Date: January 31ˢᵗ, 2022

To: Robert Aguero and Doug Bush, Permit Sonoma

From: Michael Jones, UCCE Sonoma

Subject: Sonoma County Forest Resources: Data summary from Landtrendr remote sensing analysis

The Landtrendr mapping tool (Landsat-based detection of Trends in Disturbance and Recovery; Kennedy et al., 2010) was used to detect disturbance and recovery of vegetation in Sonoma County during the period of 2013 to 2021.

The analysis detected varying amounts and magnitudes of vegetation disturbance across the county (Fig. 1). The most significant change in vegetation occurred in areas that experienced wildfire, but the central coast also appeared to have experienced some noticeable tree mortality. There were apparent false detections (lines or streaking of color on map) due to errors of the Landsat imagery in 2020. It's also likely the analysis underestimated disturbance in other areas.
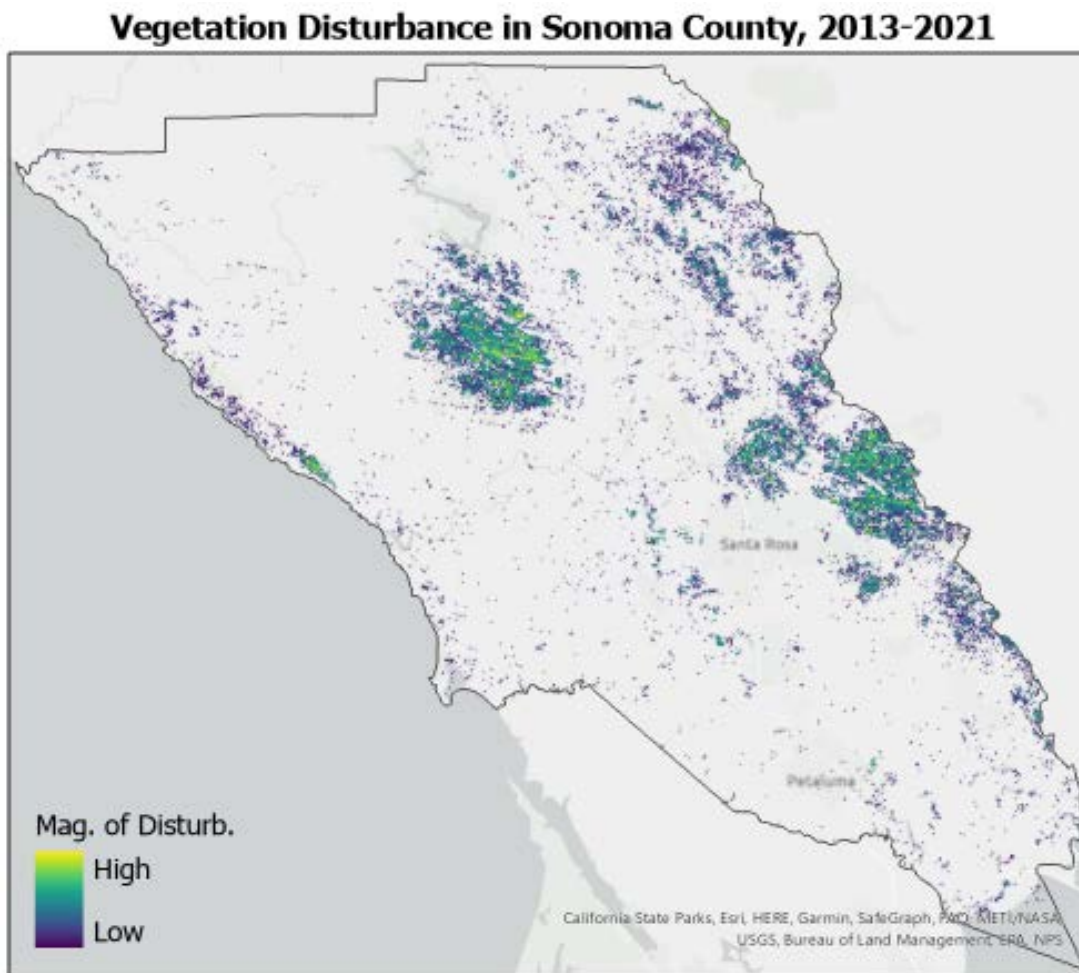

Figure 1. Map depicting LandTrendr analysis results. Color-coding indicates magnitude of disturbance.

The Landtrendr analysis depicts the magnitude of vegetation disturbance but not what caused the change (e.g., wildfire, drought, forest health issues, or conversion).

