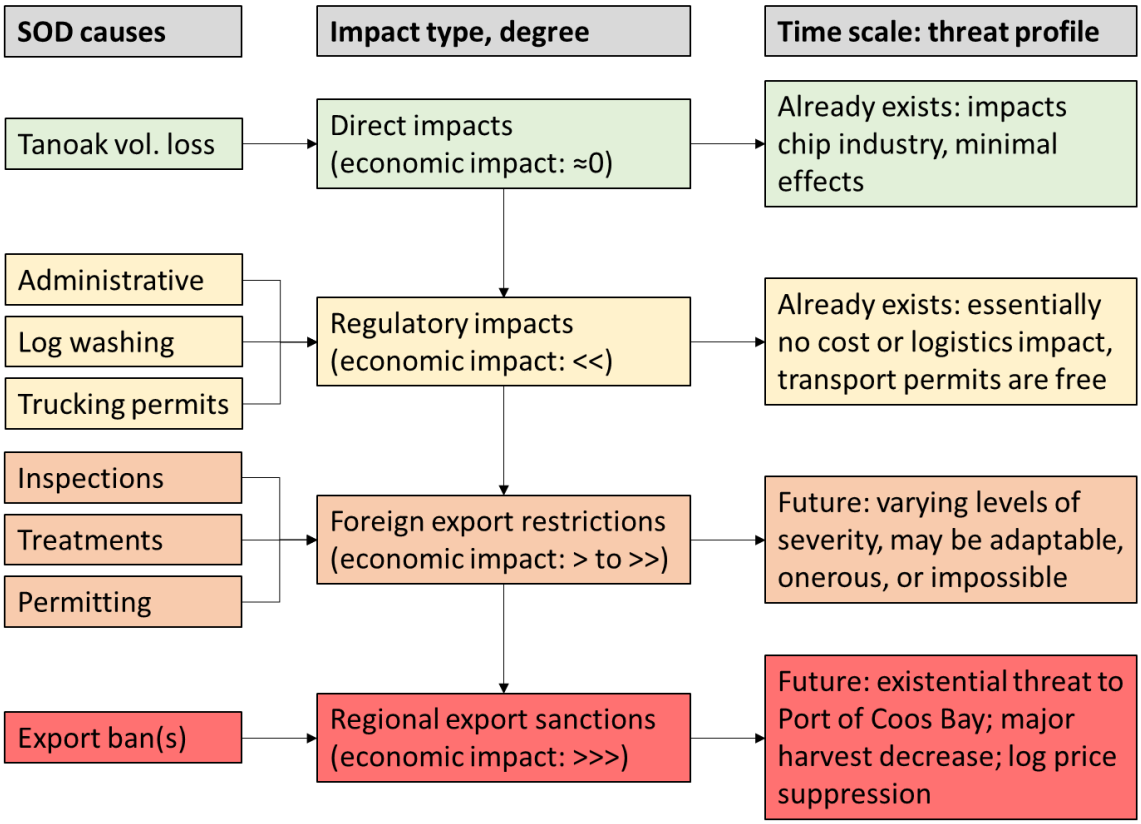

Figure 8. Event cascade, including domestic and foreign SOD-related policy decisions. Relatively minor impacts from permitting (green, yellow) would have low effect, while log treatments or port closures would have major impacts (orange, red) up to the total closure of PoCB.

The ultimate extent of SOD's impact on the regional timber industry would be mediated by a series of conditional events. We described negligible current impacts to the timber industry (§4.1) based on 2017 conditions. In the future, any economic impacts from SOD would need to be

contrasted against a baseline forecast of the major economic indicators that capture essential quantitative metrics of the timber industry. Our baseline forecast tracks several indicators from 2018, 2023, 2028, and 2038: forest sector employment (direct and DII), wages (direct and DII), harvest-dependent and harvest-decoupled forest tax revenues, and timber export related jobs, wages, and regional exported volume (Appendix 8.5). The baseline forecast is tied to increasing harvest volume (see §4.2.1, Appendix 8.3), and does not attempt to anticipate macroeconomic trends, nor to foresee the consequences of political maneuvering at any level, or substantial changes to international trade arrangements.

The decision event cascade (Figure 8) envisions outcomes that may have essentially no impact to the timber industry (e.g. administrative costs, log washing, permitting, even fee-based permitting), versus those with potentially far-reaching consequences, including fumigation treatments of logs at dock-side, through total closure of the PoCB. The potential cost of log fumigation is substantial, but not necessarily so high that it would never be undertaken. Based on interviews with the PoCB and with regional timber industry representatives, we do not believe export log fumigation will be a likely consequence of SOD. Rather, should SOD become an issue for foreign timber importers, it would be simpler, and better aligned with their national phytosanitary objectives, to simply terminate imports from Oregon. From this point, we dismiss the log treatment outcome as unlikely, and focus the impact analysis on port closure.

Table 12. Decision matrix for implementation of quarantine zone definitions with potential to impact economic activity in the timber industry. Question marks indicate placeholders for the year in which the regulatory boundary is breached by SOD. Fee-based permitting is assured, whereas international export sanctions are only a possibility.

Regulatory Boundary		Agency Oversight		International Export Sanctions		
Time and County	**Extent**	**ODF/ODA No fees**	**ODF/ODA Fee-based**	**China**	**Korea**	**Japan**
Present: Curry	South QZ, GIA	2018				
Future: Curry	Total County	X	?			
Add Coos	Coos partial	X	?	?		
Add Coos	Coos total	X		?	?	
Add Douglas	Douglas partial	X				?
Add Douglas	Douglas total	X				?
Add Josephine	Josephine partial	X				
Add Josephine	Josephine total	X				

At each successive step through the decision cascade (Figure 8, Table 12), timber producers must accept either an increase in regulatory constraints or a decrease in accessibility to foreign markets. For example, after SOD is detected north of the Rogue River in Curry County (Figure 9), a whole-county quarantine may be triggered, after which conforming to required permitting for

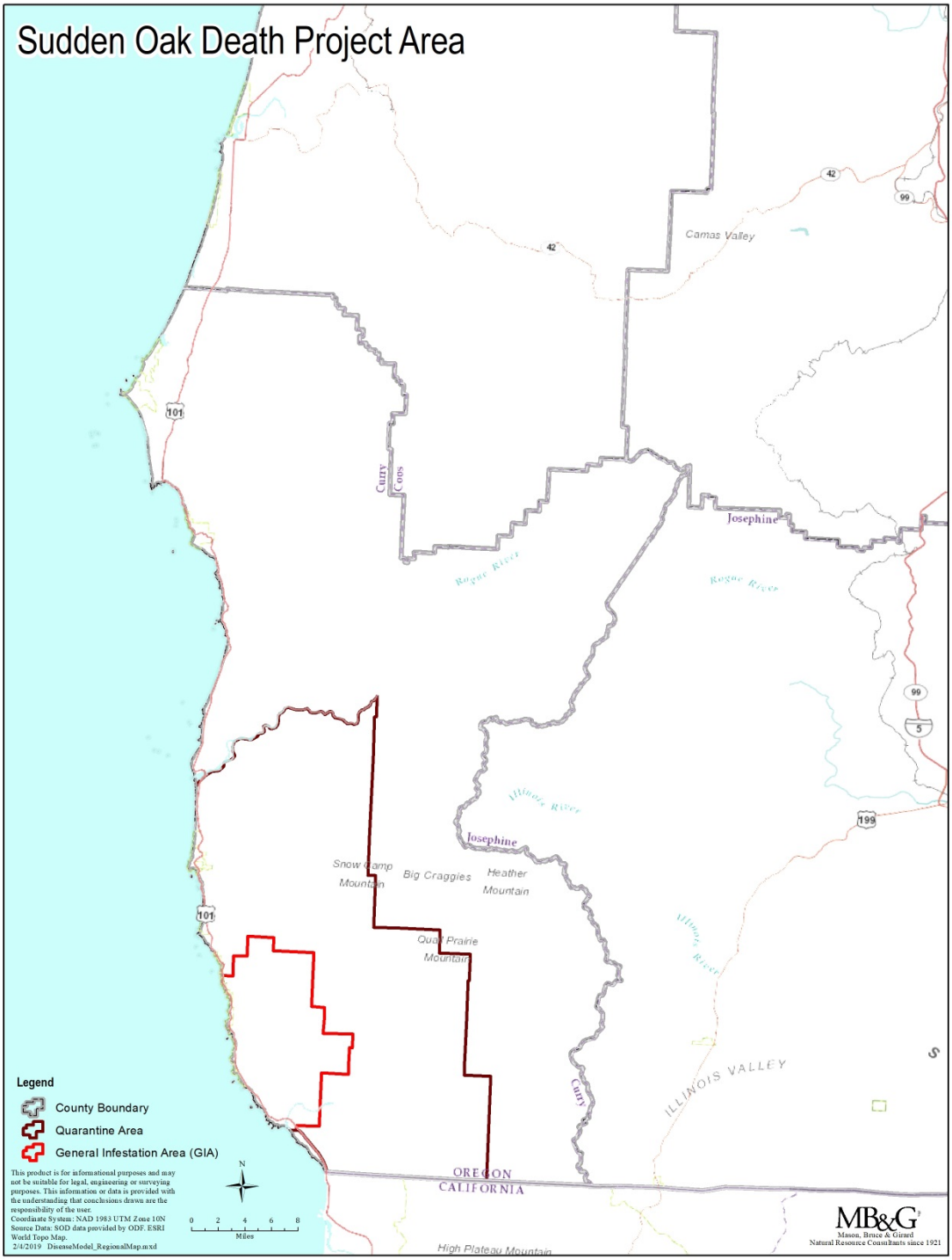

Figure 9. Decision boundaries relevant to SOD dispersal. The northern edge of the QZ (maroon) is coincident with the Rogue River; if breached by SOD, all of Curry County would be quarantined. The same outcome would occur if SOD exceeds the quarantine in the east. Bypassing Coos County southern border (grey), or the border of Douglas County, represents the next major decision point. A breach of Josephine County would trigger quarantine there, but would not necessarily lead to international export sanctions given the small contribution of Josephine to regional export.

timber transport is virtually assured to become a fee-based program required by ODA rather than the free service provided by ODF at present. After this event, there would be no return to the present free service, so permitting costs would have to be absorbed by commercial timber producers. If this is the only impact of SOD, perhaps it would register as a minor shift in forest industry profitability, with incremental reduction in corporate income tax from forestry activities. However, the State of Oregon via ODA would be receiving permitting fees, cancelling the impact of any marginal tax revenue loss.

After the Rogue River decision point, the next boundary would be the Coos County, Douglas County, or Josephine County borders. The Coos County border is the most important milestone for SOD impacts: if it is breached, the section of Coos County containing appreciable tanoak population would go under immediate quarantine. A QZ here has the potential to command the attention of major foreign timber importers (China, Japan, Korea), introducing the possibility of sanctions on timber exports from the PoCB. From our discussions with the Port and representatives of industrial timberlands, we conclude that the threat of sanctions is real. Moreover, our understanding of operations at the PoCB leads us to conclude that loss of any of these three major export destinations would have nonlinear effects. In particular, PoCB cannot simply scale back operations in proportion to reductions in market access. Outside the bounds of annual or seasonal harvest volume fluctuations, continued operations depend on a consistent volume flow at levels within a narrow range of tolerance. Sustained disruptions such as loss of export market access, even just for Korea, would be magnified well beyond the proportion of lost volume. It is not unreasonable to anticipate closure of the PoCB should a major foreign importer terminate their agreements with the Port. Is SOD breaches the Douglas County border, there is a lower probability of total closure, but still nonzero. Josephine County, on the other hand, is a minor contributor to regional log export, so we do not expect port closure if SOD remains absent from Coos and Douglas Counties while invading Josephine.

In the remainder of §4.2, we present the rationale for our baseline forecast of the timber industry economic contribution to the study region in 2018, 2023, 2028, and 2038. We apply results of the empirical SOD rate of spread under three different alternatives (§3.1), then follow the policy decision cascade (Figure 8) to determine whether or when SOD passes critical boundaries, and what the economic impacts may be. In this section, we set the effects of domestic permitting costs to zero, which implies that SOD-induced log washing costs, timber sale administration, phytosanitary certificates, and reduction in the tanoak chip market all have negligible effect. Some industry contacts suggested that in years where chip prices are high, the tanoak chip market could account for as much as 2% of annual revenues. For our analysis, however, we prefer to integrate good as well as unfavorable chip markets. A spreadsheet tool for sensitivity analysis of this question is provided to ODF for experimenting with this assumption.

4.2.1 Timber harvest

Future SOD-related timber industry economic impacts will be benchmarked against harvest levels predicted using a combination of expected log prices through 2027 tempered with observed trends in recent harvest levels for the focal counties (Table 13). This report ties the forecast of most industry metrics (employment, wages, export, and forest products harvest taxes) to annual harvest levels. Forest property taxes, however are decoupled from harvest levels, so we implement an alternative rate of increase for that tax component (see §4.2.2).

Table 13. Forecasted county-level annual timber harvest for target years.

Year	Total Forecasted Annual Harvest (Mbf)				
	Coos	Curry	Douglas	Josephine	Region Total
2018	224,786	120,593	598,977	32,399	976,755
2023	260,344	108,084	587,861	41,295	997,583
2028	259,720	109,326	593,520	41,832	1,004,399
2038	262,941	110,681	600,879	42,351	1,016,852

Direct impact of SOD on timber harvest, setting aside harvest reduction resulting from export sanctions, is likely to be trivial with current epidemiology and under the expected agency response to any further expansion of the QZ:

1. Any further encroachment of SOD, e.g. north of the Rogue River, would likely lead to termination of allowed movement of tanoak. As a commercial enterprise, tanoak chip sales are marginal. A total loss might lead to an undetermined reduction in shipped chip volume, but the profit margins on this material are slim to negative, so it is challenging to quantify any measurable impact to the industry. **Measurable impact: negligible**
2. Similarly, any further encroachment of SOD could precipitate the need for phytosanitary certificates for individual timber sales, for which ODA would charge $20 / permit. This is a trivial cost that amounts to a rounding error on an individual sale value. Potentially if international importers e.g. China require a phytosanitary certificate, this would be a $500 charge per export ship load—again, a trivial cost when compared against the value of the entire ship, which may exceed $2 million. **Measurable impact: negligible**

Policy-related impacts of decisions made by international importers to mitigate SOD risk may have more far-reaching implications. **Principally, if major foreign timber importers impose sanctions on Oregon timber, the PoCB is at risk of shutting down**. Communication with the Port suggests that operations depend on sustained existing trade agreements, and that capital investments are leveraged against continued future volume flow. Port operations would remain viable in the face of minor fluctuations arising from annual or seasonal harvest differences. Operations are existentially threatened, however, by traffic reductions such as could result from sanctions by China, Japan, or Korea.

4.2.2 Jobs, Wages, and Tax Revenue

Direct, indirect, and induced forest sector jobs and wages are projected to increase in proportion to future harvest volume. We computed the ratio of projected harvest at 2018, 2023, 2028, and 2038 to the 2017 historic harvest level. Ratios pertaining to each forecast year were then by the 2017 direct and DII jobs (Table 14), and 2017 direct and DII wages (Table 15).

Table 14. Future forest sector direct, DII, and export-related employment forecasted from the ratio of harvest (ODF data) in 2017 versus indicated year.

Year	Economic Indicator	Coos	Curry	Douglas	Josephine	Regional
2018	Forest Sector Jobs	2,066	685	5,689	1,639	10,079
2018	Export Related Jobs	427	42	382	-	850
2018	Forest Sector DII Jobs	4,202	1,392	11,569	2,433	19,595
2023	Forest Sector Jobs	2,393	614	5,583	2,089	10,679
2023	Export Related Jobs	495	37	374	-	907
2023	Forest Sector DII Jobs	4,866	1,248	11,354	3,101	20,569
2028	Forest Sector Jobs	2,387	621	5,637	2,116	10,761
2028	Export Related Jobs	494	38	378	-	910
2028	Forest Sector DII Jobs	4,855	1,262	11,463	3,141	20,721
2038	Forest Sector Jobs	2,417	628	5,707	2,142	10,895
2038	Export Related Jobs	500	38	383	-	921
2038	Forest Sector DII Jobs	4,915	1,278	11,605	3,180	20,978

Table 15. Future forest sector direct, DII, and export-related wages forecasted from the ratio of harvest (ODF data) in 2017 versus indicated year.

Year	Economic Indicator	Coos	Curry	Douglas	Josephine	Regional
2018	Forest Sector Wages (Thousands)	$ 104,868	$ 36,520	$ 294,979	$ 69,855	$ 506,222
2018	Export Related Wages (Thousands)	$ 21,219	$ 4,721	$ 24,871	$ -	$ 50,811
2018	Forest Sector DII Wages (Thousands)	$ 368,625	$ 133,592	$ 1,104,972	$ 252,034	$ 1,859,224
2023	Forest Sector Wages (Thousands)	$ 121,456	$ 32,732	$ 289,505	$ 89,035	$ 532,728
2023	Export Related Wages (Thousands)	$ 24,576	$ 4,231	$ 24,409	$ -	$ 53,216
2023	Forest Sector DII Wages (Thousands)	$ 426,936	$ 119,735	$ 1,084,466	$ 321,235	$ 1,952,371
2028	Forest Sector Wages (Thousands)	$ 121,165	$ 33,108	$ 292,292	$ 90,194	$ 536,759
2028	Export Related Wages (Thousands)	$ 24,517	$ 4,280	$ 24,644	$ -	$ 53,441
2028	Forest Sector DII Wages (Thousands)	$ 425,913	$ 121,111	$ 1,094,906	$ 325,414	$ 1,967,344
2038	Forest Sector Wages (Thousands)	$ 122,668	$ 33,519	$ 295,916	$ 91,312	$ 543,414
2038	Export Related Wages (Thousands)	$ 24,821	$ 4,333	$ 24,950	$ -	$ 54,103
2038	Forest Sector DII Wages (Thousands)	$ 431,194	$ 122,612	$ 1,108,481	$ 329,449	$ 1,991,737

Note we retain the 2017 assumptions governing the ratio between direct and DII employment and wages, as stated in §4.1.3.

Baseline forestry related tax revenues (without SOD influence) are projected to increase in direct proportion to harvest volume (Table 16, Table 17). We assume a fixed harvest tax at the 2017 empirical revenue level, in absence of new evidence showing a revenues have increased following the 2018 and 2019 $/Mbf rate increases.

Table 16. Forecasted total forest industry tax revenues.

Forest Industry Tax Revenues (Total $)					
Year	Study Region Total	Coos County	Curry County	Douglas County	Josephine County
2018	$ 77,632,564	$ 17,866,009	$ 9,584,741	$ 47,606,739	$ 2,575,075
2023	$ 79,288,004	$ 20,692,172	$ 8,590,492	$ 46,723,229	$ 3,282,110
2028	$ 79,829,673	$ 20,642,599	$ 8,689,214	$ 47,173,050	$ 3,324,810
2038	$ 80,819,452	$ 20,898,539	$ 8,796,948	$ 47,757,931	$ 3,366,034

Table 17. Forecasted harvest-dependent tax revenues.

Forest Industry Harvest Dependent Tax Revenues (Total $)					
Year	Study Region Total	Coos County	Curry County	Douglas County	Josephine County
2018	$ 58,969,166	$ 13,570,899	$ 7,280,504	$ 36,161,754	$ 1,956,009
2023	$ 60,226,627	$ 15,717,633	$ 6,525,279	$ 35,490,646	$ 2,493,069
2028	$ 60,638,075	$ 15,679,977	$ 6,600,268	$ 35,832,327	$ 2,525,503
2038	$ 61,389,905	$ 15,874,388	$ 6,682,102	$ 36,276,599	$ 2,556,816

One exception to direct proportional increase may be found with forest industry taxes that are decoupled from volume production, namely property taxes, which will be collected regardless of harvest levels. Current timber land owners may sell land if harvest is economically inviable, but the forest will continue to exist, so future owners must continue to pay the required tax. We do not investigate the outcome in which these revenues decline due forfeited timber properties. We set a 0.5% annual increase for harvest-decoupled taxes reflecting historic increases (Table 18):

Table 18. Future forest property taxes may be unrelated to harvest levels, as taxes must be paid regardless of harvest rate. We forecast these harvest-decoupled taxes at a rate reflecting their historic increase instead of tying the forecast to harvest.

Forest Industry Harvest Decoupled Tax Revenues (Total $)					
Year	Study Region Total	Coos County	Curry County	Douglas County	Josephine County
2018	$ 18,663,398	$ 4,295,110	$ 2,304,237	$ 11,444,985	$ 619,066
2023	$ 19,061,377	$ 4,974,539	$ 2,065,213	$ 11,232,583	$ 789,042
2028	$ 19,191,598	$ 4,962,621	$ 2,088,946	$ 11,340,723	$ 799,307
2038	$ 19,429,547	$ 5,024,151	$ 2,114,846	$ 11,481,332	$ 809,217

4.2.3 Logging Logistics and Sale administration

With larger SOD QZ areas in multiple counties in the future, these steps may ultimately result in increased timber sale administration costs and timber harvest logistics. Our investigation, however, cannot quantify such costs through 2018 for several reasons. Regarding administrative costs, a particular dollar impact has an uncertain definition. We must avoid releasing data about sale administrative costs from the current QZ to maintain confidentiality. Even without revealing cost points, however, industry contacts suggested that the current ODF protocol surrounding SOD testing and treatment does not impose either cost or logical burdens on sale administration.

Treatment costs, and the work of disease testing, treatment setup, GIS, assembly of treatment crews, and project monitoring, are all taken on by ODF. Timber sale administrators need to communicate with ODF, for example to set up access, but to date, treatments have been conducted in conjunction with timber harvest operations and have imposed no extra cost burden on timber landowners. ODF has worked closely with timber sale administrators in the QZ to identify sales that may be near or contain a SOD infestation. ODF representatives conduct all SOD survey procedures, and work with industry personnel to schedule site visits concurrent with standard operations. Any SOD treatments are implemented by ODF contractors, representing no cost to the timber sale. Some additional GIS procedures may be necessary for impacted sales, but industry contacts have not indicated that this represents a measurable increase in cost of administration.

This report assumes that the current experience with logging and transport logistics, as well as sale administration, will continue in the future. Even with fee-based permitting, harvesting conifer timber should not incur additional logistical or administrative costs related to SOD.

4.2.4 Export

Projected exports from focal counties should occur in proportion to current contribution of each county to the likely PoCB wood basket (Figure 7). That is, 1.6 million tons of timber may have transited the Port in 2017, but a fraction of that total originated in Coos, Curry, Douglas, and Josephine Counties. The four focal counties account for 45.7% of timber volume (as Mbf) harvested in the likely PoCB wood basket. Alternative possibilities for export fractions could be (1) direct proportionality or (2) export proportion as a function of distance from the Port. Intra-state timber transport data are not readily available to reveal whether exports are proportional to total county fraction of harvest, however. We turn to regional export evidence, e.g. from statewide timber disposition studies[12], to demonstrate that timber originating from central-latitude western Oregon counties is exported out of Longview, WA. In addition, we are aware of numerous specific instances of export from e.g. Linn and Lane Counties via PoCB[13]. Consequently, it is defensible to contend that distance from port, within a few hundred miles, is not an

[12] http://www.bber.umt.edu/FIR/H_states.asp (Select Oregon > 2013)
[13] Sources and quantity cannot be reported due to confidentiality

impediment to export, and that export fraction may justifiably reflect the county of origin harvest fraction. Extending this rationale, forecasted future county-level harvest volume (Table 19) is assumed to be exported at current rates in proportion to current (2017) county contributions to the PoCB wood basket.

Table 19. Forecasted timber exports via PoCB through 2038. We include Total Exports and Timber Exports to maintain the format of historic exports. Here, these quantities are identical because PoCB has exported 100% timber products consistently since 2016, and we are not aware of concrete plans for diversification.

Export Year	Total Exports			Timber Exports			Timber Fraction
	$	tons	Mbf	$	tons	Mbf	(% of $)
2018	$ 150,409,487	1,652,027	290,430	$ 150,360,685	1,652,027	290,430	100%
2023	$ 150,577,780	2,126,006	373,757	$ 150,382,003	2,126,006	373,757	100%
2028	$ 151,749,986	2,142,556	376,667	$ 151,552,685	2,142,556	376,667	100%
2038	$ 153,631,480	2,169,121	381,337	$ 153,431,732	2,169,121	381,337	100%

With PoCB exports in tons converted to Mbf via a factor of 5.7 tons per Mbf, known annual exports in e.g. 2018 were 290,430 Mbf. To forecast future exports, we make a set of assumptions:

1. Maintaining harvest forecast expectations per (§4.2.1).
2. Exports will adjust to reflect harvest[14].
3. Exports from the PoCB account for 8% - 16% of the annual wood basket harvest.

