Instructions for submitting comments on this draft of the Ashland Forestlands Climate Change Adaptation Project: Phase 1

COMMENTS DUE NOVEMBER 7th at 12:00PM

Thank you for taking the time to review this document and communicate your interest and care for our community forestlands. To make our jobs easier, please comment as follows:

1. Refer to the page number and paragraph on that page with specific comments either in language changes or comments or suggestions on a specific topic. Emails and text documents are acceptable as would be a scanned version of written comments.
2. Please, if possible, include references to scientific articles or publications that provide support for your comments. Links are fine, as are references that would allow us to find the document. Strong feelings are certainly valid and wanted…backed up by science is even better.
3. Include your name and email address if you want a response about your comment.

Send all comments to chris.chambers@ashland.or.us. If you have any questions, please call and leave a message at (541) 552-2066.

Thank you for your time and care!

Chris Chambers, Forestry Officer

Volunteers of the Ashland Forest Lands Committee

CITY OF ASHLAND
Better Together

Ashland Forest to Climate Change Adaptation: Phase I Project Plan and Prescriptions DRAFT
October, 2023

Introduction

Our changing climate is bringing about unforeseen conditions with forecasts of increased climatic stressors affecting our municipal forestlands governed by the 2016 Ashland Forest Plan (AFP). Recent insect outbreaks have reached epidemic levels, with Douglas-fir (DF) tree mortality measured at 20% in the lower watershed and Siskiyou Mountain Park. Due to limitations in detecting dying trees from the air, there is anywhere from 10-60% additional DF mortality in high-risk landscapes like Ashland (Lowery, unpublished data, 2023). Some localized locations are seeing up to 75% die-off and smaller pockets up to near complete DF mortality…a phenomena dubbed by Bennett et al the "Douglas-fir decline spiral" in a 2023 research paper by Oregon State University and the U.S. Forest Service that utilized data from the forests surrounding Ashland and the greater Rogue Valley.

When looked at in the context of what's happening in western United States forests, there are alarming trends:

1. Insect outbreaks in the mixed-conifer Sierra Nevada forests of California and forests of the intermountain west and southwest have radically altered forest structure and function, particularly when areas burn after an outbreak.
2. Fuel accumulations and hotter and drier weather has lead to mega-fires that have impacted communities and disrupted critical ecosystem services.
3. Forest loss is being documented, with shifting climate zones, insect outbreaks, severe fires, and over a century of departure from historic frequent fire regimes coinciding over vast areas like the Southern Sierras of California.
4. Recent research on forest regeneration after fires underscores the need for quick management action to maximize the chance for desirable tree species to establish and persist. Avoiding high severity fire that can quickly alter ecosystem function and the conditions for forests to persist is critical in frequent fire dry forests like ours.

There is more scientific certainty in the root causes of our current forest conditions, as well as certainty in the efficacy of treatments that have been part of Ashland's forest stewardship "tool box" for decades. Publications like Wildfire and climate change adaptation of western North American forests: a case for intentional management by Hessburg et al (2021) summarize dozens of previous studies (meta-analysis) and answer key questions commonly asked about forest management and adaptation.

"Resulting interactions between historical increases in forested area and density and recent rapid warming, increasing insect mortality, and wildfire burned areas, are now leading to substantial abrupt landscape alterations. These outcomes are forcing forest planners and managers to identify strategies that can modify future outcomes that are ecologically and/or socially undesirable". -Hessburg, 2021

With a sense of urgency in recognizing the predicted and already increasing climate change impacts to our local forests, escalating community wildfire risk, and threat to our municipal drinking water, the Ashland City Council adopted the Ashland Forest Plan Climate Change

Addendum in April of 2023. The Addendum, within the context of the 2016 Ashland Forest Plan, provides a solid foundation for the first phase of climate adaptation projects. This plan represents a shift in philosophy from decades of extensive and excellent work done between 1995 and the current day under the objective of forest restoration. See City Forestlands Restoration II and Restoration III planning documents as examples. Though a change in direction is now forced upon us, restorative work completed to date has turned out to be the building blocks of climate change adaptation. Promoting forest health and vigor through tree thinning, fuels reduction to minimize fire severity, and planting of pine species better adapted to a warmer and drier climate have been ongoing for decades and place us on a firmer footing than many unmanaged landscapes.

Ashland's history of active stewardship uniquely positions us to respond to changing conditions with a variety of options that would not have existed otherwise. The change from restoration to adaptation is spelled out in the following excerpt from Stephens et al in 2010*:*

> *While there are many important lessons to learn from the past, we believe that we cannot rely on past forest conditions to provide us with blueprints for current and future management (Millar et al 2007). In particular, the nature and scale of past variability in climate and forest conditions, coupled with our imprecise ability to fully reconstruct those conditions, introduce a number of conceptual and practical problems (Millar and Woolfenden 1999a). Detailed reconstructions of historical forest conditions, often dendroecologically based, are very useful but represent a relatively narrow window of time and tend to coincide with tree recruitment in the generally cooler period referred to as the little ice age. As such, manipulation of current forests to resemble past conditions may not produce the desired result when considering future climates. Restoration of forest structure to resemble those of the past provides no guarantee of sustainability into the future.*

Ashland's municipal forests have already changed significantly from conditions documented before Euro-American colonization (pre-1850). Though few individual trees in the lower watershed area pre-date recent day Ashland (pre-1850), City and APRC forests are almost exclusively second and third growth that have largely not experienced frequent, low intensity fires that once shaped forests of the region. Fires of the early 1900's, 1959, and 1973 burned at high intensity, and combined with post-fire salvage logging significantly altered vegetation composition and structure in several areas now under the AFP (upper Granite, Siskiyou Mountain Park). With climate change, the need for a new stewardship paradigm emphasizing adaptation is evident and needed as the forests we've inherited are changing quickly.

> *"But the clock is ticking; it's urgent that we implement these treatments in our forests now, lest we lose them altogether."*
>
> *– Marcos Robles, lead scientist, The Nature Conservancy in Arizona.*

We find ourselves faced with a significant challenge across the majority of acres covered by the 2016 Ashland Forest Plan. Continuing the City's well-established program of monitoring, planning, public involvement, and ecological stewardship is imperative if we want to avoid undesirable impacts forecasted to increase in intensity in the coming decades.

Climate Change Adaptation Framework

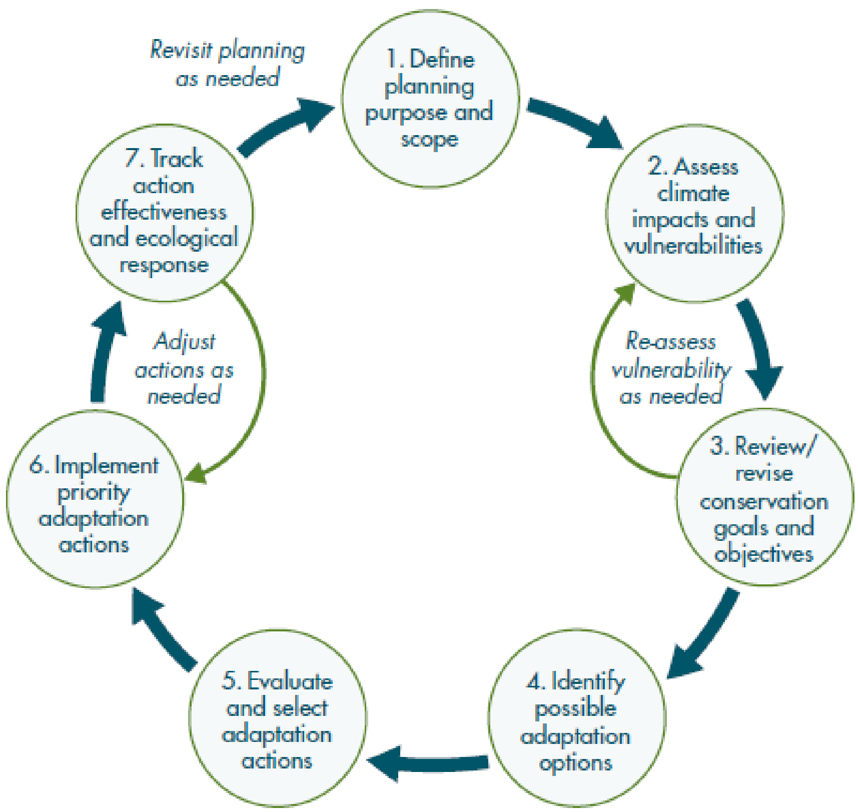


Figure 4.1. Climate-smart conservation cycle. This cycle can serve as the basis for undertaking a "stand-alone" adaptation planning effort, or can be used to help incorporate climate considerations into existing planning and decision-making processes. The steps in this cycle serve as the basis for the more detailed discussions that are the focus of Part II of this guide.[9]

Source: Stein, B.A., P. Glick, N. Edelson, and A. Staudt (eds.). 2014. Climate-Smart Conservation: Putting Adaptation Principles into Practice. National Wildlife Federation, Washington, D.C.

The process through which climate change adaptation is undertaken is critical to the success of outcomes. The Forest Lands Committee, in considering what to include in the Addendum, presented this planning cycle used in the Climate Smart approach to conservation.

Project Area and Description

The Lower Watershed

This area extends from the upper end of Reeder Reservoir to Granite Street. It is composed mostly of early to mid-seral conifer-hardwood forest (60-100 years old) and shrub-hardwood communities on moderate to steep slopes. None of these areas have reached late successional conditions. Portions of the area were burned in 1901 and again in 1910 with the northwest portion burning a third time in 1959. Trees in this area are mostly 8”-22” DBH, but there are some larger trees (24”-30” DBH or larger) that survived the fires (City of Ashland, 2003).

