Figure 1 Zone 5 PG&E crews repair destruction caused by falling trees along Mesa Road

The Bolinas Eucalyptus Project Inventory: Zone 5

A REPORT ON THE INVENTORY OF BOLINAS PUBLIC UTILITY DISTRICT AND ADJOINING TREES IN ZONE 5

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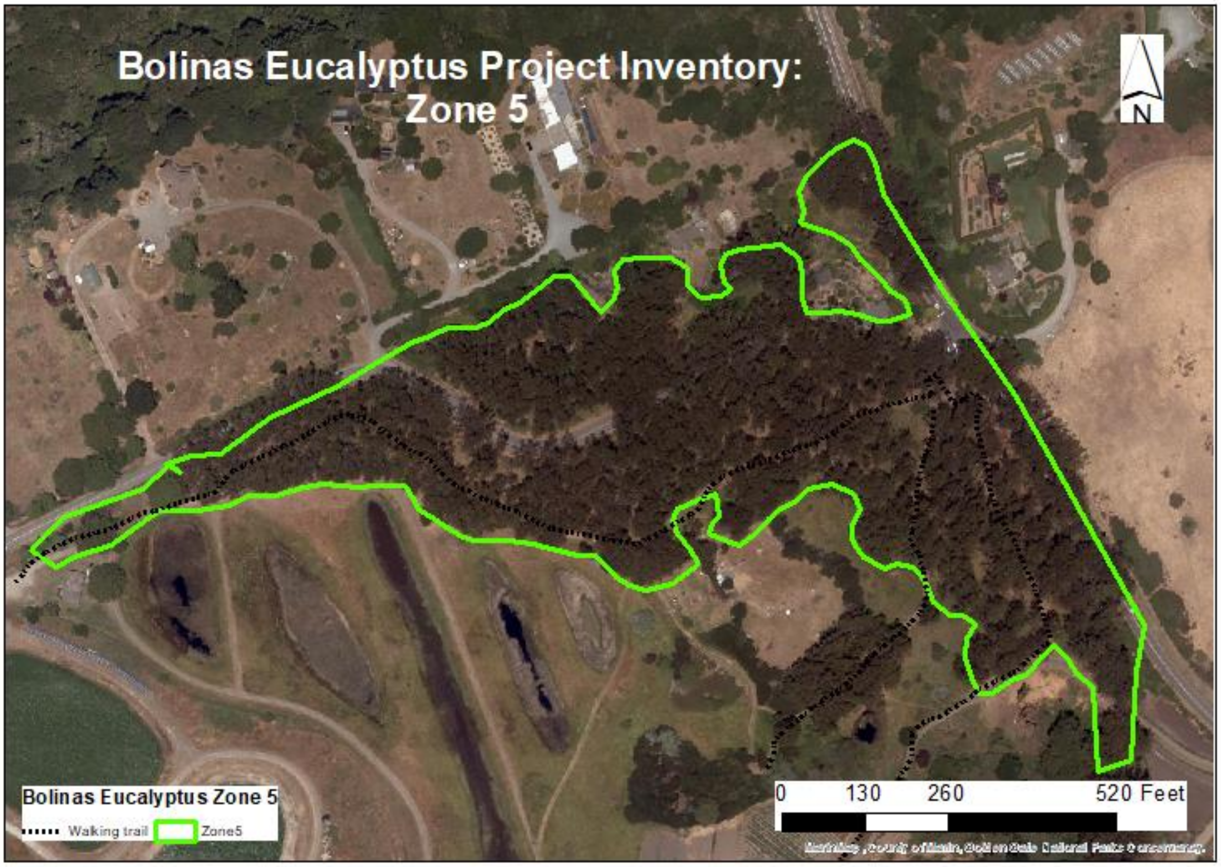

Figure 2 Zone 5   11.9 acres

1. INTRODUCTION

Iconic stands of Tasmanian blue gum (*Eucalyptus globulus*) trees have been a part of California's cultural heritage since the 1860's. They were to be the timber solution for a state about to run out of wood (Farmer, 2014). Millions of blue gums were planted throughout the Bay Area. Today Eucalyptus trees are the fading Bay Area tree giants. Stands of Eucalyptus are experiencing decline and tree mortality due to drought, winds, the maturation of over-crowded stands and disease (Dowd 2021).

The Eucalyptus trees in Bolinas are no exception. Blue gum woodlands were planted around 1900 at several locations. The stand known today as "Zone 5" at Mesa Road and Olema-Bolinas Road was most likely established as a windbreak. The trees survived and thrived. They grew rapidly and apparently also sprouted or seeded into adjoining areas that today comprise a pure 11.9 acre stand. Bolinas Public Utility District (BPUD) owns 7.6 acres and another 2.9 acres are owned by adjoining private landowners. The trees overhang the roadway on the remaining 1.4 acres. Roadside trees were topped when quite young and they responded by sprouting vigorously. Those same trees were topped again during the 1960's. Today Eucalyptus trees have grown up to 170 feet tall and many are over 60” in diameter at breast height. In 2011 BPUD, cognizant of increasing risks of wildfire and need for safer emergency ingress/egress, thinned and reduced the grove’s woody fuels. This was done by removing the thicket of smaller trees, the understory shed bark, fallen branches, climbing ivy vines, accumulated leaf litter and decomposing wood on the forest floor of its portion of the stand (south of Mesa Road). Meanwhile many backyard Eucalypts on the northern 3 residential parcels have been pruned, thinned or removed, while others are in a wild condition untended for a century by the landowners and residents.

More recently the Bolinas Eucalyptus Project has been calling for the removal of the hazardous trees. The call for removal has become more urgent following the 2023 January chain of atmospheric river events which, over the course of a few days, blew down 24 large trees measuring up to 63” in diameter. Luckily nobody was killed although 2 persons were severely injured in their vehicle when it was crushed by a falling tree. Several vulnerable homes are located nearby and when blue gums blow down, the results can be catastrophic. Another cause for concern is that the popular public walking trails through Zone 5 place users at risk from falling debris.

Recent blow down has apparently also enlarged wind corridors increasing the likelihood of ongoing windthrow. The large old trees are falling, so the call has come from many members of the community to remove the Zone 5 Eucalypts and embark upon a native forest habitat restoration project.

Tree work is extremely expensive and environmental constraints in the coastal zone are many. It makes sense to physically quantify any large vegetation management project as part of the planning process. When the BEP contacted Tom Gaman, a Registered Professional Forester who lives nearby, he recommended, with approval of resident and BEP leader Jon Cozzi, a 100% tree inventory project. Gaman designed an inventory which includes detailed maps, and a count of all trees so the community knows exactly what is there, and where. This report is the analysis of measurement of all the trees. It includes assessment of stand condition, “target” hazards of falling branches on trails, roads and buildings, Monarch observances, analysis of 2023 blowdown, estimation of surface fuels, a calculated figure of total cubic foot volume, biomass with carbon equivalents, online ground and aerial imagery, the base field data, and other information.

2. ZONE 5 LOCATION

The village of Bolinas includes several Eucalyptus stands. The largest is known as Zone 5, an 11.9 acre stand, surrounding the intersection of the Olema-Bolinas Road and Mesa Road and extending along both roads. All residential, commercial and tourist traffic coming and going passes through this intersection, a 3-way stop.