By 2023, our subsequent economic impact assessment will assume exports from the focal counties via PoCB ranging from 85.4 MMbf to 132.7 MMbf, increasing modestly by 2038 to a range of 87.2 MMbf to 174.5 MMbf). We acknowledge that these assumptions are uncertain even for the short term, but it is beyond the scope of this study to generate suppositions about international export trends.

In the event of PoCB closure, losses to the timber industry would occur via reduction in demand for log volume, registering as reduced harvest, and by direct loss of employment in port-related subsectors. Under the three SOD management alternatives in this report, we reduce timber industry economic indicators by 12% (intermediate between 8% and 16%) if the alternative identifies a possibility for port closure. This 12% reduction is applied to the fraction of sector jobs and wages *not counting port-related quantities* in order to avoid a double-counted reduction. That is, we subtract port employment and wages from the direct and indirect quantities, then apply the 12% reduction to the remaining quantities. Our assumption is that port closure results in total loss of export-related employment and wages, so 100% losses are applied to these quantities in the event of closure.

[14] This analysis sets aside impacts of tariffs, international trade disputes, etc. These considerations may have more immediate effect on timber exports than SOD, and could ultimately eclipse SOD if they occur in such a way that shuts down PoCB prior to any possible impact of SOD. It is beyond the scope of this report to compare the relatively likelihood of competing existential threats to the timber export industry.

We present a dashboard (Figure 10) for use with rate of SOD rate of spread results, whether from the current empirical / observed rate of spread assessment (§2.4.2), or from future models, including results that would be acquired when a SID-type model is available (§2.4.1). For the three alternative considered in this report, we set the appropriate field values in the source spreadsheet utility, then present the effects on various forest sector economic indicators. For use by ODF to explore ramifications of non-zero impacts of permitting, or of non-binary impacts of export sanctions, we provide the original dashboard with supporting content and metadata.

SOD Triggering Event	Year of Evaluation				Domestic Agency Impact			
	2018	2023	2028	2038	2018	2023	2028	2038
North of Rogue River/QZ	no	yes	no	no	NA	Fee Permits	Fee Permits	Fee Permits
Breaches Coos County	no	no	yes	no	NA	NA	Fee Permits	Fee Permits
Breaches Douglas County	no	no	no	no	NA	NA	NA	NA
Breaches Josephine County	no	no	no	no	NA	NA	NA	NA
	Permit Reduction Factor:†			**0**	**1**	**1**	**1**	**1**
SOD Triggering Event	**Export Implications (Int'l Sanctions)**				**Impact to PoCB**			
	2018	**2023**	**2028**	**2038**	**2018**	**2023**	**2028**	**2038**
North of Rogue River	No	No	No	No	NA	NA	NA	NA
Breaches Coos County	Unlikely	Unlikely	Possible	Possible	NA	NA	Port Closure	Port Closure
Breaches Douglas County	Unlikely	Unlikely	Less relevant	Less relevant	Unlikely	Unlikely	Less relevant	Less relevant
Breaches Josephine County	Unlikely	Unlikely	Less relevant	Less relevant	Unlikely	Unlikely	Less relevant	Less relevant
	Export Reduction Factor:‡			**1**	**1**	**1**	**0**	**0**

† Proportion of annual economic activity by which to reduce forecast under permitting; 0 value indicates no measurable impact of permitting fees

‡ Proportion of annual export by which to reduce forecast; 1 value indicates binary response by Port of Coos Bay to major export market sanctions

Figure 10. Dashboard for calculating future SOD economic impact under several forest management alternatives. Year of Evaluation field values shown here <u>do not reflect management alternatives, and are presented for purposes of illustration only</u>.

Interactive fields on which to focus in the dashboard include the SOD triggering event in the year of evaluation, as well as the Permit Reduction Factor and the Export Reduction Factor (Figure 10). Where the Year of Evaluation field reads "no", the disease model would indicate that the SOD triggering event has not occurred in the year in question. As displayed in Figure 10, some hypothetical SOD spread model identifies incursion north of the Rogue River by 2023, and into Coos County by 2028. The reaction to the Rogue River bypass is to implement fee-based permitting, seen in the Domestic Agency Impact section. With a Permit Reduction Factor of 0, however, fee-based permits still allow 100% of forest sector jobs and wages to occur into the future. In this hypothetical example, by 2028 SOD has breached the Coos County border, potentially resulting in halted operations at the PoCB should any major foreign timber export destination decide to sanction Oregon timber. The 100% Export Reduction Factor switches port related jobs, wages, and transported volume to 0% of the forecasted total after 2028. For each alternative, we present the dashboard with values derived from the spatial logistic regression model of SOD expansion, along with any negative impacts to the timber industry.

The empirical SOD rate of spread model finds expansion of SOD beyond the current QZ across the 20-year time frame of this study. In general, Alternative A finds few boundary breach dates inside the 20-year horizon, notably just the Rogue River for north vectors 1 and 2 (Table 20), and here only for the lower 95% confidence interval on the model parameters. With the set of assumptions governing the model, even using the lower parameter values, we would conclude that continuation of the current SOD management regime has the potential to limit SOD dispersal to inside Curry County. This conclusion must be presented with a strong precautionary statement: the empirical model does not account for extreme weather patterns, either wet conditions that might hasten dispersal, or dry conditions that may slow it down. Also, the empirical model cannot account for stochastic long-distance dispersal events such as anthropogenic dispersal of infected wood material or nursery stock (we repeat here that nursery operations are outside the scope of this report).

In contrast, Alternative B, in which treatments cease as of Jan 1st 2019, identifies potential decision boundary breaches as early as 2020, using mean model parameters. Breaches with the greatest economic significance are those across Curry and Douglas County boundaries, which occur in Alternative B as early as 2028 and 2038, respectively. In Alternative C, the objective was to model SOD spread if EU1 treatment is prioritized. The empirical approach to rate modeling used recorded/observed EU1 treatment locations to infer rate of spread with EU1 priority. We believe EU1 would spread either as fast or faster than NA1, so we should see fewer breached decision points in Alternative C than in Alternative A. We instead see the inverse, which must reflect the past EU1 spread rate ($\geq Rate_{NA1}$), rather than the reduced rate envisioned under the definition of Alternative C. Given the potential for strain overlap, it may be most useful to view the Alternative C dates as potentially representing and EU1-NA1 intermediate future extent.

Management strategies alter estimated SOD expansion rate

Quarantine expands as boundary decision barriers are breached. SOD expansion beyond the Rogue River would expand the QZ to all of Curry County. Any infestation in the surrounding counties would initialize a QZ in those counties corresponding to the geographic range of tanoak, except under Alternative B (no treatment), where any new QZ would be county-wide.

Alternative A: Continue current treatment, eradicating SOD along the QZ boundaries, treating both NA1 and EU1 strains.

Alternative B: Discontinue all SOD treatments from January 1st 2019

Alternative C: Treatments as in (A), focusing first on all EU1 infestations, pivoting to NA1 infestations as resources permit.

Table 20. SOD dispersal model output for north and east vectors under alternatives A, B, and C. Boundary decision dates prior to 2038 fall within the 20-year time frame of this economic impact assessment. The low 95% date indicates the earliest potential SOD bypass of a boundary under the assumptions of this dispersal model, while the model date indicates an average date. This analysis is concerned with worst-case scenarios, so we focus asymmetrically on the lower 95% and mean values of model parameters rather than the entire confidence interval.

Dispersal Vector	Group Vector	Segment Order	Boundary Decision	Breach Year Alt. A		Breach Year Alt. B		Breach Year Alt. C	
				Model	Low 95%	Model	Low 95%	Model	Low 95%
NV_17_RR1	N1	1	Rogue River	2048	**2028**	**2023**	**2021**	**2031**	**2028**
NV_17_CC1	N1	2	Coos County	2078	2051	**2033**	**2029**	2058	2051
NV_17_RR2	N2	1	Rogue River	2048	**2030**	**2024**	**2022**	**2033**	**2030**
NV_17_CC2	N2	2	Coos County	2078	**2039**	**2028**	**2025**	2044	**2039**
NV_17_RR3	N3	1	Rogue River	2048	2042	**2029**	**2026**	2046	2042
NV_17_CC3	N3	2	Coos County	2076	2048	**2032**	**2028**	2054	2048
EV_17_QB1	E1	1	Curry QZ	2041	2040	**2020**	**2019**	**2023**	**2022**
EV_17_JC_1	E1	2	Josephine County	2061	2060	**2023**	**2022**	**2030**	**2028**
EV_17_DC_1	E1	3	Douglas County	2091	2090	**2038**	**2034**	2060	2058
EV_17_QB_2	E2	1	Curry QZ	2046	2045	**2020**	**2020**	**2025**	**2023**
EV_17_JC_2	E2	2	Josephine County	2069	2067	**2023**	**2022**	**2032**	**2029**
EV_17_DC_2	E2	3	Douglas County	2099	2097	2053	2052	2062	2059
EV_17_QB3	E3	1	Curry QZ	2045	2044	**2021**	**2020**	**2025**	**2024**
EV_17_JC_3	E3	2	Josephine County	2075	2074	2051	2050	2055	2054

4.2.5 Alternative A:

In each of the next three sections, we reformulate the SOD empirical model outputs as binary data for use in the economic impact decision spreadsheet tool. The resulting decision dashboard will be presented for each Alternative, followed by any non-zero future impacts of SOD on the timber industry, mediated by the consequences of export sanctions by foreign countries.

For Alternative A, representing ODF's continued level of SOD treatment effort, using the earlier bypass dates from the model parameter upper 95% confidence interval, we find that the Rogue River would be bypassed by 2028. This would trigger quarantine of the whole of Curry County, and would require fee permits for transport of commercial conifer timber volume outside Curry County. In this analysis, we refer to reports from industry contacts that suggest the permitting costs (approximately $20 per timber sale) are unlikely to lead to any real increased cost of sale administration or operations. Thus, we set the Permit Reduction Factor to zero and anticipate no SOD-derived economic impacts through 2038 if SOD treatments continue in their current form and if we accept the underlying assumptions of the empirical rate of spread model.

As in §4.2.4, an uncritical interpretation of Alternative A versus Alternative C (see §4.2.7) leads to the conclusion that controlling NA1 and EU1 with equal priority leads to a slower rate of SOD dispersal. The epidemiology of EU1 contradicts this outcome, which we believe arises because the empirical model can only be parameterized using observed events. The management emphasis for Alternative C has not been implemented, and cannot be faithfully represented using existing observational data. It may be the case that Alternative C is a more realistic representation of the management scenario intended for Alternative A. By extension, Alternative C may show a more favorable outcome using SIR-type model results.

SOD Triggering Event	Year of Evaluation				Domestic Agency Impact			
	2018	2023	2028	2038	2018	2023	2028	2038
North of Rogue River/QZ	no	no	yes	yes	NA	NA	Fee Permits	Fee Permits
Breaches Coos County	no	no	no	no	NA	NA	NA	NA
Breaches Douglas County	no	no	no	no	NA	NA	NA	NA
Breaches Josephine County	no	no	no	no	NA	NA	NA	NA
	Permit Reduction Factor:†			**0**	**1**	**1**	**1**	**1**
SOD Triggering Event	**Export Implications (Int'l Sanctions)**				**Impact to PoCB**			
	2018	**2023**	**2028**	**2038**	**2018**	**2023**	**2028**	**2038**
North of Rogue River	No	No	No	No	NA	NA	NA	NA
Breaches Coos County	Unlikely	Unlikely	Unlikely	Unlikely	NA	NA	NA	NA
Breaches Douglas County	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Breaches Josephine County	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
	Export Reduction Factor:‡			**1**	**1**	**1**	**1**	**1**

† Proportion of annual economic activity by which to reduce forecast under permitting; 0 value indicates no measurable impact of permitting fees

‡ Proportion of annual export by which to reduce forecast; 1 value indicates binary response by Port of Coos Bay to major export market sanctions

Figure 11. Timber industry economic impacts of SOD dashboard evaluated for Alternative A using empirical SOD rate of spread model. Rogue River bypassed by 2028; no further breaches.

4.2.6 Alternative B:

The empirical SOD dispersal model relies on observed rate of spread within the GIA after 2013, at which time concerted treatments of SOD infestations were not implemented everywhere, which allows for untreated rate of spread to be estimated. These results for Alternative B, under which SOD treatments are discontinued from 2019 forward, show a more rapid rate of spread both northward and eastward.

Major decision boundaries (Figure 9) are crossed in Alternative B as early as 2023, with SOD breaching the Rogue River to the north of the current QZ, and possibly entering Josephine County in the east. We again assign zero meaningful economic impact to the Rogue River event, and also low importance to the Josephine County border breach. There would be fee permits for inter-county transport of commercial conifer timber after 2028 for both Curry and Josephine Counties, but this requirement is a trivial expense. The risk of e.g. PoCB closure from loss of access to export volume from Josephine County is also limited—the total annual Josephine County timber harvest is around 2% of the regional export, so could easily be replaced by volume from non-infested counties.

By 2028, however, under Alternative B we see SOD breaching the closest extent of Coos County (Figure 12), triggering the quarantine of Coos County and risking possible sanctions of Oregon timber by foreign export destination countries. The chance of this event forcing the closure of the PoCB is nonzero, so we present the potential impact to the timber industry that would result if this major export opportunity disappears (Table 21).

SOD Triggering Event	**Year of Evaluation**				**Domestic Agency Impact**			
	2018	**2023**	**2028**	**2038**	**2018**	**2023**	**2028**	**2038**
North of Rogue River/QZ	no	yes	yes	yes	NA	Fee Permits	Fee Permits	Fee Permits
Breaches Coos County	no	no	yes	no	NA	NA	Fee Permits	Fee Permits
Breaches Douglas County	no	no	no	yes	NA	NA	NA	Fee Permits
Breaches Josephine County	no	yes	no	no	NA	Fee Permits	Fee Permits	Fee Permits
	Permit Reduction Factor:†			**0**	**1**	**1**	**1**	**1**
SOD Triggering Event	**Export Implications (Int'l Sanctions)**				**Impact to PoCB**			
	2018	**2023**	**2028**	**2038**	**2018**	**2023**	**2028**	**2038**
North of Rogue River	No	No	No	No	NA	NA	NA	NA
Breaches Coos County	Unlikely	Unlikely	Possible	Possible	NA	NA	Port Closure	Port Closure
Breaches Douglas County	Unlikely	Unlikely	Less relevant	Marginal	Unlikely	Unlikely	Less relevant	Port Closure
Breaches Josephine County	Unlikely	Marginal	Marginal	Marginal	Unlikely	Irrelevant	Irrelevant	Irrelevant
	Export Reduction Factor:‡			**1**	**1**	**1**	**0**	**0**

† Proportion of annual economic activity by which to reduce forecast under permitting; 0 value indicates no measurable impact of permitting fees

‡ Proportion of annual export by which to reduce forecast; 1 value indicates binary response by Port of Coos Bay to major export market sanctions

Figure 12. Timber industry economic impacts of SOD dashboard evaluated for Alternative B. Coos County is infested under this alternative by 2028.

Table 21. SOD economic impact to the timber industry in 2028, continuing through 2038, under Alternative B. Values presented as losses in jobs or wages (thousands of dollars). Export related jobs and wage losses form a subset of total forest sector jobs—they are not double-counted. Josephine County does not lose export related jobs because they are not present in the county. Major export job losses occur in Coos County (directly from the PoCB) and Douglas Counties (indirectly via export support industries and general losses from harvesting, etc.).

Year	Indicator	Coos	Curry	Douglas	Josephine	Regional
2028	Forest Sector Jobs	227	70	631	254	1,182
2028	Forest Sector DII Jobs	462	142	1,283	377	2,265
2028	Forest Sector Wages (Thousands)	$ 11,598	$ 3,459	$ 32,118	$ 10,823	$ 57,998
2028	Forest Sector DII Wages (Thousands)	$ 45,357	$ 13,529	$ 125,606	$ 39,050	$ 223,542
2028	Forest Harvest Dependent Tax Revs	$ 1,881,597	$ 792,032	$ 4,299,879	$ 303,060	$ 7,276,569
2028	Forest Harvest Decoupled Tax Revs	$ -	$ -	$ -	$ -	$ -
2028	Forest Industry Tax Revenues (Σ)	$ 2,416,089	$ 1,078,777	$ 5,724,116	$ 380,099	$ 9,599,081
2028	Export Related Jobs	494	38	378	-	910
2028	Export Related Wages (Thousands)	$ 24,517	$ 4,280	$ 24,644	$ -	$ 53,441
2028	Export (MMbf) Upper Range (16%)	39,656	21,275	105,669	5,716	172,315
2028	Export (MMbf) Lower Range (8%)	19,828	10,637	52,834	2,858	86,158

Year	Indicator	Coos	Curry	Douglas	Josephine	Regional
2038	Forest Sector Jobs	230	71	639	257	1,197
2038	Forest Sector DII Jobs	468	144	1,299	382	2,293
2038	Forest Sector Wages (Thousands)	$ 11,742	$ 3,502	$ 32,516	$ 10,957	$ 58,717
2038	Forest Sector DII Wages (Thousands)	$ 45,919	$ 13,697	$ 127,163	$ 39,534	$ 226,313
2038	Forest Harvest Dependent Tax Revs	$ 1,904,927	$ 801,852	$ 4,353,192	$ 306,818	$ 7,366,789
2038	Forest Harvest Decoupled Tax Revs	$ -	$ -	$ -	$ -	$ -
2038	Forest Industry Tax Revenues (Σ)	$ 2,464,749	$ 1,102,187	$ 5,844,928	$ 387,507	$ 9,799,372
2038	Export Related Jobs	500	38	383	-	921
2038	Export Related Wages (Thousands)	$ 24,821	$ 4,333	$ 24,950	$ -	$ 54,103
2038	Export (MMbf) Upper Range (16%)	40,147	21,538	106,979	5,787	174,452
2038	Export (MMbf) Lower Range (8%)	20,074	10,769	53,490	2,893	87,226

4.2.7 Alternative C:

Limited impact to the timber industry are shown to occur under Alternative C, which may more closely represent a continuation of treatment for NA1 rather than the intended EU1 treatment regime due to limitations of the available dispersal model. The model suggests eastward dispersal of SOD past the current QZ by 2023, and into Josephine County by 2028. Northward dispersal past the Rogue River occurs for one vector by 2038. These infestations would trigger ODA requiring fee-based timber transport permits, but would be unlikely to have implications for the timber export market.

The critical barriers for future impacts to the timber industry consist of the Coos County and Douglas County borders. Under this set of model results for Alternative A, SOD breaches neither of these borders, so the impact assessment in the form of lost jobs and wages from the timber export industry is not triggered.

If the lower confidence interval on model parameters is used to compute rate of SOD dispersal, we see that the Coos County border is passed in 2039. While this is outside the time frame of concern for the current impact assessment, we would point out that minor changes to disease model assumptions or relaxing the parameter confidence interval could shift that date to 2038 or earlier.

As with previous alternatives, the disease model used here does not anticipate future climate conditions nor does it accommodate the observed frequency of past long-distance stochastic dispersal events. Future such events could occur due to natural processes or, also as in the past, from human transport of SOD-infected plant material. All of these events could hasten the dates at which SOD crosses decision barriers, moving forward any export-mediated impacts.

SOD Triggering Event	**Year of Evaluation**				**Domestic Agency Impact**			
	2018	**2023**	**2028**	**2038**	**2018**	**2023**	**2028**	**2038**
North of Rogue River/QZ	no	yes	no	yes	NA	Fee Permits	Fee Permits	Fee Permits
Breaches Coos County	no	no	no	no	NA	NA	NA	NA
Breaches Douglas County	no	no	no	no	NA	NA	NA	NA
Breaches Josephine County	no	no	no	yes	NA	NA	NA	Fee Permits
	Permit Reduction Factor:†			**0**	**1**	**1**	**1**	**1**
SOD Triggering Event	**Export Implications (Int'l Sanctions)**				**Impact to PoCB**			
	2018	**2023**	**2028**	**2038**	**2018**	**2023**	**2028**	**2038**
North of Rogue River	No	No	No	No	NA	NA	NA	NA
Breaches Coos County	Unlikely	Unlikely	Unlikely	Unlikely	NA	NA	NA	NA
Breaches Douglas County	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Breaches Josephine County	Unlikely	Unlikely	Unlikely	Marginal	Unlikely	Unlikely	Unlikely	Irrelevant
	Export Reduction Factor:‡			**1**	**1**	**1**	**1**	**1**

† Proportion of annual economic activity by which to reduce forecast under permitting; 0 value indicates no measurable impact of permitting fees

‡ Proportion of annual export by which to reduce forecast; 1 value indicates binary response by Port of Coos Bay to major export market sanctions

Figure 13. Timber industry economic impacts of SOD dashboard evaluated for Alternative C. The current QZ is exceeded by eastward SOD dispersal in 2023, and by northward dispersal past the Rogue River by 2038. The Josephine County border is bypassed in 2038, but again this is not likely to precipitate loss of export markets.

4.2.8 Aggregate Future SOD Impacts

Government agencies (APHIS, ODA, ODF) would impose additional permitting requirements if SOD expands beyond the 2018 quarantine, but these changes would have limited economic impact on the primary timber industry. On the other hand, SOD could bring timber importing countries to impose sanctions on Oregon timber, causing loss of access to vital markets. Regional exports are sensitive to relatively minor fluctuations in demand; loss of access to any major importing country (China, Japan, Korea) could mean closure of the PoCB. Port closure would directly reduce forest sector jobs and wages in the maritime cargo and support subsectors, and indirectly via lower demand for timber. Secondary industries might be unaffected, or possibly see gains if export volume becomes accessible at reduced prices. Such a tertiary effect would only occur (1) if SOD exceeds Coos or Douglas county boundaries *and* (2) if a major foreign timber importer imposes regional sanctions *and* (3) if the regional domestic market shifts in the anticipated direction. It is beyond the scope of this report to assign probabilities to these events.

In Alternative B, representing the outcome should ODF discontinue SOD treatment, the dispersal model suggest that Coos County could be infested by SOD as early as 2028 using mean parameter values for the dispersal model. If this event occurs, and if it is then followed by sanctions from any or all of the major timber importing countries, direct forest sector losses in 2028 could amount to 1,182 jobs and $57.9 million in wages (Table 21). Of those quantities, the majority would be from export-related activity in the region: 910 jobs and $53.4 million in wages. Looking to the end of the study period, in 2038, direct losses would be 1,197 jobs and $58.7 million in wages (Table 21), assuming a missed opportunity to increase jobs and wages in proportion to the forecasted annual regional timber harvest (§4.2)

Potential Port Closure Impacts from SOD Management Alternatives

Placing these potential losses into context, if ODF continues treatments at the current rate (using the 2018 funding level of $1.5 million per year as an estimate for program costs), by 2028 the Department would have spent $15 million dollars on SOD control efforts. Under Alternatives A or C, the result of these efforts would potentially be to delay the dispersal of SOD to Coos and/or Douglas Counties through at least 2028 and possibly 2038. After the 2028 checkpoint, expenditure of $15 million to-date and $1.5 million annually thereafter via the ODF SOD treatment program could potentially offset the loss of 1,182 regional jobs and $57.9 million in annual wages. Adopting a conservative approach and keeping that annual wage loss constant from 2028 through 2038, and assuming continued treatment (again either Alternatives A or C), 20 years of SOD treatments costing $30 million could potentially offset a decade of export-related job losses, or $579 million in regional wages.

We reiterate that the possibility of total loss of the timber export industry from these four counties would depend on decisions made by several non-coordinated entities, and that this report cannot estimate the likelihood that each link in the series of necessary decisions would occur. Other events could eclipse the importance of SOD. For example, if timber tariff agreements with major foreign countries (China, Canada) go unresolved, export markets could be effectively terminated by international trade disputes, which might take effect earlier, and have greater consequences, than SOD-related outcomes.

5.0 NON-TIMBER IMPACTS

This section addresses non-timber potential economic costs of SOD, including those related to tribal concerns; aesthetics; fish, wildlife, and habitat values; recreation; tourism, subsistence hunting and fishing; public safety; and wildfire risks. Per the scope of work for this analysis, this section does not address economic impacts of SOD on the nursery industry or other agricultural enterprises, which must comply with the USDA confirmed nursery protocol if SOD is detected in their plant material.