To identify potential causes of disturbance in forest vegetation, data were collected from California Timber Regulation and Environmental Evaluation System (CalTREES; CAL FIRE, 2022) for Sonoma County (document search: %-SON) and Sonoma County Vineyard and Orchard Site Development (VESCO) data from 2013 to 2021. Visual observation of satellite imagery compared with the Landtrendr data were used to confirm sources and determine unknown causes of disturbance.

Data were analyzed in two groups: areas that experienced wildfire from 2013 to 2021 and areas that did not experience wildfire during the same period. Wildfire perimeters were determined from CAL FIRE Wildfire Perimeter data layers (CAL FIRE, 2021a). Data were also analyzed by landowner type using CAL FIRE Data Public Lands datasets (CAL FIRE, 2021b). Groups were then summarized by forest alliances as identified in the Sonoma Vegetation Map data (Sonoma County, 2017; Table 1).

Table 1. Total acres of each forest alliance in Sonoma County.

Forest Alliances	Acres*
Abies grandis (ABGR)	1.9
Acer macrophyllum (ACMA)	708.6
Aesculus californica (AECA)	441.2
Arbutus menziesii (ARME)	20,904.9
Hesperocyparis macnabiana (HEMA21)	22.3
Hesperocyparis macrocarpa Semi-Natural (HEMA22)	521.7
Hesperocyparis sargentii (HESA)	6,834.0
Notholithocarpus densiflorus (NODE)	21,100.7
Pinus attenuata (PIAT)	4,546.6
Pinus lambertiana (PILA)	689.2
Pinus muricata (PIMU)	2,747.3
Pinus ponderosa - Pseudotsuga menziesii (PIPO/PSME)	830.3
Pinus radiata (PIRA)	316.6
Pinus sabiniana / Quercus durata Provisional (PISA/QUDA)	2,064.1
Populus fremontii (POFR)	2,273.4
Pseudotsuga menziesii - Notholithocarpus densiflorus (PSME/NODE)	14,344.3
Pseudotsuga menziesii (PSME)	98,252.4
Quercus (QUSP; agrifolia, douglasii, garryana, kelloggii, lobata, wislizenii)	42,195.6
Quercus agrifolia (QUAG)	44,161.6
Quercus chrysolepis (QUCH)	10,439.7
Quercus douglasii (QUDO)	8,062.6
Quercus durata (QUDU)	3,864.8
Quercus garryana (QUGA)	49,375.6
Quercus kelloggii (QUKE)	8,008.1
Quercus lobata (QULO)	12,304.6
Quercus wislizeni (QUWI; tree)	12,899.8
Sequoia sempervirens (SESE)	104,178.4
Southwestern North American Riparian Evergreen and Deciduous (Riparian)	2,979.9
Umbellularia californica (UMCA)	46,837.6
Vancouverian Riparian Deciduous Forest Group (Vancouver)	7,571.9
Total	529,479.6

* Acres are approx. and derived from Sonoma Vegetation Map data.

Forest Disturbance from Wildfires

Data were collected for 241,140 acres that experienced wildfire since 2013 (Table 2). Of that area, 78,856 acres (33%) exhibited some magnitude of disturbance, with 69,657 acres (88% of disturbed areas) classified as native forest. Private lands experienced most of the vegetation disturbance at 58,709 acres, with public lands accounting for 10,948 acres.

Table 2. Summary of data by forest alliance collected from the Landtrendr analysis for areas that burned, 2013-2021.