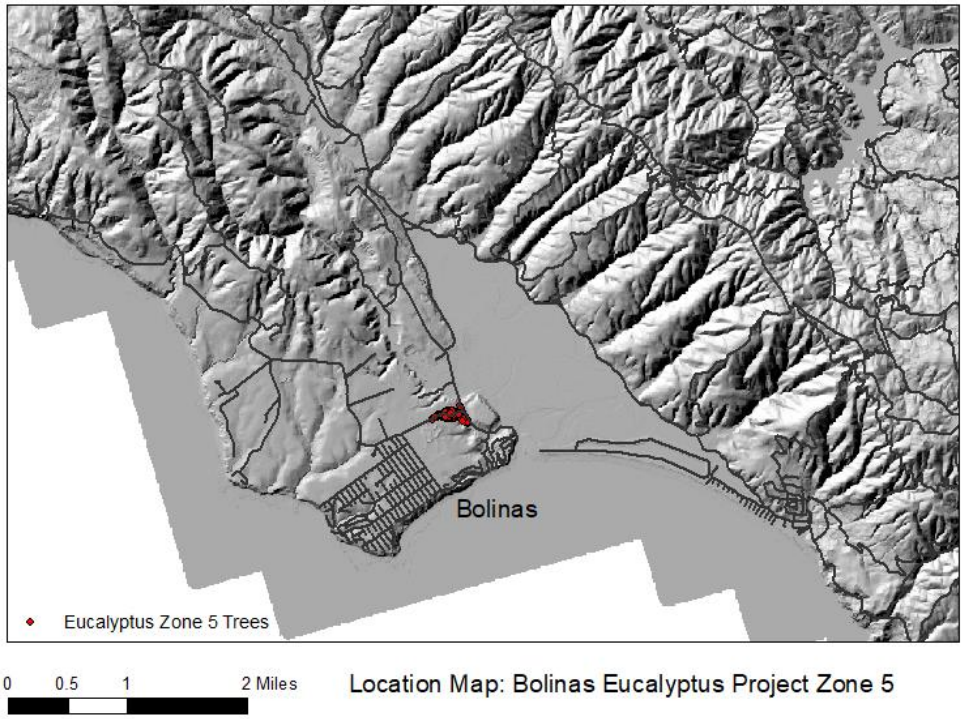

Figure 3 Zone 5 location map

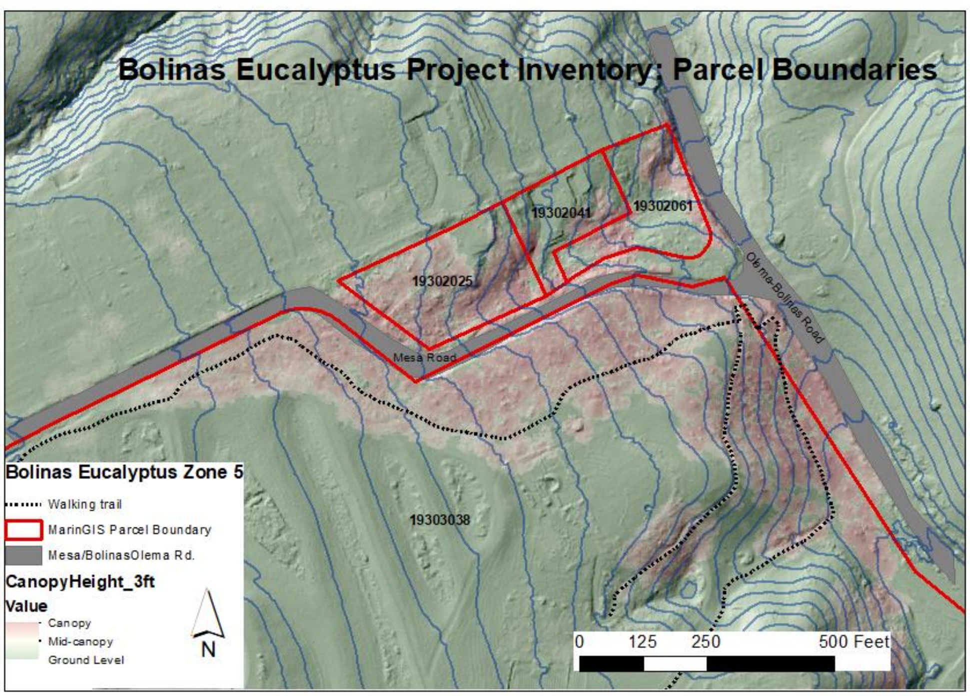

Figure 4 Zone 5 Marin Parcels. The 3 smaller parcels are privately owned, and the large southern parcel belongs to the Bolinas Public Utility District

3. METHODS

This 100% georeferenced inventory of the grove provides necessary baseline planning information. The forester designed the inventory to include measurements and a GPS waypoint for every tree in 20+" diameter-at breast height" (dbh) classes and to provide sufficient georeferencing. Diameter of each of the smaller trees surrounding each 20+ inch larger measure tree, when present, was estimated and the total number of smaller co-located trees was also recorded at each location. Smaller trees were assigned randomized coordinates on a 10x10 meter grid surrounding the applicable nearest larger measure tree so location of each could be approximated and mapped with reasonable accuracy.

Round aluminum 16d nails were used to attach aluminum numbered tags near the base of each measure tree. Prior to field work, each tag and nail was lightly sprayed with brown paint at the office so that tags would blend in well and trail users would not notice them. Each tree was assigned a tag numbered from 00 to 99, and the GPS assigned waypoints of the same number prefixed with a single letter (A through N) to avoid possible confusion of duplicated tree tags. The waypoints were collected using a Garmin Csx60 GPS that, under ideal conditions, is capable of 3- to 5-meter accuracy.

In the field the forester measured each 20"+ diameter class tree with a steel diameter tape and/or a Biltmore stick (which triangulates diameter). The forester used a survey grade Impulse 200 laser with a built-in clinometer to measure a subset of tree heights throughout the grove and estimated the others so that height was recorded for 100% of the measure trees. With a few minor exceptions each tree with 19.5" or greater diameter (20"+ class) is tagged near its base with an aluminum numbered tag. The diameter, height, canopy width, live crown ratio (crown status), condition, position, rot defect, Monarch observations, and potential local hazard target was recorded for each of these "measure" trees. All data variables are listed below:

Table 1: Measure Trees >=19.5" at breast height (20"+ diameter classes)

For measure trees (20+ inches diameter classes) the following data were recorded:
Grove name
Date
Tree Tag #
Waypoint ID
Tree Species
Stems (of measure tree plus surrounding dbh only count trees)
DBH1 (in)
Height (ft)
% Defect
Crown Diameter (ft)
Position
Condition
Tree Photo
Branch/Bole Structure
Target hazard
Live Crown Ratio
Photo Series Fuels (tag 10x)
Butterfly Use observation
Notes

It is also important to have an accurate count of the smaller trees but detailed data is not as important. Therefore the smaller trees, as explained above, were counted and attributed with estimated diameter and approximate location.

Table 2 Trees <20" diameter at breast height

For smaller "satellite" trees diameter only was estimated for each tree up to a maximum of 7 trees (including the measure tree (DBH1).
Species
DBH2
DBH3
DBH4
DBH5
DBH6
DBH7
Instrument Longitude
Instrument Latitude

The tabular data items were collected using the smart phone app "GISCloud". At the end of each field day data were downloaded and imported to Excel and into ArcGIS 10.8.4. The forester also randomly photographed approximately half of the trees measured and GISCloud attached the photo to the applicable tree data set. The individual photographs with accompanying tree numbers are included in the Excel file named "Bolinas_Zone5_photo_report.xlsx" available as an 80 Megabyte download[1].

Given the thousands of data items the GISCloud app served as an excellent tool with which to keep data collection organized and efficient.

MAPPING

Standard GIS mapping tool ArcGIS served to georeference and map all of the Zone 5 trees. Standard topographic contours, LIDAR "Hillshade" raster data, vector data for roads, and NRCS "NAIP Imagery" provide locational context for the maps. In the office the technician digitized the local roadway using the Hillshade model as a base map[2]. Given the dense stand of trees it turned out that the Garmin GPS and the Android smart phone GPS did not in many cases provide the exact location of trees. For example, many roadside trees appeared in the middle of the road. The maps show adjusted locations for many roadside trees to improve mapping accuracy. Within the stand some trees may be mapped outside of the 3-5 meter locational tolerance that the Garmin device had estimated in the field.

BLOWDOWN

During January 2023 severe rainfall and windy weather struck the Northern California coast in the form of a string of 9 "atmospheric river" storms. Over several nights 24 trees in the stand blew down. All trees in the blowdown area were measured after the storm when they were already on the ground. As such, post-storm blow down inventory and standing tree inventory are independent of each other and reported separately here. Please refer to the blowdown section below under "Results".

[1] Photos, Excel files, aerial video, and maps located for public access at https://drive.google.com/drive/folders/1CV_BGTtmhURdHhsIrPEJJqJ9wqpd7PXe?usp=sharing

[2] See https://gisopendata.marincounty.org/

4. RESULTS

THE TREES

The grove at Zone 5 is one of many stands of Tasmanian blue gum (Eucalyptus globulus) in the Bolinas area. Based on a ring count of one roadside tree that fell in January 2023, this grove of Eucalyptus was planted around 1900. Untended trees within the grove soon spread and developed to dominate 11.9 acres in 2 age groups, “roadside “and “sprouts”. Trees within the grove are largely untended except that some understory fuels and trees up to 8” in diameter were in 2011 thinned from the BPUD parcel to reduce fire hazard, resulting in the clean, open and parklike understory ground cover that is mowed each year and still exists there. Electric and phone wires are strung on poles running along Mesa Road and Olema-Bolinas Road. The trees themselves have long been in competition with each other for sunlight, moisture, and nutrients. The recent drought has also affected the stand. Throughout the stand dead branches are scattered within the crowns of all but those trees (27% of total) assessed as in “Good” condition. In some areas, particularly on the private parcels, English ivy (*Hedera helix*) and Cape ivy (*Delairea odorata*) are covering the ground and clinging to the trees. A few coast live oaks (*Quercus agrifolia)* and even two understory Douglas-fir (*Pseudotsuga menziesii)* trees have survived in less-shaded areas, but the ground understory does not support any other significant native vegetation.