5.1 Tribal cultural values

5.1.1 Tribal cultural values:

In addition to tanoaks that can be killed by SOD, there are over 135 plants that are hosts of SOD that are typically not killed by the disease (Oregon Department of Agriculture, n.d.). Because of the number and variety of plant species infected by SOD, the disease can affect Native American traditions and cultural activities that have relied on many of these plants for many generations. For this reason, the SOD infestations in northern California and southwest Oregon could potentially affect the cultural values and traditions of many local tribes, including the Siletz, Tolowa Dee-ni' Nation, Coquille, and Cow Creek Band of Umpqua, among other tribes. Several reservations are located near the current SOD quarantine zone, which covers 515 square miles in Curry County, extending from the Rogue River south to the California border (Appendix). The Smith River Rancheria (home to the Tolowa Tribe) lies less than 10 miles from the quarantine zone. The Coquille and Cow Creek Reservations are approximately 50 miles north of the quarantine zone. The Siletz Reservation is approximately 200 miles north. In addition to these lands, there are also tribally-owned lands near the quarantine zone. These include the Coquille-owned Sek-wet-se Tribal Forest in the Sixes River area and the Coquille Forest between Coos Bay and Roseburg (Smith, 2018).

Tanoak, the primary species killed by SOD in southwest Oregon, have traditionally been a sacred tree to local Native American Tribes (Alexander & Lee, 2010). For at least 5,000 years, Tribes in southwest Oregon have collected the acorns from tanoak trees and used them to make teas, breads, soups, and mushes (Bowcutt, 2014). The acorn dishes have held special cultural significance, being used as special nourishment during spiritual fasts, a means of blessing ceremonial houses, gifts when visiting friends, and in feasts to celebrate special occasions (Kentta, 2018; Ortiz, 2008). Tribes (including the Cow Creek Band of Umpqua Indians, the Tolowa Dee-ni' Nation, the Siletz, and the Coquille) still collect these acorns today from the forests in their ancestral territories in southwest Oregon and Northern California. In the same areas, these tribes collect materials for basket weaving from *Corylus cornuta* spp. *californica* (California hazel), which is a host for SOD (Smith, 2018; Ford, 2018; Kentta, 2018; Robison, 2018). Dozens of other SOD-affected plant species have been used by California Indians for a wide variety of uses, including clothing, traditional medicines, hygiene products, food ingredients, decorations, tools, musical instruments, and building materials (Ortiz, 2008).

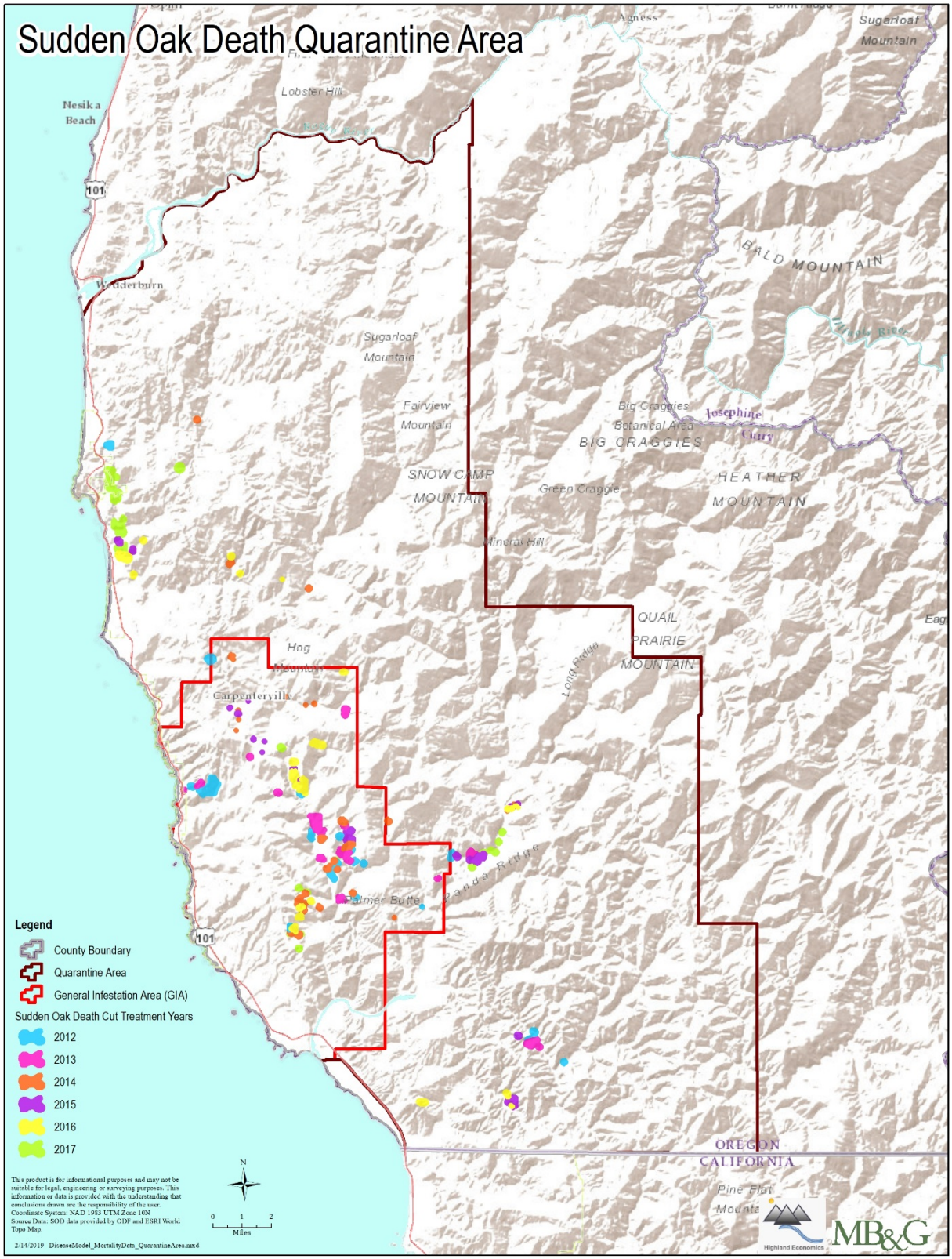

Figure 14. Extent of SOD infestation in the GIA and QZ through 2017

Tanoaks and other oak species are also indirectly valuable to Tribes as an important source of food and habitat for fish and wildlife species that provide cultural value. Deer, elk, and bear use acorns as a valuable source of protein. Tanoak trees along riparian corridors help to cool stream temperatures, enhancing habitat for Coho salmon (Bounds, 2018). A variety of bird species feed on acorns and use tanoaks as nesting habitat. Small mammals, such as mice, fishers, and squirrels, depend on the acorns for food, and in turn act as food for other species, such as cougar and coyotes (Bowcutt, 2014). In this way, SOD-affected species help to indirectly support the cultural value of a diverse set of other species.

5.1.2 Current SOD Impacts on Tribal Cultural Values

To assess the impacts of SOD on tribal peoples, we reached out to members of the Cow Creek Band of Umpqua Indians, the Tolowa Dee-ni' Nation, the Confederated Tribes of Siletz Indians, the Elk Valley Rancheria, and the Coquille Indian Tribe. That effort resulted in a total of six interviews, with each tribe being represented (except the Elk Valley Rancheria). Interviewed representatives included current and prior tribal leaders and natural resource administrators.

To date, SOD has impacted tribal cultural values in a number of ways. According to a representative of the Siletz Tribe, it has degraded the culturally-important experience of collecting acorns. People who were accustomed to gathering acorns in thriving tanoak forests now encounter either barren areas or stands of dead tanoaks. This is especially disappointing to those who travel from outside the area to reach traditional harvesting forests, a journey that is already difficult for some tribal members whose transportation opportunities are limited (Kentta, 2018).

SOD has also impacted other traditional practices, such as basket making. Because the California hazel, a traditional material used for basket making, is also a host for SOD, care must be taken to not transport infected material outside of areas where the plant is harvested. This has forced a change in the practice of collecting sticks for baskets. Harvesters must now peel the sticks right away in the forest and leave the remnants in place rather than being able to peel the sticks in another location after harvest. The danger of spreading SOD has left some people afraid to harvest the sticks at all (Kentta, 2018).

To date, SOD has had varying impacts on the tribes based on their proximity to and use of lands in the GIA. Representatives of the Coquille and Cow Creek Tribes report there has been limited evidence of impacts on their tribal members so far (Ivy, 2018; Smith, 2018; Robison, 2018; Vredenburg, 2018). This is likely because the tribes' ancestral territory and areas of contemporary use falls outside of the area(s) most heavily-impacted by SOD. Representatives from the Tolowa Dee-ni' Tribe report only minor, indirect impacts from SOD through 2018. They have seen an increase in the use of their ancestral territory by outside tribes whose own land has been damaged by SOD, and the trading of resources between tribes has decreased because of the disease (Ford, 2018). Only a representative from the Siletz Tribe reported high impacts from SOD to-date, when considering the combined effects on wildlife and cultural practices (Kentta, 2018).

5.1.3 Future SOD impacts on Tribal cultural values

The consensus among tribal contacts (including those from the Siletz, Tolowa Dee-ni', Coquille, and Cow Creek) is that there is a great deal of concern over future impacts because of the potential for much broader impact (Kentta, 2018; Smith, 2018; Ford, 2018; Ivy, 2018; Robison, 2018). Widespread tanoak mortality could mean that the Tribes can no longer gather tanoak acorns, depriving them of a traditional food source and cultural commodity. Values associated with fish and wildlife could also be reduced if populations of culturally-important animals are adversely affected (due to reduction in acorns that are a primary source of food). These include deer, whose populations are already diminished according to some local reports, resulting from a combination of diminished food supply due to SOD, over-predation, diseases, and wildfires (Boice, 2018; Riddle, 2018).

Widespread tree mortality in tanoak-dominated forests could increase sedimentation in nearby streams, as roots decompose and soils become more easily erodible (Schmierer, 2018). This could degrade salmon habitat in some cases, and further harm species that are valuable to Native cultures in the region. Steep terrain would exacerbate sedimentation issues. The loss of riparian trees could also degrade salmon habitat by increasing stream temperatures (Bounds, 2018). [15] The Tribes are also concerned that SOD impacts are being added to other major stressors on forest ecosystems (including wildfires, droughts, inadequate management, and climate change), which may increase the threat to their natural resources (Kentta, 2018; Ivy, 2018; Ford, 2018; Robison, 2018).

It is important to note that impacts to cultural values can arise not just from the disease itself, but also from the treatment of the disease. Treatment for SOD occurs in two phases, a spring or summer herbicide application prior to cutting and piling the dead material, followed in the fall or winter by burning the piles (see §5.2). The use of herbicides in the initial treatment was not identified during interviews as an issue of concern for tribal cultural values. Following this treatment, previous tanoak forest cover is completely removed, resulting in loss of habitat for culturally significant species that depend on tanoak. In some cases if there is a degree of conifer cover, the treatment may not leave a completely deforested area, but species reliant on tanoak exclusively will not find the resulting forest structure hospitable. Ultimately the impact on culturally significant species is the same with or without treatment, but SOD treatments as currently implemented are not a solution to restoration of culturally important tanoak forests.

[15] Habitat degradation after tree mortality is not an assured outcome. At time of writing, definitive studies showing a direct link between SOD, tanoak mortality, and salmon habitat degradation are not available for citation.

5.2 SOD treatment activities

Since 2001, agencies (ODF, USFS, BLM) have spent an average of $1.9 million per year to treat SOD in Curry County with the objective of preventing is spread to neighboring counties. The main funding source is the USFS emergency fund, which derives from the federal tax base. The treatment funding therefore represents an increase in regional economic activity (jobs and wages), bringing outside resources to Curry and Coos Counties, as treatment crews are currently based in both counties. Benefits of treatment activity in these counties accrue to individuals in the form of wages, and to local governments via taxation.

5.2.1 Current economic impacts of SOD treatment

Two entities are currently contracted by ODF to treat SOD in the quarantine area. Together, these contractors employ approximately 20 to 30 full-time equivalent (FTE) workers. One contractor is based on Coos County, while the other is headquartered in Curry County. To respect confidentiality, we cannot report a specific breakdown of employees per contractor or wages per employee. We can estimate the broader economic impacts of treatment procedures. The ODF SOD treatment procedure is extremely labor-intensive. Treatment crews identify infected tanoak trees and their surrounding neighbors, kill the trees if they have not already died from SOD, and cut the trees down. All of these steps are completed manually. Next, the cut trees are moved to several piles across the work site. Some of this work is done by machine, but the smaller trees and branches are moved by hand. Depending on the size of tanoak trees in the infested forest area, mechanical piling might account for 25% - 90% of the tanoak mass that needs to be moved into piles. Much of this work is done during the summer dry season, but the final treatment step, burning the wood piles, cannot be done until the winter wet season. This is another step that is completely manual. In terms of crew labor expense versus machine operating expenses, again we cannot report specific breakdowns to maintain confidentiality, but we can report that manual work typically accounts for more than 75% of the treatment cost. Since such a large proportion of the treatment cost goes to labor wages, the average $1.9 million annual funding level corresponds to approximately $1.4 million in wages and related overhead expenses that are paid directly into the local county-level economy. The balance, consisting of machine operating costs, is also partially diverted to the local economy in the form of maintenance costs, although fuel costs are largely exported.

5.2.2 Future SOD treatment impacts

Treating SOD produces a positive impact on the economy. In the future, if SOD treatments are discontinued either due to lack of USFS funding or from State-level decision making, wage and job responses may diverge. Workers currently employed to treat SOD would not be laid off, in most cases, if the SOD treatment program is terminated. Their wages, however, would then come from local rather than national sources, removing an external wage influx of approximately $1.4 million per year. In this report, we do not speculate about the likelihood of continued SOD treatments.

5.3 Property valuation and aesthetics

Natural aesthetics are an important factor that defines the character of an area. Widespread die-offs of tanoak trees in prominent viewsheds could negatively impact an area's aesthetics. The treatment of SOD could have similar or even worse impacts on aesthetics, as clear-cutting and burning may be considered less attractive than standing dead trees. Alternatively, if areas treated for SOD are replanted with conifers or hardwood species not susceptible to SOD, then the resulting green-up may ultimately be more visually appealing than the partial regeneration and repeated mortality in an untreated tanoak forest. The type of aesthetic impact and the sensitivity and magnitude of impact on associated property value depends on several factors, including land ownership, visibility of the SOD affected land from prominent viewing locations, and the surrounding land uses. Planting new trees after treatment has not a typical component of the current management regime, but could be a cost for some landowners who opt to plant.

Much of southwest Oregon is publicly held land, mostly controlled by the federal government. These consist of lands owned by the U.S. Forest Service (USFS), Bureau of Land Management (BLM), and Oregon and California Railroad Revested Lands (commonly called O&C lands). In the four counties of interest, the proportion of public held land is 68% for Josephine, 62% for Curry, 52% for Douglas, and 29% for Coos (Cansler, 2018). In Curry County, the majority of public land is held by the USFS with a smaller proportion of BLM lands. In Douglas and Josephine Counties, there are large tracts of USFS land and also significant amounts of O&C lands. In contrast, Coos County has a much smaller proportion of public land, with the majority in O&C lands.

One indicator of the economic value of a change in aesthetics is the effect on private property values. Changes in private property values only reflect the change in aesthetic value to property buyers (and do not include changes in aesthetic value to other such as visitors, tourists, and passing motorists), and thus do not reflect the total change in economic value due to aesthetic changes.

Residential land owners in particular are often sensitive to changes in aesthetics on or near their properties, and this is reflected in changes in property values when aesthetics change. For example, specific to SOD, a study in Marin County, California estimated the impact of SOD on property prices. Using property sales records, the study used statistical modeling to estimate how proximity to SOD infection influenced property values (after accounting for other key factors influencing property value).[16] The study did not analyze how SOD impacted properties differently based on the property's size, characteristics, or location in the urban/rural environment; however, it did examine how distance from infected woodlands impacted property values. The researchers examined effects at three distances: three-, six-, and nine-twentieths of a mile. The results indicated that homes within six-twentieths (three-tenths) of a mile of infested tanoak

[16] Hedonic modeling is a statistical analysis whereby various characteristics of a property (in this case size, location, proximity to SOD) are used to determine an average contribution of each characteristic to the overall value of the property.

woodlands experienced statistically-significant property value declines of 3% - 6% (Kovacs, Holmes, Englin, & Alexander, 2011). This same study found that if there were tanoaks dying from SOD on properties, the decline in property value was 1% - 5%. However, this effect was found to be temporary, presumably because property values recovered after home owners removed dying trees. The largest harm to property values occurred in areas that had dying tanoaks located throughout the neighborhood and in nearby woodlands. These properties experienced value declines of 8% - 15%, which lasted several years (Kovacs, Holmes, Englin, & Alexander, 2011).

Other studies, largely conducted in urban environments, highlight how trees increase the value of residential property as well as increase the income of adjacent businesses. For example, street treescaping has been shown to increase business income by 12% (Burden, 2006). This is likely due to the fact that consumers have been shown to travel further to, stay longer, and willingly pay more for the same item in shopping districts that include street trees compared with the same item in non-treescaped retail locations (Wolf, 2005). In terms of residential property values, studies in places as diverse as Tarrant County, Texas; Portland, Oregon; and Ramsey and Dakota counties in Minnesota have shown increased residential property value in neighborhoods with increased street tree canopy. These studies, cited below, provide further evidence of how loss of tree cover due to tanoak may result in reduced economic value as indicated by property value impacts:

- Increased urban tree cover reduced the adverse effect on house prices of proximity to chemical facilities in Tarrant County, Texas (Lee, Taylor, & Hong, 2008);
- A 2010 study of urban tree cover value in two Minnesota counties found that increasing neighborhood tree cover positively affects median home sale price. Increasing tree cover by 10% within 330 feet increased a home's sale price by an average of 0.5% ($1,585); within 850 feet, the increase was 0.3% ($966) (Sander, Polasky, & Haight, 2010).[17] Assuming 10 homes within 850 feet would translate into approximately $9,666 in increased property value.
- In Portland, Oregon, street trees (but not trees on the property) were shown to increase value of residential properties within 100 feet of the street tree. The study found that an average-sized street tree in the city (having 29 square meters of canopy) adds $8,240 (3%) to the price of the house it fronts, and an additional $14,828 to neighboring houses, for a total of $23,070 in value (Donovan & Butry, 2010). [18]
- In Perth, Australia, a 2012 study found that a 10% increase in broadleaf tree cover on the street increases median price of single-family houses by 20%. This translates into an implicit price of approximately $8,213 per broad-leaved street tree. [19] The study found

[17] These values were $1,371 and $836 in 2010 dollars, which we adjusted to 2018 values using the Consumer Price Index.

[18] These values were $7,130, $12,828, and 19,958 in 2010 dollars, which we adjusted to 2018 values using the Consumer Price Index.

[19] This value was $7,467 in AUD 2012 dollars. Average 2012 exchange rates from AUD to US were approximately 1.0, so we assume equivalent value in US dollars and inflate to 2018 values using the Consumer Price Index.

no increased property value for trees located on the property (Pandit, Polyakor, & Sadler, 2012);

- In the Lake Tahoe Basin of California, forest density and health characteristics were shown to increase property values between 5% and 20% (Thompson, Hanna, Noel, & Piirto, 1999).

5.3.1 Current impacts on aesthetic value

As noted above, the effect of SOD on aesthetics, and the associated effect on property values, depends on land ownership and land use. Table 22 summarizes the land ownership in Curry County, while Table 23 summarizes the acreage by land use type (residential, commercial, industrial, agricultural, etc.) in the GIA and quarantine zone. The Quarantine Zone consists of a mix of private land, BLM land, and USFS National Forest. The private land lies in a rough band along the coast, while the BLM and USFS land primarily lies inland. The GIA encompasses a mix of private land along the coast and patches of BLM land further inland. The only urban area that lies within the GIA is Brookings (population of roughly 6,400). Gold Beach (population 2,300) is the only urban area in the Quarantine Zone, and it lies approximately 20 miles north of the GIA.

Table 22. Curry County level land ownership data.

Land Ownership	Acres	% of Total
Local Public or Private Lands, Zoned	187,463	18%
Other Private lands, not Zoned	152,894	15%
Public Lands	699,431	67%
Water	3,524	0.3%
Tribal	3,198	0.3%
Total:	**1,046,510**	**100%**

As shown in Table 23, we expect that the types of land uses (and associated users) that are most sensitive to changes in aesthetics include: residential, commercial, recreation, and high-use public spaces such as roads and other public facilities. Of these land uses, based on the literature cited above, we expect that the change in aesthetic value will translate into changes in property value most likely for residential land uses, of which there are approximately 4,600 acres in the GIA and 8,600 acres in the quarantine area. We do not expect any change in property value associated with aesthetics related to industrial or agricultural land uses, and potentially limited effects on commercial land uses. As such, we focus on the potential impact on residential property values as an indication of the change in economic value associated with aesthetic changes.

Table 23. Level of impact and acreage by land use type (as indicated by zoning code).

Land Use Type	County Zoning Codes	Level of Impact	Acres		
			GIA	Quarantine	County
Beaches and Dunes Conservation Area	CON	Aesthetic impact, no or low property value impact	0	719	2,431
Public Facilities	PF		1,206	2,226	7,903
City	CITY, UGB		2,486	2,503	3,593
Commercial	C-1, C-2, C-4, RC		477	874	1,967
Residential (within UGB)	R-1, R-1-6, R-2, R-3	Aesthetic & property value impact	951	2,441	5,256
Rural Residential (outside UGB)	RR-5, RR-10, RCR, RRC		3,612	6,131	11,176
Industrial	I, RI	Little to no aesthetic or property value impact (except if highly visible from roads or residential/commercial/recreation areas)	333	494	703
Agriculture and Timber	EFU, AFD, MPA, T, FG		27,638	69,898	151,953
Other	CN, MA, NH, SW, UK		0	258	2,481
Subtotal Acres, Zoned Lands			**36,703**	**85,544**	**187,463**

Interviews with local residents indicate that SOD infestation may currently be adversely impacting residential property values near the infestation areas, and that impacts could be much greater as SOD spreads. In areas where the SOD infestation is endemic, such as around Brookings, dead trees and clear-cut land (from SOD treatment) are common sights, and according to some locals, give the area a very unattractive appearance (Riddle, 2018). Some land owners have had to cut and burn all the tanoaks on their land (Timchak, 2018). Dead and cut trees may make a property less aesthetically pleasing and therefore less valuable. Interviews with OSU extension agents and others in Curry County indicate that property in the area has become less desirable, and that property sales have likely declined as a result of SOD (Burris, 2018; Riddle, 2018). Property buyers ask about dead and cut trees on the property, and express concern over the aesthetic character of it, indicating that aesthetics both hold value and influence purchase decisions (Kennedy, 2018). One local real estate agent estimates that heavily-impacted properties can see their value fall by 5% - 6% (Kennedy, 2018). This range overlaps with the analysis cited above regarding SOD-infected properties in Marin County, which estimated value declines of 1% - 5%. Given the overlap of these ranges, we use an impact estimate of 5%, and couple it with the number of residential properties located within a SOD infestation to estimate the potential economic cost of SOD related to aesthetics. As shown in Table 24, on tax parcels that have infested acres (as recorded by ODF), there are buildings valued at $57.3 million, of

which $52.2 million is for residential homes. A 5% decrease in this home value would indicate that the impact to homeowners (aesthetic and nuisance value) of SOD may be approximately $2.6 million. Land value associated with the residential dwellings is estimated at $112.2 million; if this land value were also to be adversely impacted by approximately 5%, this would equate to an additional impact to homeowners of approximately $5.6 million, for a total potential impact to homeowners on SOD-infected parcels of approximately $8.2 million.

This value is likely an underestimate as it does not include impacts to others in the area who are adversely affected by the aesthetics of SOD-infected trees. It also does not include impacts to surrounding homes that may not be infected but that have adverse aesthetic effects from views of SOD-infected lands. In particular, residential properties within 0.3 miles may have adverse effects, based on research conducted on SOD-infections in Marin County, California. There are approximately 18,300 additional acres of land that are within 0.3 miles of SOD infested areas in Curry County, which is roughly seven times the area of the SOD infestation (2,668.8 acres). If these surrounding but uninfected lands had residential property value per acre similar to the value of infected lands, and if these properties also experienced a 5% decrease in value, the total potential impact to homeowners of surrounding lands could be seven times as high as impacts to infected lands, or approximately $57.4 million.

This method may also underestimate the impact to property values as Kovacs *et al.* found that properties in heavily-impacted neighborhoods may experience value declines of 8% to 15% (Kovacs, Holmes, Englin, & Alexander, 2011). Following Kovacs *et al.* 2011, we expect that impacts of SOD-affected trees located on a property will be transient as owners remove the diseased trees and property values recover; however, the impacts of infested woodlands have the potential to impact nearby property values for several years.