Forest Alliances	Burned Area, 2013-2021 (acres)					
	Within Fire Footprint	% Total*	Disturbance Detected	% Total*	Public Land	Private Land
ABGR	-	-	-	-	-	-
ACMA	305.9	43%	150.1	21%	37.6	112.5
AECA	103.0	23%	11.7	3%	0.6	11.2
ARME	9,368.3	45%	5,596.1	27%	724.3	4,871.7
HEMA21	17.0	77%	4.1	19%	-	4.1
HEMA22	-	-	-	-	-	-
HESA	2,702.4	40%	1,789.2	26%	811.9	977.3
NODE	1,496.5	7%	1,496.5	7%	106.2	1,390.2
PIAT	3,499.0	77%	2,527.8	56%	520.5	2,007.3
PILA	52.6	8%	49.5	7%	-	49.5
PIMU	-	-	-	-	-	-
PIPO/PSME	340.7	41%	263.9	32%	1.0	262.9
PIRA	2.7	1%	1.0	0%	1.0	-
PISA/QUDA	1,232.7	60%	540.2	26%	36.3	503.9
POFR	42.9	2%	0.5	0%	-	0.5
PSME/NODE	1,058.9	7%	620.7	4%	104.6	516.1
PSME	31,560.4	32%	18,339.4	19%	3,503.5	14,835.9
QUSP	16,343.3	39%	4,924.8	12%	402.7	4,522.1
QUAG	20,590.1	47%	7,191.2	16%	842.6	6,348.6
QUCH	3,877.1	37%	1,520.5	15%	307.7	1,212.8
QUDO	4,086.2	51%	443.0	5%	100.0	343.0
QUDU	2,381.8	62%	750.9	19%	215.0	535.9
QUGA	19,877.8	40%	7,152.0	14%	1,061.1	6,090.9
QUKE	3,320.1	41%	1,301.8	16%	95.9	1,205.9
QULO	3,155.6	26%	236.5	2%	15.7	220.7
QUWI; tree	6,015.9	47%	2,466.3	19%	199.7	2,266.5
SESE	11,075.5	11%	6,021.2	6%	624.3	5,396.9
Riparian	159.0	5%	14.1	0%	2.0	12.1
UMCA	15,631.2	33%	6,015.8	13%	1,210.8	4,805.0
Vancouver	1,416.1	19%	228.2	3%	22.5	205.7
Total area forest distrubance			69,656.9		10,947.6	58,709.2
Total area forest alliances	159,712.7				24,044.0	135,668.8
Total area of disturbance across all alliances			78,855.8		12,448.2	66,407.6
Total area of all alliances	241,140.0				33,667.8	207,472.1

* Approx. proportion of total area for each forest alliance in Sonoma County.

California Timber Regulation and Environmental Evaluation System (CalTREES)

From 2013 to 2021, there were 139 *Notice of Emergency Timber Operations* (timber salvage) permits documented for burned areas (Table 3). While not summarized by forest alliances, most timber salvage operations were conducted in stands where Douglas-fir was dominant. There were ten *Public/Private Utility Right-of-Way* permits and 13 *Post Fire Recovery* permits (for removal of fire damaged or killed trees with 300 ft of legal structures) submitted for removal of hazard trees from burned areas.

Table 3. Data from CalTREES summarizing *Notice of Emergency Timber Operations*, *Post Fire Recovery,* and *Public/Private Utility Right-of-Way* permits submitted for post-fire management, 2013-2021.

Permit	Year	No. of Permits	Acres	Redwood	Ponderos/ Sugar Pine	Douglas-fir	Fir	Port-Orford Cedar	Cedar (IC, WRC)	Other Conifer	Other Hardwood
				% of Timber Indicated for Removal							
Notice of Emergency Timber Operations	2016	1	190.0	-	50%	50%	-	-	-	-	-
	2018	63	2,904.7	15%	5%	73%	4%	-	-	1%	1%
	2019	4	206.8	-	-	100%	-	-	-	-	-
	2020	22	4,017.6	30%	0%	70%	-	-	-	-	-
	2021	49	4,153.4	21%	8%	70%	0%	-	-	-	0%
Total		139	11,472.5								
Post Fire Recovery	2018	9	19.1	13%	11%	74%	1%	-	1%	-	-
	2020	4	11.3	-	23%	53%	-	-	-	25%	-
Total		13	30.4								
Public/Private Utility Right-of-Way	2021	10	318.8	10%	4%	27%	3%	0%	1%	3%	52%

Sonoma County Vineyard and Orchard Site Development (VESCO)

From 2013 to 2021, eight VESCO permits (two in 2017, three in 2018, one in 2020, and one in 2021) were documented for areas within wildfire footprints for a total of 280.9 project acres (155.6, 107.0, 15.1, and 3.2 acres each year, respectively).

General Observations

When Landtrendr disturbance data, wildfire burn severity data, and satellite imagery were compared to each other, there appeared to be a robust relationship between areas where disturbance was detected and areas with moderate to high burn severity (Appx. A). These results were not unexpected since Landtrendr and fire severity analyses use similar remote sensing variables; however, the two datasets helped confirm the accuracy of detections and the slight differences in the analyses can help elucidate causes of disturbance.

For the more recent LNU Complex (Meyers Grade and Walbridge, 2020) and Glass (2020) fires there were large areas with high magnitudes of disturbance (Appx. B). These detections were likely due to the more recent occurrence of these fires and less time for recovery of vegetation. Disturbance data assessed with satellite imagery indicated factors contributing to high magnitudes of disturbance where minimal regrowth of ground cover and shrubs, stand replacement fires resulting in complete loss of canopy, stands with heavily damaged canopies and limited new regrowth, negligible growth of basal and epicormic sprouts, and young tree regeneration.