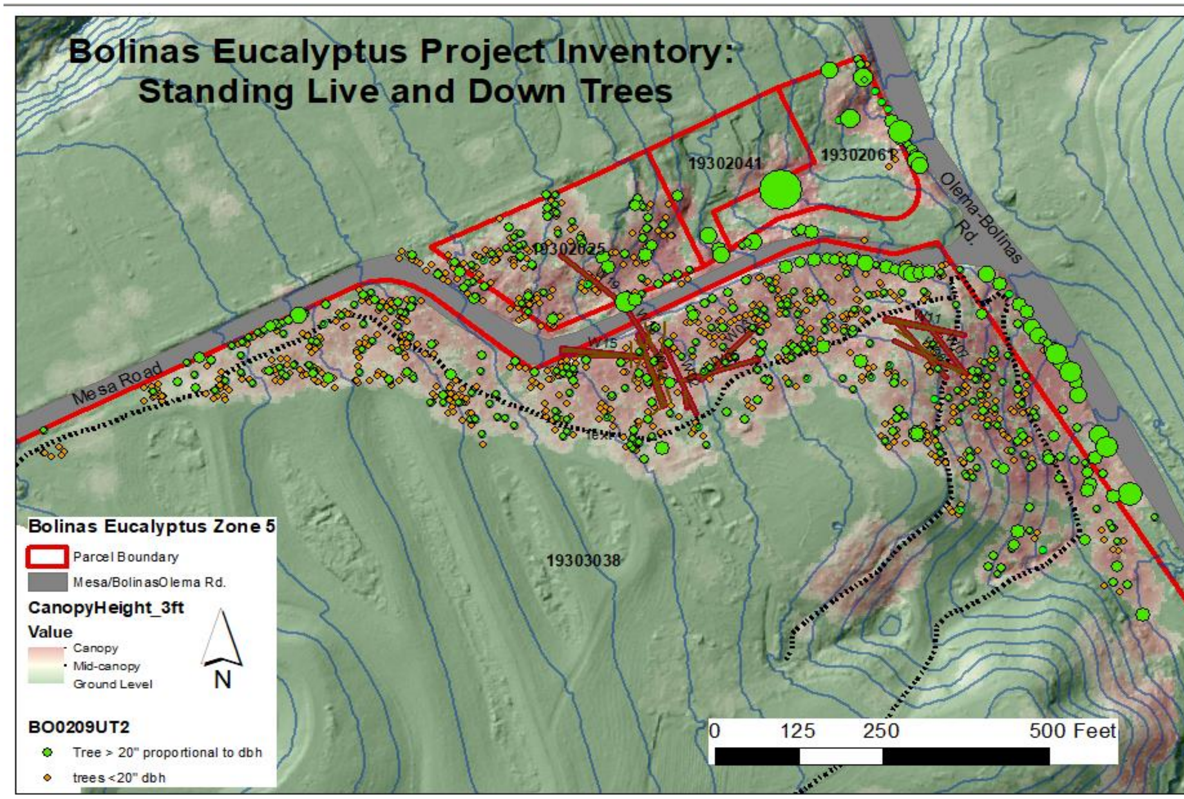

Figure 5 1139 trees. 11.9 acres. The size of each green dot represents relative tree diameter

GPS TREE LOCATION

As noted above the GPS files identified only the approximate locations of each tree. Trees obviously in the incorrect locations, and streetside trees, were checked in the field and, where inadequate, the map locations were manually adjusted accordingly. On-site aluminum tags can be used to confirm tree identity in the field.

THE INVENTORY

<u>Measure trees.</u> Four hundred thirteen (413) live trees over 19.5” dbh were measured and GPS locations were recorded in the field. Detailed data items described above were recorded for each tree. The raw data are included in a file named “linkfile022323.xlsx” and this file is reproduced here in Appendix 5.

<u>Tree Species</u>. Of the large trees measured 399 (95.7%) were blue gum (*E. globulus*), the largest of which is a 140” Eucalyptus (which splits into 4 stems) near a house on the north side of Mesa Road. There were 12 Monterey cypress (*Cupressus macrocarpa*) and 6 Monterey pine (*Pinus radiata*), all of which are located at perimeter of the grove. A very small number of coast live oaks and Douglas-fir are also present at the edges of Zone 5 but none met the threshold for measurement.

<u># Stems by Diameter.</u> Tree diameters were measured to the nearest inch of diameter at breast height (4.5 feet off the ground on the uphill side of the tree) and assigned to diameter classes. For instance, a 19.6” tree is included within the 20” diameter class. There are 413 “Measure”

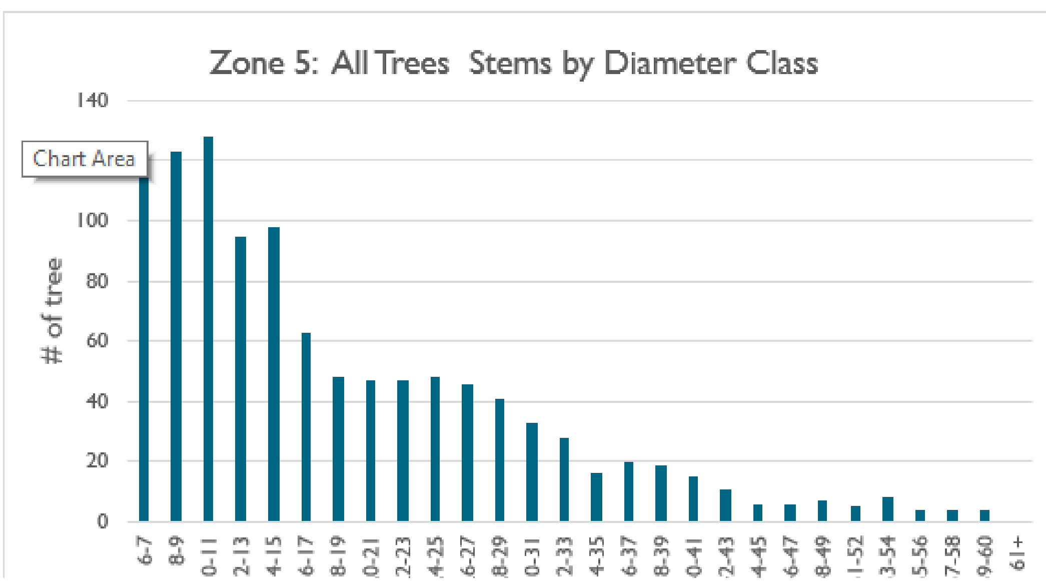

Figure 6 Number of trees by diameter class

trees in the 20” and above diameter classes in Zone 5 and 1139 trees including all trees 6” and larger. Figure 6 shows the number of trees in each 2-inch diameter class grouping.

Height (Ht). Individual "measure" trees were each assigned a measured or estimated height. Smaller trees were assigned heights in the office using a regression equation. Mature tree heights generally varied from 120' tall to 170' or more on better sites. Height competition is intense. Many of the smaller trees are almost equal in height to their more robust neighbors. Of the 413 large trees measured the average height was 132'.

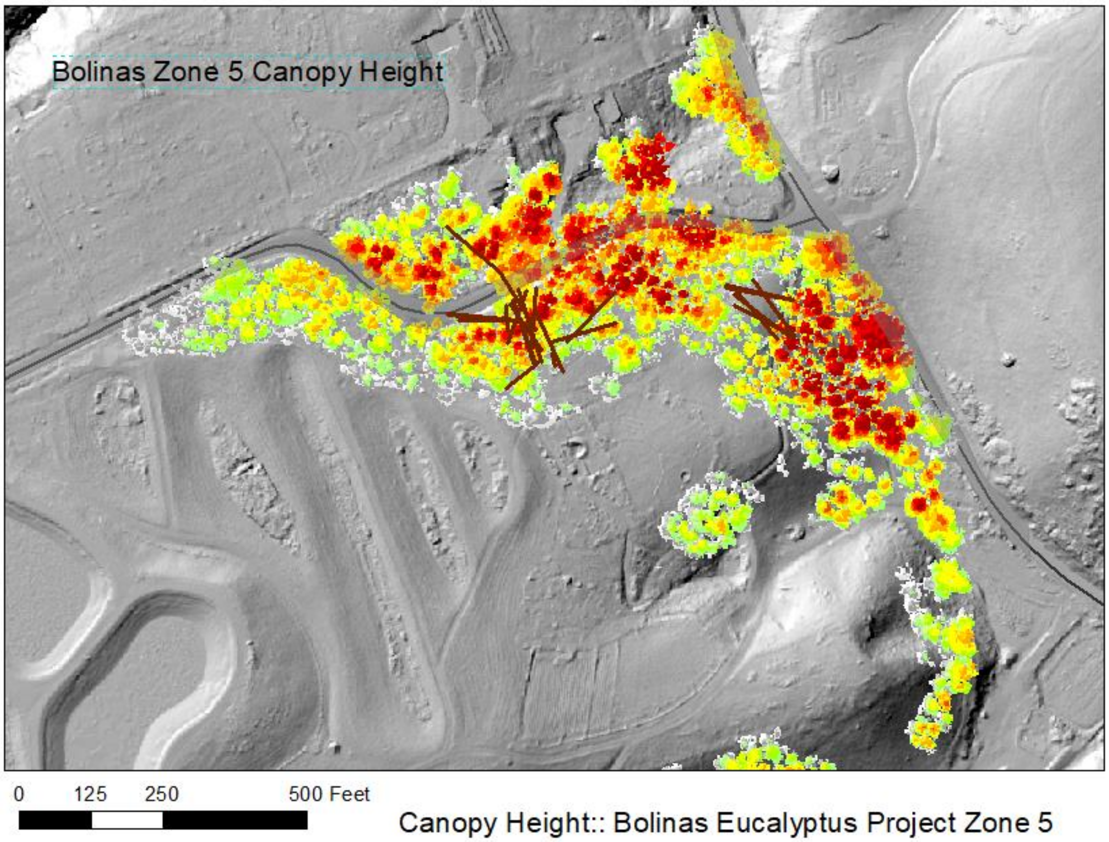

Figure 7 Canopy height: low to tall trees in white, green, yellow, orange and red respectively.