Outside of the GIA, SOD impacts on property values appears to be minimal, although there is concern that the impacts could arise as the SOD range expands. So far, SOD has primarily impacted rural properties and those in the urban/rural interface, but the impacts could be more severe if SOD were to reach the urban areas (Kennedy, 2018), although tanoak cover in urban areas is less extensive than in rural areas. Given that the potential for further disease dispersal is high, SOD threatens one of the area's primary appeals: the ocean-to-forest character (Kennedy, 2018). Many Curry County residents are already inclined to move away from the area because of the recent large and devastating wildfires (Boice, 2018) The spread of SOD could further compromise the area's attractiveness to residents and weaken overall property demand.

Table 24. Acreage and value of private lands with known SOD infestation (per ODF database), excluding treated areas in GIA, QZ.

Land Use Type	Market Value (As reported in County Assessor Data)		Acres		
	Land	Buildings	Total Parcel Acres	Infested Acres	% Infested
Commercial[1]	$2,700,000	$1,500,000	257	150	58%
Residential[2]					
With Residential Dwelling	$49,600,000	$22,100,000	489	246	50%
Without Residential Dwelling	$15,300,000	$1,900,000	1,773	366	21%
Mixed Farm-Forest[3]					
With Residential Dwelling	$63,000,000	$30,100,000	1,049	501	48%
Without Residential Dwelling	$51,100,000	$1,800,000	23,131	1,340	6%
Total, All Private Lands	$181,700,000	$57,300,000	26,698	2,601	10%
Total, With Residential Dwelling	$112,600,000	$52,200,000	1,538	746	49%
Impact on Property Value of SOD infected parcels, Assuming 5% Decrease (Potentially Short-Term if Diseased Trees are Removed)	~$5,600,000	~$2,600,000			

1/This is based on the state zoning code, and includes the following zones: commercial-central and rural commercial.
2/This is based on the state zoning code, and includes the following zones: future urban development, low-density residential, medium low-density residential, medium-density residential, rural residential 10 acres, rural residential 5 acres, and very low-density residential.

5.3.2 Future aesthetic impacts

Expansion of SOD infested areas will increase property value and other aesthetic impacts in proportion to the infested acreage. Directly extrapolating from GIA impacts to all of Curry County or to the tanoak range in other counties will not yield an accurate assessment, however, because the distribution of tanoak is highly variable across the landscape. A thorough assessment of future aesthetic impacts will require infestation area results from a suitable SOD dispersal model, such as a SIR-type disease model, which may be available later in 2019.

5.4 Public safety hazards

Dead trees can pose a safety risk to the public and a cost to agencies responsible for removal. There are a number of lands and infrastructure types that are at risk. A downed tree on a highway has the potential to disrupt transportation travel time and access (causing delays and possibly eliminating exit from an area). Downed trees on roads also have the potential to cause traffic accidents and injury to motorists (if vehicles are not able to avoid colliding with the tree or another vehicle or lose control while avoiding it). Similarly, fallen trees in recreational areas could adversely impact access, or pose risks to recreators, such as those that use off-highway vehicle (OHV) trails.

Property owners are also put at risk by dead trees, as dead trees can fall onto homes and other property. To avoid this, property owners and land managers must pay the costs of having dead trees cut down. A particular safety risk is posed to power lines, which, if downed, can cause power outages and have the potential to start wildfires. In sum, as SOD increases the number of dead trees, it has the potential to increase safety risks to the public and increase the costs of managing those risks (i.e. removing the dead trees) to property owners and land managers.

5.4.1 Current SOD hazard impacts

On private lands, without government assistance to cover the costs of tree removal, many homeowners in the area cannot afford to have SOD-affected trees on their property removed, which can result in a hazard for the property owners and their homes (Roberts, 2018; Mitchell, 2018). Among the concerns regarding public safety risk of SOD are that dead trees could fall on electrical lines and cause a wildfire. The need to remove SOD-killed trees has taken time away from trimming non-diseased trees that encroach on power lines, increasing the danger of normal trees damaging power infrastructure and starting wildfires (Mitchell, 2018). A large number of residences in the area have only a single, narrow road for access. As a result, a downed tree has the potential to not only start a wildfire, but trap residents within it (Riddle, 2018). Another concern is that dead trees are common in the GIA, and have a tendency to grow outward toward roads in order to reach light. This makes them heavier in the direction of the road, and more likely to fall toward roadways (Riddle, 2018).

For agencies that are removing SOD affected trees, Curry County provided some cost estimates. These costs can be as little as $300 per incident for a branch that has fallen into the roadway and only requires one person with a chainsaw. For a large downed tree in the road that requires flaggers, a dump truck, and up to four hours to remove, it can cost roughly $3,000 (Christensen, 2018).

Local tree service companies provided a wide range for the costs of removing SOD-affected trees, which vary depending on the condition of the tree, surrounding terrain, time of season, and proximity to structures. Removing a tree near a home can cost the property owner as little as $200, but costs can rise as high as $4,000 per tree if special equipment and procedures are needed to avoid damaging the nearby structures. Removing trees away from structures costs

roughly $400 to $2,500 per incident or per tree. Trees near roads can cost as little as $500 per incident if the work can be done on the side of the road without interfering with traffic. However, costs rise by $800 to $2,000 per tree when there is a need to control traffic and use additional equipment to remove trees quickly from the site (Roberts, 2018; Mitchell, 2018).

To date, interviews with local officials have not identified any known injuries due to downed or falling trees. However, there does not appear to be a consensus regarding SOD's current impact on public safety; some local experts show great concern while others do not foresee major safety issues arising even if SOD spreads.

Tree removal efforts to date may have limited the public hazard threat of the current level of SOD infestation. On private lands, while not all landowners may choose or be financially able to remove dead trees, local tree service companies in the area have reportedly seen an increase in demand for their services as a result of the SOD infestation (Burris, 2018). On public lands, ODF led a large effort to remove SOD-affected trees years ago, which helped to address the danger of falling trees near power lines. Others report that the USFS has done an effective job of removing hazardous trees along roads, and that SOD-affected trees falling into roadways does not present a significant risk (Boice, 2018).

The occurrence of SOD infestations near roads varies across the GIA and QZ, in some areas causing little concern for public safety, while in other areas (e.g. Carpenterville Rd, pers. comm. S. Navarro, ODF) representing a significant safety hazard. The local power company, Coos Curry Electric Cooperative, has not had a noticeable increase in the number of downed trees or dead trees that need to be removed for safety reasons, and does not expect this will change in the future (Adams, 2018). Similarly, an authority on Curry County roads reported no noticeable increase in the number of tanoak trees requiring removal from roadsides, and that fir and alders are the primary species that need to be removed (Christensen, 2018).

No estimates were available on the number of trees that have been removed by private or public entities, and so no quantitative cost of total tree removal cost to date is provided in this analysis.

5.4.2 Future hazard impacts

Current hazards caused by SOD are unevenly distributed over the GIA and QZ, so we should expect uneven hazard impacts as the QZ expands across Curry County and potentially into surrounding counties. While the exponential decay model of SOD expansion is suitable for estimating the rate of SOD dispersal along a vector, it does not enable a method for estimating infection probability, so infestation levels in the area traversed are unknown. Following publication of results from a SIR-type model later in 2019, it will become possible to estimate future hazard tree impacts by positioning a road network over the SOD results for each management alternative. Hazard impacts should be revisited in a follow-up study.

5.5 Recreation and tourism

5.5.1 Recreation

There are diverse outdoor recreation activities in southwest Oregon enjoyed by residents and tourists. On the coast in Curry and Coos counties, the most popular activities include windsurfing, ocean fishing, and visiting the beaches, scenic areas, and dunes (Lacey, 2018; Curry County, 2018; Coos County, n.d.). Further inland, the forests and rivers provide opportunities for a variety of recreation. Rafting, kayaking, jet boat rides, and fishing are very popular activities on the area's rivers (Coos County, n.d.; Curry County, 2018; Popoff, 2018; Douglas County, n.d.; Josephine County, n.d.). Hiking, camping, hunting, backpacking, mountain biking, horseback riding, and OHV riding are popular activities in the forests (George, 2018; Lacey, 2018; Popoff, 2018). Table 25 summarizes the potential number of residents who participate in key outdoor recreation activities, based on Oregon statewide outdoor recreation participation rates.

Table 25. Estimated participation in outdoor activities in the study region.

Statewide Participation Rates [1]		Hunting	Fishing	Day hiking	Backpacking	Biking on unpaved trails
		11%	27%	74%	13%	15%
County	**Population**	**Estimated Number of Annual Participants**				
Curry	22,669	2,500	6,000	16,800	3,000	3,400
Coos	63,888	7,000	17,000	47,300	8,400	9,500
Douglas	109,405	12,000	29,100	81,000	14,400	16,300
Josephine	86,352	9,500	23,000	63,900	11,400	12,900
Total	259,645	31,000	75,100	209,000	37,200	42,100

1/ Source: (Bergerson, 2018)

Specific to hunting, in the Oregon Department of Fish and Game Southwest region (which includes Curry, Josephine, Coos, and parts of Jackson and Douglas counties), there were 9,100 elk and deer hunting licenses issued in 2017 (Oregon Department of Fish & Wildlife, 2018).

There are numerous public recreation areas for locals and tourists alike to engage in these outdoor recreation activities. Table 26 summarizes state park and national forest acreages and total attendance estimates in Curry County[20].

[20] Note 11/15/2018: Future disease model outputs are not yet available; we assume that models will predict SOD dispersal to other counties, and will include comparable tables for those counties as necessary in the final draft of this impact assessment.

Table 26. State Part and National Forests in Curry County, acreage and annual attendance (2017).

Recreation Area	Acres			2017 Attendance (persons)	
	Park	GIA[b]	Quarantine	Overnight	Day Use
Alfred A Loeb State Park	320	158	158	21,325	104,040
Azalea State Park	33	0	0	N/A	N/A
Battle Rock Wayside	19	0	0	N/A	N/A
Buena Vista State Park	77	0	77	N/A	N/A
Cape Sebastian State Park	1,400	0	1,149	N/A	97,916
Cape Blanco	1,895	0	0	37,750	235,644
Floras Lake State Park	2,104	0	0	N/A	N/A
Forest Wayside State Park	137	137	137	N/A	N/A
Geisel Monument State Park	4	0	0	N/A	14,774
Harris Beach State Park	174	112	0	98,858	1,637,444
Humbug Mountain State Park	1,842	0	0	42,251	86,060
Otter Point State Wayside	121	0	0	N/A	32,058
Pistol River State Park	448	0	362	N/A	81,284
Port Orford Cedar State Park[a]	25	0	0	130,228[a]	
Samuel H Boardman State Park	1,471	844	844	N/A	822,210
Rogue River-Siskiyou National Forest[d]	654,885	224	185,409	72,000[c]	272,000[c]
Total:	**661,700**	**1475**	**188136**	**402,412**	**3,383,430**

Sources: (Oregon State Parks and Recreation, 2018)
a/ (White, 2018)
b/ Geospatial analysis of park boundaries overlaid with the SOD GIA and quarantine boundaries.
c/ Data from 2012. Source: (U.S. Forest Service, 2012)
Note: All N/A in the overnight visitation column are not applicable (no overnight accommodations in the park, while all N/A in the day use visitation indicate that data are not available.
d/ In Curry County, but total of 1.8 million acres in CA and OR combined

5.5.2 Tourism

Tourism, defined separately from recreation—although recreation may be conducted as an element of tourism—is an important industry in southwest Oregon. Local leaders note that tourism brings critical economy activity to a region that has struggled after the decline of other major industries, such as timber and commercial fishing (Burris, 2018; Popoff, 2018). Table 27 shows the size of the tourism industry (in terms of earnings and employment supported) for each county in the area. Tourism is estimated to directly and indirectly support over 10,000 jobs and $250 million in annual earnings in the four-county area (Dean Runyan Associates, 2018). When compared with total earnings and employment, tourism accounts for about 5% - 10% of earnings and 7% - 15% of employment for Coos, Douglas, and Josephine Counties (U.S. Bureau of Labor Statistics, 2017). However, tourism is a much larger part of the economy in Curry County, where it accounts for nearly a quarter of all earnings and supports almost a third of all employment.

Table 27. Economic impacts from tourism (2017).

County	Earnings from Tourism (million) [1]	Employment Supported by Tourism [1]	% of Total Earnings [2]	% of Total Employment [2]
Coos	$79.0	3,300	9%	15%
Curry	$51.3	2,040	23%	31%
Douglas	$70.5	3,170	5%	8%
Josephine	$46.2	1,820	5%	7%
Total	$247	10,330	7%	11%

1/ Source: (Dean Runyan Associates, 2018)
2/ Total earnings and employment are taken from (U.S. Bureau of Labor Statistics, 2017)

Common tourist activities are fishing, kayaking, jet boat tours, mountain biking, hiking, and visiting beaches, dunes, and other scenic areas (Lacey, 2018; Cribbins, 2018). While hunting and backcountry hiking are common recreational activities, they are primarily limited to local residents (Timchak, 2018; Burris, 2018). Fishing tourism brings in valuable economic activity, both for its popularity and the fact that non-resident fisherman often hire local guides (Burris, 2018; Becker, 2018). Popular rivers to fish include the Chetco, Rogue, and Sixes (Popoff, 2018). Table 28 summarizes 2008 expenditures associated with fishing and hunting recreation; in contrast to the table above, this data source only reported expenditures, not local income or employment supported by the expenditures. Local earnings would be much smaller than the expenditures reported in the table.

Table 28. Expenditures by county from fishing and hunting tourism (2008).

County	Expenditures (millions) [1]
Coos	$3.5
Curry	$1.4
Douglas	$5.4
Josephine	$2.3
Total	$12.6

1/ Source: (Dean Runyan Associates, 2009). Values presented in 2008 dollars.

5.5.3 Current impacts

5.5.3.1. Recreation

There are several ways in which SOD could impact recreation and the value of recreation experiences to recreators. First, recreation areas may be closed to recreators if dead or dying trees pose a hazard, or if treatments are actively occurring. Second, recreation areas may be less scenic with dead or dying trees present in areas used by recreators. Third, if fish or wildlife populations decline because of SOD adversely affecting their habitats, then hunting, fishing, or wildlife-viewing recreation may also be adversely affected. All of these changes may result in reduced quality of recreation (thereby reducing recreator enjoyment per recreation visit), or if severe enough, may result in reduced quantity of recreation through fewer recreation visits. Changes in recreation quality and/or recreation visitation translate into changes total recreation value. For example, regarding recreation quality, survey research indicates that hunters may be willing to pay between $82 and $278 per hunting trip to improve their chances of harvesting more deer (Livengood, 1983; Keith & Lyon, 1985; Loomis, Griffin, Wu, & Gonzalez-Caban, 2002; Schwabe, Schuhmann, Boyd, & Doroodian, 2001).[21] Similarly, anglers may be willing to pay $47 and $345 per day to improve fish populations and the associated chances of a successful catch (Dalton, Bastian, Jacobs, & Wesche, 1998; Loomis, 2006).[22]

Table 29 shows average economic value of participating in recreation activities, specific to recreators along the west coast (Oregon, Washington, California), collected in a study conducted for the US Forest Service (Loomis, 2005). These values (often referred to as consumer surplus values in the economic literature) represent the net benefit of a recreation day to the recreator, and equal the total value of the recreation day to the recreator, less any costs. For example, if a recreator valued a day angling on the Chetco River at $100, but paid $40 in travel costs, then his or her economic benefit from the experience is $60 = $100 - $40. These per day recreation values indicate the reduced economic value per person day that would result from any decreases in recreation visitation resulting from SOD (Table 29).

[21] Values were adjusted from their original estimates to 2018 dollars using the Consumer Price Index.
[22] Values were adjusted from their original estimates to 2018 dollars using the Consumer Price Index.

Table 29. Estimated average economic value for common recreation activities.

Recreation Activity	Number of Studies	Value Per Person Per Day		
		Low	High	Average
Fishing	15	$6	$138	$59
Hiking	49	$1	$172	$31
Hunting	18	$8	$148	$61
Mountain biking	16	$42	$105	$66
Off-road vehicle driving	1	$54	$54	$54
Sightseeing	4	$7	$81	$27
General Recreation	9	$2	$167	$43

Source: (Loomis, 2005)

US Forest Service managers believe that SOD has had little-to-no impact on recreation thus far (George, 2018). This is likely because areas with the highest level of SOD infestation are not heavily used by recreators (Bounds, 2018). The backcountry trails that support forest recreation (such as hiking and OHV riding) are challenging and not well-maintained, and use is primarily limited to a small number of local users who are minimally impacted by SOD (Burris, 2018). Because of this, SOD has likely not noticeably changed the available recreation opportunities or quality of recreation. While some local residents speculate that deer populations may have declined in part due to SOD impacts, there has been no reduced demand for hunting permits or lower rates of success for hunters (Boice, 2018; Riddle, 2018). No local interviews indicated that SOD was impacting angling.

In the southwest Oregon hunting region (which includes each of the four counties of interest), hunters of elk and deer totaled nearly 9,100 in 2017 (Oregon Department of Fish & Wildlife, 2018). While these permitting and tourism value represented by these hunters is not equivalent to the value lost from diminished chances of harvesting game that might be caused by SOD, it does provide some context for potential losses in hunting and fishing value due to SOD impacts.

5.5.3.2. Tourism

Similar to recreation, SOD has the potential to negatively impact tourism. First, it could decrease the area's appeal to tourists by detracting from its natural beauty. Large numbers of dead trees and clear-cut areas area aesthetically displeasing, and tourists may be less likely to visit an area with reduced attractiveness (Cribbins, 2018). Such a change could affect the number of non-local visitors that come to recreate in the area's scenic areas and forests.

Another way SOD could reduce tourism is by impeding tourist activities. For example, SOD-affected trees could fall onto trails and disrupt tourist access. While blocking hiking trails pose less of an obstacle, a blocked mountain bike OR OHV trail could cause significant disruption and possibly injury. If this became a common occurrence in the area, its reputation as a recreation destination could suffer and tourism could fall. Such a change could harm Coos County's recent

$500,000 investment into a new mountain biking trail or Curry County's recent efforts to expand its trail network aimed at encouraging tourism (Cribbins, 2018; Burris, 2018).

SOD could also harm tourism through its impacts on wildlife, primarily fish but to a lesser extent terrestrial game animals. By increasing sedimentation in streams, SOD could reduce fish populations.[23] This could weaken tourism in the area as anglers choose to visit other areas with higher fish populations and a greater chance of successfully catching fish. This would be detrimental to guiding services in areas that see a large amount of sport fishing tourism, such as around the Rogue River in Curry County.

According to interviews with local tourism establishments and leaders, there appears to be no noticeable impact to tourism from SOD (Boice, 2018; Lacey, 2018; Popoff, 2018). Local experts state that SOD has generally not impacted popular tourist destinations enough to be noticeable by the public (such as coastal beaches) (Boice, 2018; Lacey, 2018). However, they acknowledge there is potential for SOD to have up to a moderate impact on tourism in the future by degrading the aesthetic quality of the region's scenic areas and by reducing fish populations (Burris, 2018; Lacey, 2018).

5.5.4 Future impacts

The way SOD impacts tourism in the future should correspond to the mechanisms of impact operating in the present. We distinguish a 'regional character' impact from a particular physical impacts like the potential link between SOD, fish populations, and the angling tourism industry. Curry County and surrounding counties are still broadly attractive recreation and tourism destinations today, but as the SOD-impacted areas proliferate, the regional character could shift toward being viewed unfavorably for recreation. This public perception is difficult to quantify even if area-based model results, such as might become available later in 2019, were available at present. The situation parallels that of timber exports: a real possibility exists for a future shift related to SOD that could have a substantial impact, but the tipping point for this shift is not clear. For recreation and tourism, we may suppose that some threshold of SOD infestation would trigger a reaction of intolerance and render the region disagreeable for recreation purposes, but that threshold is difficult to define in principle or to derive from our surveys of attitudes about the current GIA. In practice, public perception is capricious and adaptable. Recreation and tourism may be more substantially impacted by the ultimate extent of regional wildfire. SOD may contribute to fires because dead material is more inflammable, but wildfire is driven by anthropogenic ignition events (see §5.7) and summer season tanoak forest cover is readily combustible even when alive. Wildfire impacts could be a far stronger determinant of regional recreation and tourism levels in the future, and the influence SOD may have on wildfire behavior is an open question.

[23] For a further description of this connection, see the section on wildlife and habitat.

5.6 Ecological effects of SOD

Tanoaks, the primary species of tree killed by SOD, are an important part of the ecological system in southwest Oregon and northwest California. Tanoaks provide habitat and a food source (acorns) for numerous species, including deer, elk, bears, squirrels, chipmunks and fishers (Timchak, 2018; Burris, 2018; Schmierer, 2018; Becker, 2018). Tanoaks also indirectly support a number of threatened and endangered species. By providing food and habitat to small mammals, the tanoaks support the prey of the Northern spotted owl, a species listed as threatened under the Endangered Species Act (ESA). By providing shade and cooling stream temperatures, tanoaks in riparian areas support another federally-protected species, Coho salmon (Bounds, 2018).

The social context for economic valuation of ecological processes

People value fish and wildlife for many different uses and reasons, from personal use (i.e. enjoying hunting, fishing, or viewing the species and/or its habitat), personal beliefs and moral ethics (i.e. believe protecting a species and its habitat is the right thing to do), altruism (i.e. believing a resource should be protected so that others can use it or benefit from it), to a desire to bequest the resource (i.e. believing a resource should be protected for future generations). The most common way to measure the dollar value of species and habitat conservation is through surveys in which people are asked about their willingness to pay to protect a species or habitat. These surveys are highly challenging to develop and implement well, and results from different surveys aiming to measure similar changes in resources can be highly variable. However, results from these surveys indicate that to protect various threatened types of forest (high elevation forests, old-growth forests, etc.), households may be willing to pay, on average, in the range of $28 to $380 per household per year ((Walsh, Loomis, & Gillman, 1984) (Hjerpe, Hussain, & Phillips, 2015) (Kramer, Holmes, & Haefele, 2003) (Meldrum, Champ, & Bond, 2010) (Gerber-Yonts, Kerkvliet, & Johnson, 2004).

5.6.1 Current SOD ecological impacts

To identify a full list of wildlife species most likely to be associated with tanoak, we identified the two main southwest Oregon wildlife habitat types that include tanoak as a component of the vegetation community[24]: Southwest Oregon Mixed Conifer-Hardwood Forest and Westside Lowland Conifer-Hardwood Forest. Southwest Oregon Mixed Conifer-Hardwood Forest is the only wildlife habitat that specifically includes tanoak as a key component of its vegetation

[24] Specifically, to identify overlap, we overlaid the geographic study area with wildlife habitat relationship polygons (WHR Wildlife Habitats) following Johnson & O'Neil (2001), and the most current vegetation inventory data (https://lemma.forestry.oregonstate.edu/). Agriculture, Pasture, and Mixed Environments as well as *Ceanothus*-Manzanita Shrublands were also habitat types that overlapped with tanoak, but the area in each of these habitat is quite small compared to the other two habitat types noted.

community. Westside Lowland Conifer-Hardwood Forest is common in Oregon, and in the southwest part of the state it is found in the Coast Range where it often occurs adjacent to the Southwest Oregon Mixed Conifer-Hardwood Forest. This habitat type does not specifically include tanoak as a characteristic species. The habitat type maintains a complex and diverse understory and its early seral stages can be dominated by vigorous deciduous species. Tanoak is most likely a component of the early-seral vegetation stages.

Species that are potentially economically important due to their status as game species or furbearers, and that are closely or generally associated with either Westside Lowland Conifer-Hardwood Forest or Southwest Oregon Mixed Conifer-Hardwood Forest include an assortment of mammals and birds (Table 30).

Table 30. Animal species present in southwest Oregon that depend in some way on the tanoak ecosystem.

Order	Functional Group	Common names	Scientific names
Mammals	Predator	• Coyote • American black bear • Mountain lion • Bobcat • Gray fox	• *Canis latrans* • *Ursus americanus* • *Puma concolor* • *Lynx rufus* • *Urocyon cinereoargenteus*
	Ungulate	• Roosevelt elk • Black-tailed deer	• *Cervus elaphus* • *Odocoileus hemionus columbianus*
	Fur-bearing / small	• American beaver • Raccoon • Western gray squirrel • Mink	• *Castor canadensis* • *Procyon lotor* • *Sciurus griseus* • *Mustela vison*
Birds	Game	• Wild turkey • California quail • Ruffed grouse • Blue grouse • Mountain quail	• *Meleagris gallopavo* • *Callipepla californica* • *Bonasa umbellus* • *Dendragapus fuliginosus* • *Oreortyx pictus*

Tanoak is an ecologically important species, as a key food source and habitat component. Estimates vary for the exact number of species reliant on tanoak, ranging from at least 38 (Barret 1980) to "nearly" 100 species (Clark 1992). Since acorns are dropped in late summer and fall, they are thought to be a critical resource for deer (*Odocolileus* spp.) and black bear (*Ursus americanus*) (Bowcutt 2014 and McDonald and Huber 1995). For example, tanoak mast was present in 33% of bear scat collected on the Hoopa Valley Reservation (Matthews et al. 2008 and Hoopa Valley Tribal Forest, Hoopa, California, USA, unpublished data). Tanoak acorns are also consumed by

wild turkey (*Meleagris gallopavo*) and raccoon (*Procyon lotor*), and mule deer (*O. hemionus*) browse the leaves as well as mast (Bowcutt 2014 and Fryer 2008). Generally however, there remains a dearth of studies quantifying the importance of tanoak acorns in the diets of economically important game species such as deer and elk. Deer and elk feed on numerous plant species depending on their specific range and behavioral habitat use patterns, the effects of the disturbance pattern (e.g. forest management or wildfire) and the resulting available vegetation community (Innes 2013, Innes 2011). This ability to use a wide range of food resources is likely to reduce the impact of tanoak absence in SOD infected stands.