The older McCabe (2013), Valley (2015), Sawmill (2016), Nuns, Pressley, Pocket, Tubbs (2017), and Kincade (2019) fires had less area with high magnitudes of disturbance, suggesting more substantial recovery of vegetation. While there were still areas that exhibited varying magnitudes of disturbance, high magnitudes of disturbance within these fire footprints were often associated with stand replacement fire, removal of vegetation due to re-building of structures, changes in land use, or post-fire management (timber salvage). However, most timber salvage activities appeared to have been conducted in areas that experienced high burn severity (based on fire severity maps) which often resulted in stand replacement events, so it was difficult to discern if the timber operations themselves contributed to the high magnitudes of disturbance since unmanaged areas adjacent to salvaged stands had similar patterns of disturbance.

Areas that reburned did not appear to have significantly more disturbance than other burned areas.

VESCO

Most disturbance associated with vegetation removal conducted under VESCO permits after wildfire events was not discernable from disturbance caused by wildfire. However, if vegetation was removed from areas that had low severity burn damage, disturbance was detected, and conversion could be observed from satellite imagery. Predominant forest alliances where conversion was detected was oak woodlands (*Quercus* sp.) and other hardwoods, knobcone pine, and Douglas-fir. Less common were Sierra foothill pine and redwood alliances.

Forest Disturbance not from Wildfire

Data were collected for areas that did not experience wildfire since 2013 and a time series analysis was conducted for each year of the study period to detect disturbance that might have occurred within fire footprints prior to a wildfire event (Table 4. Within Sonoma County, 16,212 acres (1.6%) exhibited some magnitude of disturbance, with 5,963 acres (37% of disturbed areas) classified as native forest. Private lands experienced most of the disturbance at 4,436 acres, with public lands accounted for 1,527 acres.

Table 4. Summary of Landtrendr disturbance data by forest alliance for areas that did not experience wildfire, 2013-2021.

Forest Alliances	Disturbance not from Wildfire, 2013-2021			
	Disturbance (acres)	% Total*	Public Land	Private Land
ABGR	-	-	-	-
ACMA	2.4	0.3%	1.4	1.0
AECA	0.0	0.0%	-	0.0
ARME	165.3	0.8%	65.2	100.1
HEMA21	-	-	-	-
HEMA22	61.3	11.8%	33.8	27.5
HESA	20.4	0.3%	8.0	12.4
NODE	366.5	1.8%	68.6	297.9
PIAT	48.0	1.1%	20.2	27.8
PILA	2.5	0.4%	-	2.5
PIMU	384.2	14.2%	226.5	157.7
PIPO/PSME	0.4	0.1%	0.0	0.4
PIRA	16.7	5.3%	1.5	15.2
PISA/QUDA	4.3	0.2%	0.3	4.0
POFR	53.1	2.3%	1.7	51.4
PSME/NODE	65.8	0.5%	7.5	58.3
PSME	874.2	0.9%	176.2	698.0
QUSP	178.1	0.4%	14.3	163.8
QUAG	248.8	0.6%	18.2	230.6
QUCH	16.6	0.2%	3.1	13.5
QUDO	73.2	0.9%	0.3	72.9
QUDU	16.3	0.4%	3.1	13.2
QUGA	109.3	0.2%	15.0	94.4
QUKE	19.2	0.2%	1.7	17.5
QULO	100.1	0.8%	5.6	94.5
QUWI; tree	48.8	0.4%	8.4	40.4
SESE	2,715.8	2.6%	820.3	1,895.5
Riparian	62.2	2.1%	-	62.2
UMCA	221.1	0.5%	26.3	194.8
Vancouver	82.4	1.1%	-	82.4
Total area forest distrubance	5,963.1		1,527.2	4,435.9
Total area forest alliances		529,479.6	89,346.1	429,029.7
Total area of disturbance across all alliances	16,212.9		3,037.8	13,175.1
Total area of all alliances		1,018,471.7	133,646.5	884,825.2

* Approx. proportion of total area for each forest alliance in Sonoma County.

California Timber Regulation and Environmental Evaluation System (CalTREES)

Of the 32 *Timber Harvest Plans* (THPs) documented from 2013 to 2021, 16 were active or completed (5,405 acres), 11 were still in review or had not started (2,550 acres), and five had expired or were denied at the time of data collection. THPs were submitted for redwood and Douglas-fir dominant forests stands. Table 5 summarizes data for the other regulatory permits documented in CalTREES during the period of 2013 to 2021.

Table 5. CalTREES data summarized by permits submitted in areas that did not experience wildfire, 2013-2021.