Siskiyou Mountain Park

Siskiyou Mountain Park (SMP) borders Ashland at the top of Park Street, upper Greenmeadows Drive to the east, and upper Elkader Street on its northwest corner. Purchased in 1992 from a timber company, SMP encompasses a total of 271.5 acres though only 148 acres are in this project area. After decades of heavy timber cutting, SMP experienced a high intensity wildfire in 1973. The Hillview Fire burned roughly half of what is now SMP, and was held at the main dividing ridge resulting in two distinct vegetation types today. The burned area (NE portion of the park) is dominated by pacific madrone woodlands and whiteleaf manzanita brushfield with smaller incursions of Oregon white oak woodland and mixed conifer forests on the lower slopes where fire intensity was lower. Due to this past high intensity disturbance, general lack of Doug-fir, and generally drier sites, this half of the park has not experienced the extent of tree mortality that the other half of SMP has.

Figure 1. 1973 Hillview Fire c/o Terry Skibby

The southwest portion of SMP is dominated by dry Douglas-fir approximately 100-110 years old with often heavy pacific madrone and scattered ponderosa pine and California black oak. Basal area ranges from 110 ft^2 to 190 ft^2 in generally smaller size classes due to the past history of industrial ownership and overstory removal.

Project Proposal

Due to the urgent need to continue and accelerate the process of adapting Ashland’s community forests to climate change, and given the unprecedented levels of tree mortality currently taking place, the following actions are being proposed as the first phase of climate adaptation:

1. Assess conditions to determine the extent and intensity of Douglas-fir mortality (completed in summer 2023)
2. Use available tools to model and predict future changes and develop project proposal (included in this document)
3. After public input and City Council and Ashland Parks and Recreation Commission consideration, finalize project plan and move to implementation.

4. Develop guidelines to help field crews designate excess dead and dying trees for removal. Include guidelines for thinning green trees where appropriate and outlined in the final project plan.
5. Mark trees for removal and contract for helicopter tree yarding to be completed before fire season 2024 (June 1), including burning of all slash created during tree removal operations.
6. Monitor work and results, report out.
7. Write site-specific plans for replanting with appropriate species. Contract for native plant revegetation. Begin process of replanting climate adapted species.
8. Implement prescribed fire as weather allows.
9. Maintain opportunities for stakeholders and public engagement throughout the process.

No trees will be removed purely for financial gain. First and foremost, this project is planned to address forest health and community safety. Climate change adaptation is ecosystem driven. What is left behind is more important than what is removed. Timber and other forest commodities will be generated only as a by-product of adaptation activities.

Ashland's Forestlands: A Rich Stewardship History

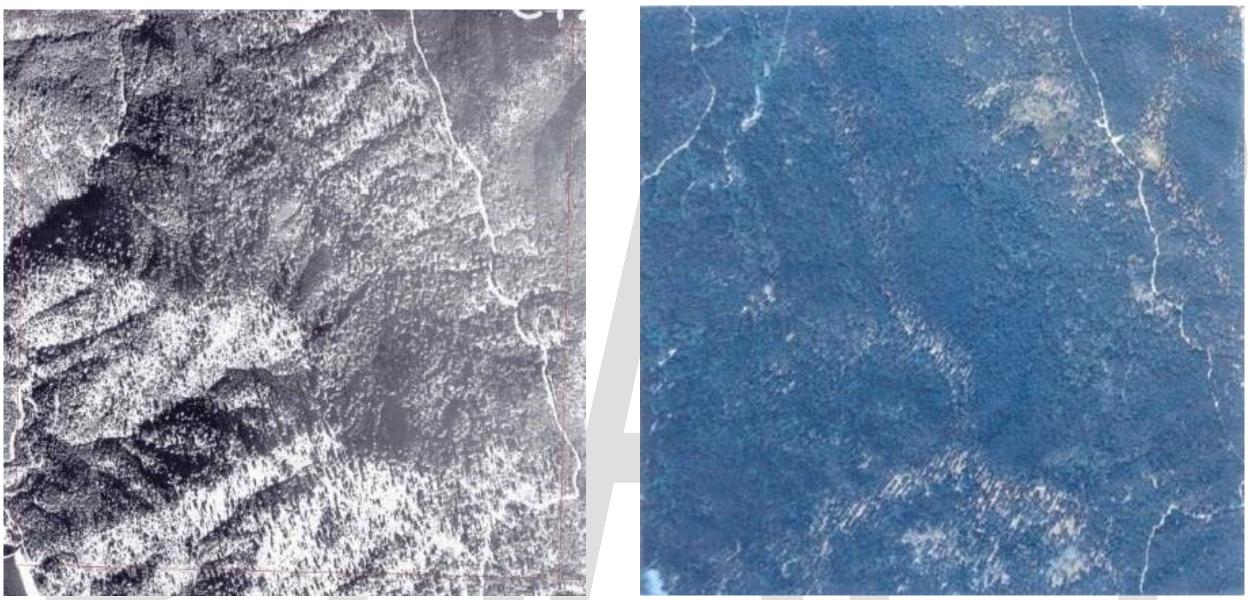
Going back to the 1850's when the early period of European colonization led to intense tree harvesting, uncharacteristic severe fires, and cessation of indigenous land stewardship, forest species composition and function shifted significantly (Metlen, 2018) in dry forests of Southwest Oregon. The transition from predominantly open forests composed of drought and fire tolerant species (Lieberg, other early sampling, etc..) transitioned to predominantly closed canopy forests dominated by drought and fire intolerant species and structures such as even-aged Douglas-fir and pacific madrone. Figure 1 shows the change in species composition from data gathered by Leiburg in the Ashland Watershed in 1900 and the most recent City inventory in 2017.

Table 1. Changes in Percent Basal Area (4"+ dbh) by Species- 1900 and 2017 (Main, 2003)

Year	**Species**			
	Douglas-Fir	**Ponderosa Pine**	**Sugar Pine**	**Oak, Madrone**
1900 (Leiberg)	25%	60%	15%	5%
2017 (COA Inventory)	64.6%	7.6%	0.5%	25.1%

Importantly, the role of forest disturbance, or external forces that disrupt or change the growth and development of forests, has been altered. Forests that had consistent levels of lower intensity disturbances from indigenous use of fire, lightning fires, insects, disease, and wind events transitioned abruptly to forests experiencing infrequent but high intensity disturbance from intensive logging, high severity fires, and insect outbreaks (2016 Ashland Forest Plan). It can't be underestimated how significant this change has been. Current day Doug-fir dominated forests are over 100 years old have often not experienced disturbance, growing tightly packed in homogeneous stands that are as artificial to this landscape as invasive species. The photo comparison from the 2016 Ashland Forest Plan shows the stark changes between 1939 and 2004.

Township 39 South, Range 1 East, Section 21
White Rabbit Parcel
Change in Forest Conditions 1939 to 2004



1939 2004

Since 1995, when the City first hired forestry consultant Marty Main of Small Woodland Services, the City's objectives and actions set out to reverse the trend toward increasingly dense forests composed of fire and drought intolerant species toward increasingly open forests composed of species more tolerant of fire and drought reestablishing a mosaic of open forests warmer, exposed slopes and cooler, denser forests on less exposed northerly slopes.

The City's primary objectives in the 1992 Ashland Forest Plan were to lessen fire danger to the community and protect the upslope Ashland Municipal Watershed. This resulted in a series of forest stewardship projects known as Restoration I, II, and III. By using an ecologically informed and data-driven approach to active forest stewardship and monitoring, the City has achieved the objectives set forth in the original 1992 Ashland Forest Plan…and more. Through forest stewardship, the City engaged the community via meetings, the creation of the Ashland Forest Lands Commission, field tours, and many hundreds of individual interactions. The transition from a "hands off" approach to active stewardship developed an environmental ethic in the community that allowed for further evolution of active forest stewardship on U.S. Forest Service land, leading to the Ashland Forest Resiliency Project, or AFR. AFR now covers nearly 14,000 acres of federal, private, and municipal land in the Ashland watershed and adjacent areas from the Siskiyou Summit to Wagner Creek above Talent.

We recognize the thousands of years of indigenous forest stewardship, the stark changes in our forests over the past 150 years, and recent restorative work from 1995 to present day as important milestones in our history that help understand our current trajectory. Ashland's approach has always been underpinned by adaptive management, or doing, learning, and evolving. That remains a fundamental principle along with public involvement. Adapting our forests to the changing climate is a long-term goal that will last for generations to come.

<u>Ashland Forest Plan Objectives</u>

Reducing fire danger through active management of vegetation and fuels has been a primary theme since the first plans were laid for managing Ashland's community forests. The original 1992 Ashland Forest Plan listed three priorities, one of which was the "*Reduction in the fire-prone nature of the forestland through active management of vegetation and fuels.*"

The 2016 Ashland Forest Plan update contained three ecological goals. One of the goals is to "*Significantly diminish the likelihood of a high-severity wildfire through active vegetation and fuels management that emulates the historic range of natural disturbances.*"

Through thinning of surface and ladder fuels, pile burning, and the reintroduction of frequent, low intensity fire through underburning, the City and APRC have largely accomplished these objectives. The recent DF mortality is a challenge to this crucial objective, and predicted ongoing DF die-off will make it more difficult to keep fuels levels low given the already significant increase in wildfire acres burned and the lengthening of fire seasons creating a wider window for unwanted summer fires. Massive inputs of large fuel from mortality epidemics are particularly concerning:

> *High densities of both snags and logs were associated with high reburn severity in a subsequent fire, while shrub cover had a marginally insignificant (P = 0.0515) effect on subsequent fire severity. Our results demonstrate that high levels of large dead wood, which is often not considered in fire behavior modeling, corresponded with repeated high-severity fire effects. - Lyderson et al 2019.*

Severe fire (not only crown fire, but severe surface fuel driven fires) have the potential to eliminate forest cover and significantly alter future options to sustain forests. But, with ecologically informed forest management, the effects of shifting climate zones can be partially offset if we act quickly.