The loss of tanoak due to SOD could affect the prey species base for predatory species of special concern. Tanoak acorns and symbiotic ectomycorrhizal fungi on its roots are consumed by dusky-footed woodrats (*Neotoma fuscipes*), Northern flying squirrels (*Glaucomys sabrinus*), and Allen's chipmunks (*Neotamias senex*) (Fryer 2008 and Raphael 1987). These rodents also commonly nest in tanoaks. These species are important prey items for several predators of concern, such as the northern spotted owl (*Strix occidentalis caurina*), cougar (*Puma concolor*), coyote (*Canis latrans*), and Pacific fisher (*Martes pennant*) (Bowcutt 2014 and Raphael 1987). Although the extent of the potential impact is difficult to determine, SOD removal of tanoak from a system could affect individuals of species that rely on prey species known to utilize tanoak, if tanoak death significantly affects the prey population base.

Interviews with local experts suggest that perceptions of the impacts of SOD on wildlife to date are uncertain. While stating that no one currently knows exactly which species have been impacted and how, most speculate that SOD alone has had a relatively minor impact on wildlife so far, and that any substantial impacts have been limited to the most heavily-infected areas (i.e. the GIA) (Timchak, 2018; Bounds, 2018). Short-term impacts are more likely to arise from procedures used to treat the disease rather than from the disease itself (Becker, 2018; Bounds, 2018), although long-term impacts would be roughly comparable, because tanoaks would no longer be present whether treated or untreated.

Within the GIA, interviews with natural resource managers suggest that the impacts to wildlife may be higher, especially when coupled with other ecological stresses, such as the recent wildfires, climate change, droughts, and disease (Timchak, 2018; Bounds, 2018; Burris, 2018; Becker, 2018). Many of the tanoaks in this area have reportedly died, removing an important source of food, which may be contributing to lower deer populations and poor health in species that rely on the tanoak acorns (Burris, 2018; Riddle, 2018; Boice, 2018; Timchak, 2018). Elk, chipmunks, squirrels, salamanders, and snakes are also speculated to be suffering from the tanoak mortality. Animals that depend on tanoak and are able to move to other areas are likely to have done so, escaping some impacts, while species that have small home ranges are more likely to have suffered under the changes (Burris, 2018; Bounds, 2018).

5.6.2 Future impacts

As SOD spreads to other areas, local experts expect its effects on wildlife to worsen in southwest Oregon. The further loss of tanoaks, both from the disease and from treatment efforts, is expected to cause additional loss and degradation of habitat (Bounds, 2018; Burris, 2018). This is expected to result in the disappearance of foraging sites, which will have detrimental impacts on wildlife and their offspring, cause population declines in some species, and force others to move out of the area (Timchak, 2018; Bounds, 2018; Burris, 2018). Impacts to prey species, such as mice, chipmunks, and squirrels, could result in impacts on predator species, such as the Northern spotted owl (Bounds, 2018; Becker, 2018).

Interviewees expect that the loss of tanoaks will impact more than just acorn-eating species; it is also expected to harm fish, although the mechanism of impact has not been specifically studied. Tree roots play an important role in stabilizing soils, so when there is a large die-off of trees and roots decompose, soils are transported more easily and can increase sedimentation in streams. This phenomenon has been observed after a severe wildfire burns an area. Where tanoak dies but is not treated, some amount of regrowth is observed, so total loss of root stabilizing effect would be unlikely. Where treatments are applied and reforestation is unsuccessful, however, similar effects to wildfire may occur (Schmierer, 2018; Bounds, 2018). Because much of southwest Oregon consists of steep terrain, the area is especially prone to sediment runoff (Burris, 2018).

Increased sedimentation in streams degrades water quality and can harm fish populations by damaging gills, impeding feeding, and disrupting reproductive processes (Burris, 2018). Where riparian tanoaks are lost to SOD, the result may be an increase in stream temperatures, degrading fish habitat that already experiences overly-warm temperatures in some years (Bounds, 2018; Becker, 2018). The combined impacts of sedimentation and loss of riparian shade trees causes concern for important fish species such as Coho salmon, which is present in the area, including in the Bravo Creek watershed that lies within the GIA. While SOD offers the potential to bring negative impacts to streams, the harm could be mitigated by replanting affected areas, as has been done in the past with success (Bounds, 2018; Burris, 2018). Opposing or neutral outcomes are also possible. Fallen dead tanoak in streams constitutes large wood debris could serve as secure habitat for fish. Temperature change from standing dead riparian trees is not conclusively tied to increased stream temperature, and regenerating trees after SOD outbreak could replace dead or dying tanoak canopy and mitigate stream impacts.

In the long-term, a shift in forest structure and composition is expected after the SOD infestation reaches is maximum extent, transforming forests in the area from a broadleaf-dominated ecosystem to a conifer-dominated one. While the timeline of this transition is uncertain, one estimate puts it at 50 years (Burris, 2018; Bounds, 2018). As tanoaks die and are removed, other trees will move into the spaces they left behind. Some of these may be conifers or other oak species that are unaffected by SOD, such as the Oregon white oak. While the white oak also produces acorns, it is unlikely to be able to fulfill tanoak's role in the ecosystem. White oaks are shade-intolerant and are typically out-competed by Douglas-fir for sunlight, and do not grow well

or produce large nuts under shade conditions (Burris, 2018). The loss of diversity, both from tanoaks and the species they support, are expected to degrade forest health and convert tanoak forests from high-quality to low-quality habitat (Schmierer, 2018; Burris, 2018).

Although by no means guaranteed, a potential outcome of SOD could be local extirpation or regional extinction of tanoak-obligate species, such as squirrels and other small mammals. Biodiversity loss, or compromise of ecosystem services, is often difficult to quantify in clear economic terms.

Climate change may also mediate impacts of SOD, either in positive or negative ways. Climate across the American West is projected to become both drier and warmer for the next 50 years. Dry, warm conditions reduce the spread of SOD, so climate change could in fact slow the spread of the disease. The same climate projections also predict an increase in extreme weather events, however, including the kinds of winter storms with high winds and heavy rainfall that are thought to increase the incidence of long-distance SOD dispersal events. Thus, climate change may both more rapidly expand SOD infestation areas, while at the same time reducing the severity of infestations where they do occur.

5.7 Wildfire risk

A key concern regarding SOD voiced during interviews with local leaders and SOD experts is potential increased wildfire risk associated with stands of dead trees and dry wood (Robison, 2018; Ford, 2018; Christensen, 2018; Amrhein, 2018; George, 2018; Schmierer, 2018; Riddle, 2018; Kentta, 2018; Knoblach, 2018). While this analysis does not quantify the increased wildlife risk posed by current or future spread of SOD, this section identifies the types of costs imposed by wildfires.

There are numerous economic costs of wildfires. Wildfire can take lives, destroy homes, and damage infrastructure, including highways, airports, and railroads, which require new funding to repair. Businesses lose revenue when fires hamper consumer access or disrupt supply lines. Evacuations cost money for those who have to flee the fire (both in terms of time and money expended), and cost government entities that support the evacuation effort. Injuries resulting from the fire impose healthcare costs, suffering, and lost wages. Post-fire impacts (including flooding and erosion) can harm both human systems (i.e. property and infrastructure) and ecosystems (Western Forestry Leadership Coalition, 2010). Recreation in fire-damaged areas can be suspended or reduced in quality, which can reduce recreation opportunities and value.

Wildfires are also costly to fight. In 2017, the ODF spent $39 million to fight wildfire on more than 47,000 acres, for an average of $1,150 per acre (Oregon Department of Forestry, 2018).[25] From 1985 to 2017, federal agencies spent over $43 billion to fight wildfires on roughly 10 million acres (National Interagency Fire Center, 2018).[26] This averages out to approximately $250 in suppression costs for every acre burned.

Fires also can result in a reduction in aesthetics and amenities that is associated with a decline in property values. Loomis (2004) examined the impact of a wildfire on home values in Colorado. The results showed that property values in a nearby town dropped roughly 15% within five years after the fire. While the price declines could be attributable to the perception of wildfire risk, the author theorizes that the declines could reflect the loss of amenities in the burned area (Loomis, 2004). Similarly, a study of properties in Montana indicated that proximity to and view of areas burned by wildfire had large and persistent negative effects on home values (Stetler, Venn, & Calkin, 2010). Homes within five kilometers (km) of a wildfire were about 14% lower than equivalent homes at least 12 miles from a fire, and homes three to six miles away were around 8% lower. The results also showed that when a nearby burned area was not visible from a home, it had no effect on a home's value.

The tourism economy can also decline due to wildfires. A recent study examined the impacts of the 2017 wildfire season on the 2018 Oregon tourism economy. Approximately 1.2 million acres burned across the state in that year, which the study estimated to result in a $51.5-million loss

[25] Annual costs for each year were adjusted for inflation to 2018 dollars using the Consumer Price Index.
[26] Annual costs for each year were adjusted for inflation to 2018 dollars using the Consumer Price Index.

in visitor spending and a $16-million loss in earnings in 2017 (Dean Runyan Associates, Inc., 2018). Of these losses, the Chetco Bar fire, which was almost entirely in Curry County, burned over 191,000 acres. This fire was estimated to reduce tourism spending in the area by roughly $5 million, with an associated reduction in earnings of $1.28 million (Dean Runyan Associates, Inc., 2018). This translates into nearly $7 per acre burned of reduced local earnings in the year of the fire. The potential future economic impacts related to tourism were assessed using surveys of local businesses and organizations. Nearly half of survey respondents indicated that they believe that wildfires will have an adverse effect on their business in 2018, primarily because their area will have less appeal to visitors. More than 30% of respondents reported that they believe their organization will lose future revenue because the fire reduced the scenic appeal of the area.

5.8 Subsistence

Many local residents of southwest Oregon hunt, with the meat from game animals serving as a key food source for their household. This low-cost source of meat is important to an area with a significant number of low-income and retiree households (Burris, 2018). If changes in habitat and food availability due to SOD were to adversely affect the population of game species, SOD has the potential to diminish the ability of local residents to rely on hunting for subsistence food. This could result in locals having to purchase more of their food, which can put a strain on household budgets. Further, declines in big game populations may also lead to regulatory measures (such as limits in the number of hunting permits) that could further restrict hunting in order to protect dwindling species populations (Timchak, 2018).

As noted above, there is no evidence that either animal populations or hunting success to date has diminished as a result of SOD. We therefore expect that there are little to no impacts on subsistence values. Even with widespread SOD, we do not necessarily expect that SOD will cause large game species to decline. Deer and elk can feed on a variety of vegetation species (Innes 2013, Innes 2011). Because these species have versatile diets, the loss of acorns associated with SOD is less likely to impact their presence and population.

If SOD were to reduce deer and elk populations in the region, some hunters that used to rely on harvested venison and elk meat to supplement their diets might begin to rely more on purchased meat. A 140-lb mature doe will provide roughly 50 pounds of meat (Schmidt, 2000). Assuming that a hunter would replace venison by purchasing a mix of ground beef, pork chops, and chicken breast at an average price of $3.30 per pound, the cost of purchasing meat to replace subsistence meat from a doe would be roughly $165.[27]

[27] In September 2018, the average retail price for ground beef, pork chops, and boneless chicken breast in U.S. cities were $3.743, $3.289, and $2.896 per pound, respectively **Invalid source specified.**.

6.0 CONCLUSIONS

Overview

This report investigates current economic impacts of Sudden Oak Death (SOD, *Phytophthora ramorum*) in Curry County, Oregon, through the end of 2018, and potential future economic impacts through 2038. The disease affects primarily tanoak (*Notholithocarpus densiflorus*), but also several genera of common native plants, and species important to the nursery industry. Potential economic impacts of SOD on the timber industry could include a reduction in annual harvest volume of tanoak, changes in logistics of harvesting commercial conifer species, regulatory or policy decisions related to SOD, and implications for international timber exports. Non-timber economic impacts from SOD may include potential impact to tribal cultural values, regional property value and aesthetics, public safety hazards, recreation, and tourism. This report does not address impacts of SOD on the nursery industry.

Economic impacts from SOD on the timber industry beyond 2018 are anticipated using a model of potential future disease dispersal to Coos, Douglas, and Josephine Counties under three alternative scenarios of disease-related forest management: continuing current practice, halting all management, and accelerating strategic management of certain disease strains. The report briefly reviews SOD pathology and epidemiology, introduction and northward migration from California, and the present state of mechanistic disease expansion modeling research. A mechanistic SOD expansion model is under construction by researchers at North Carolina State University (NCSU). This report is designed so that economic impacts, both to the timber industry and non-timber concerns, may be easily updated when NCSU results are available. The geographic extent of SOD expansion from 2018 through 2038 for the current report is based on empirical measurements of SOD dispersal rates across landscapes with varying levels of tanoak forest cover. Economic impacts to the regional timber industry presented in this report may be recalculated using future versions of SOD epidemiological models or observational data, and can be revised with new economic data as those become available.

Timber industry impacts of SOD

Through 2018, SOD has neither directly nor indirectly impacted the timber industry in Curry County to a measurable extent. The principal ways SOD could have negative effects on the timber industry are direct impacts (loss of timber volume), regulatory impacts (reduced profitability due to newly imposed regulations), or market impacts (chiefly loss of access to export markets). Representatives of the timber industry in Curry County do report a minor reduction in the volume of tanoak being trucked out of the county destined for Coos County and fiber processors around the Port of Coos Bay. A reduction in tanoak volume, however, has not translated to a loss of jobs, wages, or profitability. Margins for tanoak fiber are narrow, with the product sometimes shipped at a loss. Any reductions to tanoak fiber volume caused either by diseased material being forbidden from leaving Curry County, or by industrial land managers deciding to forego fiber shipments due to permitting requirements have not impacted regional fiber exports to date.

Oregon State University and US Forest Service expert pathologists were consulted during preparation of this report. The pathologists confirmed that there are two strains of SOD in Oregon, the NA1 and the EU1. They further confirmed that the EU1 strain is a more aggressive form of the disease, with the potential to produce up to an order of magnitude more spores per unit of infected tanoak leaf area. One important point of confusion has propagated through the press about SOD: although both NA1 and EU1 may infect the Douglas-fir (*Pseudotsuga menziesii*) seedlings, either strain does so only when Douglas-fir seedlings grow directly under heavily infested mature tanoak canopy. In a vast majority of ecologically and economically important forests, Douglas-fir seedlings do not grow where they may be affected by an infested tanoak canopy. The ecological ranges of the two species are sufficiently separate that any widespread infection of Douglas-fir by SOD is unlikely. This report makes no attempt to speculate about future mutations to SOD that might alter its interaction with Douglas-fir or other economically important conifer species.

Looking to the future, when SOD will likely expand across southwest Oregon, contacts at the Oregon Department of Forestry explain that policies directed toward SOD eradication will undergo a series of predictable changes. First, an existing quarantine zone will expand to encompass all of Curry County when/if SOD disperses to the north of the Rogue River, which represents the current northern extent of the SOD quarantine zone. After this point, permits for movement of tanoak fiber will be required throughout Curry County, regardless of whether the material originates near a known SOD infestation. This report presents a range of dates when the quarantine may expand beyond the Rogue River boundary. Currently, the ODF provides tanoak disease-free certification as a free service to timber producers in Curry County. Once the quarantine expands to the whole county, however, the SOD program will be overseen by the ODA and ODF, and permits will become a fee service.

Beyond the next quarantine expansion, should SOD travel into Coos, Douglas, or Josephine Counties, a similar quarantine would be set up across the range of tanoak in those counties. By that point, the permitting process would apply to all tanoak as well as any commercial conifer timber harvested in the quarantine zone within a quarter mile of any SOD-infested tanoak trees. Timber transportation permits relating to SOD would be processed by ODA. This report does not investigate economic impacts to the nursery industry, or to any botanical industries aside from commercial timber. Representatives from several industrial timberland owners, processors, and export establishments were interviewed to catalog their expectations regarding future SOD impacts. Throughout the report, we present concrete numeric values of timber industry economic impacts where possible, but we maintain confidentiality of industry sources.

Whereas SOD has had no consequential economic impact on the timber industry through December 2018, industry contacts identify concerns about an array of future impacts. All industry contacts expressed limited concern for permitting requirements that might be imposed by ODA as quarantine expands. These permits are a trivial expense relative to the costs of timber harvest, and do not threaten the profitability of operations or appear to cause logistical problems. Most

industry contacts focus on loss of market share as the principal concern, specifically reduced access to Asian timber markets—China, Japan, and Korea. Most contacts agreed that the threat from SOD would not likely take the form of requirements for log treatment (washing, fumigation), but rather that one or more of the major importers could decide to halt all timber purchases from southern Oregon in order to reduce their exposure to SOD transmission. All of the major destination countries could substitute timber from other sources with little difficulty. Inaccessible export markets as a consequence of SOD expansion could mean near-total shut down of export activities, primarily in Coos County. Discussions with the PoCB and representatives of industrial timberlands lead to the conclusion that the threat of SOD-related export sanctions is real. It is beyond the scope of this report to estimate the probability that any one of the major importing countries will make such a decision. Rather, we present the economic impact to the timber industry that would likely emerge as a result of export sanctions by a major foreign nation.

Extrapolating based on observed prior rates of dispersal, SOD could expand to Coos County as soon as 2028 if ODF halts SOD treatments, whereas SOD might remain within Curry County through 2038 if ODF continues treatments. Industry contacts make the case that major foreign timber importers could respond with sanctions on timber from southwest Oregon if SOD breaches Coos County; sanctions by a major foreign timber importer could threaten timber exports from the Port of Coos Bay (PoCB). Outcomes would be binary: without SOD-related sanctions, the PoCB could continue operations at present levels, whereas with major sanctions the port would be unable to adjust to the lost volume increment and would shut down. If timber exports from the PoCB cease in 2028, the regional forest sector could lose 1,182 jobs and $58 million in annual wage, or $580 million in wages over the subsequent decade.

Treating SOD costs approximately $1.5 million each year, received by ODF from the USFS emergency fund. Treatment is a labor-intensive process, so much of that $1.5 million annual sum is paid toward forest sector wages in Curry and Coos Counties, where the current treatment contractors are based. Continued SOD treatments could sustain $580 million in export-related wages from 2028 to 2038, enable export of 174 MMbf of timber from Coos Bay each year, and secure federal funding of $30 million for treatment, much of that sum going toward wages for local contractors. To maintain confidentiality, we cannot report the fraction of SOD treatment funding allocated to wages versus other costs of implementing the treatments. It goes beyond the scope of this report to quantify the probability of total loss of export market access, or to estimate other existential threats to exports commerce, e.g. tariffs, international trade developments, or major wildfire events.

Non-timber impacts of SOD

With the current level of spread of SOD, the potential non-timber economic costs of SOD are expected to include cultural impacts to tribes, adverse impacts on aesthetics and related private

property values, increased public safety risk, and increased wildfire risk.[28] There may also be potential adverse impacts on tourism, recreation, and subsistence hunting/fishing values (due to changes in aesthetics, fish and wildlife populations, or access to recreation areas); however, there is little evidence that these types of impacts on tourism/recreation/subsistence are currently being experienced. Local fish and wildlife experts indicated that SOD-related impacts on fish and wildlife population are relatively minor (with the potential exception of wildlife with small home ranges within the GIA), and local recreation experts similarly did not see evidence of measurable impacts on recreation and tourism value due to SOD. The bullets below summarize the potential current impacts of SOD on cultural values, aesthetics, public safety, and wildfire.

- **Cultural Values:** SOD infestations in northern California and southwest Oregon could potentially affect the cultural values and traditions of many local tribes, including the Siletz, Tolowa Dee-ni' Nation, Coquille, and Cow Creek Band of Umpqua, among other tribes. To date, only one tribe, the Siletz, identified impacts of SOD as high; other tribes identified minor or little to no impacts. Infected or dead stands of tanoaks adversely affect cultural practices due to the change in aesthetics, change or limitation to harvesting practices to limit transmission of SOD, and a reduced trading of resources between tribes. Affected cultural traditions may include: acorn collection and use for traditional foods, plant collection for basket-weaving, and hunting and fishing of culturally important fish and wildlife species.

- **Aesthetics:** Widespread die-offs of tanoak trees or cutting and burning treatment practices can negatively impact aesthetics. The types of land uses (and associated users) that are most sensitive to changes in aesthetics include: residential, commercial, recreation, and high-use public spaces such as roads and other public facilities. Residential land owners in particular are often sensitive to changes in aesthetics on or near their properties, and this is reflected in changes in property values when aesthetics change. Interviews with OSU extension agents, real estate agents, and others in Curry County indicate that property in SOD-infected areas has become less desirable due to SOD, and that property values have likely declined as a result of SOD, potentially in the range of 5% - 6% (Burris, 2018; Riddle, 2018; Kennedy, 2018).

  Assuming a 5% decrease in the home and land value for residential tax lots infected by SOD would indicate that the impact to homeowners (aesthetic and nuisance value) of SOD may be approximately $8.2 million ($2.6 million impact to home value and $5.6 million for land value associated with the dwellings). This value is likely an underestimate as it does not include impacts to others in the area who are adversely affected by the

[28] Per the scope of work for this analysis, this section does not address the (potentially high) economic costs of SOD to nurseries, which must comply with the USDA confirmed nursery protocol if SOD is detected in their plant material.

aesthetics of SOD-infected trees. It also does not include impacts to surrounding homes that may not be infected but that have adverse aesthetic effects from views of SOD-infected lands. In particular, residential properties within 3/10 of a mile may have adverse effects, based on research conducted on SOD-infections in Marin County, California. If the 18,300 acres of surrounding but uninfected lands had residential property value per acre similar to the value of infected lands, and if these properties also experienced a 5% decrease in value, the total potential impact to homeowners of surrounding lands could be approximately $57.4 million. However, it is important to note that the past research in Marin County found that adverse impacts on property value of SOD were short term, with property values rebounding after dead tree, even without replanting new trees.

- **Public Safety:** To date, interviews with local officials have not identified any known injuries due to downed or falling trees. There does not appear to be a consensus regarding SOD's current impact on public safety; some local experts show great concern while others do not foresee major safety issues arising even if SOD spreads. Dead trees can pose a safety risk or a disruption of transportation/access if trees fall on roads, buildings, recreation areas, etc., and removal costs are a cost to public agencies and homeowners. On private lands, without government assistance to cover the costs of tree removal, many homeowners in the area cannot afford to have SOD-affected trees on their property removed, which can result in a hazard for the property owners and their homes (Roberts, 2018; Mitchell, 2018). Among the concerns regarding public safety risk of SOD are that dead trees could fall on electrical lines and cause a wildfire. The need to remove SOD-killed trees has taken time away from trimming non-diseased trees that encroach on power lines, increasing the danger of normal trees damaging power infrastructure and starting wildfires (Mitchell, 2018). A large number of residences in the area have only a single, narrow road for access. As a result, downed tree has the potential to not only start a wildfire, but trap residents within it (Riddle, 2018).

- **Wildfire:** A key concern regarding SOD voiced during interviews with local leaders and SOD experts is potential increased wildfire risk associated with stands of dead trees and dry wood (Robison, 2018; Ford, 2018; Christensen, 2018; Amrhein, 2018; George, 2018; Schmierer, 2018; Riddle, 2018; Kentta, 2018; Knoblach, 2018). Historically, tanoak forests experienced a fire return interval averaging 15 to 35 years, with tanoak re-sprouting vigorously after top kill. These forests are susceptible to wildfire even without SOD, and the current delayed fire return interval is principally a result of active management. Regionally, wildfire frequency and severity are driven by multiplying anthropogenic ignition events and fuel continuity resulting from fire universal suppression policies. In cases where dead tanoak trees are close to individual structures, SOD may magnify wildfire outcomes. Policies of fire suppression, more frequent ignition events, and drought are substantially stronger drivers of wildfire.