Permit	Year	No. of Permits	Acres	Redwood	Ponderos/ Sugar Pine	Douglas-fir	Fir	Port-Orford Cedar	Cedar (IC, WRC)	Other Conifer	Other Hardwood
< 3 Acre Conversion	2015	1	-	5%	-	85%	-	-	-	-	10%
	2019	1	-	99%	-	1%	-	-	-	-	-
10% Dead, Dying, & Diseased	2013	16	4,249.0	15%	1%	67%	1%	-	-	-	17%
	2014	13	6,401.5	7%	17%	61%	4%	1%	-	-	11%
	2015	13	1,488.0	7%	0%	71%	-	-	-	-	21%
	2016	12	3,226.6	10%	-	43%	1%	-	-	-	46%
	2017	7	2,345.0	14%	-	71%	1%	-	-	1%	11%
	2018	9	20,605.0	3%	3%	72%	1%	-	-	1%	19%
	2019	2	1,128.0	3%	-	85%	3%	-	-	-	10%
	2020	6	8,155.0	14%	1%	76%	1%	-	-	-	8%
	2021	3	6,040.0	5%	33%	53%	2%	-	-	-	7%
Total		**81**	**53,638.1**								
Public/Private Utility Right-of-Way	2013	1	10.0	-	-	-	-	-	-	-	100%
	2014	3	2.6	30%	-	67%	-	-	-	3%	-
	2015	1	10.0	50%	-	50%	-	-	-	-	-
	2016	1	10.0	-	-	-	-	-	-	-	100%
	2017	4	15,773.4	10%	2%	44%	-	-	-	-	45%
	2018	12	1,917.2	39%	1%	22%	8%	-	-	1%	29%
	2019	42	86,601.3	12%	2%	11%	-	-	-	3%	72%
	2020	25	64,172.8	15%	2%	8%	-	-	-	2%	73%
	2021	2	32.0	80%	-	20%	-	-	-	-	-
Total		**91**	**168,529.3**								
Structures Protection (0-150 ft)	2013	17		93%	0%	7%	-	-	-	-	0%
	2014	7		56%	8%	31%	17%	-	-	-	5%
	2015	1		10%	-	90%	-	-	-	-	-
	2016	1		95%	-	5%	-	-	-	-	-
	2017	7		35%	-	65%	-	-	-	-	-
	2018	15		58%	-	24%	1%	6%	0%	0%	11%
	2019	7		54%	-	46%	-	-	-	-	-
	2020	7		47%	17%	35%	-	-	-	-	2%
Total		**62**									
Structures Protection (150-300 ft)	2017	1		95%	0%	5%	-	-	-	-	0%
	2018	1		100%	-	-	-	-	-	-	-
	2020	1		100%	-	-	-	-	-	-	-
Total		**473**	**444,335**								

Sonoma County Vineyard and Orchard Site Development (VESCO)

Fifty-eight VESCO permits were analyzed for changes in vegetation not associated with post-wildfire activities (Table 6). The time series analysis of disturbance data was used for project areas that fell within fire footprints to detect changes in vegetation prior to wildfire events. Some magnitude of disturbance was detected on 204.1 acres of forested area within the 687 project acres identified in the dataset (Table 7).

Table 6. VESCO data for areas not associated with post-fire activities, 2013-2021.

Year	No. of Permits	Acres	Trees/ac removed
2012	4	41.0	7.3
2013	4	122.1	15.8
2014	2	10.8	4.5
2015	1	21.0	1.0
2016	20	187.2	33.2
2017	11	113.3	32.1
2018	5	65.8	14.7
2019	5	68.6	19.3
2020	3	17.2	1.0
2021	3	40.0	14.6
Total	**58**	**687.0**	**143.5**

Table 7. Disturbance data summarized by forest alliance for VESCO project areas not associated with post-fire activities, 2013-2021.

Forest Alliances	Disturbance (acres)	% Total*
ABGR	-	-
ACMA	-	-
AECA	-	-
ARME	2.8	0.0%
HEMA21	-	-
HEMA22	0.4	0.1%
HESA	-	-
NODE	0.2	0.0%
PIAT	0.5	0.0%
PILA	-	-
PIMU	-	-
PIPO/PSME	-	-
PIRA	-	-
PISA/QUDA	1.3	0.1%
POFR	0.2	0.0%
PSME/NODE	0.8	0.0%
PSME	27.3	0.0%
QUSP	34.9	0.1%
QUAG	57.4	0.1%
QUCH	1.1	0.0%
QUDO	37.3	0.5%
QUDU	8.8	0.2%
QUGA	5.6	0.0%
QUKE	6.0	0.1%
QULO	5.7	0.0%
QUWI; tree	1.8	0.0%
SESE	2.3	0.0%
Riparian	0.1	0.0%
UMCA	6.6	0.0%
Vancouver	3.0	0.0%
Total area forest distrubance	**204.1**	

* Approx. proportion of total area for each forest alliance in Sonoma County.