It is critical not only to reduce the current and future inputs from dead and dying DF, and to a lesser extent pine, but to eliminate as much of the non-merchantable fuels as possible through piling and burning or underburning immediately. With helicopter yarding, the majority of small diameter fuel is left in the forest, needing to be burned before the ensuing fire season.

Where dead trees are not able to be retrieved by helicopter, and ecological targets for CWD have been met, trees can be felled and limbs and tops cut, piled, and burned. Whole tree yarding, or hauling the tree including limbs and tops, can be considered in certain situations where activity fuel treatment isn't feasible and added costs are acknowledged and accepted.

The 2016 Ashland Forest Plan (Chapter 5) laid out the following five objectives associated with climate change:

1. Reducing the likelihood of high-severity fire through strategically placed fuels treatments and subsequent implementation of prescribed underburning to maintain reduced fuels and less fire-prone conditions;
2. Managing for both development and maintenance of older forests that may sequester and retain large amounts of carbon over time;
3. Focusing on protection and restoration of diverse forest structures, plant communities and associated genetic resources which are important mechanisms of resilience;
4. Emphasizing multiple species management including species well selected to thrive in future warmer and drier conditions such as pines, hardwoods and shrub species (within prescribed spatial considerations for their potential to aggravate fire potential and hazard); and
5. Monitoring and control of invasive species that are prone to establishment and/or expansion in changing climates

As the impacts and changing conditions associated with climate change became more pressing, the following climate change adaptation objectives were outlined in the 2023 Climate Change Adaption Addendum:

1. Where feasible, maintain and promote refugia conditions to buffer against climate change impacts, allowing diverse habitats to persist. Delineate refugia at a fine of scale as practical.
2. Enhance the existing mosaic of open and closed forest structure to further reduce fuel continuity, increase biodiversity, and regenerate shade intolerant species such as pine, oak, bunch grasses, and shrubs.
3. Promote and maintain healthy and productive soils by preventing high intensity fire, maintaining cover in landslide hazard zones, and providing for soil carbon balance through Coarse Woody Material (CWM) budgeting on a site-specific basis.
4. Proactively remove and treat excess dead and dying trees and slash to reduce fuel accumulation and escalation of fire hazard and impacts to trail use and public safety. Prioritize pre-emptive treatment of sites prone to future tree mortality using the Main risk rating system.

Current Conditions and Trends: Key Resources and Values

Fire and Fuels

"Exceptional fire seasons like 2020 will become more likely, and wildfire activity under future extremes is predicted to exceed anything yet witnessed. Safeguarding human communities and supporting resilient ecosystems will require new lines of scientific inquiry, new land management approaches and accelerated climate mitigation efforts." – Coop et al, 2022

The effect of dead and dying trees on wildfire behavior is of highest concern given the proximity of all areas to homes and critical infrastructure like the City's water treatment plant. Recent studies in frequent-fire mixed conifer forests show a relationship between tree mortality and extreme fire behavior, especially within the first four years of more widespread die-off when needles are still attached to trees, or the "red phase" (Wayman et al, 2020). Though certain measures of fire behavior decrease over time, such as crown fire potential, as trees drop their branches and eventually fall over, surface fuels increase significantly over time and surface fire intensity increases substantially with negative implications for soils, firefighter safety, suppression effectiveness, smoke production, as well as carbon storage and emissions (Reed et al, 2023). Also significant in the Reed et al study was that fire severity in areas with significant tree die-off increased in less than extreme weather conditions, widening the window for fire impacts on site resources and adjacent values.

The "mass fire" phenomena described in 2022 by Stephens et al shows the interaction between high-intensity mortality events (bark beetle epidemic), understory vegetation responding to open conditions after mortality, and overly dense forests that lead to unpredictable fire behavior during the 2020 Creek Fire in California.

An important note is the potential for high severity fires in these locations above the community does not significantly lessen the potential for a fire to impact not only properties and homes directly adjacent to Ashland's forestlands, but further into the community as well. The study titled Downslope Wind-Driven Fire in the Western United States, describes an alarming increase in the number, impact, and acres burned in fires that predominantly move downhill, much like the 2020 Almeda Fire and to some extent the 2009 Siskiyou Fire. It would not be safe to assume that fires above Ashland will not impact the community. There are fire behavior scenarios in addition to wind that could cause fire to impact Ashland from above.

"Downslope winds had an outsized direct impact on human life and infrastructure. We found that downslope wind-driven fires were three times as likely to be associated with a fatality and twice as likely to produce structure loss than other fire events." –Abatzoglou et al 2023.

Fire and Tree Mortality in Dry, Mixed-Conifer Forests

There is research consensus that when forests experience a rapid die-off event like the one happening now in Ashland's forests, there is a spike in fire danger as needles turn red (the "red phase") and trees pass from green with moisture to dead and dry. This bump in available crown fuels is short-lived, as the needles tend to fall within two years of tree death. However, a longer-term rise in available large diameter fuels drives another spike in fire danger that is, perhaps, more concerning than the initial red phase immediately after die-off. An extensive review by Stephens et at (2018) stated:

"The magnitude of this effect depends on the proportion and timing of tree mortality. If mortality is acute and extensive, increases in flammability would be expected."

Of particular concern is the compounding effect of climate change that is both contributing to mass tree mortality events, but is also drying out larger diameter, or 10,000 hour fuels, making them more available during fires which can lead to severe fire effects:

"By removing the dampening effect of FMC (Fuel Moisture Content), especially in large dead fuels, climate change is not only increasing the overall and seasonal flammability of these systems but is also increasing the amount of energy stored in biomass that can be released as heat when wildfire occurs." -Goodwin, 2021

Stephens et al (2018) described this further in connecting the incidence of mass fire to insect mortality events in Frequent Fire (FF) forests like those surrounding Ashland:

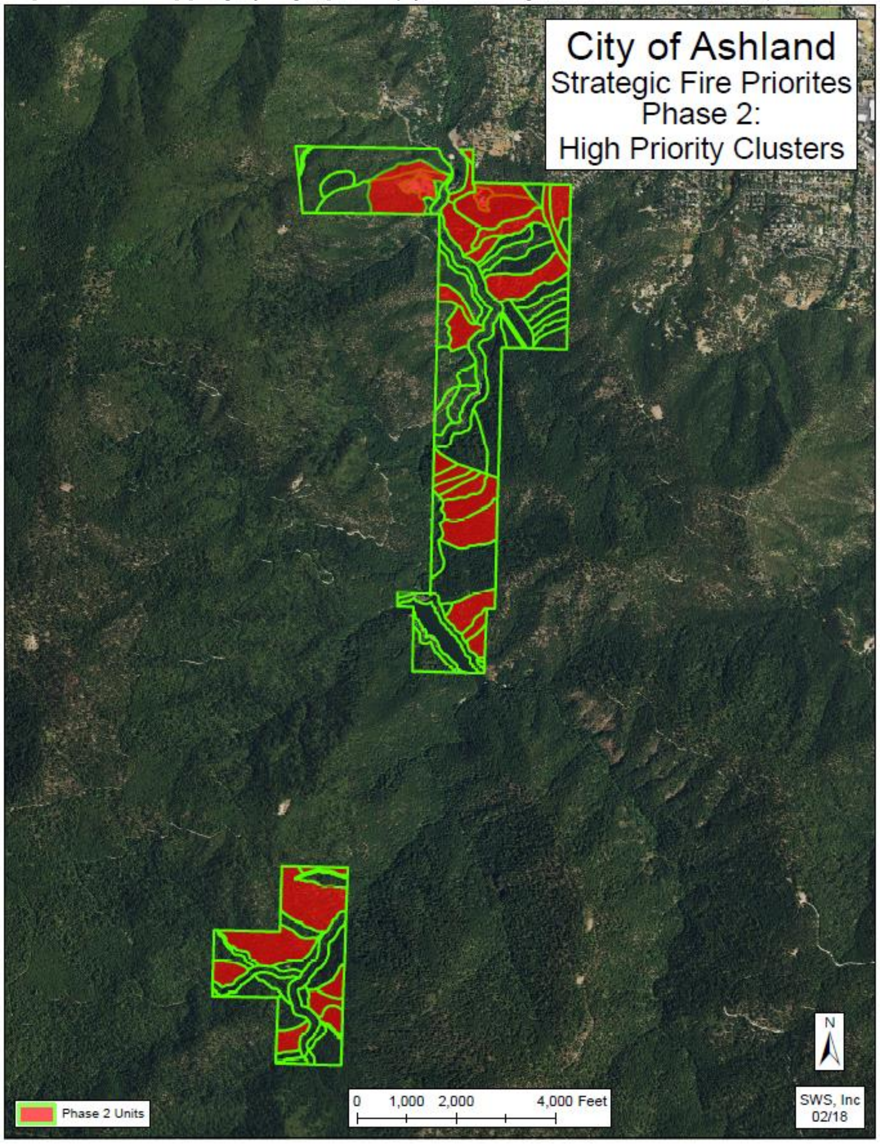
"The fuel impacts of large-scale forest mortality suggest this could lead to a greater incidence of mass fire behavior. Mass fires strongly contrast with historical fire regimes in FF forests, are not predictable by fire models, and risks are poorly understood. Thus, fire departments, communities, and forest managers likely will underestimate the wildfire threat posed to people, homes, and natural resources following severe tree mortality in forests adapted to FF."