Crown Diameter. Crown width varied dramatically. Open grown trees and dominant trees without significant competition from neighbors had crowns spreading 40 to 60 feet or more. The many tall but smaller-in-diameter trees that are in crown competition with neighbors, and have endured prolonged drought, commonly had live crowns as low as 5 to 10 feet in diameter. The average crown width was 26 feet per ocular estimation of 413 "measure" crowns.

Live Crown Ratio. Live Crown ratio is the percentage of the total tree height which supports green live branching. The value is commonly used in assessing forest health and in modeling predicted future forest conditions. In natural stands in the Sierra and Coast ranges of California healthy trees normally exhibit a live crown ratio of 40% or more. In this stand the average live crown ratio is 24% reflecting intense competition among unhealthy tree crowns struggling for access to sunlight. Dead branches are interspersed with live branching.

Figure 8 Typical view of Zone 5 sparse Eucalyptus crown looking upwards

To further investigate the canopy and crown condition of the trees aerial drone imagery (flown March 1, 2023) vertical aerial photography and video demonstrates the crowded condition, branch mortality, and sparse foliage of the trees. The high-resolution photos and video are viewable online at the link in the footnote on page 7. Note the crowded stem density, sparse crowns and dead branches.

Canopy Closure. An important metric in forest stand assessment is canopy closure. This inventory does include a crown diameter estimate for each large measure tree. When all the trees' crown areas are compiled the large ("measure") tree canopy closure on the 11.9 acres is 55%. Placing a grid over Zone 5 and counting squares reveals a canopy density of 90%. The crowns are mostly non overlapping so this measurement indicates that 700+ trees less than 19.5" in diameter collectively share 35% of the crown space. As such the available canopy area represents insufficient crown availability for the codominant trees in the lower diameter classes. Throughout the inventory it was clear that most such smaller tree crowns are very sparse and most of those trees are severely stressed as a result.

Figure 9 Looking west toward sparse tree tops and crowded canopies at Zone 5. Aerial imagery March 2023.

Position. Each tree is evaluated as to its status relative to neighboring trees. Classifications are Open-grown, Dominant, CoDominant, Intermediate, and Suppressed as defined in the Forest Inventory and Analysis Field Handbook (Appendix 3, USFS 2021); 86% of trees were Dominant or Codominant[3]

Row Labels	Count of Position
1 Dominant	171
2. Codominant	184
3. Intermediate	48
4. Suppressed	5
5. n/a (broken)	5
Grand Total	**413**

Structure and Defect. Tree structure was also recorded for "measure" trees. Options were "None", "Previously topped", "Falling Branches" and "Shedding Bark" and combinations of these classifications. Fifty-six (56) trees, mostly roadside trees, had clearly been previously topped wherein the top of tree was removed and the live tree had responded by sprouting multiple tops, often leaving a structural wound vulnerable to wind throw, moisture accumulation and subsequent rot or breakage at a weak point. One hundred ninety-six trees had "Falling Branches" which means that there were "top heavy" or fully dead branches in the crown that can unpredictably fail even in calm weather. Nineteen trees had "Shedding Bark"

[3] See Appendix 2 US Forest Service 2021 FIA Manual

which could add to the fuel bed and fire hazard, and 156 trees had no structural issues. Many trees had “defect” which means that there are areas where rotten wood or another irregularity is evident. Defect is the percentage of visible wood volume in the stem of the tree suspected to include rotten areas often at risk of breakage that also would not be suitable for carbon storage or forest products. Most trees in the grove are defect free but some exhibited rotten bole or other areas of rot. Overall defect averaged 3.3% by volume. The internal effects of visible structural defects are classically illustrated by Alex Shigo (Shigo 1983) who spent his career investigating rot and woody defect in many species.

Condition. The forester used his experience and judgement to classify each measure tree according to its overall vigor into 3 groups: Good, Fair or Poor. Both “Fair” and “Poor” classifications outnumbered the “Good”. The reason for this is that these mature trees were never thinned and lived long lives in intense competition with one another for light, water and nutrients, and the condition of most reflects those life-long struggles. Also Dowd (2021) reports that Matteo Garbelotto, UC Berkeley Forest Pathologist, found two fungi, *Diaporthe foeniculina* and *Dothiorella viticola,* that seem to be ubiquitous in these trees, and may be negatively impacting Eucalyptus stands here. Voracious leaf chewing Australian tortoise beetles (Family *Chrysomelidae*) are also known to consume vast quantities of tree leaves in this stand of trees (Cozzi, 2023). With only 27% of trees in the “Good” condition group this begs the question of whether it is possible to sustain this fragile overstocked woodland much longer. Thinning is not the answer to improve health as this stand is highly exposed and vulnerable to severe and increasing wind disturbances.

Tree Condition

Classification	**Count of Condition**	**% of total**
Good	112	27.1%
Fair	177	42.7%
Poor	124	30.0%

Number of trees and basal area. There are 413 measure trees, and another 726 smaller trees growing among the larger measure trees. The diameter distribution is shown on Figure 6 above. Basal area is a commonly used forestry metric that describes stand stocking measured as the total combined area of stems at 4.5’ above the ground. For instance, a forest with 400 6” dbh trees per acre has the same basal area (sigma pi*radius squared; 78.5 sq. ft./acre in this example) as a stand with 100 12” dbh trees. When added together the trees at Zone 5 account for a basal area of 288 square feet of live growing stem per acre and represent an extremely densely stocked hardwood stand of trees. By comparison using the example above, a well-stocked coast live oak stand has about 80 to 100 square feet of basal area. This means that this area, a native coast live oak woodland, is now supporting about 3 times the woody basal area of its native condition, and the trees themselves are double the height of the natives, resulting in perhaps as much as 6 times the native biomass stocking by volume.

Biomass and Carbon. Trees in the inventory ranged from 6 inches to 140 inches in diameter at breast height. The overall average diameter is 19.4 inches for 1139 trees. Pillsbury et al. (1989) produced the volume equations for central California coastal Eucalyptus that became the basis for volume calculations. A portion of the Pillsbury report is replicated with tree tables and notes below:

TABLE 2. Blue gum eucalyptus volume table for California's central coast

	Total height in feet:														
DBH	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**	**130**	**140**	**150**	**160**	**170**
inches	*cubic feet*														
4	1	1	2	2	3	3	3	4	4	5					
6	2	3	4	5	6	6	7	8	9	10					
8	4	5	6	8	10	11	13	14	16	18	19				
10	6	8	10	12	14	17	19	22	24	27	29	32			
12		11	14	17	20	24	27	30	34	37	41	45	48	52	
14		14	18	23	27	31	36	41	45	50	55	59	64	69	74
16		18	24	29	35	40	46	52	58	64	70	76	82	89	95
18			30	36	43	50	58	65	72	80	87	95	103	111	118
20			36	44	53	61	70	79	88	97	106	116	125	135	144
22			43	53	63	73	84	94	105	116	127	138	150	161	172
24				62	74	86	99	111	124	137	150	163	176	189	203
26				72	86	100	114	129	144	159	174	189	204	220	236
28					99	115	131	148	165	182	200	217	235	253	271
30					112	131	150	169	188	207	227	247	267	287	308
32					127	148	169	190	212	234	256	279	301	324	347
34					142	165	189	213	237	262	287	312	337	363	389
36					158	184	210	237	264	291	319	347	375	404	433
38						203	233	262	292	322	353	384	415	447	479
40						224	256	289	321	355	389	423	457	492	527

NOTES: The equation for this table is: Volume (cubic feet) = 0.0015658 x DBH (in)^1.86903 x Tot Ht (ft)^1.13556.
Data shown are gross cubic foot volumes (outside bark) to a 2-inch top.

Figure 10 From Pillsbury et al. 1989

Heights were not recorded for trees <19.6" dbh. Using Excel the technician calculated the height for each of those trees via linear regression, then used the volume equation for English values (above) to calculate the cubic foot volume (Vol) for each Eucalyptus tree. Altogether, this process accounts for 163,852 net cubic feet of above-ground wood including bark but not branches. At the generally accepted cordwood volume denominator (85 solid cubic feet per cord, not including the airspace in a 128 cubic-foot cord of stacked firewood) the stand contains 1,927 cords of wood.