General Observations

The Landtrendr analysis detected a high amount of vegetation disturbance in the coastal forests, notably in central and northern areas. Landtrendr data compared to satellite imagery indicated much of the disturbance in the central coast appeared to be associated with tree decline and mortality likely associated with a suite of forest health issues (e.g., sudden oak death related mortality of tan oak and several true oak species, bishop pine decline, balsam woolly adelgid and decline in grand fir, and drought and stand condition related mortality in Douglas-fir). In north coast areas changes in vegetation appeared to be associated with both forest health issues and active forest management (e.g., timber harvests).

Development and new construction contributed to some of the disturbance detected in urban areas.

In general, areas that had large numbers of dead or dying standing trees or where bare soil had been exposed for an extended period had the most significant magnitudes of disturbance in this analysis.

THPs

Comparing satellite imagery with disturbance data, the magnitude of disturbance was not the same for all forest management activities conducted in *THPs*, nor was disturbance detected on all project acres. Sites that appeared to use even-aged silvicultural practices had more disturbance detected and had higher magnitudes of disturbance when compared to sites with uneven-aged silviculture. Timing of management activities was also an important factor for how much vegetation disturbance was detected,

regardless of management practice (i.e., older projects exhibited less disturbance than newer projects). Additionally, not all disturbance detected within redwood or Douglas-fir forests appeared to be associated with *THPs* and included other types of permitted tree removals or forest health issues.

Dead, Dying, and Diseased

There were 53,638 acres of project area under this permit; however, the permit limits removals to <10% of the standing tree basal area and most project areas did not exhibit disturbance in the analysis. When disturbance was detected, it appeared to be associated with tree decline and mortality on the landscape and was not specific to the project area.

Public/Private Utility Right-of-Way

These permits accounted for 168,529 acres of project area, most of which were part of the PG&E Enhanced Vegetation Management program. Under this program, approx. 200 ft buffers centered on utility infrastructure are established by the removal or reduction of vegetation. A significant proportion of the forest alliances impacted by these projects were hardwood forests.

Visual inspection of permitted areas with Landtrendr data detected small areas of minor disturbances; however, no disturbance was detected in most project areas, even though the management activities in some instances resulted in vegetation conversion along the utility corridor. The likely under-detection of these changes in vegetation in the analysis was potentially due to several causes. First, for several urban area projects it appeared only a few trees were removed along the linear corridor which did not result in a significant change in vegetation structure. Second, most utility right-of-ways were already established prior to the study period; therefore, the removal of several trees along the corridor did not appear as significant disturbance events. Lastly, when large numbers of trees were removed along the utility corridor, the rapid "green-up" of vegetation (e.g., regeneration of grasses, shrubs, and trees) masked any change in vegetation structure.

Structure Protection

A visual inspection of data with satellite imagery indicated disturbance was detected for structure protection projects, but typically only when many trees were removed. Since the permit limits tree removal to within 300 ft (common project sizes were ~ 1 acre) of legally permitted structures, disturbance appeared associated with areas that already exhibited other types of conversion (clearings, roads, structures, infrastructure, etc.).

VESCO

Disturbance was detected at varying magnitudes within VESCO project areas. Satellite imagery confirmed high magnitudes of disturbance were associated with significant tree removal and conversion of vegetation. In several instances, disturbance was detected for projects in which it appeared only a few trees were removed for expansion of agriculture practices.

Disturbance was detected for both Level I and Level II projects. Observation of satellite imagery and disturbance data suggested there was not a noticeable difference in disturbance detected between project levels. In several instances, Level II projects did have larger areas and higher magnitudes of disturbance.

References

CAL FIRE. 2022. California Timber Regulation and Environmental Evaluation System (CalTREES), https://caltreesplans.resources.ca.gov/caltrees/Default.aspx. Accessed: 27 Jan 2022.

CAL FIRE Fire and Resource Assessment Program. 2021a. California Fire Perimeters, https://services1.arcgis.com/jUJYIo9tSA7EHvfZ/ArcGIS/rest/services/California_Fire_Perimeters/FeatureServer/0. Accessed: 1 Nov 2021.