This underscores the need to maintain low fuel levels for the foreseeable future to preserve the inherent functions of our frequent fire forest ecosystem and the many values we derive from our forests along with safety of the adjacent community.

Spatial Fire Planning: Fire Management Zones

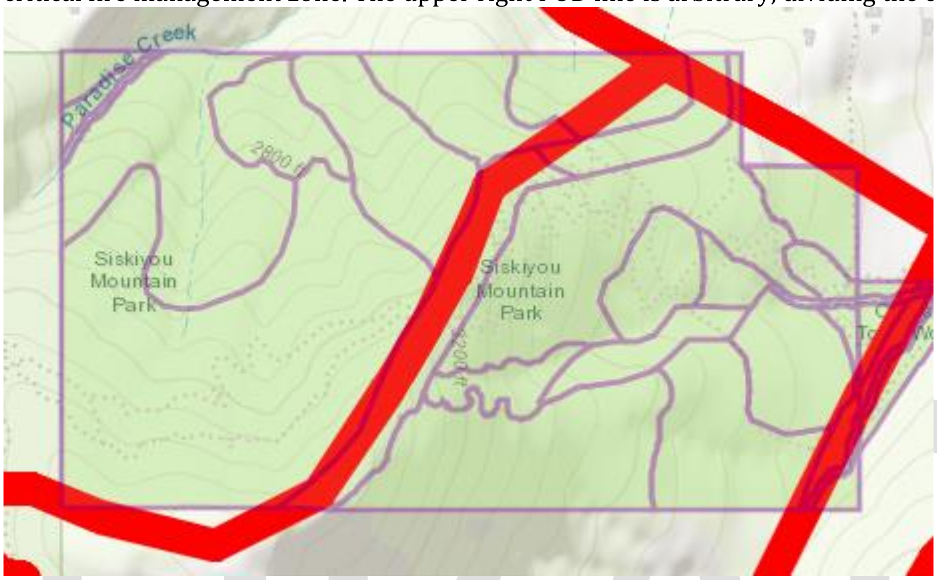
Fire management was emphasized in original mapping done by Main on the City ownership in the 1990's. These units are still appropriate today, with the more recent overlay of Potential Operational Delineations, or PODs. These two approaches are complimentary and help inform this project: PODs are broader landscape-scale while the Main priorities "fill in" the finer scale priorities using similar factors such as landform, access, and fuels. This fine-scale planning wasn't done for Siskiyou Mountain Park, but the PODs boundary is sufficient.

Map 1. 2017 Mapping of high priority fire management unit clusters. (Main, 2017)

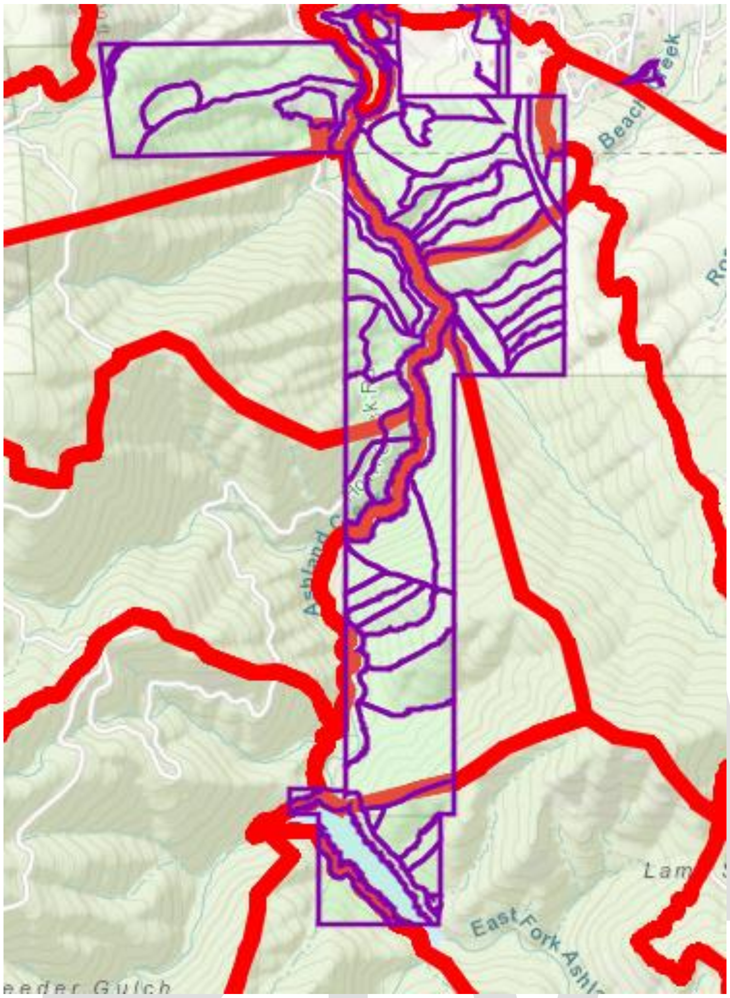


All clusters shown here have been managed emphasizing fire suppression opportunities including prescribed underburning, completed between 2012 and 2023, but no underburning has been done on the Winburn Parcel to the south of Reeder Reservoir to date. Within these areas, the management focus is maximizing fire suppression effectiveness. Maintaining frequent role of low intensity fire through prescribed burns, keeping CWD at minimum levels, and emphasizing stands with excellent height to crown base and lower crown bulk density are strategies for effective fuels management.

Map 2. PODs boundaries on Siskiyou Mt. Park emphasize the major ridgeline that cuts the park in half as a critical fire management zone. The upper right POD line is arbitrary, dividing the city and forestlands.



Map 3. Lower City forestlands with PODs boundaries showing up along roads, ridges, and sub-ridges.



Fuel Loading and Fuel Models: How much is too much?

Ashland forestland data has tracked fuels through transects taken at monitoring plots (lower City ownership) or estimated via the Anderson fuel models (1982). The majority of areas are now classified as Fuel Model 8, closed timber litter. Fuel Model 8 is very desirable as a fire management objective…yet units seldom fit fuel models perfectly. The 2017 lower City lands inventory shows a range of 2.29 to 9.64 tons per acre with a unit-acre weighted average of 5.59 tons/acre (Table 3). The Anderson publication, shown below in Table 2, uses 5 tons/acre in the 1-to-100-hour fuel loading for Fuel Model 8.

Table 2. Fuel loading by time lag class for the 13 Fuel Models (Anderson, 1982)

Fuel model	Typical fuel complex	Fuel loading 1 hour	10 hours	100 hours	Live	Fuel bed depth	Moisture of extinction dead fuels
		--------------------Tons/acre-------------------				Feet	Percent
	Grass and grass-dominated						
1	Short grass (1 foot)	0.74	0.00	0.00	0.00	1.0	12
2	Timber (grass and understory)	2.00	1.00	.50	.50	1.0	15
3	Tall grass (2.5 feet)	3.01	.00	.00	.00	2.5	25
	Chaparral and shrub fields						
4	Chaparral (6 feet)	5.01	4.01	2.00	5.01	6 0	20
5	Brush (2 feet)	1.00	.50	.00	2.00	2.0	20
6	Dormant brush, hardwood slash	1.50	2.50	2.00	.00	2.5	25
7	Southern rough	1.13	1.87	1.50	.37	2.5	40
	Timber litter						
8	Closed timber litter	1.50	1.00	2.50	0.00	0.2	30
9	Hardwood litter	2.92	41	.15	.00	.2	25
10	Timber (litter and understory)	3.01	2.00	5.01	2.00	1.0	25
	Slash						
11	Light logging slash	1.50	4.51	5.51	0.00	1.0	15
12	Medium logging slash	4.01	14.03	16.53	.00	2.3	20
13	Heavy logging slash	7.01	23.04	28.05	.00	3.0	25

Table 3. Lower City Lands Fuel Loading 1,10, and100-hour fuels by ton. The range of total tonnage is 2.29 to 9.64 with the acre-weighted mean at 5.59 tons/acre.

	#Plots	1 Hour	10 Hour	100 Hour	TOTAL
Al	3.00	0.45	2.44	3.47	**6.36**
B	14.00	0.27	1.38	3.19	**4.84**
C	5.00	0.08	0.42	3.26	**3.76**
D	2.00	0.07	0.86	4.36	**5.29**
E	9.00	0.48	0.95	2.92	**4.35**
F	2.00	0.28	2.30	0.77	**3.35**
G	15.00	0.31	1.81	5.29	**7.41**
H	4.00	0.47	2.02	4.60	**7.09**
J	5.00	0.34	1.04	1.39	**2.77**
K	14.00	0.52	2.35	4.70	**7.57**
L	6.00	0.68	1.94	5.04	**7.66**
Ml	4.00	0.29	0.83	2.61	**3.73**
M2	3.00	0.60	1.44	2.32	**4.36**
N	8.00	0.81	2.35	4.18	**7.34**
P	11.00	0.56	2.31	2.33	**5.20**
Q	6.00	0.82	3.11	5.71	**9.64**
R	5.00	0.61	2.11	5.68	**8.40**
S	6.00	0.62	1.37	3.97	**5.96**
U	6.00	0.31	0.89	1.61	**2.81**
W1	3.00	0.22	0.94	1.13	**2.29**
W2	4.00	0.46	1.38	3.31	**5.15**
Total*	**135.00**	**0.45**	**1.62**	**3.52**	**5.59**

Anderson fuel models only use up to 3" diameter (100-hour) fuels, a criticism recently made by Stephens et al (2022) that an important category of larger diameter fuels is ignored and therefore does not predict fire behavior being documented in fires burning in downed, larger diameter fuel resulting from mass mortality episodes.