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8.0 APPENDIX

8.1 Quarantine Definition

603-052-1230

Quarantine: *Phytophthora ramorum*

(1) Establishing a quarantine: A quarantine is established against Phytophthora ramorum, the cause of sudden oak death and other plant diseases. This quarantine is established under ORS 561.510 and 561.540 to protect Oregon's agricultural industries and natural resources from the artificial spread of P. ramorum. This pathogen causes mortality in susceptible oak (Quercus spp.), tanoak (Notholithocarpus densiflorus syn. Lithocarpus densiflorus), rhododendron (Rhododendron spp.), viburnum (Viburnum spp.), evergreen huckleberry (Vaccinium ovatum), and other plant species. In other susceptible plants it causes leaf spots, twig dieback and/or stem cankers. Methods for exclusion of commodities potentially infected with this disease and procedures for eradication of incipient infections are prescribed in this quarantine.
(2) Area under quarantine:
(a) The following counties in California: Alameda, Contra Costa, Humboldt, Lake, Marin, Mendocino, Monterey, Napa, San Francisco, San Mateo, Santa Clara, Santa Cruz, Solano, Sonoma, and Trinity;
(b) The following portion of Curry County that lies inside the area starting at the point where the mouth of the Rogue River meets the Pacific Ocean and continuing east along the Rogue River to the northeast corner of T35S R12W section 31, then south to the northeast corner of T38S R12W section 18, then east to the northeast corner of T38S R12W section 13, then south to the northeast corner of T38S R12W section 25, then east to the northeast corner of T38S R11W section 29, then south to the northeast corner of T40S R11W section 8, then east to the northeast corner of T40S R11W section 10, then south to the state border with California, then west to the intersection of the Oregon/California state border with US Highway 101, and then northwest along US Highway 101 to the intersection with West Benham Lane and then west along West Benham Lane and continuing directly west to the Pacific Coastline; then following the coastline north-northwest back to the point of beginning;
(c) Any country, state, county, province or area covered by the federal Domestic Quarantine for Phytophthora ramorum, 7 CFR 301.92;
(d) Any property in Oregon where P. ramorum is found, including a buffer zone of up to three (3) miles surrounding the infested site during any eradication or containment program.
(3) The following definitions apply to ORS 603-052-1230:
(a) "Best management practices" is defined as any actions or activities that can be used to prevent or eliminate new
P. ramorum infections.

(b) "Disease-free area" means an area located more than one-quarter (1/4) mile from the generally infested area, or any other infested sites, which has been officially surveyed within the past 6-months and found free of P. ramorum.
(c) "Generally-infested area" means the area within the quarantine boundary where P. ramorum has been commonly found or in which there is reason to believe P. ramorum is

present because of the proximity, one-quarter (1/4) mile or less, to known infested sites. A map showing the generally infested area is available from the Oregon Department of Agriculture, http://www.oregon.gov/ODA/CID/PLANT_HEALTH/, 635 Capitol St. NE, Salem, OR 97301, telephone: 503-986-4620.

(d) "Hosts and associated plants" means plants on the USDA APHIS List of Regulated Hosts and Plants Proven or Associated with Phytophthora ramorum, effective date November 27, 2013.

NOTE: This list is available from the Oregon Department of Agriculture, 635 Capitol St. NE, Salem, OR 97301, telephone: 503-986-4644.

(e) "Infested site" is defined as the area within fifty (50) feet of one or more plants officially confirmed as infected with P. ramorum.

(f) "Treatment area" is defined as the area delimited by the Oregon Department of Agriculture (ODA) or an official cooperator in which treatments to eliminate or reduce P. ramorum inoculum and sources thereof is required or recommended. The treatment area may range from 50 to 300 or more feet from infected or symptomatic plants.

(g) "Type 1" is defined as an infested site(s) that because of its geographical location in relationship to other infested sites, surrounding flora, and based on the best available data on disease spread, is considered to be of highest risk for advancing further spread of P. ramorum into previously un-infested areas. By definition, Type 1 sites are typically located outside of the generally infested area.

(h) "Type 2" is defined as an infested site(s) that because of its geographical location in relationship to other infested sites, surrounding flora, and based on the best available epidemiological data on disease spread, is considered to be of less risk for advancing further spread of P. ramorum into previously un-infested areas. By definition, Type 2 sites are typically located inside of the generally infested area.

(i) "Non-commercial" is defined as any activity or entity that does not in some sense involve commerce, relative to similar activities that do have a commercial objective.

(j) "Nursery stock" is defined in ORS 571.005. Tissue culture plantlets in sealed, sterile containers are exempt from this regulation;

(4) Commodities regulated:

(a) All plants and plant parts of hosts and associated plants: Examples of regulated commodities include all portions of the plants including, but not limited to nursery stock, logs, bark, wood chips, mulch, firewood, sawdust, green waste, other plant products that contain bark or foliage;

(b) Any other plant found to be naturally infected with P. ramorum, any product or article that an official inspector determines to present a risk of spreading P. ramorum, and all life stages of P. ramorum.

(5) Provisions of the quarantine: Movement out of the quarantined area of regulated commodities originating from the area under quarantine, and any other area found to be infested with P. ramorum during the life of this quarantine, is prohibited unless one of the following requirements has been met:

(a) The regulated commodity meets the official treatment and certification requirements for interstate movement as defined in the federal domestic quarantine, 7 CFR 301.92. The regulated commodity must be accompanied by an official certificate that includes the

following additional declaration "The (type of covered commodity) from (name of county or other location identifier) has been treated for Phytophthora ramorum as required prior to shipment." As applicable, the specific requirements of the treatment must be recorded on the official certificate;

(b) Provisions for Douglas fir, grand fir, alder, and other non-hosts and non-bole hosts (as defined in 7 CFR 301.92) harvested within the quarantine area, including the generally-infested area. Logs and firewood of non-hosts and non- bole hosts are not regulated per 7 CFR 301.92 and can move freely within or outside the quarantine area. Soil, needles, foliage, and plant debris (including branches less than or equal to one (1) inch in diameter) must stay within the quarantine area.

(c) Provisions for tanoak logs and firewood harvested within the quarantine area.

(A) Tanoak logs and firewood - Intrastate. Tanoak logs and firewood may be shipped intrastate provided the logs were harvested from a disease-free area and the logs and firewood are safeguarded from contamination prior to shipment out of the quarantine area.

(B) Tanoak logs and firewood - Interstate. Tanoak logs and firewood may be shipped interstate provided the logs and firewood were harvested from a disease-free area, have been debarked according to federal requirements (see 7 CFR 301.92), and are accompanied by an official phytosanitary certificate verifying the debarking of the logs and firewood prior to shipment.

(C) Tanoak logs and firewood harvested within the generally-infested area are not eligible for movement outside of the quarantine area.

(d) Nursery stock grown in a quarantined county or area may be eligible for shipment to and within Oregon providing the nursery is part of an official certification program and has been inspected and tested as required by the federal domestic quarantine, 7 CFR 301.92, for P. ramorum. The official certificate must include the following additional declaration: "The (covered commodity) from (name of county or other location identifier) has met the Phytophthora ramorum quarantine requirements for shipment into and within Oregon."

NOTE: Recipients of tree and shrub nursery stock imported into the state must notify the ODA no later than two business days after its arrival as required by OAR 603-054-0027.

(e) Soil and potting media from the quarantine area at a known infested site or from within four (4) meters of an infected host plant must be sterilized before shipment. The soil or potting media must reach a minimum temperature of 50 degrees C (122 degrees F) for 30-minutes measured at the center of the mass of soil or potting media. Soil or potting media that has never been associated with the covered commodities is exempt. Treatments must be officially verified. The official certificate must include the following additional declaration "The (soil or potting media) from (name of county or other location identifier) has been treated for Phytophthora ramorum as required prior to shipment." The length and temperature of the treatment must be recorded on the official certificate.

(6) Infested properties in Oregon: Confirmation of a P. ramorum infection must be made by the ODA or an official cooperator. The required response depends on whether the infested site is of high priority (Type 1) or normal priority (Type 2) in terms of importance for slowing disease spread as determined by ODA or an official cooperator. The ODA or an official cooperator will notify the landowner when a Type 1 infested site has been detected on their property.

(a) Type 1 sites must be treated as quickly as possible in accordance with USDA APHIS's Official

Regulatory Protocol for Phytophthora ramorum Detections in Residential or Landscaped Commercial Settings, last revised January 15, 2013 or the USDA Forest Service, USDA APHIS, National Association of State Foresters, and National Plant Board's National Framework for Managing Sudden Oak Death caused by Phytophthora ramorum in Forests and Wildlands, October 2011. Subject to the availability of funds dedicated to the rapid treatment of P. ramorum infested sites, the cost of treatment will be borne by the State.

NOTE: These protocols are available from the Oregon Department of Agriculture, 635 Capitol St. NE, Salem, OR 97301, telephone: 503-986-4644. Affected property owners will be issued infestation and treatment area location and treatment requirements in the form of an Administrative Directive. For public and private forested lands, the Oregon Departments of Agriculture and Forestry (ODF) will work with the landowner to develop a treatment plan that will be based on the best available science. The treatment plan may include some or all of the following activities:

(A) Cutting and piling susceptible trees and shrubs;
(B) Burning the wood and plant debris when safe to do so;
(C) Herbicide treatment of stumps, standing trees, and sprouts;
(D) Fungicide application;
(E) Sampling and monitoring;
(F) Replanting with suitable plant species to meet landowner objectives and to prevent intensification and spread of the disease.

(b) On Type 2 sites disease suppression through the implementation of best management practices is encouraged. Subject to availability of funds dedicated to the suppression of P. ramorum in urban and forested environments, a cost-share program may be available through the ODF to help defray costs of implementing best management practices to suppress disease spread (Oregon Department of Forestry, 415 Redwood Street, Brookings, OR 97415, telephone: 541-469-5040). A landowner with a Type 2 site may, after consultation with the ODA and ODF, allow use of their infested site(s) for P. ramorum-related research by Oregon State University, ODF, or ODA. Trees killed by P. ramorum within an infected Type 2 treatment area may be used as firewood under the following conditions:

(A) The firewood from the infected tree(s) is for non-commercial use only;
(B) The firewood does not leave the generally-infested area or any other infested site outside of the generally- infested area.

NOTE: Best management practices for managing P. ramorum infestations within the generally infested area are available on the California Oak Mortality website, http://www.suddenoakdeath.org, or from the Oregon Department of Agriculture, 635 Capitol St. NE, Salem, OR 97301, telephone: 503-986-4644, or the Oregon Department of Forestry - Coos Bay, 63612 Fifth Road, Coos Bay, 97420, telephone: 541-267-4136.

(7) Infested nurseries in Oregon: Confirmation of a P. ramorum infestation must be made by the ODA or an official cooperator. Nurseries are required to eradicate the disease as quickly as possible in accordance with USDA APHIS's Official Regulatory Protocol for Nurseries Containing Plants Infected with Phytophthora ramorum Version 8.2, revised March 27, 2014. Infected nurseries must also notify their customers of shipments of high-risk nursery stock [Camellia, Kalmia, Pieris, Rhododendron (including Azalea), and Viburnum] to non-regulated

areas as required by the Federal Order for Phytophthora ramorum, (DA-2012-53, December 10, 2012). Nurseries from within the federally regulated area for P. ramorum (7 CFR 301.92) are subject to the following requirements:

(a) Nurseries from which P. ramorum has been detected in multiple growing seasons will be required to implement best management practices as described in USDA APHIS's official regulatory protocols for positive nurseries for the mitigation of Phytophthora disease in plants for planting. Alternatively, such nurseries may enter Oregon's Grower Assisted Inspection Program;

(b) Nurseries within the federally regulated area that ship interstate and from which P. ramorum has been detected since March 31, 2011, must comply with the requirements as described by the Federal Order Domestic Quarantine Phytophthora ramorum (DA-2014-02, January 10, 2014);

(c) Nurseries within the federally regulated area that do not ship interstate and from which P. ramorum has been detected since March 31, 2011, must be inspected annually as described in 7 CFR 301.92;

(d) Nurseries within the federally regulated area that ship interstate and from which P. ramorum has not been detected since March 31, 2011, must be inspected as described in ORS 571.145.

(e) Nurseries within the federally quarantined area must be inspected as described in 7 CFR 301.92.

NOTE: These best management practices and protocols and information about the GAIP for nurseries are available from the Oregon Department of Agriculture, 635 Capitol St. NE, Salem, OR 97301, telephone: 503-986-4644.

(8) Special permits: The Department, upon receipt of an application in writing, may issue a special permit allowing movement into this state, or movement within this state, of regulated commodities not otherwise eligible for

movement under the provisions of this quarantine order. Movement of such commodities will be subject to any conditions or restrictions stipulated in the permit, and these conditions and restrictions may vary depending upon the intended use of the commodity and the potential risk of escape or spread of P. ramorum.

(9) Violation of quarantine: Violation of this quarantine may result in a fine, if convicted, of not less than $500 no more than $5,000, as provided by ORS 561.990. In addition, violators will be subject to civil penalties of up to $10,000 as provided by 561.995. Commodities shipped in violation of this quarantine may be treated, destroyed or returned to their point of origin without expense or indemnity paid by the state.

Stat. Auth.: ORS 561 & 570Stats. Implemented: ORS 561.510 - 561.545, 570.105 - 570.190, & 570.990 - 570.995 Hist.: DOA 1-2001(Temp), f. & cert. ef. 1-5-01 thru 4-4-01, DOA 5-2001, f. & cert. ef. 3-27-01; DOA 1-2005, f. & cert. ef. 1-24-05; DOA 4-2006, f. & cert. ef. 3-10-06; DOA 7-2007, f. & cert. ef. 3-27-07; DOA 5-2008, f. & cert. ef. 1-16-08; DOA 5-2009, f. & cert. ef. 4-9-09; DOA 21-2010, f. & cert. ef. 12-17-10; DFW 14-2011, f. & cert. ef. 9-9-11; DOA 6-2012, f. & cert. ef. 3-22-12; DOA 4-2013, f. & cert. ef. 3-1-13; DOA 5-2014, f. & cert. ef. 4-29-14; DOA 14-2014, f. & cert. ef. 8-22-14; DOA 9-2015, f. & cert. ef. 7-23-15

8.2 Disease Model Implementation

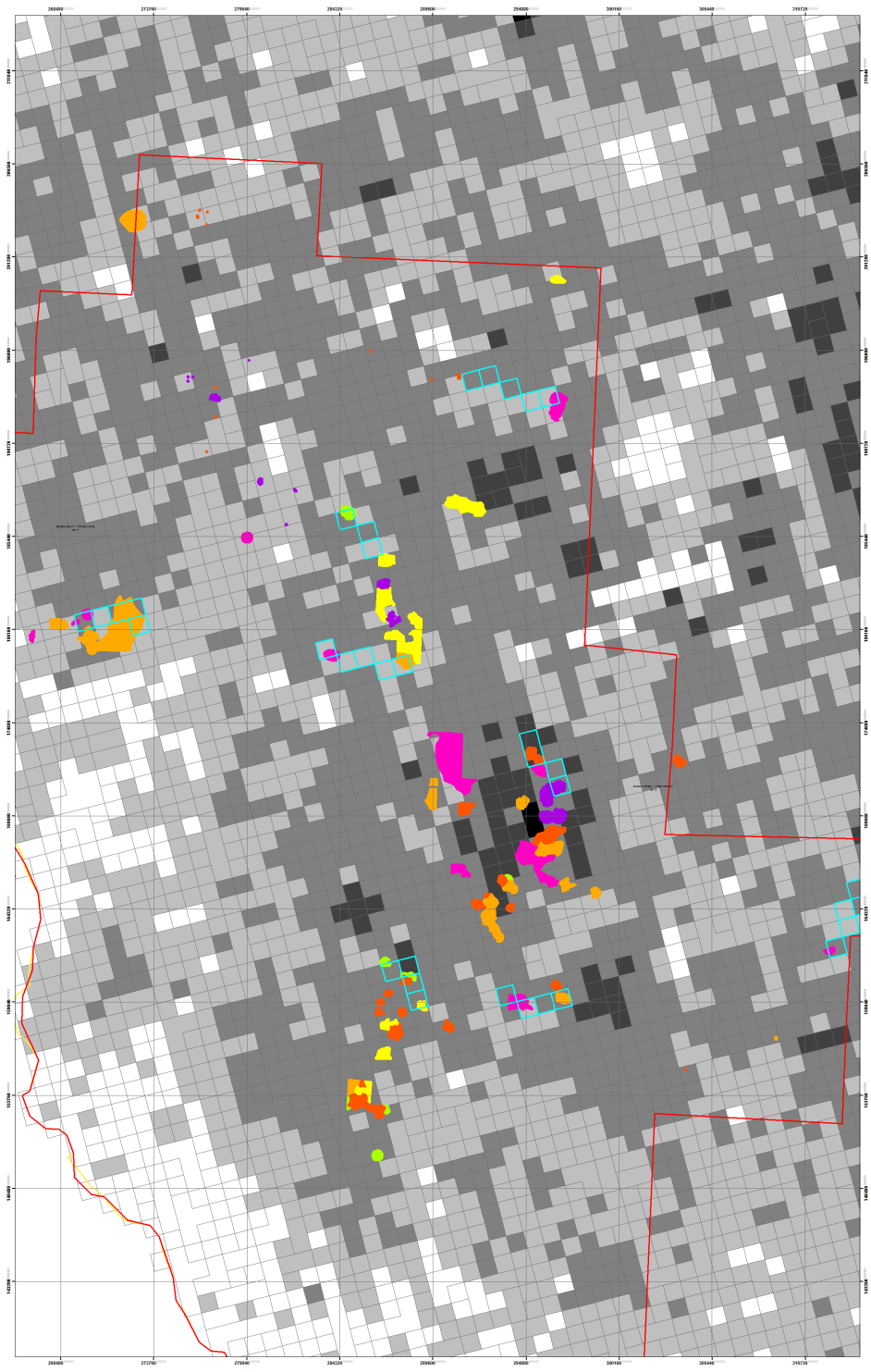


Figure 15. Sample model input vectors intersecting grid cells with tanoak percentage bins for the GIA. Dispersal events occur between colored polygons, with cyan highlighting on intersected grid cells.

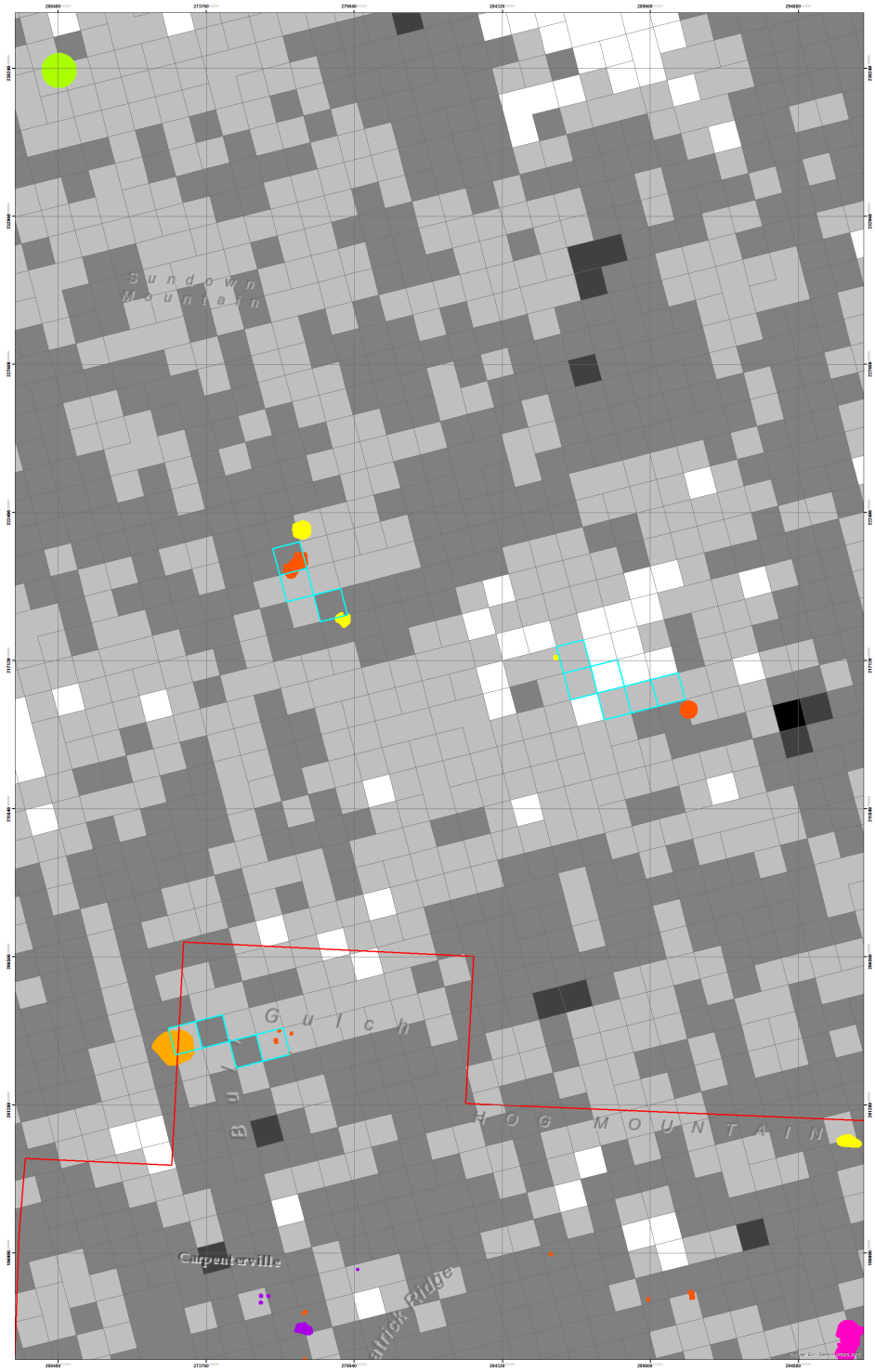


Figure 16. Sample model input vectors intersecting grid cells with tanoak percentage bins for the quarantine zone. Dispersal events occur between colored polygons, with cyan highlighting on intersected grid cells.

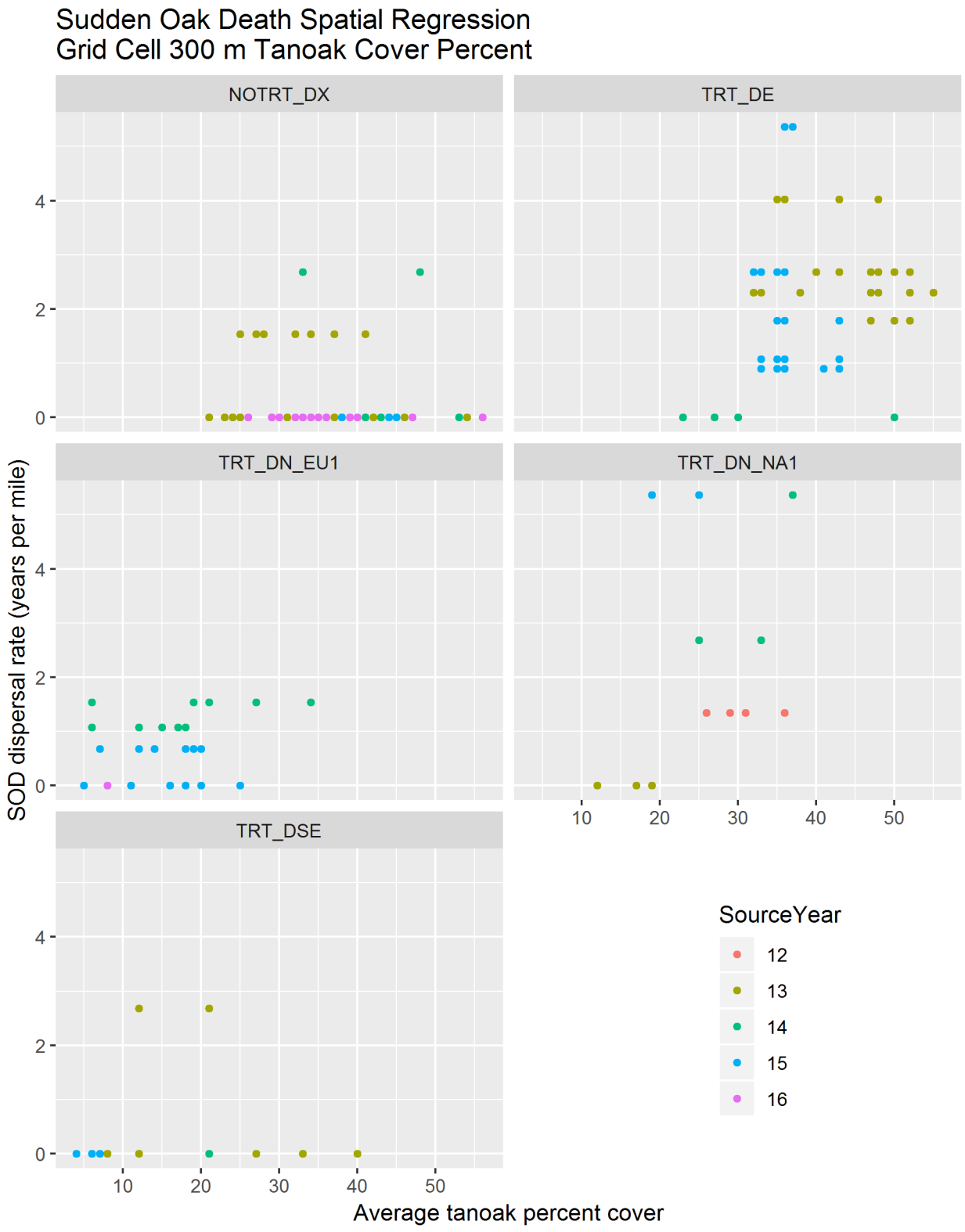


Figure 17. Dispersal event data derived from GIA and QZ k nearest neighbor selections.