CAL FIRE Fire and Resource Assessment Program. 2021b. CAL FIRE Ownership Maps, https://egis.fire.ca.gov/arcgis/rest/services/FRAP/ownership/FeatureServer. Accessed: 1 Nov 2021

Kennedy, Robert E., Yang, Zhiqiang, & Cohen, Warren B. 2010. Detecting trends in forest disturbance and recovery using yearly Landsat time series: 1. LandTrendr - Temporal segmentation algorithms. Remote Sensing of Environment, 114, 2897-2910

Sonoma County Water Agency, Sonoma County Agricultural Preservation and Open Space District, Sonoma County Vegetation Mapping and LiDAR Program. 2017. Sonoma County Vegetation and Habitat Map (v. 5/1/17).

Appendix A.

# Vegetation Burn Severity from Wildfires in Sonoma County, 2013-2021
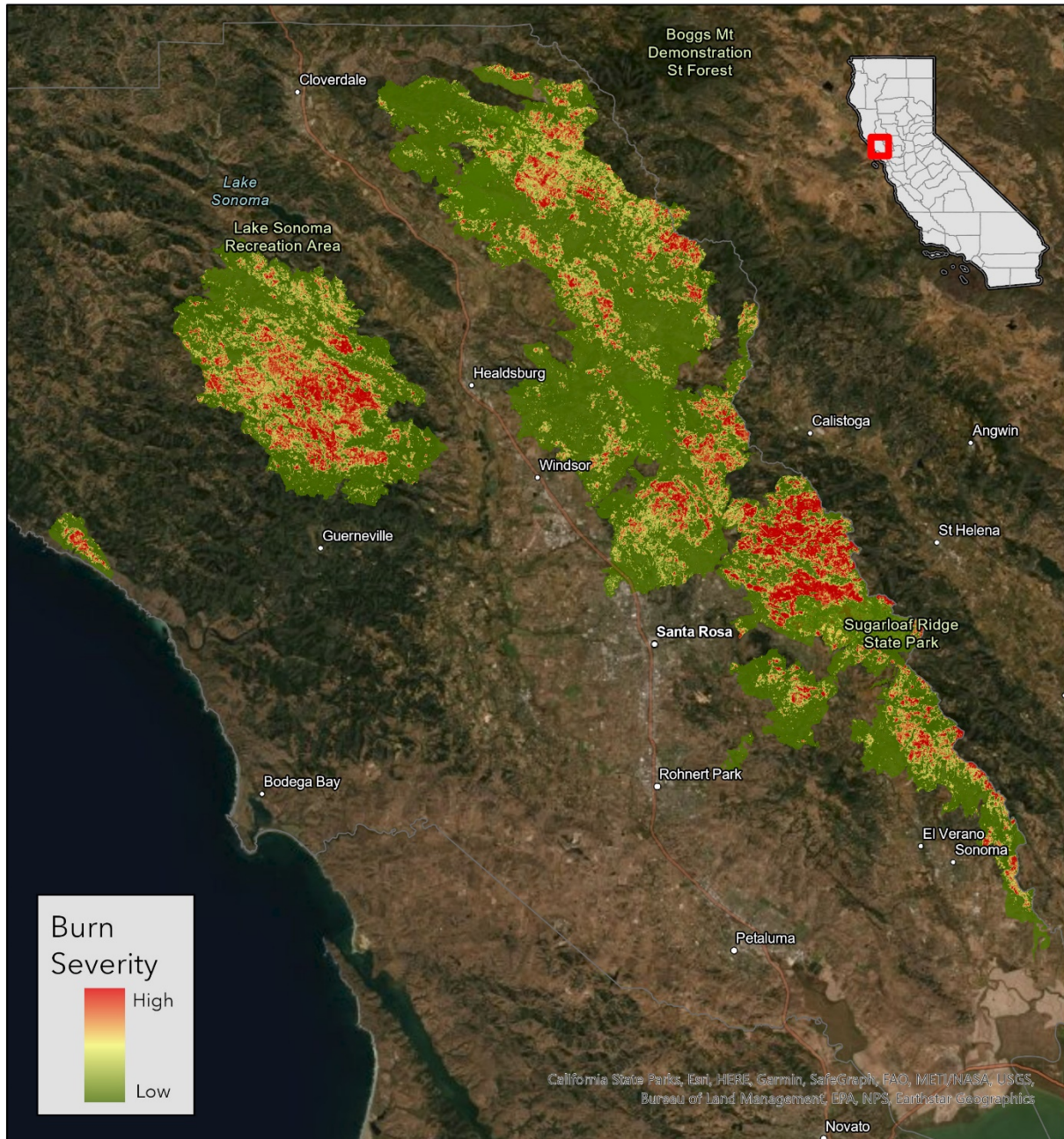
Relativized burn ratio was determined using the model developed by: Parks SA, Holsinger LM, Voss MA, Loehman RA, Robinson NP. 2018. Mean composite fire severity metrics computed with Google Earth Engine offer improved accuracy and expanded mapping potential. Remote Sensing 2018, 10, 879. Available at - https://www.mdpi.com/2072-4292/10/6/879. This map is intended for use as a reference only. Map by: M.I. Jones.