In the Lower City lands data, there are three larger categories of fuel size classes, which have much more tonnage/acre when compared to the three lowest classes. Lower City Land average tonnage of smaller fuels is 5.59 tons/acre while the three inch and above size classes averaged 17.23 tons/acre in 2017. Mortality since 2017 has undoubtedly increased this number and the level of current dead and dying will increase that number considerably over time as needles, branches, and boles fall to the ground.

Given the more recent documentation of fire behavior and fire effects driven by large diameter fuels resulting from die-off (Stephens 2022), the larger size classes of surface fuel (CWD) need to be considered and addressed as mortality events are predicted to continue (Bennett et al, 2023) in our local DF forests.

Table 4. Fuel loading from the 2017 Inventory on lower City lands

Unit	# of Plots	Tons per acre by size class (inches)							
		0-0.25	0.26-1	1.1-3	3-4	5-9	10-19	20+	Total
A1	3	0.45	2.44	3.47	3.80	26.70	22.67	0	59.53
B	14	0.27	1.38	3.19	1.95	16.32	12.02	0	35.13
C	5	0.08	0.42	3.26	0.76	1.49	0	0	6.01
D	2	0.07	0.86	4.36	0	15.48	5.89	0	26.66
E	9	0.48	0.95	2.92	0.61	5.98	17.94	0	28.88
F	2	0.28	2.30	0.77	3.74	15.88	0	0	22.97
G	15	0.31	1.81	5.29	2.87	8.26	5.22	0	23.76
H	4	0.47	2.02	4.60	0	13.02	12.44	0	32.55
J	5	0.34	1.04	1.39	0.45	4.87	0	0	8.09
K	14	0.52	2.35	4.70	0.95	5.22	8.83	0	22.57
L	6	0.68	1.94	5.04	2.68	3.64	8.06	0	22.04
M1	4	0.29	0.83	2.61	0.49	7.23	0	0	11.45
M2	3	0.60	1.44	2.32	1.27	1.37	0	0	7.00
N	8	0.81	2.35	4.18	4.40	5.94	6.18	9.49	33.35
P	11	0.56	2.31	2.33	1.69	3.99	0	0	10.88
Q	6	0.82	3.11	5.71	2.42	13.68	12.36	0	38.10
R	5	0.61	2.11	5.68	2.68	8.17	19.64	0	38.89
S	6	0.62	1.37	3.97	1.61	12.63	0	0	20.20
U	6	0.31	0.89	1.61	1.29	0.52	0	0	4.62
W1	3	0.22	0.94	1.13	1.91	5.05	16.42	0	25.67
W2	4	0.46	1.38	3.31	0.48	17.31	7.42	0	30.36
Total*	135	0.45	1.62	3.52	1.82	8.43	7.94	0.86	24.64

*Weighted by unit acreages

"The accumulation of coarse woody surface fuels resulting from multi-year drought and concurrent bark beetle outbreaks combined with the increasing frequency of drought in the western U.S. (Diffenbaugh et al. 2015; Seager et al. 2007) have the potential to lead to extremely heavy and dry fuel loads that under certain weather conditions may result in more extreme fire behavior and/or more severe fire effects." –Reed et al, 2023

Coarse Woody Debris (CWD)

Coarse woody debris, including snags and logs and wood on the forest floor is a critical ecosystem component for habitat, soil function, and carbon storage. Excess CWD can lead to fire concerns and when an area burns, significant negative outcomes. Clearly, a balance between ecosystem benefit and fire risk is needed. Identifying not only the appropriate amounts, but the spatial distribution of CWD is critical to balancing these competing values.

Table 5. Lower Watershed Snag Density Increase from 2007 to 2017 (City of Ashland data)

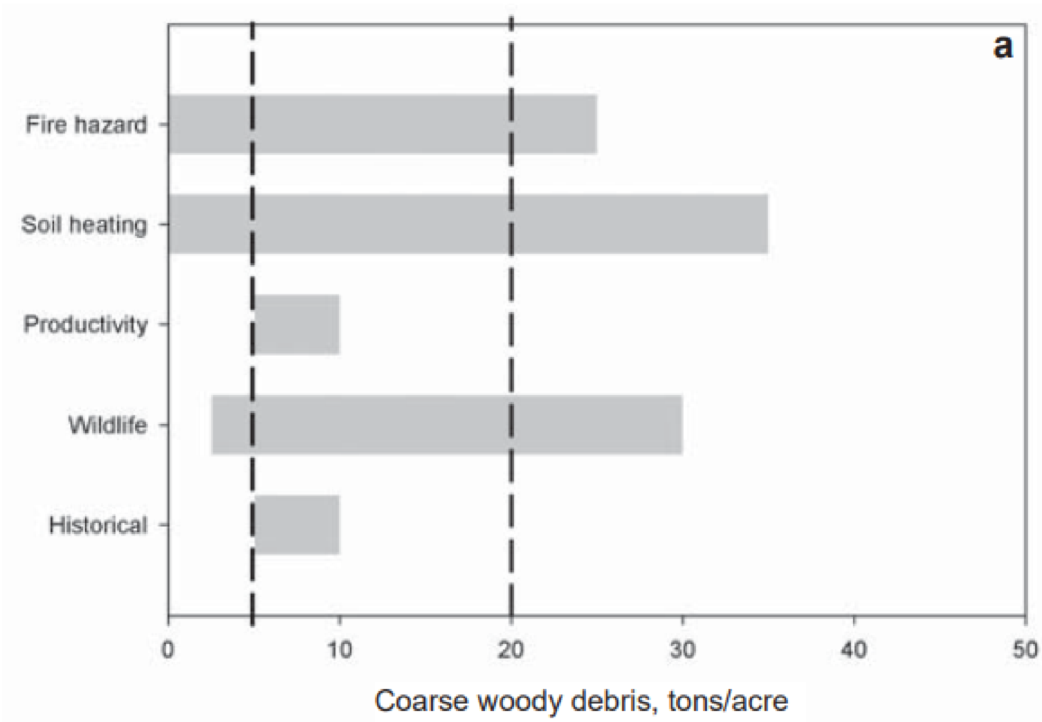
Unit	# of Plots	Snags per acre by diameter class							
		5-11"		11-19"		19"+		Total	
		2007	2017	2007	2017	2007	2017	2007	2017
A1	3	0	0	0	14	0	0	0	14
B	14	10	19	5	10	0	0	15	29
C	5	13	7	0	3	0	1	13	11
D	2	0	0	8	8	0	0	8	8
E	9	0	0	12	9	2	2	14	11
F	2	0	0	0	0	0	5	0	5
G	15	0	0	1	2	0	1	1	3
H	4	0	0	5	4	3	2	8	6
J	6	0	0	0	0	2	3	2	3
K	13	0	8	6	6	2	6	8	20
L	6	0	0	0	5	3	3	3	8
M1	4	0	0	4	4	0	0	4	4
M2	3	69	126	0	9	2	2	71	137
N	8	21	35	8	8	1	1	30	44
P	11	0	14	0	4	1	1	1	19
Q	6	0	0	6	4	1	1	7	5
R	5	11	17	13	12	4	3	28	32
S	6	10	5	2	2	2	6	14	13
W1	3	0	14	0	0	0	0	0	14
W2	4	40	61	19	10	0	2	59	73
Total*	129	7	12	5	6	1	2	13	20

Fire Risk, Fuel Loading, and Coarse Woody Debris: Finding Balance

Brown et al in 2003 analyzed the risks and benefits of CWD (logs and snags) and provided recommendations for different forest types that balance the risks and benefits of CWD. They found the optimum range for multiple benefits while minimizing fire hazard in dry forests is 5 to 20 tons per acre, shown below on the left between the dotted lines. They included a key component, soil heating, which is important for potential wildfire effects as well as prescribed burning.

To summarize the negative values, fire hazard including resistance-to-control and fire behavior reach high ratings when large fuels exceed about 25 to 30 tons per acre in combination with small woody fuels of 5 tons per acre or less. Excessive soil heating is likely at approximately 40 tons per acre and higher. Thus, generally high to extreme fire hazard potential exists when downed CWD exceeds 30 to 40 tons per acre. – Brown et al 2003

Figure 1. Optimum range of CWD (snags and downed wood) considering multiple values for a dry forest (DF and pine) setting (Brown et al 2003).



In the Brown analysis, they include downed wood and snags in the tons/acre levels by converting standing snags to tons, where snags are usually measured in diameter and number per acre. The conversion is species-specific due to differing wood density. Larger CWD has more value for wildlife, lasts longer, and maximizes tonnage while minimizing fire hazard (least surface area per ton).