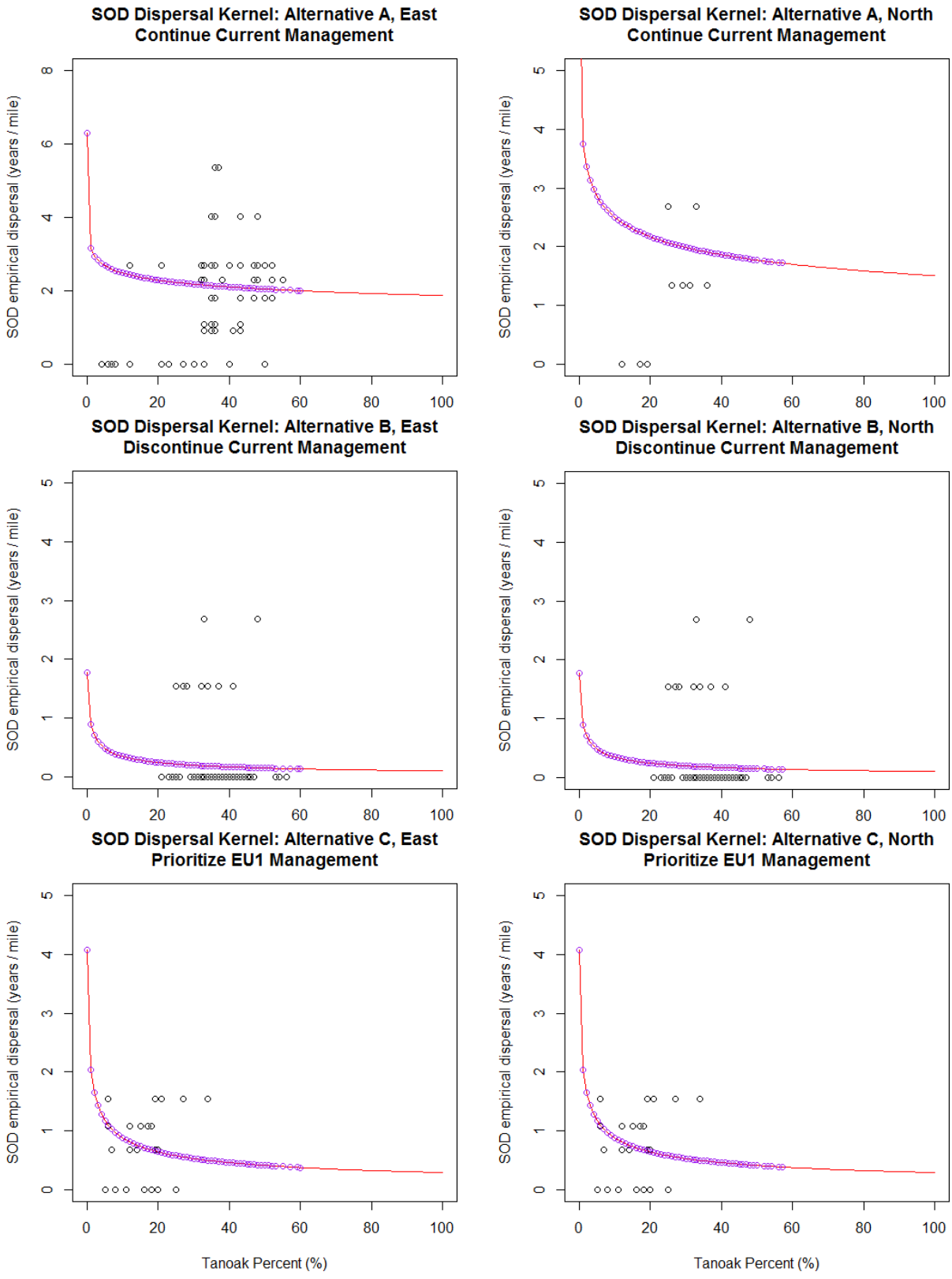


Figure 18. Exponential decay two-parameter SOD dispersal kernels for north and east vectors.

8.3 Timber Harvest

Table 31. Timber harvest forecast for southwest Oregon counties, private land (top) vs. public land (bottom). Forecast computed as a function of price of Douglas-fir #2S and historic harvest data spanning 2008 through 2016.

Year	Source	Total Annual County Harvest (Mbf), Private Land			
		COOS	CURRY	DOUGLAS	JOSEPHINE
2008	Historic	232,122	71,433	364,952	14,814
2009	Historic	172,933	50,452	322,566	16,516
2010	Historic	183,826	60,648	375,336	12,690
2011	Historic	208,891	72,193	382,946	11,680
2012	Historic	219,577	73,445	427,121	25,772
2013	Historic	266,890	103,383	490,441	21,833
2014	Historic	219,119	97,163	545,301	26,963
2015	Historic	211,258	60,135	496,059	19,769
2016	Historic	208,335	76,843	544,975	16,142
2017	Historic	181,364	104,326	533,745	26,382
2018	Historic	184,509	106,135	543,001	26,839
2019	Forecast	210,345	98,097	564,752	28,175
2020	Forecast	212,260	93,333	537,030	26,863
2021	Forecast	213,410	90,474	520,396	26,075
2022	Forecast	213,218	90,951	523,168	26,207
2023	Forecast	213,136	91,155	524,357	26,263
2024	Forecast	213,054	91,359	525,545	26,319
2025	Forecast	212,972	91,563	526,733	26,375
2026	Forecast	212,890	91,768	527,921	26,432
2027	Forecast	212,808	91,972	529,109	26,488

Year	Source	Total Annual County Harvest (Mbf), Public Land			
		COOS	CURRY	DOUGLAS	JOSEPHINE
2008	Historic	49,662	5,181	51,731	5,788
2009	Historic	22,736	4,555	61,667	2,783
2010	Historic	49,760	4,009	60,587	4,998
2011	Historic	65,742	14,867	85,873	7,220
2012	Historic	55,478	18,555	81,246	5,580
2013	Historic	43,038	9,347	76,746	16,937
2014	Historic	62,232	19,649	87,520	15,748
2015	Historic	55,335	10,242	63,003	13,099
2016	Historic	53,249	18,173	66,057	15,463
2017	Historic	39,590	14,212	55,022	5,465
2018	Historic	40,277	14,458	55,976	5,560
2019	Forecast	41,954	19,389	64,947	17,245
2020	Forecast	45,560	17,701	63,957	15,726
2021	Forecast	47,723	16,687	63,363	14,815
2022	Forecast	47,363	16,856	63,462	14,967
2023	Forecast	47,208	16,929	63,504	15,032
2024	Forecast	47,054	17,001	63,547	15,097
2025	Forecast	46,899	17,073	63,589	15,162
2026	Forecast	46,745	17,146	63,632	15,227
2027	Forecast	46,590	17,218	63,674	15,292

Harvest predictions at the County level are based on a combined price forecast used in current timber appraisal projects, consisting of a several log price benchmarks and informed by industry contacts and macroeconomic trends. Robust growth in certain sectors (e.g. cross-laminated timber, veneer) may be offset by losses in others (e.g. exports, fiber), resulting in a long-term growth rate of around 4%. Individual county forecasts vary depending on past harvest dynamics, with local trends having more influence than regional averages.

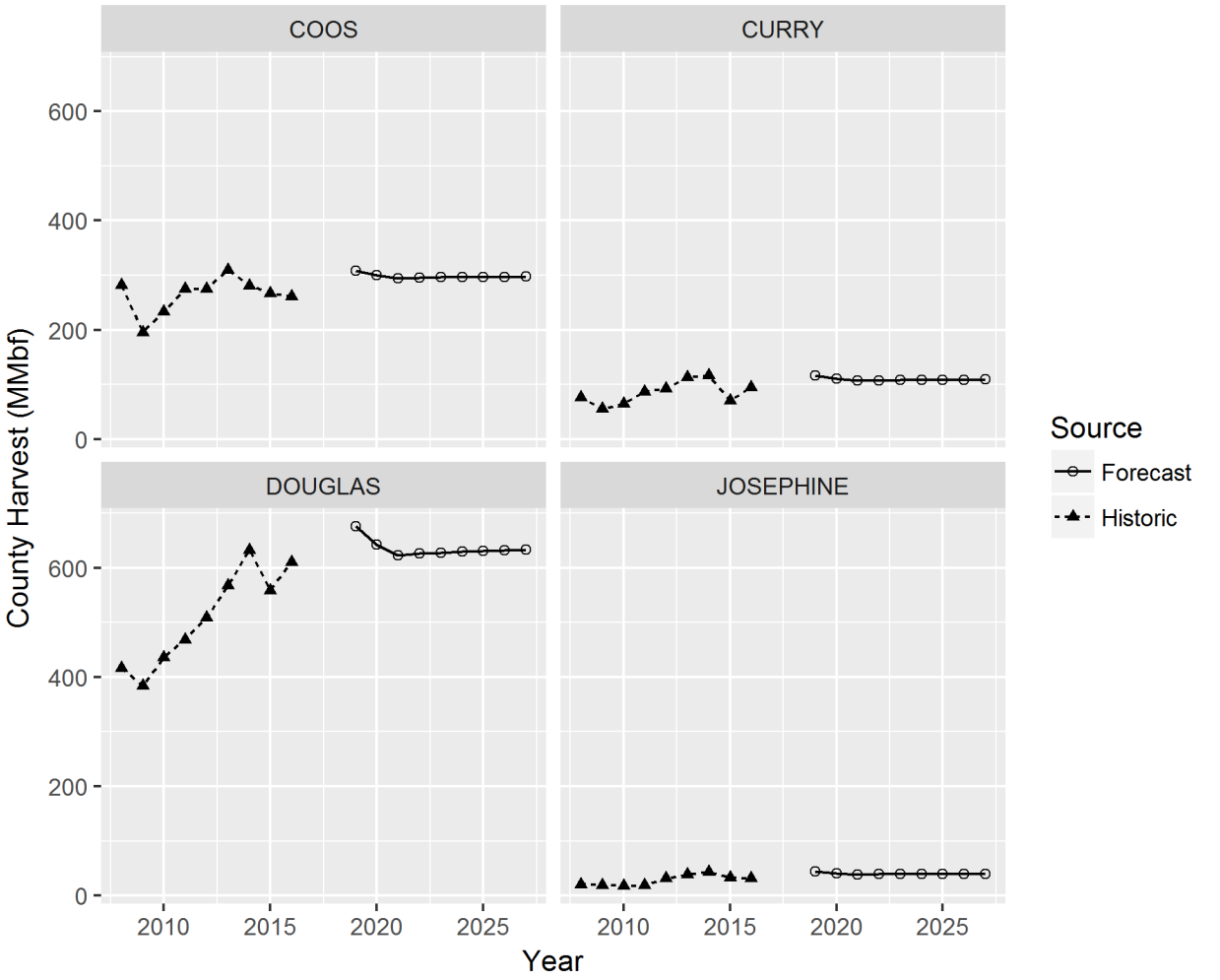


Figure 19. Forecasted annual harvest (MMbf) by county through 2027, aggregating across ownerships.

Note that the forecast period listed here ends in 2027, or one decade after the latest complete year of taxation data. Long-term timber price models rapidly lose resolution on unpredictable future events, so we view forecasts as reasonable through a decade. After that point, claiming any degree of forecast accuracy becomes questionable, and keeping a static forecast or an extremely modest percentage increase (as we do here) is more appropriate. We forecast harvest volume, with benchmarked tax revenues, at 2018, 2023, 2028, and 2038 (see §4.2.1 and §4.2.2).

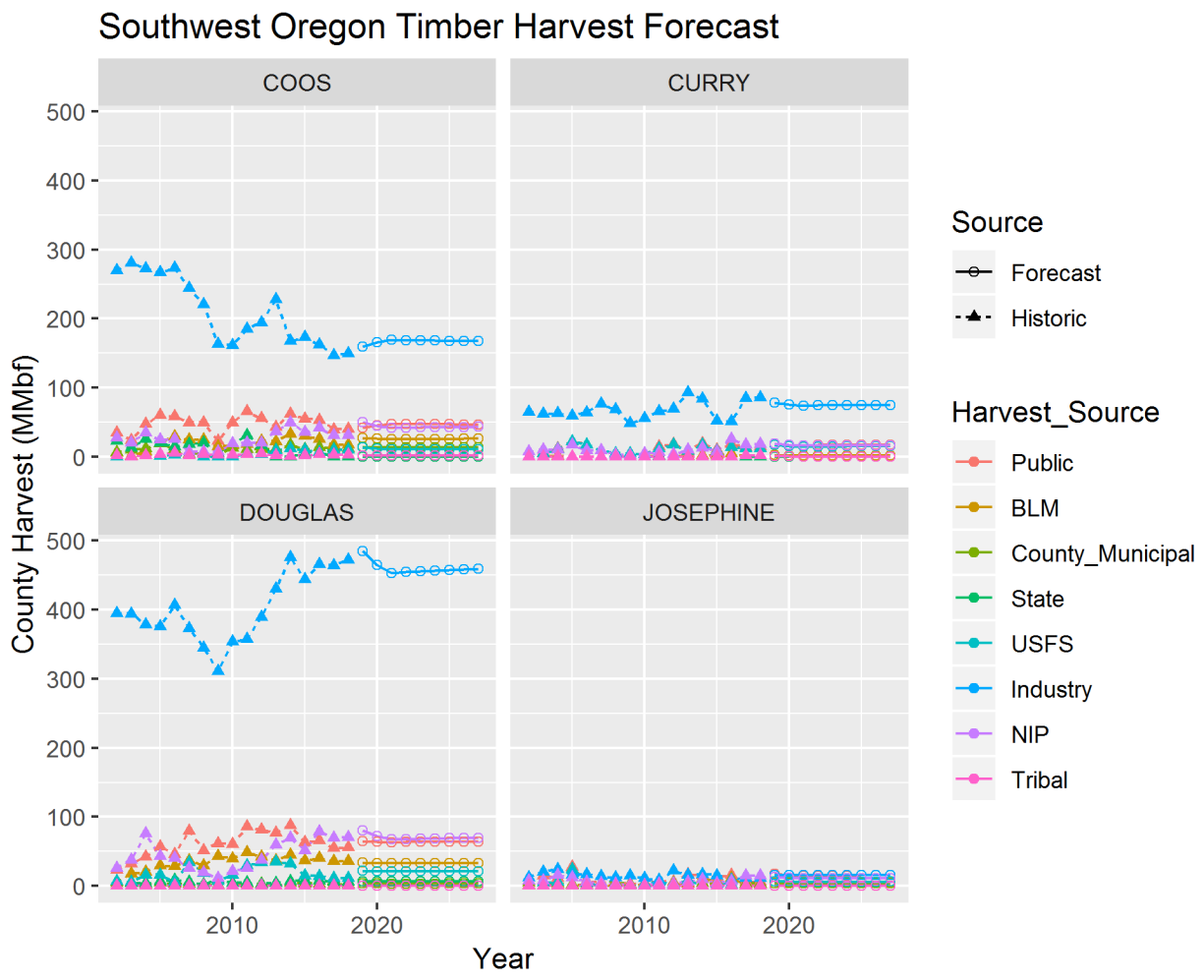


Figure 20. Forecasted annual harvest (MMbf) by county through 2027, divided across ownerships reported by ODF.

8.4 Timber Industry Tax Revenue

Table 32. Timber industry tax revenues for Oregon, 2001 through 2017 (latest available complete data year).

Statewide Timber Industry Tax Revenues									
Year	Annual Harvest (Mbf)	Forest Products Harvest Tax	Industrial Property Tax	Forestland Property Tax	Forest/Fire Protection Services Payments	Corporate Income and ExciseTaxes	Weight-Mile Tax Revenue	Income Tax	Forest Industry Tax Revenues
2001	3,439,794	$ 10,512,054	$ 31,931,497	$ 17,018,512	$ 10,142,483	$ 2,945,463	$ 7,843,058	$ 183,733,583	$ 264,126,650
2002	3,922,358	$ 9,284,458	$ 33,619,343	$ 19,008,801	$ 15,258,062	$ 2,653,644	$ 7,285,598	$ 188,541,730	$ 275,651,636
2003	4,001,818	$ 11,032,593	$ 39,212,383	$ 19,297,484	$ 15,741,398	$ 2,182,710	$ 7,764,312	$ 190,796,300	$ 286,027,180
2004	4,451,195	$ 12,863,856	$ 43,078,515	$ 16,885,273	$ 16,340,938	$ 5,120,379	$ 18,058,533	$ 199,659,842	$ 312,007,336
2005	4,411,428	$ 12,293,463	$ 50,075,980	$ 19,595,243	$ 16,893,243	$ 11,961,053	$ 16,932,121	$ 207,895,991	$ 335,647,094
2006	4,327,704	$ 11,797,643	$ 47,285,115	$ 16,233,641	$ 17,796,446	$ 8,784,534	$ 16,037,889	$ 209,622,400	$ 327,557,668
2007	3,798,554	$ 11,020,829	$ 47,312,537	$ 17,038,351	$ 18,313,703	$ 162,242	$ 15,037,013	$ 204,775,185	$ 313,659,860
2008	3,441,403	$ 10,180,877	$ 25,716,548	$ 15,603,210	$ 18,002,646	$ 7,991,791	$ 13,882,128	$ 187,477,924	$ 278,855,124
2009	2,748,479	$ 11,969,766	$ 29,185,706	$ 18,636,044	$ 11,710,648	$ 3,333,879	$ 13,077,673	$ 151,090,845	$ 239,004,561
2010	3,226,550	$ 11,180,719	$ 35,935,015	$ 19,215,819	$ 13,461,784	$ 1,955,051	$ 14,408,304	$ 145,412,271	$ 241,568,963
2011	3,649,130	$ 11,326,155	$ 32,778,731	$ 18,559,146	$ 13,388,067	$ 7,883,235	$ 15,255,570	$ 148,455,866	$ 247,646,771
2012	3,748,788	$ 12,900,547	$ 31,371,257	$ 19,263,050	$ 14,150,741	$ 1,384,597	$ 17,365,290	$ 159,478,771	$ 255,914,253
2013	4,199,202	$ 14,148,783	$ 27,877,898	$ 20,418,685	$ 14,191,423	$ 2,101,037	$ 20,407,721	$ 172,703,466	$ 271,849,013
2014	4,125,608	$ 14,992,588	$ 29,118,392	$ 20,686,541	$ 14,673,677	$ 4,422,895	$ 20,239,984	$ 182,227,141	$ 286,361,218
2015	3,788,050	$ 13,481,741	$ 32,784,267	$ 21,376,478	$ 15,194,245	$ 2,368,355	$ 20,597,673	$ 190,754,093	$ 296,556,853
2016	3,888,348	$ 13,357,996	$ 34,516,480	$ 22,069,509	$ 16,001,712	$ 6,377,876	$ 19,753,902	$ 189,336,205	$ 301,413,681
2017	3,851,038	$ 13,282,418	$ 34,761,658	$ 22,397,476	$ 16,424,778	$ 8,178,617	$ 19,254,189	$ 191,781,666	$ 306,080,802

Table 33. Ratio of timber industry tax revenues to harvest ($/Mbf) for Oregon, 2001 through 2017.

Statewide Timber Industry Tax Ratios ($/Mbf)							
Year	Forest Products Harvest Tax	Industrial Property Tax	Forestland Property Tax	Forest/Fire Protection Services Payments	Corporate Income and ExciseTaxes	Weight-Mile Tax Revenue	Income Tax	Total Forest Industry Ratio
2001	$ 3.0560	$ 9.2830	$ 4.9475	$ 2.9486	$ 0.8563	$ 2.2801	$ 53.4141	$ 76.7856
2002	$ 2.3671	$ 8.5712	$ 4.8463	$ 3.8900	$ 0.6765	$ 1.8575	$ 48.0685	$ 70.2770
2003	$ 2.7569	$ 9.7986	$ 4.8222	$ 3.9336	$ 0.5454	$ 1.9402	$ 47.6774	$ 71.4743
2004	$ 2.8900	$ 9.6780	$ 3.7934	$ 3.6711	$ 1.1503	$ 4.0570	$ 44.8553	$ 70.0952
2005	$ 2.7867	$ 11.3514	$ 4.4419	$ 3.8294	$ 2.7114	$ 3.8382	$ 47.1267	$ 76.0858
2006	$ 2.7261	$ 10.9261	$ 3.7511	$ 4.1122	$ 2.0298	$ 3.7059	$ 48.4373	$ 75.6886
2007	$ 2.9013	$ 12.4554	$ 4.4855	$ 4.8212	$ 0.0427	$ 3.9586	$ 53.9087	$ 82.5735
2008	$ 2.9584	$ 7.4727	$ 4.5340	$ 5.2312	$ 2.3222	$ 4.0339	$ 54.4772	$ 81.0295
2009	$ 4.3551	$ 10.6189	$ 6.7805	$ 4.2608	$ 1.2130	$ 4.7581	$ 54.9725	$ 86.9588
2010	$ 3.4652	$ 11.1373	$ 5.9555	$ 4.1722	$ 0.6059	$ 4.4655	$ 45.0674	$ 74.8691
2011	$ 3.1038	$ 8.9826	$ 5.0859	$ 3.6688	$ 2.1603	$ 4.1806	$ 40.6825	$ 67.8646
2012	$ 3.4413	$ 8.3684	$ 5.1385	$ 3.7748	$ 0.3693	$ 4.6322	$ 42.5414	$ 68.2659
2013	$ 3.3694	$ 6.6389	$ 4.8625	$ 3.3796	$ 0.5003	$ 4.8599	$ 41.1277	$ 64.7383
2014	$ 3.6340	$ 7.0580	$ 5.0142	$ 3.5567	$ 1.0721	$ 4.9059	$ 44.1698	$ 69.4107
2015	$ 3.5590	$ 8.6547	$ 5.6431	$ 4.0111	$ 0.6252	$ 5.4375	$ 50.3568	$ 78.2875
2016	$ 3.4354	$ 8.8769	$ 5.6758	$ 4.1153	$ 1.6403	$ 5.0803	$ 48.6932	$ 77.5172
2017	$ 3.4490	$ 9.0266	$ 5.8160	$ 4.2650	$ 2.1237	$ 4.9997	$ 49.8000	$ 79.4801

Table 34. Timber industry tax revenues for Coos County, 2001 through 2017.