Tejedor calculated the specific gravity of *Eucalyptus globulus* at 571 kg per metric ton. Volume and carbon were calculated for the Eucalyptus trees only. The biomass of the Zone 5 Eucalyptus trees calculates to be 2,415 metric tons of which 79% is in the large trees. Three hundred ten (310) Eucalyptus "measure" trees, averaging 31" dbh and totaling 1391 metric tons above ground biomass, are located south of Mesa Road on BPUD property. Eighty-0ne (81) trees averaging 38" dbh, with 522 tons of biomass, are on north side private parcels. There are many trees among both groups likely located within the county road right of way. Biomass metric tons and carbon dioxide equivalents for above ground Eucalyptus are provided in the table below.

Table 3 Eucalyptus Biomass and Carbon Dioxide Equivalents

Bolinas Zone 5 Eucalyptus Only		
Area	**Biomass metric dry tons above ground**	**CO2 Equivalent metric tons**
South of Mesa Road 20"+ measure trees	1,391	2,548
North of Mesa Road 20"+ measure trees	522	956
Grand Total for all Zone 5 Eucalyptus Trees down to 6" dbh	2,415	4,424

Target Hazards. The grove is located at a sensitive area along main roads, near houses, and in an area with popular recreational trails. Tree failures have been dramatic. I assessed the immediate area around each tree for "local target" in the event of failure of branches or breakage of the upper stem. All measure trees were assessed plus 4 individuals that became place markers for smaller trees, which were not assessed for target hazards. Targets further than about 50 feet from each tree were not considered unless tree condition is poor and the tree is leaning in the particular direction of a clear "target". Overall almost 69% of trees had some local target in the immediate vicinity. Fifty-nine percent of the trees could potentially impact a road or trail.

Row Labels	Count of "Local Target" hazard	% of total
0. None	131	31.4%
1. Road	126	30.2%
2. Trail	120	28.8%
3. Building	40	9.6%

When great weather disturbances happen and Eucalyptus trees fail in the spectacular manner of the trees in this stand, and entire 150' tall trees and enormous branches collapse without warning, these numbers are not applicable. In such cases every tree is clearly a hazard tree. It is quite impossible to predict what will happen next, but it is at the same time very clear that this stand of trees at the gateway to Bolinas and Point Reyes National Seashore creates extraordinarily threatening roadside conditions.

Forest Fuels. Eucalypts are known for dropping branches that establish understory fuels and for creating fuel ladders simply by shedding bark, and for their highly combustible fragrant oils in the bark and leaves. The 1991 Oakland fire storm was unstoppable, partially due to blue gums burning out of control. Forest fuels accumulate in the understory and on the ground and, in times of drought when dry autumn winds reduce moisture content of the vegetation to very low levels, Eucalyptus stands pose a serious threat to nearby communities.

As part of the inventory the forester assessed woody forest fuels under most of the measure trees. The quick assessment was completed with the aid of the Wright and Vihnanek photo series which measured the woody ground fuels and classified them for field comparison with a photo series which includes photos of East Bay Eucalyptus stands classified from Low (1) up to High (7) categories.

Forest Ground Woody Fuels

Row Labels	Count of Woody Fuels	Tons per Acre per Wright and Vihanaek
1. EBE1	23	5.27
2. EBE2	91	8.23
3. EBE3	111	9.79
4. EBE4	83	13.43
5. EBE5	33	16.35
6. EBE6	22	13.91
7. HiF03 (estimated)	16	20

In an ideal world where the fuels reported by Wright and Vihnanek correspond perfectly with the conditions viewed in Zone 5 at Bolinas, the forest floor at present would be supporting 11 tons of woody debris per acre, but of course this is just an estimate. The fact remains, however, that the woody fuels on the forest floor vary dramatically over the area encompassed by Zone 5 as shown in the map below. Cognizant of the fire hazard, BPUD did some work in the grove in 2011 and the understory fuels were thinned out. Each year BPUD mows the area under the trees to maintain understory fuels at levels as low as possible. The map below shows the accumulation of fuels to be widely distributed (from low to high) throughout the grove.

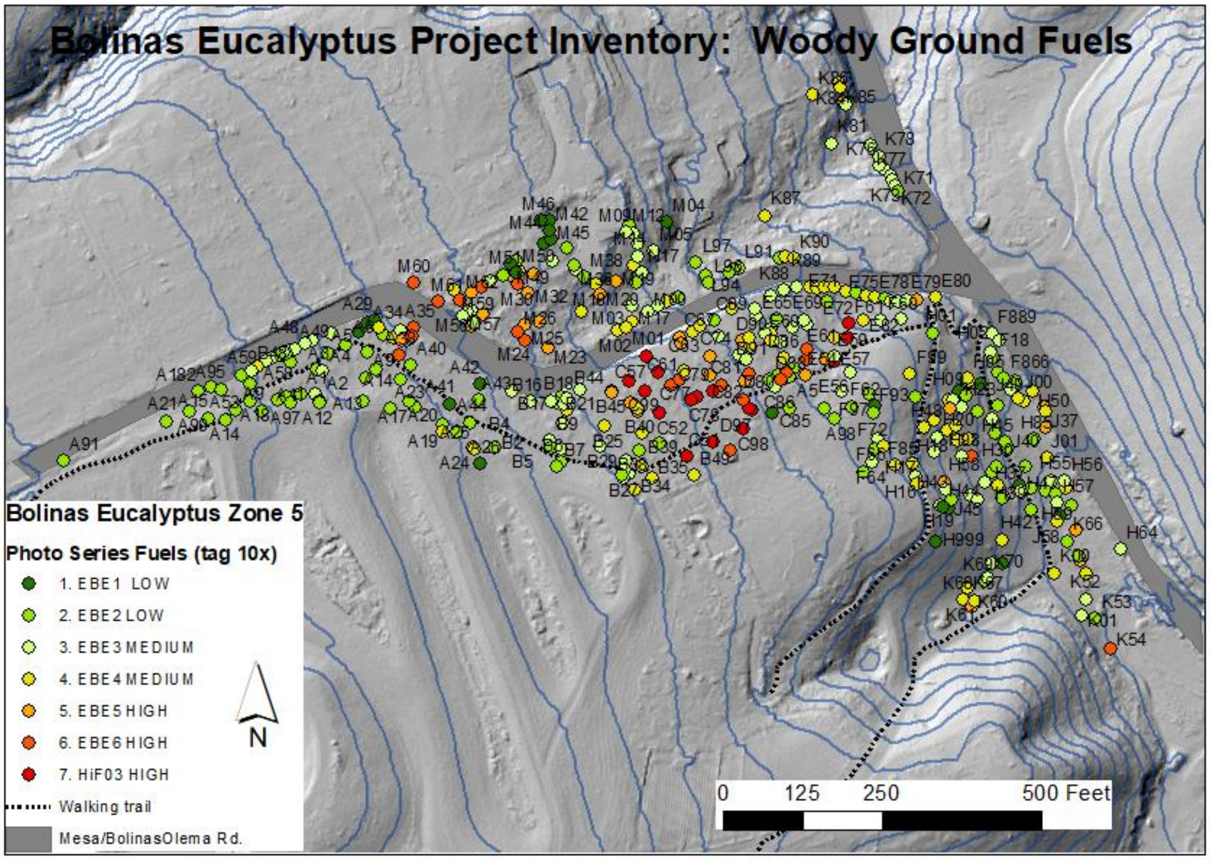

Figure 11 Woody ground fuels (Low in green and High in red)

WINDFALL AND BLOWDOWN TREES, ROOT STRUCTURE

During the January 2023 storm series 24 trees within the grove blew down over several nights. These trees were 14” to 63” in diameter and each had been over 100’ tall. Half of the blown down trees were over 20” in diameter and 5 of them were 30” and larger. Several smaller but tall trees were hit by falling trees. They broke and they fell. A small number of other trees are “leaners”, supported by their neighbors, and they could fall at any time. Aside from the damage to the stand of trees the impacts of the storm included major injuries to 2 persons in a passing vehicle. The forester reviewed the damage to the stand and measured each fallen tree’s diameter, GPS location and direction of fall. Most windfall trees were lying on the ground with azimuth of west to northwest. The exceptions were the very large 63” blue gum that fell across the road, and collateral damage of fallen trees struck by adjacent blown down trees. The elimination of 24 trees created new gaps in the canopy which render residual trees increasingly vulnerable to ongoing blow down. Though most trees that fall are blown down by the south or northerly winds during saturated soils conditions, it does not seem possible to predict which trees will fall next, or in which direction.