The 2017 City lands inventory shows 17.23 tons of existing CWD (ground only) in sizes over three inches and 17 snags per acre or 7 tons equivalent, for a total of 24.23 tons average over lower City lands. This 2017 number already exceeds the high end of the range defined by Brown as between 5 to 20 tons per acre. Given the additional die-off since 2017 across all Ashland forestlands, there is an excess of CWD at the current time that is growing as DF mortality continues.

Across all acres surveyed in the summer of 2023 there was an average of 7.3 dead/dying trees recorded through multi-spectral imaging. That number has since increased and will continue to increase as DF mortality continues. Though we don't know the overlap between the 2017 data and the recent aerial survey, all trees that have died since 2017 inventory are in excess of the optimized upper range from Brown, increasing the wildfire hazard. The vast majority of newly dead and dying are of much larger size classes than the bulk of the snags from 2017. These new snags will add more tonnage per acre per tree and add more valuable snags for wildlife habitat (larger snags are used preferentially and over longer periods than smaller snags). Larger trees are also preferable because they meet the targets for ground-based CWD with a smaller footprint, so in the event of a fire less area is impacted by deep soil heating.

Table 6. Snags per acre by size class for lower City lands units (LW) and tonnage of snags per acre by size class. Conversion used Brown's conversion for Douglas-fir wood density by snag diameter for the midpoint diameter of each class.

Unit	Acreage	# of Plots	Snags per acre by diameter class				Tons/Acre by Diameter Class DF		
			5-11"	11-19"	19"+	Total	5-11"	11-19"	19"+
A1	5.01	3	0	14	0	14	0	8.33	0
B	51.73	14	19	10	0	29	2.337	5.95	0
C	12.16	5	7	3	1	11	0.861	1.785	1.22
D	9.94	2	0	8	0	8	0	4.76	0
E	33.03	9	0	9	2	11	0	5.355	2.44
F	4.34	2	0	0	5	5	0	0	6.1
G	18.17	15	0	2	1	3	0	1.19	1.22
H	4.51	4	0	4	2	6	0	2.38	2.44
J	6.97	6	0	0	3	3	0	0	3.66
K	24.69	13	8	6	6	20	0.984	3.57	7.32
L	8.97	6	0	5	3	8	0	2.975	3.66
M1	14.20	4	0	4	0	4	0	2.38	0
M2	3.65	3	9	9	2	20	1.107	5.355	2.44
N	31.44	8	35	8	1	44	4.305	4.76	1.22
P	23.04	11	14	4	1	19	1.722	2.38	1.22
Q	16.5	6	0	4	1	5	0	2.38	1.22
R	18.52	5	17	12	3	32	2.091	7.14	3.66
S	16.09	6	5	2	6	13	0.615	1.19	7.32
W1	8.00	3	14	0	0	14	1.722	0	0
W2	4.63	4	61	10	2	73	7.503	5.95	2.44
Total*	**315.59**	**129**	**9**	**6**	**2**	**17**	**1.2**	**3.4**	**2.4**

*Total for each diameter class is the mean of the unit per acre number. Unit (LW)M2 snag density for the 5-11" class was substituted with the overall mean for that size class due to one non-representative plot in that small unit that was a clear outlier.

Table 7. Comparison of existing, required (ODF), and optimum (Brown) CWD in tons per acre.

	2017 COA CWD Inventory	**ODF Forest Practices Required CWD**	**Current Dead/Dying DF from 2023 Survey**	**Optimum CWD (snags and down) Brown (2003)**

1 to 100 hour fuels/acre	**5.59 tons**	**NA**	**NA**	**<5 tons**
1000+ hour fuels/acre	**17.23 tons**	**2 logs**	**NA**	**5 to 20 tons/acre combined down wood and snags.**
Snags per acre	**7.0 tons**	**2**	**6.84 tons**	

Coarse Woody Debris and Fire Hazard: Spatial Designation
The benefit of competing objectives in forest ecosystems is they don't have to be met everywhere all at once. Spatial designation helps bring not only people together with sometimes opposing views but can also focus on satisfying objectives where they have the most value. Designating where CWD has the most benefit and the least risk is critical in this landscape where fire hazard and habitat can conflict.

The City of Ashland Restoration II project said to focus snags in riparian corridors as a priority, with two snags in the riparian zone to every one snag in the upland. This should be modified to ensure that minimal numbers of snags are left in high priority fire management zones, both to minimize fire behavior like spotting distance, but also for firefighter safety and effectiveness. Falling trees, and especially dead trees, are a major cause of fireline accidents and fatalities.

Guidelines for CWD Retention:

1. Leave the largest snags first before removing excess to meet fuels targets.
2. Use site assessments to guide decision making when available. Unit level inventories or at least ocular estimates can guide what levels of CWD area appropriate in each location. Use Brown's 5-20 tons guidance.
3. Prioritize leaving CWD in riparian areas, north aspects, in or adjacent to mapped refugia, and in draws. Leave up to 30 tons/acre in higher density pockets over 20% of these locations. Otherwise, leave 15-20 tons/per acre.
4. Minimize CWD in fire management zones (clusters and POD boundaries), ridgelines, and along non-riparian zone roads. Five tons/acre is a target, though isolated areas with up to 10 tons/acre are allowable as long as they don't present potential hazards to the public or firefighters.
5. Cluster snags and CWD as much as possible to allow for leave areas when conducting prescribed burn operations.
6. Minimize hazards and maintenance near roads and trails by removing dead trees where they are likely to fall on those spaces. Consider topping trees with significant habitat value.

<u>Vegetation</u>

Of critical importance to all resource values and community safety is the maintenance of vegetation that results in low-intensity wildfire behavior and fire effects. Vegetation community transition already evident in the lower Ashland Watershed, Siskiyou Mountain Park, and all lower elevation municipal forestlands will challenge this objective over the next decades as predicted Doug-fir canopy cover decreases and sites become hotter and drier.

Anticipating and facilitating vegetation type transitions is a best-case strategy to keep fire risk low while cultivating forested plant communities suited to hotter and drier conditions to come.

In recognition that past vegetation management:

1. Involved thousands of years of frequent, low intensity aboriginal burning, particularly at lower and mid elevations;
2. Beginning in the 1850's, Euro-American management altered vegetation significantly in structure, composition, and functional process leading to infrequent and high intensity disturbance (logging and high intensity wildfire);
3. Since 1995, active ecological stewardship and fuels reduction have beneficially affected City forests by reducing density, selecting for and planting fire tolerant species, restoring open forest structure, and reintroducing low intensity fire as a process.

The ecological stewardship approach has laid a solid foundation for climate adaptation but could not have anticipated the speed with which climate change is altering forest structure, adding fuels, and forcing vegetation transitions. Basing past management on Plant Associations, and Plant Association Groups (PAGs) is one tool that helps us anticipate and facilitate plant community transitions. PAGs that are drier than what was previously analyzed at the site level can be utilized as one guide, though the plant associations we have available to us aren't a tight match to the sites that are transitioning. Though most commonly recorded by the PAG (Dry Douglas-fir, for example), we can use the Plant Association itself at a finer scale to help find transitional species better suited to drier conditions. Looking at a range of possible species within various plant associations can offer a "menu" of transitional options rather than trying to force a particular plant association that may offer only select options that fit our setting.

Vegetation Transitions

If our forests are succumbing to bark beetles, what will do better in the future?
Plant associations have been used since the early 1990's to characterize the underlying conditions (soils, rainfall, aspect, elevation) that lead to expressions of certain assemblages of species across the landscape. Ashland's forestlands have been assessed using Plant Association Groups (PAGs) to characterize broad areas into dry-Douglas-fir, moist Douglas-fir, and ponderosa pine, and oak PAGs. The individual associations within each PAG are useful as a guide to aide transitions in plant communities, while recognizing that vestiges of each association will be present for many decades as species become unsuitable for certain sites and other species are transitioned, resulting in unique groupings of species that may persist.

Importantly, plants (including trees) are often not capable of moving between their niche habitats as quickly as conditions are changing. Some species that spread seeds over longer distances (colonizers such as bull thistle) will do well, while others will need help through site preparation and planting. For example, sugar pine is highly desirable and historically more common, but needs to be planted because natural stocks aren't resistant to blister rust and there aren't enough sugar pine right now to reliably seed into areas where we want them.

The common PAG transition will be from Dry Douglas-fir PAG to Ponderosa Pine PAG. It is worth noting that there are only two ponderosa pine associations in the SW Oregon guide. In plant association terms this would be from the association of Douglas-Fir-Ponderosa Pine/Poison Oak (most common association here of the dry Doug-fir series) to Ponderosa Pine/Black Oak (ponderosa pine series). The warmest DF plant association is the Douglas-fir/California Black Oak/Poison Oak Association, so while we are deemphasizing Doug-Fir overstory trees we may want some of the associated shrubs, forbs, and grasses in our 'menu' of suitable species.

Douglas-fir/California Black Oak/Poison Oak Plant Association

Common name	Code	Constancy	Cover	Avg. Richness
Overstory trees				3
Douglas-fir	PSME	100	32	
Sugar pine	PILA	100	13	
Ponderosa pine	PIPO	73	9	
Understory trees				7
Douglas-fir	PSME	100	40	
California black oak	QUKE	100	16	
Pacific madrone	ARME	100	12	
Sugar pine	PILA	100	5	
Tanoak	LIDE3	91	5	
Canyon live oak	QUCH2	82	7	
Ponderosa pine	PIPO	55	2	
Incense-cedar	CADE27	36	6	
Shrubs				5
Poison oak	RHDI6	100	6	
Baldhip rose	ROGY	82	2	
Hairy honeysuckle	LOHI2	73	2	
Creeping snowberry	SYMO	45	1	
Herbs				10
Scouler's harebell	CASC7	73	1	
White-flowered hawkweed	HIAL2	64	2	
Slender-tubed iris	IRCH	64	1	
Braken	PTAQ	64	1	
Rattlesnake-plantain	GOOB2	55	1	
Mountain sweet-root	OSCH	45	1	
Woodland tarweed	MAMA	45	1	

The Ponderosa pine plant association plots were taken at higher elevations than exist in the City ownership, with average of four plots at 3820 feet, so some species listed may not be appropriate for low elevations.