Coos										
Year	Annual Harvest (Mbf)	Harvest Share (% of State)	Forest Products Harvest Tax	Industrial Property Tax	Forestland Property Tax	Forest/Fire Protection Services Payments	Corporate Income and ExciseTaxes	Weight-Mile Tax Revenue	Income Tax	Forest Industry Tax Revenues
2001	244,037	7.09%	$ 745,780	$ 2,265,388	$ 1,207,382	$ 719,561	$ 208,967	$ 556,428	$ 13,035,023	$ 18,738,528
2002	334,250	8.52%	$ 791,190	$ 2,864,926	$ 1,619,865	$ 1,300,240	$ 226,135	$ 620,854	$ 16,066,885	$ 23,490,094
2003	326,277	8.15%	$ 899,511	$ 3,197,072	$ 1,573,366	$ 1,283,431	$ 177,961	$ 633,041	$ 15,556,041	$ 23,320,423
2004	356,720	8.01%	$ 1,030,913	$ 3,452,324	$ 1,353,190	$ 1,309,567	$ 410,349	$ 1,447,216	$ 16,000,795	$ 25,004,354
2005	356,554	8.08%	$ 993,620	$ 4,047,395	$ 1,583,787	$ 1,365,398	$ 966,753	$ 1,368,540	$ 16,803,209	$ 27,128,702
2006	363,819	8.41%	$ 991,798	$ 3,975,139	$ 1,364,721	$ 1,496,102	$ 738,493	$ 1,348,264	$ 17,622,419	$ 27,536,935
2007	303,382	7.99%	$ 880,209	$ 3,778,746	$ 1,360,815	$ 1,462,674	$ 12,958	$ 1,200,973	$ 16,354,935	$ 25,051,310
2008	281,784	8.19%	$ 833,616	$ 2,105,685	$ 1,277,600	$ 1,474,067	$ 654,372	$ 1,136,676	$ 15,350,797	$ 22,832,813
2009	195,669	7.12%	$ 852,148	$ 2,077,781	$ 1,326,732	$ 833,701	$ 237,345	$ 931,022	$ 10,756,420	$ 17,015,150
2010	233,586	7.24%	$ 809,428	$ 2,601,514	$ 1,391,129	$ 974,565	$ 141,536	$ 1,043,089	$ 10,527,117	$ 17,488,379
2011	274,633	7.53%	$ 852,405	$ 2,466,922	$ 1,396,759	$ 1,007,584	$ 593,291	$ 1,148,132	$ 11,172,766	$ 18,637,859
2012	275,055	7.34%	$ 946,535	$ 2,301,762	$ 1,413,363	$ 1,038,264	$ 101,590	$ 1,274,121	$ 11,701,228	$ 18,776,863
2013	309,928	7.38%	$ 1,044,271	$ 2,057,567	$ 1,507,030	$ 1,047,418	$ 155,070	$ 1,506,221	$ 12,746,622	$ 20,064,198
2014	281,351	6.82%	$ 1,022,438	$ 1,985,765	$ 1,410,745	$ 1,000,690	$ 301,625	$ 1,380,291	$ 12,427,208	$ 19,528,762
2015	266,593	7.04%	$ 948,809	$ 2,307,271	$ 1,504,420	$ 1,069,331	$ 166,679	$ 1,449,610	$ 13,424,772	$ 20,870,892
2016	261,584	6.73%	$ 898,643	$ 2,322,055	$ 1,484,700	$ 1,076,496	$ 429,064	$ 1,328,920	$ 12,737,369	$ 20,277,248
2017	220,954	5.74%	$ 762,081	$ 1,994,456	$ 1,285,059	$ 942,375	$ 469,250	$ 1,104,713	$ 11,003,508	$ 17,561,441

Table 35. Timber industry tax revenues for Curry County, 2001 through 2017.

	Curry									
Year	Annual Harvest (Mbf)	Harvest Share (% of State)	Forest Products Harvest Tax	Industrial Property Tax	Forestland Property Tax	Forest/Fire Protection Services Payments	Corporate Income and ExciseTaxes	Weight-Mile Tax Revenue	Income Tax	Forest Industry Tax Revenues
2001	52,421	1.52%	$ 160,199	$ 486,622	$ 259,355	$ 154,567	$ 44,888	$ 119,525	$ 2,800,022	$ 4,025,178
2002	72,559	1.85%	$ 171,752	$ 621,918	$ 351,640	$ 282,256	$ 49,089	$ 134,775	$ 3,487,800	$ 5,099,230
2003	78,446	1.96%	$ 216,267	$ 768,664	$ 378,281	$ 308,572	$ 42,787	$ 152,201	$ 3,740,102	$ 5,606,874
2004	84,729	1.90%	$ 244,865	$ 820,004	$ 321,413	$ 311,052	$ 97,467	$ 343,746	$ 3,800,548	$ 5,939,095
2005	99,357	2.25%	$ 276,881	$ 1,127,843	$ 441,337	$ 380,480	$ 269,394	$ 381,356	$ 4,682,366	$ 7,559,658
2006	91,751	2.12%	$ 250,120	$ 1,002,485	$ 344,167	$ 377,300	$ 186,240	$ 340,017	$ 4,444,173	$ 6,944,501
2007	94,690	2.49%	$ 274,726	$ 1,179,403	$ 424,730	$ 456,522	$ 4,044	$ 374,841	$ 5,104,617	$ 7,818,884
2008	76,614	2.23%	$ 226,651	$ 572,513	$ 347,365	$ 400,783	$ 177,917	$ 309,050	$ 4,173,715	$ 6,207,993
2009	55,007	2.00%	$ 239,558	$ 584,111	$ 372,975	$ 234,372	$ 66,723	$ 261,732	$ 3,023,874	$ 4,783,345
2010	64,657	2.00%	$ 224,051	$ 720,104	$ 385,067	$ 269,761	$ 39,177	$ 288,729	$ 2,913,924	$ 4,840,813
2011	87,060	2.39%	$ 270,216	$ 782,026	$ 442,779	$ 319,409	$ 188,076	$ 363,963	$ 3,541,821	$ 5,908,292
2012	92,000	2.45%	$ 316,595	$ 769,890	$ 472,739	$ 347,277	$ 33,980	$ 426,166	$ 3,913,807	$ 6,280,454
2013	112,730	2.68%	$ 379,832	$ 748,398	$ 548,151	$ 380,977	$ 56,404	$ 547,857	$ 4,636,324	$ 7,297,944
2014	116,812	2.83%	$ 424,498	$ 824,455	$ 585,716	$ 415,469	$ 125,229	$ 573,073	$ 5,159,559	$ 8,107,999
2015	70,377	1.86%	$ 250,473	$ 609,089	$ 397,147	$ 282,289	$ 44,001	$ 382,678	$ 3,543,961	$ 5,509,637
2016	95,016	2.44%	$ 326,417	$ 843,448	$ 539,292	$ 391,019	$ 155,850	$ 482,708	$ 4,626,635	$ 7,365,370
2017	118,538	3.08%	$ 408,843	$ 1,069,991	$ 689,412	$ 505,568	$ 251,744	$ 592,659	$ 5,903,192	$ 9,421,410

Table 36. Timber industry tax revenues for Douglas County, 2001 through 2017.

Douglas										
Year	Annual Harvest (Mbf)	Harvest Share (% of State)	Forest Products Harvest Tax	Industrial Property Tax	Forestland Property Tax	Forest/Fire Protection Services Payments	Corporate Income and ExciseTaxes	Weight-Mile Tax Revenue	Income Tax	Forest Industry Tax Revenues
2001	410,323	11.93%	$ 1,253,952	$ 3,809,015	$ 2,030,089	$ 1,209,867	$ 351,356	$ 935,576	$ 21,917,044	$ 31,506,898
2002	444,581	11.33%	$ 1,052,350	$ 3,810,596	$ 2,154,559	$ 1,729,430	$ 300,778	$ 825,789	$ 21,370,326	$ 31,243,828
2003	464,984	11.62%	$ 1,281,912	$ 4,556,212	$ 2,242,236	$ 1,829,043	$ 253,616	$ 902,160	$ 22,169,231	$ 33,234,411
2004	496,491	11.15%	$ 1,434,848	$ 4,805,023	$ 1,883,401	$ 1,822,686	$ 571,132	$ 2,014,268	$ 22,270,270	$ 34,801,628
2005	476,504	10.80%	$ 1,327,888	$ 5,408,998	$ 2,116,596	$ 1,824,737	$ 1,291,983	$ 1,828,937	$ 22,456,055	$ 36,255,195
2006	492,992	11.39%	$ 1,343,933	$ 5,386,501	$ 1,849,261	$ 2,027,289	$ 1,000,693	$ 1,826,962	$ 23,879,213	$ 37,313,853
2007	479,302	12.62%	$ 1,390,610	$ 5,969,902	$ 2,149,901	$ 2,310,825	$ 20,472	$ 1,897,372	$ 25,838,557	$ 39,577,639
2008	416,683	12.11%	$ 1,232,694	$ 3,113,744	$ 1,889,227	$ 2,179,750	$ 967,641	$ 1,680,840	$ 22,699,714	$ 33,763,610
2009	384,233	13.98%	$ 1,673,354	$ 4,080,115	$ 2,605,289	$ 1,637,130	$ 466,071	$ 1,828,238	$ 21,122,260	$ 33,412,458
2010	435,923	13.51%	$ 1,510,571	$ 4,855,000	$ 2,596,153	$ 1,818,754	$ 264,137	$ 1,946,634	$ 19,645,923	$ 32,637,172
2011	468,819	12.85%	$ 1,455,118	$ 4,211,220	$ 2,384,371	$ 1,720,021	$ 1,012,792	$ 1,959,947	$ 19,072,745	$ 31,816,214
2012	508,367	13.56%	$ 1,749,423	$ 4,254,207	$ 2,612,232	$ 1,918,960	$ 187,763	$ 2,354,880	$ 21,626,669	$ 34,704,134
2013	567,187	13.51%	$ 1,911,079	$ 3,765,473	$ 2,757,956	$ 1,916,838	$ 283,787	$ 2,756,475	$ 23,327,089	$ 36,718,697
2014	632,821	15.34%	$ 2,299,691	$ 4,466,428	$ 3,173,078	$ 2,250,774	$ 678,421	$ 3,104,582	$ 27,951,556	$ 43,924,530
2015	559,062	14.76%	$ 1,989,712	$ 4,838,489	$ 3,154,862	$ 2,242,453	$ 349,535	$ 3,039,922	$ 28,152,576	$ 43,767,550
2016	611,032	15.71%	$ 2,099,134	$ 5,424,071	$ 3,468,099	$ 2,514,579	$ 1,002,247	$ 3,104,215	$ 29,753,119	$ 47,365,463
2017	588,767	15.29%	$ 2,030,686	$ 5,314,546	$ 3,424,244	$ 2,511,107	$ 1,250,390	$ 2,943,682	$ 29,320,593	$ 46,795,247

Table 37. Timber industry tax revenues for Josephine County, 2001 through 2017.

Josephine											
Year	Annual Harvest (Mbf)	Harvest Share (% of State)	Forest Products Harvest Tax	Industrial Property Tax	Forestland Property Tax	Forest/Fire Protection Services Payments	Corporate Income and ExciseTaxes	Weight-Mile Tax Revenue	Income Tax	Forest Industry Tax Revenues
2001	22,276	0.65%	$ 68,076	$ 206,787	$ 110,211	$ 65,682	$ 19,075	$ 50,791	$ 1,189,853	$ 1,710,476
2002	26,327	0.67%	$ 62,318	$ 225,654	$ 127,588	$ 102,413	$ 17,811	$ 48,901	$ 1,265,498	$ 1,850,183
2003	43,561	1.09%	$ 120,093	$ 426,839	$ 210,059	$ 171,350	$ 23,759	$ 84,517	$ 2,076,875	$ 3,113,492
2004	51,673	1.16%	$ 149,334	$ 500,090	$ 196,018	$ 189,699	$ 59,441	$ 209,638	$ 2,317,810	$ 3,622,028
2005	56,241	1.27%	$ 156,729	$ 638,415	$ 249,818	$ 215,371	$ 152,491	$ 215,866	$ 2,650,452	$ 4,279,142
2006	30,385	0.70%	$ 82,832	$ 331,991	$ 113,977	$ 124,950	$ 61,677	$ 112,603	$ 1,471,768	$ 2,299,797
2007	22,402	0.59%	$ 64,995	$ 279,026	$ 100,484	$ 108,005	$ 957	$ 88,681	$ 1,207,663	$ 1,849,811
2008	20,602	0.60%	$ 60,948	$ 153,952	$ 93,409	$ 107,773	$ 47,843	$ 83,106	$ 1,122,339	$ 1,669,370
2009	19,299	0.70%	$ 84,048	$ 204,933	$ 130,857	$ 82,229	$ 23,410	$ 91,828	$ 1,060,915	$ 1,678,219
2010	17,688	0.55%	$ 61,293	$ 196,996	$ 105,341	$ 73,798	$ 10,718	$ 78,987	$ 797,152	$ 1,324,285
2011	18,900	0.52%	$ 58,662	$ 169,771	$ 96,124	$ 69,341	$ 40,830	$ 79,013	$ 768,900	$ 1,282,641
2012	31,352	0.84%	$ 107,889	$ 262,361	$ 161,099	$ 118,344	$ 11,580	$ 145,228	$ 1,333,738	$ 2,140,238
2013	38,770	0.92%	$ 130,632	$ 257,388	$ 188,520	$ 131,025	$ 19,398	$ 188,419	$ 1,594,520	$ 2,509,902
2014	42,711	1.04%	$ 155,213	$ 301,453	$ 214,161	$ 151,912	$ 45,789	$ 209,538	$ 1,886,535	$ 2,964,599
2015	32,868	0.87%	$ 116,978	$ 284,461	$ 185,479	$ 131,837	$ 20,550	$ 178,721	$ 1,655,127	$ 2,573,153
2016	31,605	0.81%	$ 108,576	$ 280,554	$ 179,384	$ 130,064	$ 51,840	$ 160,562	$ 1,538,949	$ 2,449,930
2017	31,847	0.83%	$ 109,842	$ 287,469	$ 185,221	$ 135,828	$ 67,635	$ 159,227	$ 1,585,980	$ 2,531,202

8.5 Baseline Timber Industry Forecast

Table 38. Latest completely available data year (2017), forest sector economic indicators benchmarked to BLS QCEW and OFRI sector impact reports (2012, 2017 forthcoming).

Year	Indicator	Coos	Curry	Douglas	Josephine	Regional
2017	Forest Sector Jobs	2,031	673	5,592	1,611	9,907
2017	yes	4,130	1,369	11,371	2,391	20,146
2017	yes	$ 103,080	$ 35,898	$ 289,951	$ 68,665	$ 497,594
2017	Forest Sector DII Wages (Thousands)	$ 362,341	$ 131,316	$ 1,086,137	$ 247,740	$ 1,827,534
2017	Forest Harvest Dependent Tax Revs	$ 13,339,551	$ 7,156,438	$ 35,545,351	$ 1,922,684	$ 57,964,024
2017	Forest Harvest Decoupled Tax Revs	$ 4,221,890	$ 2,264,971	$ -	$ 608,518	$ 7,095,380
2017	Forest Industry Tax Revenues (Σ)	$ 17,561,441	$ 9,421,410	$ 46,795,247	$ 2,531,202	$ 76,309,300
2017	Export Related Jobs	420	41	375	-	1,271
2017	Export Related Wages (Thousands)	$ 20,857	$ 4,640	$ 24,447	$ -	$ 60,579
2017	Export (MMbf) Upper Range (16%)	35,893	19,256	95,642	5,173	155,965
2017	Export (MMbf) Lower Range (8%)	17,946	9,628	47,821	2,587	77,982

Table 39. Forest sector economic indicators forecasted from 2017 through 2018 (data not yet available for 2018).

Year	Economic Indicator	Coos	Curry	Douglas	Josephine	Regional
2018	Forest Sector Jobs	2,066	685	5,689	1,639	10,079
2018	Forest Sector DII Jobs	4,202	1,392	11,569	2,433	19,595
2018	Forest Sector Wages (Thousands)	$ 104,868	$ 36,520	$ 294,979	$ 69,855	$ 506,222
2018	Forest Sector DII Wages (Thousands)	$ 368,625	$ 133,592	$ 1,104,972	$ 252,034	$ 1,859,224
2018	Forest Harvest Dependent Tax Revs	$ 13,570,899	$ 7,280,504	$ 36,161,754	$ 1,956,009	$ 58,969,166
2018	Forest Harvest Decoupled Tax Revs	$ 4,243,000	$ 2,276,296	$ 11,306,146	$ 611,561	$ 18,437,002
2018	Forest Industry Tax Revenues (Σ)	$ 17,813,898	$ 9,556,800	$ 47,467,900	$ 2,567,570	$ 77,406,169
2018	Export Related Jobs	427	42	382	-	850
2018	Export Related Wages (Thousands)	$ 21,219	$ 4,721	$ 24,871	$ -	$ 50,811
2018	Export (MMbf) Upper Range (16%)	30,577	16,404	81,476	4,407	132,864
2018	Export (MMbf) Lower Range (8%)	15,288	8,202	40,738	2,204	66,432

Table 40. Forest sector economic indicators forecasted from 2017 through 2023.

Year	Economic Indicator	Coos	Curry	Douglas	Josephine	Regional
2023	Forest Sector Jobs	2,393	614	5,583	2,089	10,679
2023	Forest Sector DII Jobs	4,866	1,248	11,354	3,101	20,569
2023	Forest Sector Wages (Thousands)	$ 121,456	$ 32,732	$ 289,505	$ 89,035	$ 532,728
2023	Forest Sector DII Wages (Thousands)	$ 426,936	$ 119,735	$ 1,084,466	$ 321,235	$ 1,952,371
2023	Forest Harvest Dependent Tax Revs	$ 15,717,633	$ 6,525,279	$ 35,490,646	$ 2,493,069	$ 60,226,627
2023	Forest Harvest Decoupled Tax Revs	$ 4,348,547	$ 2,332,920	$ 11,587,393	$ 626,774	$ 18,895,634
2023	Forest Industry Tax Revenues (Σ)	$ 20,066,180	$ 8,858,199	$ 47,078,040	$ 3,119,842	$ 79,122,261
2023	Export Related Jobs	495	37	374	-	907
2023	Export Related Wages (Thousands)	$ 24,576	$ 4,231	$ 24,409	$ -	$ 53,216
2023	Export (MMbf) Upper Range (16%)	39,349	21,110	104,853	5,672	170,984
2023	Export (MMbf) Lower Range (8%)	19,675	10,555	52,426	2,836	85,492

Table 41. Forest sector economic indicators forecasted from 2017 through 2028.

Year	Economic Indicator	Coos	Curry	Douglas	Josephine	Regional
2028	Forest Sector Jobs	2,387	621	5,637	2,116	10,761
2028	Forest Sector DII Jobs	4,855	1,262	11,463	3,141	20,721
2028	Forest Sector Wages (Thousands)	$ 121,165	$ 33,108	$ 292,292	$ 90,194	$ 536,759
2028	Forest Sector DII Wages (Thousands)	$ 425,913	$ 121,111	$ 1,094,906	$ 325,414	$ 1,967,344
2028	Forest Harvest Dependent Tax Revs	$ 15,679,977	$ 6,600,268	$ 35,832,327	$ 2,525,503	$ 60,638,075
2028	Forest Harvest Decoupled Tax Revs	$ 4,454,094	$ 2,389,545	$ 11,868,641	$ 641,987	$ 19,354,266
2028	Forest Industry Tax Revenues (Σ)	$ 20,134,071	$ 8,989,812	$ 47,700,968	$ 3,167,490	$ 79,992,341
2028	Export Related Jobs	494	38	378	-	910
2028	Export Related Wages (Thousands)	$ 24,517	$ 4,280	$ 24,644	$ -	$ 53,441
2028	Export (MMbf) Upper Range (16%)	39,656	21,275	105,669	5,716	172,315
2028	Export (MMbf) Lower Range (8%)	19,828	10,637	52,834	2,858	86,158

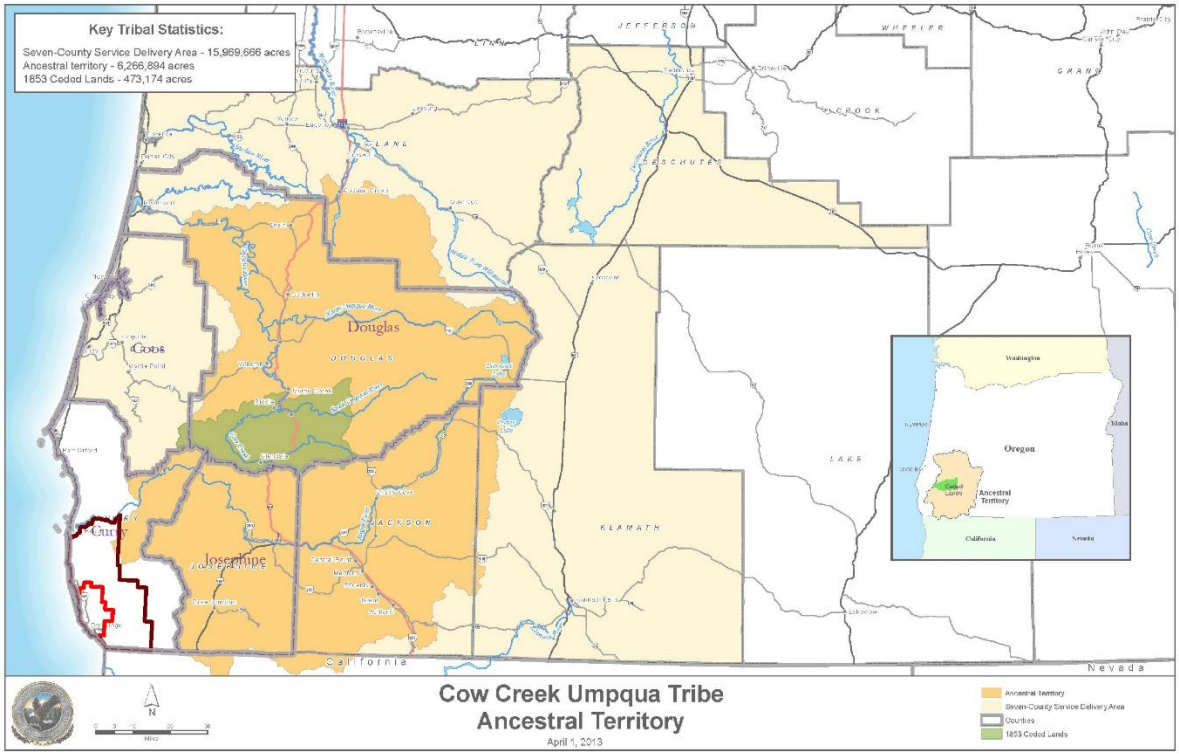
Table 42. Forest sector economic indicators forecasted from 2017 through 2038.

Year	Economic Indicator	Coos	Curry	Douglas	Josephine	Regional
2038	Forest Sector Jobs	2,417	628	5,707	2,142	10,895
2038	Forest Sector DII Jobs	4,915	1,278	11,605	3,180	20,978
2038	Forest Sector Wages (Thousands)	$ 122,668	$ 33,519	$ 295,916	$ 91,312	$ 543,414
2038	Forest Sector DII Wages (Thousands)	$ 431,194	$ 122,612	$ 1,108,481	$ 329,449	$ 1,991,737
2038	Forest Harvest Dependent Tax Revs	$ 15,874,388	$ 6,682,102	$ 36,276,599	$ 2,556,816	$ 61,389,905
2038	Forest Harvest Decoupled Tax Revs	$ 4,665,189	$ 2,502,793	$ 12,431,136	$ 672,413	$ 20,271,530
2038	Forest Industry Tax Revenues (Σ)	$ 20,539,576	$ 9,184,895	$ 48,707,735	$ 3,229,229	$ 81,661,435
2038	Export Related Jobs	500	38	383	-	921
2038	Export Related Wages (Thousands)	$ 24,821	$ 4,333	$ 24,950	$ -	$ 54,103
2038	Export (MMbf) Upper Range (16%)	40,147	21,538	106,979	5,787	174,452
2038	Export (MMbf) Lower Range (8%)	20,074	10,769	53,490	2,893	87,226

8.6 Tribal Land Ownership Boundaries

Sudden Oak Death Project Area
CoquilleTribe Ancestral Territory and Sek-wet-se Forest

Sudden Oak Death Project Area
Cow Creek Umpqua Tribe Ancenstral Territory



Legend

- County Boundary
- Quarantine Area
- General Infestation Area (GIA)

N

0 5 10 15 20
Miles

Highland Economics MB&G

This product is for informational purposes and may not be suitable for legal, engineering or surveying purposes. This information or data is provided with the understanding that conclusions drawn are the responsibility of the user.
Coordinate System: NAD 1983 UTM Zone 10N
Source Data: Cow Creek Ancestral TerritoryMap from http://www.cowcreek.com/wordpress/wp-content/uploads/2015/10/ancestral-territory-map.pdf. SOD data provided by ODF.

2/13/2019 DiseaseModel_CowCreekAncestralTerritory.mxd

Sudden Oak Death Project Area
Confederated Tribes of Siletz Ancestral Tribes and Homelands

Legend
- County Boundary
- Quarantine Area
- General Infestation Area (GIA)

N

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Highland Economics MB&G

This product is for informational purposes and may not be suitable for legal, engineering or surveying purposes. This information or data is provided with the understanding that conclusions drawn are the responsibility of the user. Coordinate System: NAD 1983 UTM Zone 10N. Source Data: Confederated Tribes of Siletz Ancestral Tribes and Homelands Map from https://www.energy.gov/sites/prod/files/-2015/12/f28/tap_2012_programreview_wood_1112.pdf. SOD data provided by ODF.

2/14/2019 DiseaseModel_Siletz_AncestralTerritory.mxd

Sudden Oak Death Project Area
Talowa Dee-ni' Nation Ancestral Territory