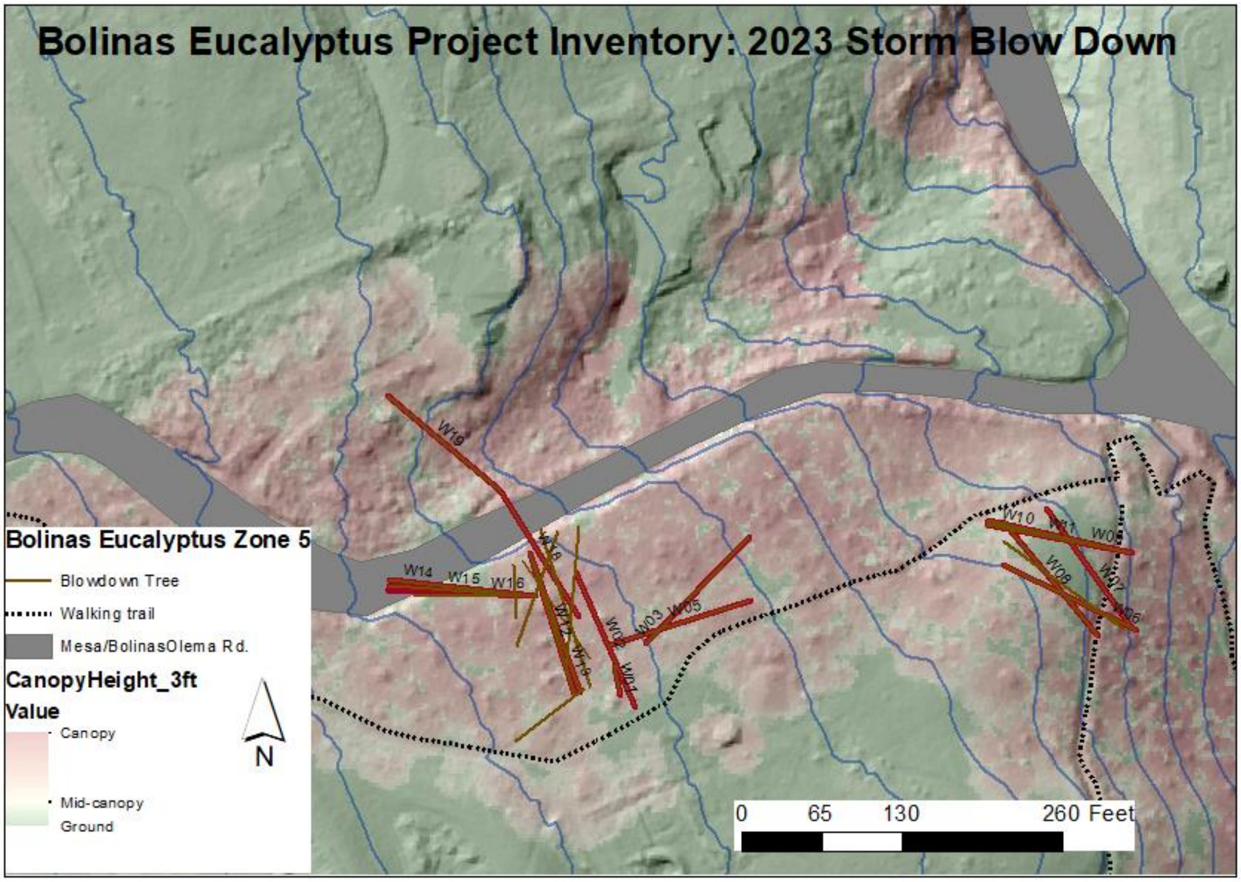

Figure 12 Trees blown down in the January 2023 winds

Figure 13 Some January 2023 wind thrown blown down trees

On March 3, 2023, a month after the January storms another tree, nearby the 63" tree that had fallen earlier, failed during calm clear conditions. Its collapse caused 2 of its neighboring trees also to fall. Those trees and large broken branches descended onto Mesa Road, destroying a power pole and wires, extinguishing electricity service to the local area for some time. PG&E

crews worked day and night (Figure 1). Fortunately, no vehicles were traveling the road as the trees fell. Others were not so lucky. On March 22 falling trees killed 3 persons in separate Bay Area incidents during a “bomb cyclone” event.

Figure 14 Two large trees fell across Mesa Road on March 3, 2023

The photo below shows the ground saturation that occurred shortly after a tree along Mesa Road blew down. The root balls had been consistently anchored each with a large number of 1-2” diameter roots. In Figure 15 the water table had risen to the point that the large tree structure was not supportable given the wet soil conditions, but earlier in the same week, other trees had blown down without a high level of root ball saturation. The trees at Zone 5 today are up to 3 times the height of the native oak woodland trees that most likely occupied the site in pre-European times. This suggests that the soils in the area have not evolved with large, and tall trees that are vulnerable to the high gusts of southerly winds characteristic of Pacific coastal winter storms.

Figure 15   Root ball alongside Mesa Road

MONARCH BUTTERFLY USE

The Monarch butterfly migration occurred during the period of the inventory project and this is a phenomenon of great interest. The forester, accompanied by local butterfly experts, on a single occasion observed four blue gum trees being used by butterflies for roosting or daytime activities. Three of those trees were at the edge of the grove with sunny south-facing exposure, during calm temperate conditions which evidently created a suitable microclimate on that late-autumn day. Campbell (2022) cites many native and non-native host tree species each that "provides a dense and mature canopy". Over time, use of the Zone 5 stand represents 1.45% of Bolinas Thanksgiving Count Monarch observations over the last 25 years (Xerces, 2023). New Year's counts conducted from 2018 to 2023 have likewise only produced 22 Monarchs over the 7-year period, or an average of 3 butterflies a year. Given the sparse and deteriorating canopy conditions of this stand, the fact that no Monarch use has been reported at the site for 14 of the past 22 years, and supposing that the Monarchs have been utilizing coastal woodland habitats for many thousands of years, the evidence suggests that a native woodland restoration project could be developed that would enhance future Monarch habitat here.

Monarch butterfly populations and ecology will be covered in detail by the forthcoming WRA biological report.

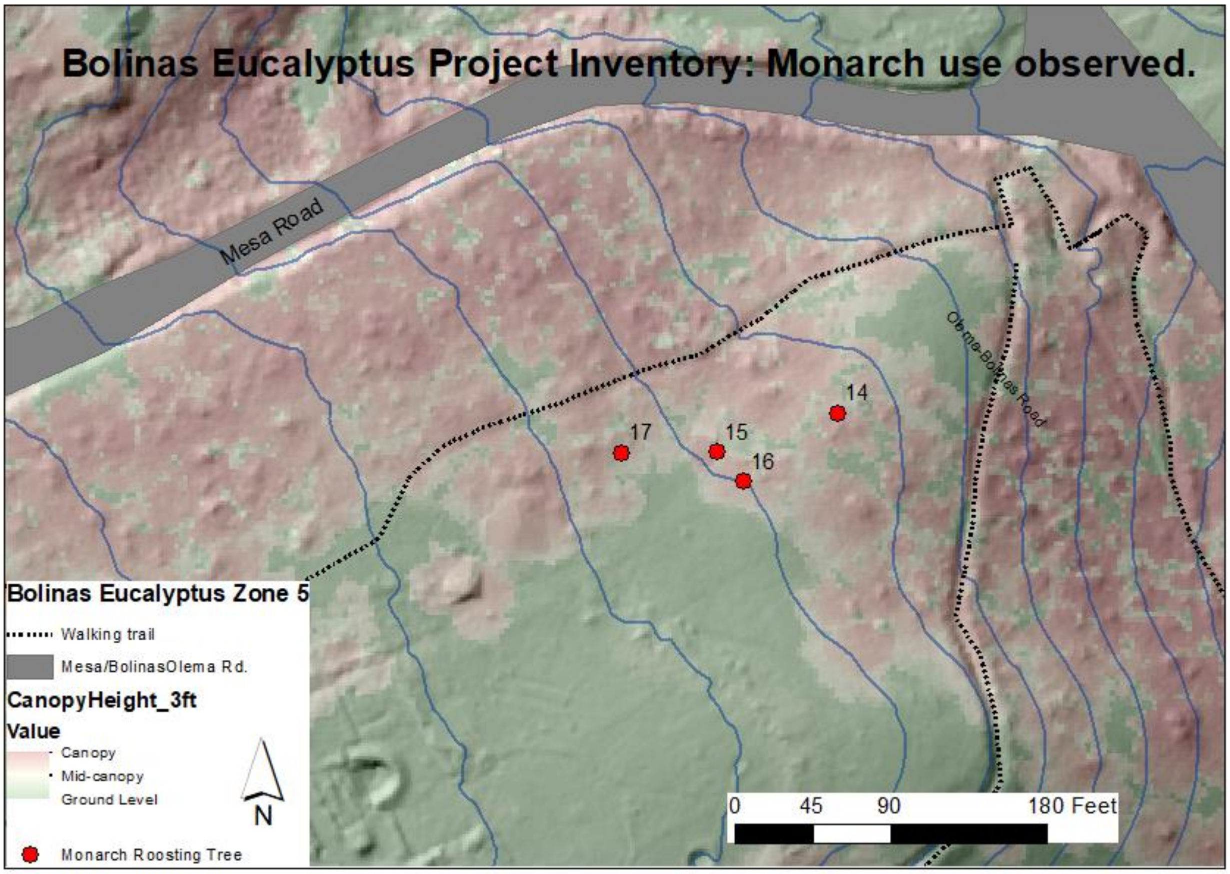

Figure 16 Monarch use observed December 2022

IVY AND INVASIVE PLANTS

Figure 17 Vines of English ivy and Cape ivy climbing trees on a private parcel

There is extensive vine cover of English ivy and Cape Ivy spreading mostly on the northerly parcels. Suffice it to say that the allelopathic nature of Eucalyptus stands effectively eliminates native flora and instead results in fire- and windthrow-prone monocultures that attract hardy invasives such as broom, English Ivy, cape Ivy, and Acacias. Such conditions are common around the Bay Area and they create artificial exotic vegetative conditions that beg for the restoration of oak woodland biodiversity that supports the broad array of native flora and fauna.