Ponderosa Pine/Black Oak Plant Association Species List

Common name	Code	Constancy	Cover	Avg Richness
Overstory trees				2
California black oak	QUKE	75	13	
Oregon white oak	QUGA4	25	5	
Douglas-fir	PSME	25	1	
Ponderosa pine	PIPO	25	1	
Understory trees				4
Ponderosa pine	PIPO	100	6	
California black oak	QUKE	75	22	
Douglas-fir	PSME	75	1	
Oregon white oak	QUGA4	25	2	
Western juniper	JUOC	25	1	
Pacific madrone	ARME	25	1	
Shrubs				2
Deerbrush	CEIN3	50	18	
Common snowberry	SYAL	50	1	
Herbs				20
Common vetch	VISA	100	4	
Woods strawberry	FRVEB3	75	13	
Hedgehog dogtail	CYEC	75	7	
Mountain sweet-root	OSCH	75	7	
White-flowered hawkweed	HIAL2	75	1	
Slender-tubed iris	IRCH	75	1	
Meadow fescue	FEPR	50	11	
Rough bluegrass	POTR	50	10	
Western fescue	FEOC	50	6	
Fragrant bedstraw	GATR	50	3	

Overstory Tree Species

The ponderosa pine/black oak PAG is useful in thinking about future overstory composition, though in most sites where significant DF mortality is already present and/or in progress, the overstory composition will tend much more heavily toward ponderosa pine than indicated by the species list, will not have Oregon white oak, and will eventually have less DF than the ponderosa pine PAG indicates.

Of note is the appropriateness of sugar pine on relatively cooler and moister sites where DF is transitioning, though the DF may persist in low density for decades (lower slopes, concave landforms, north trending aspects). Sugar pine doesn't show up at all in the ponderosa pine association species list. There are white pine blister rust resistant varieties of sugar pine that have already been planted on lower City forestlands and should be more widely planted.

Pine Retention

A mantra has often been expressed that returning to a pine-dominated forest type will lead to a healthy forest that is well prepared to withstand both drought and wildfire. While pine species (ponderosa and sugar pine) are better suited for drier conditions and can withstand frequent, low intensity fire, ponderosa pine is subject to periodic and potentially widespread outbreaks of western pine beetle. Pine species have been particularly vulnerable to drought induced beetle attack in the dry, mixed conifer forests of the Sierra Nevada in California, leading to "mass fire" events (previously cited), loss of carbon storage capability, and forest cover loss (previously cited).

Research has found that if not exposed consistently to fire during their lifespan, ponderosa pine doesn't develop the degree of fire resistance or insect resistance of ponderosa pine that have persisted through decades and sometimes centuries of consistent, low intensity fire and periodic drought.

In the past five years, there have been major outbreaks of western pine beetle mortality on the Lithia Park Hillside, Red Queen Trailhead, Hald-Strawberry Park, Acid Castle property, and various smaller private parcels in and around the community. This has resulted in significant costs to taxpayers and owners to cut, remove, and treat the small and large diameter fuels resulting from western pine beetle mortality (which is often mixed with pine engraver beetle attack in the same tree).

"Our paper found that as forests reach a certain threshold of ponderosa pine density, they become exponentially more likely to have western pine beetle-driven die-off," -- Zachary Robbins, postdoctoral researcher at Los Alamos National Laboratory and lead researcher on a research paper describing carbon storage related to ponderosa pine mortality.

Another research paper on western bark beetle-caused mortality in the southern Sierra Nevada compared ponderosa pine that survived drought and western pine beetle pressure with those pine that died. They concluded:

"Compared to beetle-killed trees, surviving trees had higher growth rates and grew in plots with lower ponderosa pine basal area." (Keen et al, 2020)

In learning what factors help pine survive drought/beetle episodes we can understand there are limits to pine survivorship and employ strategies that can maximize chances to sustain pine into a hotter and drier future like what Sierra Nevada forests have already experienced.

Data collected in August and September 2023 on City lands units LW-C and LW-A show that ponderosa pine in the lower Ashland Watershed have slow growth, and pine basal area is high. Growth rate is a surrogate for gauging a pine tree's health and ability to resist insect attacks.

Key pine retention strategies:

1. Expose pine to frequent, low intensity fire throughout their lifetimes, at least once a decade or less if possible.
2. Maintain low to moderate pine basal area to maintain vigorous growth, but also to reduce the number of host trees to discourage future western pine beetle outbreaks.

Invasive Vegetation
Non-native plant species are known and mapped on City forestlands, less so on APRC properties. Changing climatic conditions afford non-natives a growing opportunity to colonize new areas via weakening of native species and/or disturbances that afford conditions ripe for non-native species. The following are species of concern and priority with recommended actions to reduce non-native plant impacts.

Known invasive species:

**Himalayan Blackberry*
**Dalmation Toadflax*
Hedgehog dogtail
**Vinca major*
**English Ivy*
**Star Thistle*
Puncture Vine (not known on forestlands, but in the general area)
**Scots broom*
**French broom*
Bachelor's buttons
Bull thistle
Rose campion
Jimsonweed/Datura
**Mazzard cherry (riparian)*
**Japanese knotweed (riparian)*
Field hedge parsley
**Pyracantha*

*species being actively mapped, mitigated, and monitored

Recommendations

- Update mapping annually and add APRC forests to mapping
- Monitor populations and assess treatment effectiveness
- Continue eradication actions as appropriate for each species of concern
- Reestablish native species where possible to discourage non-natives

Soils and Geology

Soil protection of is a critical issue on Ashland forestlands. Previous projects and plans have established a solid foundation for soil resource protection and for minimizing the risk of slope failures leading to landslides. Extensive geologic mapping and mitigation have been completed and the current geologic hazard framework is implemented at a site scale by Oregon Department of Forestry. An ODF site review is conducted for any proposed activities that potentially impact slope stability on forested lands. Currently, ODF prohibits removal of live trees on slopes over 70% without a site-specific plan.

Soils Objectives (Main, unpublished 2022):

- Prevent large scale, high severity fire or insect-related mortality
- Minimize management on slopes > 55-65% to reduce the likelihood of slope failure in storms of increasing intensity. Consider decreasing importance of fire management objectives on steeper slopes.
- Avoid long duration fire and excess high amounts of snags and LWD; manage for endemic rather than outbreak levels of insect-related mortality. Maintain adequate amounts of snags and LWD for soil health, wildlife habitat, and other ecosystem level needs. Reduce excess amounts of snags and LWD when they occur, especially in more hazardous spatially explicit locations.
- Elevate amounts of prescribed underburning to decrease possibility of high severity fire; burn in ways that minimize potential surface soil erosion. Minimize bare soil exposure through retention of duff, litter and protective understory vegetation. Burn cool at least initially; retain unburned patches (mosaic burning).
- Avoid ground-based disturbance except of gentlest of slopes; remove merchantable fuel through utilization of helicopters on steeper slopes. No new roads.
- Elevate the importance of understanding below-ground processes in guiding management, particularly when considering water and carbon.

Wildlife Habitat

Wildlife habitat is a critical component of forest stewardship objectives. Habitat is changing as DF trees die and climate change drives weather extremes in temperature and drought. Species will seek out places to escape environmental extremes and the refugia strategy is designed to prioritize those places and encourage more complex habitat through increased CWD levels where wildlife activity is most common.

While there are no known Threatened or Endangered species on the lower Ashland lands, the Pacific fisher (weasel family) has been a species of concern and proposed for listing. Fisher are known from radio collaring done in the Ashland Watershed by Dave Clayton and Tessa Smith of the U.S. Forest Service to use all the Ashland forestland areas.

Fisher have been denning in primarily hardwood (oak, madrone) cavities in lower elevations, though one denned in ponderosa pine at White Rabbit trailhead in 2013. Fisher have been found to be tolerant of human activity and even forest management work though they will avoid helicopter logging areas, but return when work is done. Denning areas need to have higher canopy cover (over 50%) and complex structures, which are characteristics in refugia. A high percentage of the area will lose canopy cover to the DF flat headed borer mortality event and not meet that habitat requirement as mortality continues.

It is important to note that high intensity and widespread fire is a worst-case scenario for fisher habitat. Actions that reduce the risk of that kind of fire are ultimately beneficial to fisher populations, though may have short-term impacts to individuals.

Wildlife habitat recommendations:

- Complete proposed work as early as possible in spring before denning and nesting season is preferable.
- Maintain areas of high canopy cover with complex CWD component (refugia) at various scales.
- Leave hardwoods and snags intact, especially with cavities. Favor hardwoods in thinning to promote longevity.
- Manage to keep high intensity fire to a minimum on the landscape.
- Leave CWD and unburned piles for habitat outside of fire management areas and refugia.
- Create diversity through variable density thinning, adding skips and gaps to homogenous stands.