Appendix B.

Wildfire Footprints and Vegetation Disturbance in Sonoma County, 2013-2021
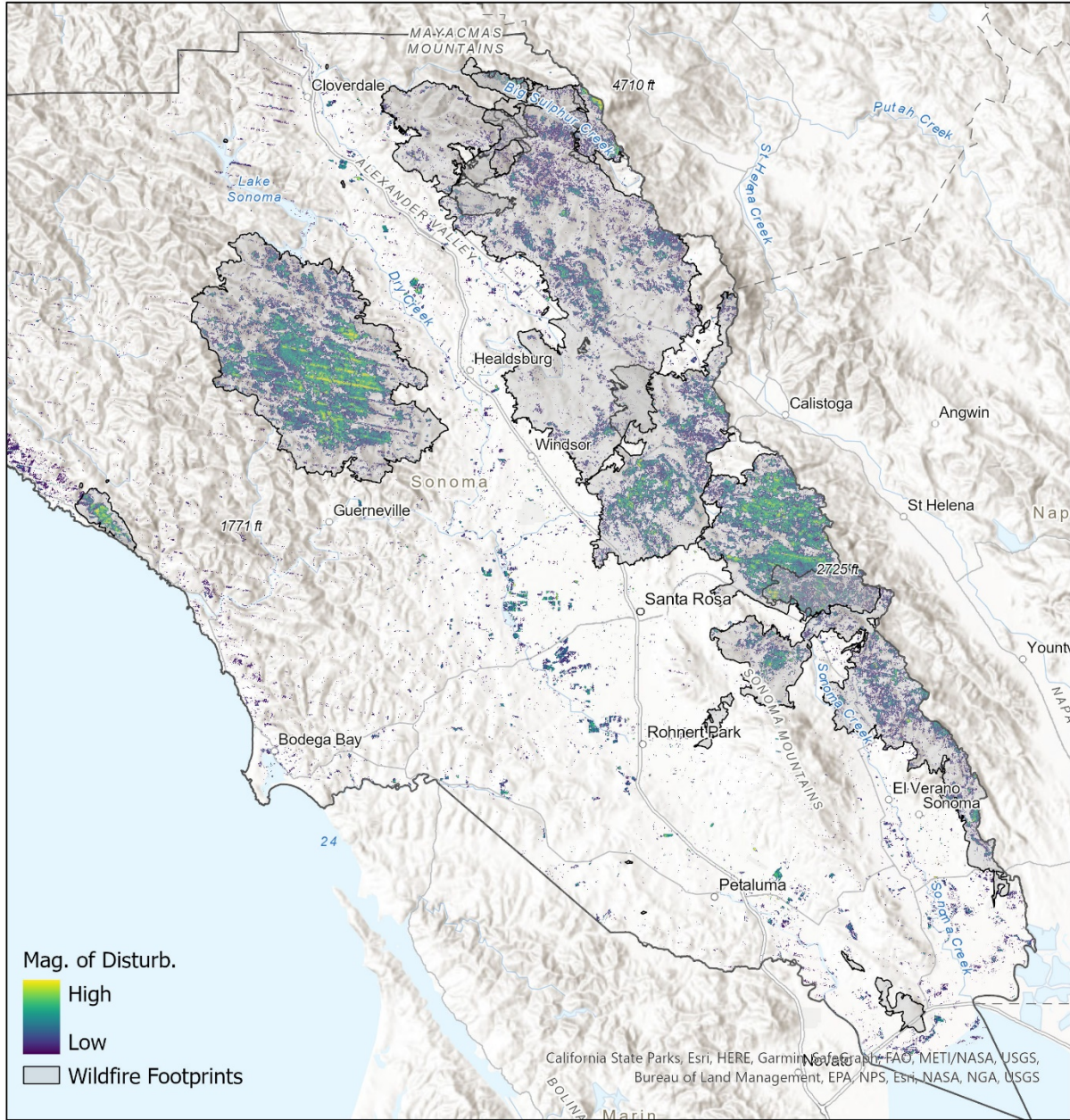
Mag. of Disturb.
High
Low
Wildfire Footprints

Vegetation Disturbance was determined by measuring the change in NDVI (normalized Difference Vegetation Index) values from 2013 to 2021 using the remote sensing model LandTrendr tools in Google Earth Engine. Color-coding indicates magnitude of disturbance.
This map is intended for use as a reference only. Map by: M.I. Jones.

0   4   8   16 Miles

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