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6. APPENDICES

Appendix 1. Digital TREE PHOTO REPORT linkfile021023_photo_report.xlsx Photos, Excel files, and maps located for public access at https://1drv.ms/u/s!AihFbfICwtAwgahAx7p5-r4ESYk2VA?e=ljZl91

Appendix 2. High Resolution MAPS (see below)

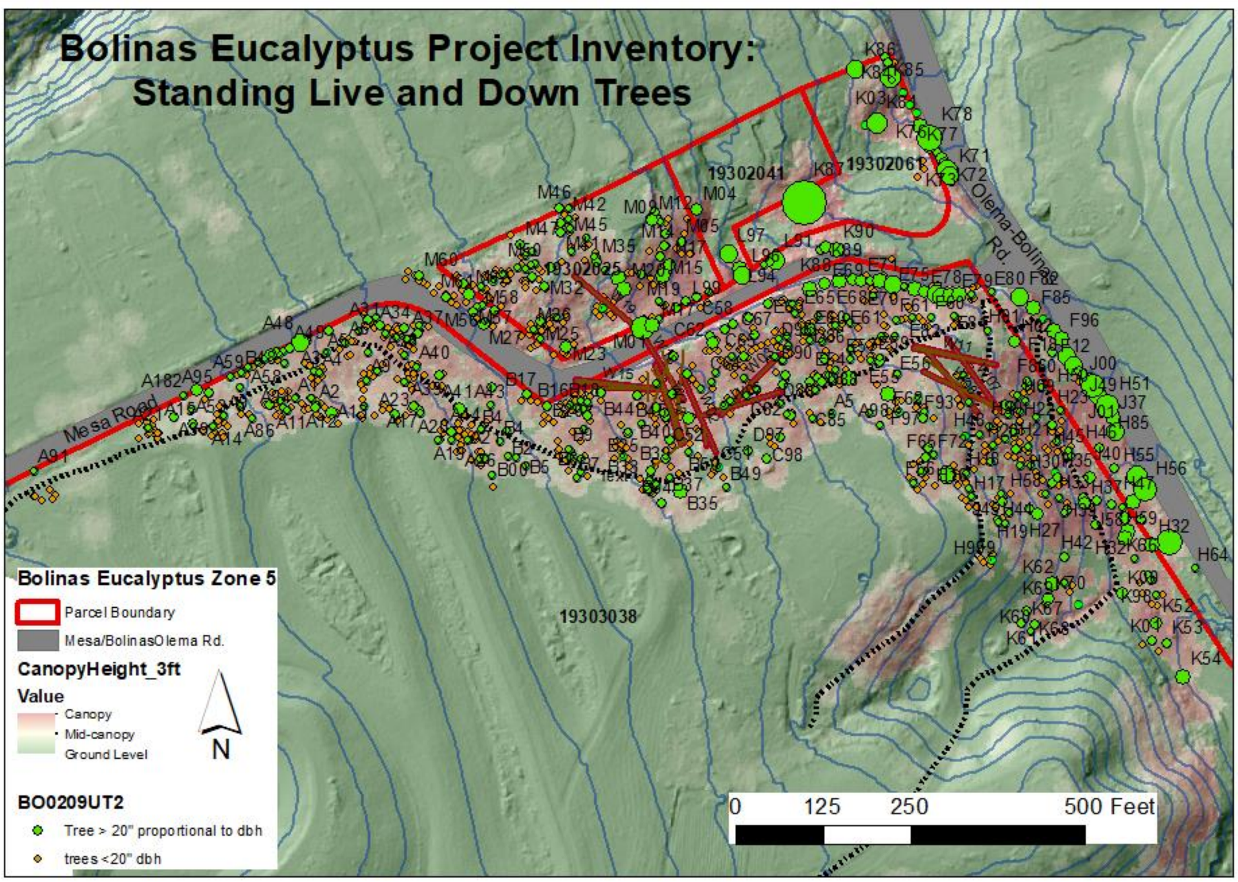

Figure 18 This is Figure 5 with tree numbers included

High Resolution Maps 1 to 3. Please note that these slightly adjusted GPS positions are per Garmin CSX60 capabilities under dense canopy.

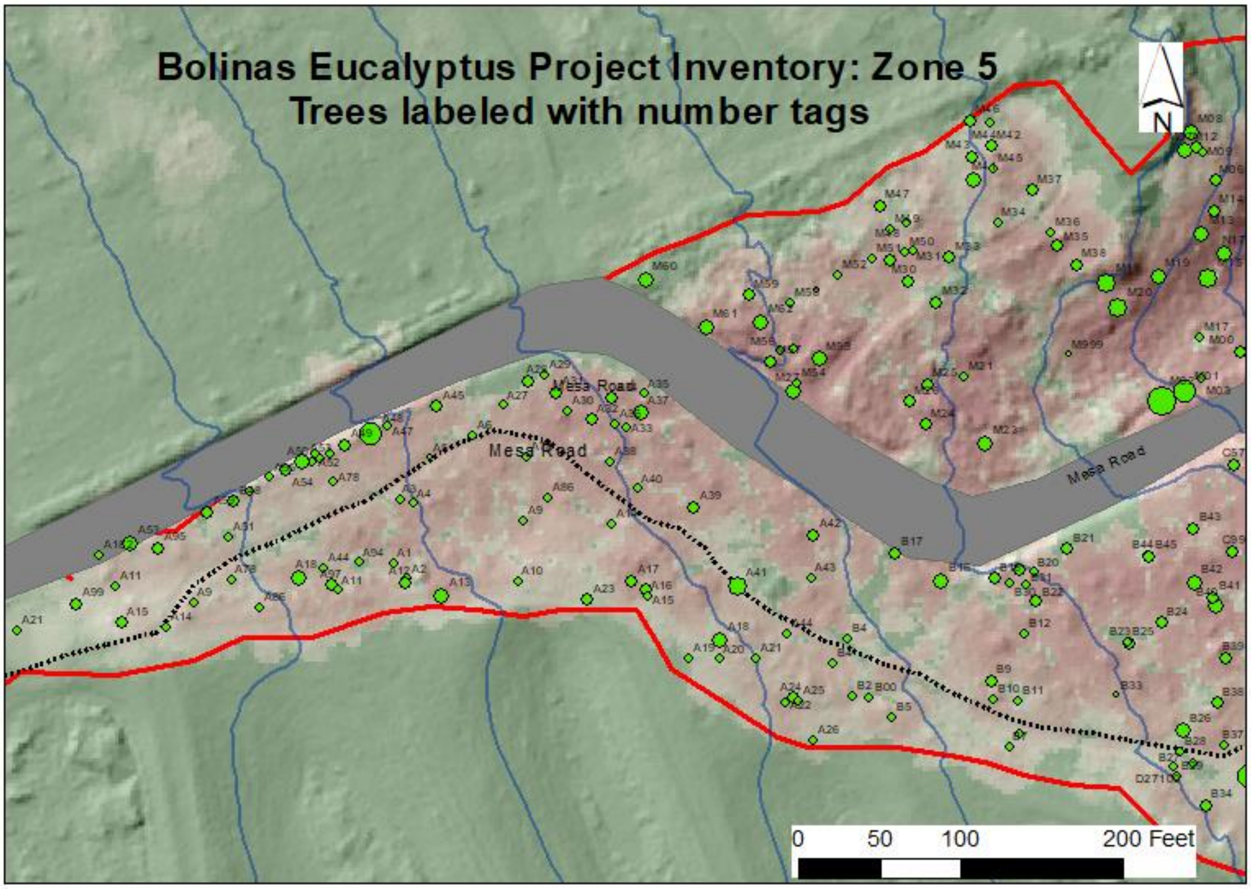

Figure 17 Field Map West

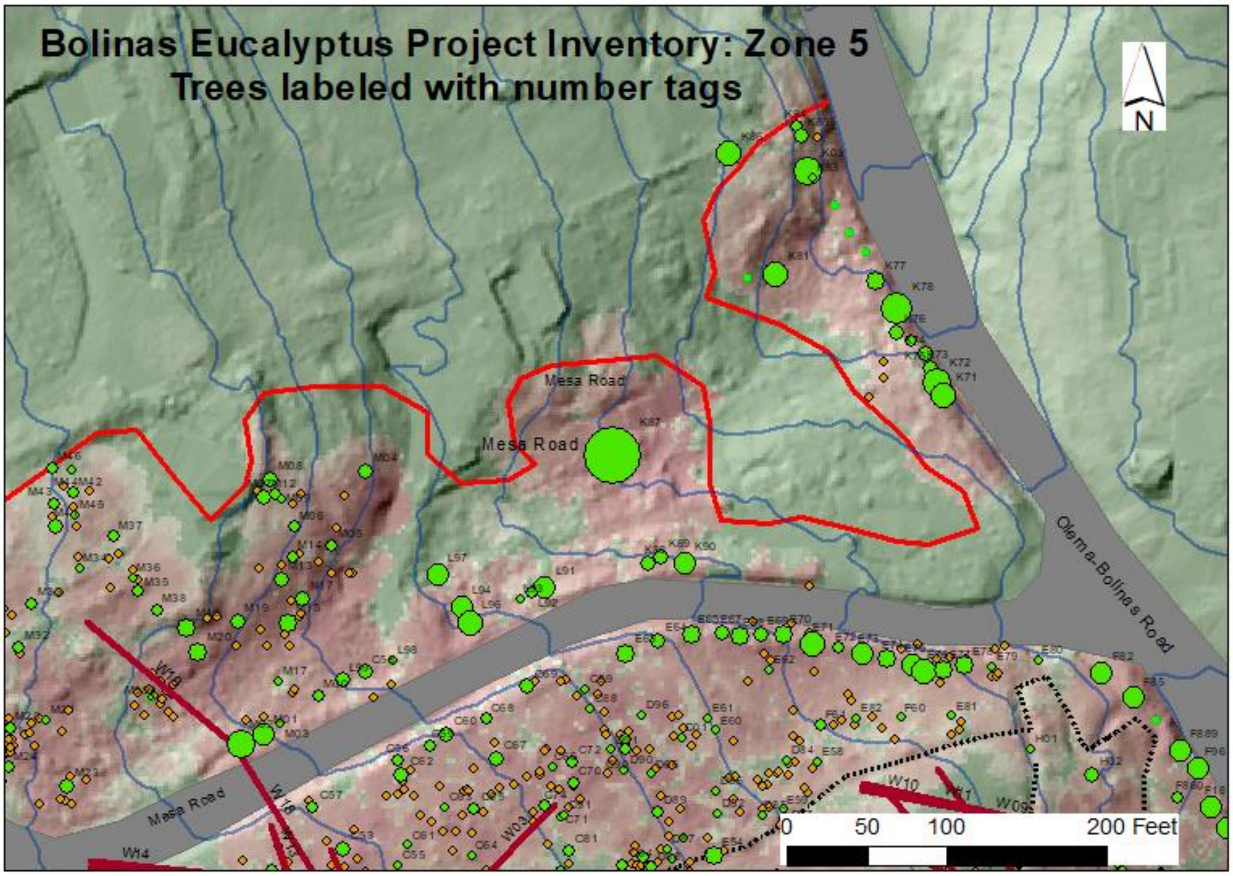

Figure 20 Trees with Tag Numbers Northeast

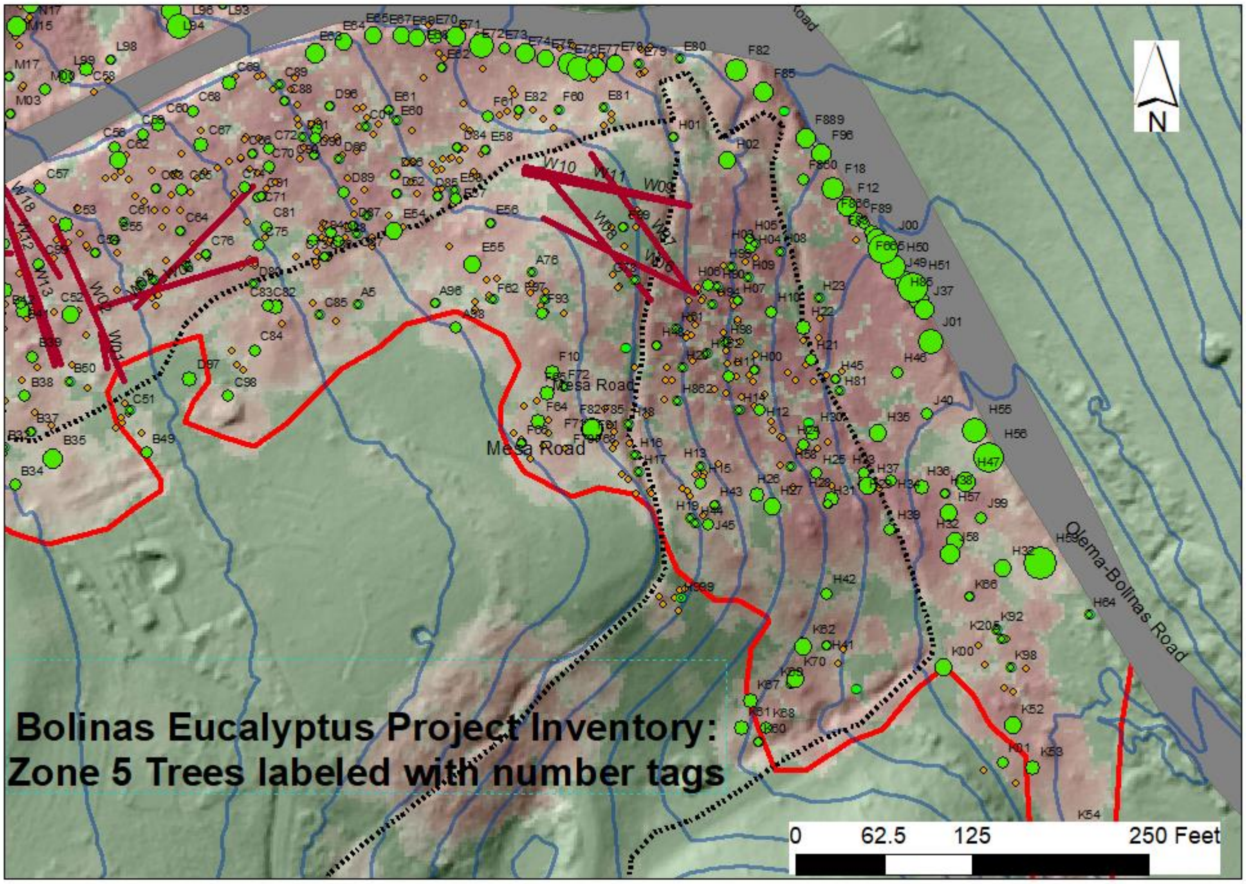

Figure 21 Trees with tag numbers southeast

Appendix 3. This Appendix is included to inform readers on "Crown Class".

FIELD INSTRUCTIONS

FOR THE ANNUAL INVENTORY OF

CALIFORNIA, OREGON, AND WASHINGTON

2021

When GROWTH SAMPLE TREE = N, the CROWN CLASS from the previous visit will be downloaded. Update this value if there is an obvious error or change.

When Collected:	All live tally trees ≥1.0 in*ch* DBH/DRC	
Field width:	1 digit	
Tolerance:	No errors	
Values:	Code	Description
	1	Open Grown – trees with crowns that received full light from above and from all sides throughout most of its life, particularly during its early developmental period.
	2	Dominant – trees with crown extending above the general level of the crown canopy and receiving full light from above and partly from the sides. These trees are taller than the average trees in the stand and their crowns are well developed, but they could be somewhat crowded on the sides. Also, trees whose crowns have received full light from above and from all sides during early development and most of their life. Their crown form or shape appears to be free of influence from neighboring trees.
	3	Co-dominant – trees with crowns at the general level of the crown canopy. Crowns receive full light from above but little direct sunlight penetrates their sides. Usually they have medium-sized crowns and are somewhat crowded from the sides. In stagnated stands, co-dominant trees have small-sized crowns and are crowded on the sides.
	4	Intermediate – trees that are shorter than dominants and co-dominant, but their crowns extend into the canopy of co-dominant and dominant trees. They receive little direct light from above and none from the sides. As a result, intermediate trees usually have small crowns and are very crowded from the sides.
	5	Overtopped – trees with crowns entirely below the general level of the crown canopy that receive no direct sunlight either from above or the sides.

Appendix 4: Photos, Excel files, aerial video, and maps located online for public access at https://1drv.ms/u/s!AihFbfICwtAwgahAx7p5-r4ESYk2VA?e=ljZl91

Appendix 5: Inventory Field Data