<u>Douglas-fir Decline: Rating our Risk</u>

Ashland’s forests have experienced Doug-fir die-off in the past and fielded a project to remove excess die-off by helicopter in 2004, but the regional impact has never been so severe, nor the prognosis for such a high severity event to continue. It’s necessary to look ahead with all the data and insight available, to make decisions now that will potentially save money and lessen future negative outcomes.

Figure 2. Trees killed by DFFB since 1975. Data from U.S. Forest Service, graphic by Oregon State University.

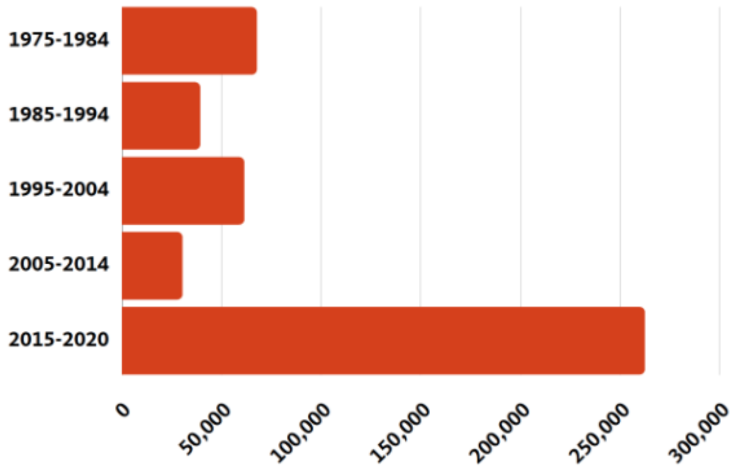


Figure 4A. Trees killed in southwest Oregon by the flatheaded fir borer.

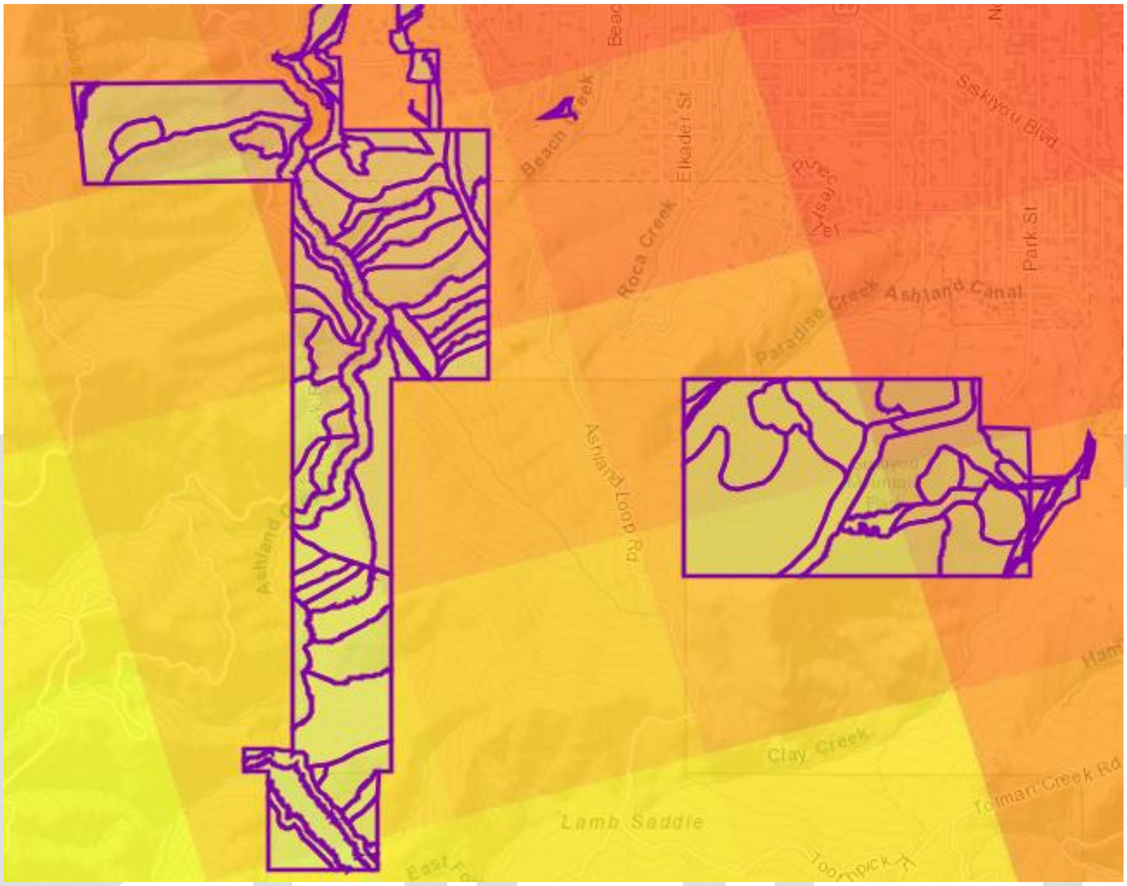
Credit: © Oregon State University

The following risk rating system assesses the likelihood of Douglas-fir decline and mortality in the next five years at the watershed or landscape scale, the abundance and severity of mortality, and the probability that mortality will increase in that area. Two broad-scale risk rating systems are provided first — one based on average annual precipitation (Table) and one based on climatic water deficit (Table 4). Taken from OSU Extension "Trees on the Edge" website:

Table 8. Relative Douglas-fir mortality risk by precipitation zones (OSU Extension)

Average annual precipitation (inches)	Relative risk level	Interpretation
Less than 35 inches	High	Douglas-fir decline and mortality abundant; some favorable sites such as northeasterly aspects with deep soils may serve as refugia.
35–45 inches	Moderate	Douglas-fir decline and mortality are common, particularly on harsh sites.
45–60 inches	Low	Douglas-fir decline and mortality observed occasionally, especially on marginal sites, such as those bordering oak woodlands.
More than 60 inches	Very low	Douglas-fir decline and mortality due to drought-related agents is uncommon.

Map 4. Lower Ashland forestlands precipitation ranges from 22.35 inches at the top of Lithia Park (north) to 26.2 Inches of Precipitation in the south near Reeder Reservoir (City of Ashland GIS map). Under 35 inches is considered high risk for abundant Douglas-fir mortality.



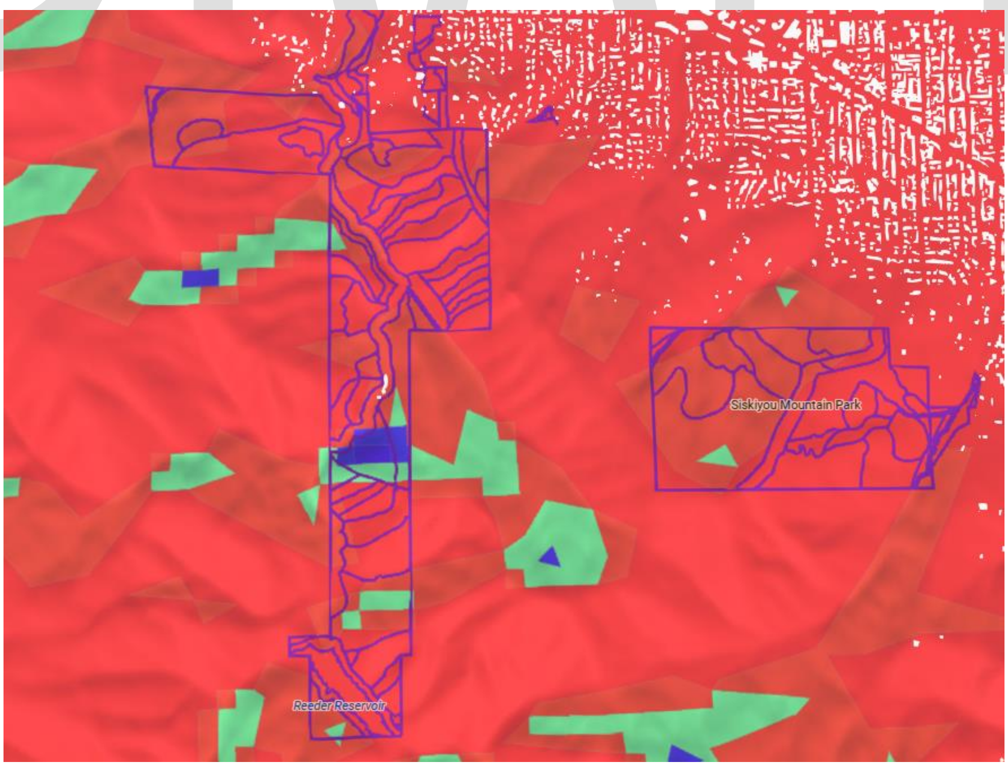
Climatic Water Deficit

Climatic Water Deficit is a useful measure for calculating and predicting current and future drought stress on vegetation. [The National Parks Service] defines it as:

Evapotranspiration returns water to the atmosphere through evaporation and transpiration, which is water movement through plants. When soils dry sufficiently to limit evapotranspiration, a climatic water deficit occurs. Water deficit is the additional amount of water plants could use if it were available. Site conditions, like how much water the soil can hold and which way a hill slope faces, modify the effects of precipitation and temperature.

Table 9. Relative risk by climatic water deficit (OSU Trees on the Edge website)		
Climatic water deficit (mm)	**Relative risk level**	**Interpretation**
More than 400mm	Very high	Too hot and dry for Douglas-fir; Douglas-fir seldom encountered.
350–400mm	High	Douglas-fir decline abundant; some favorable sites such as northeasterly aspects with deep soils may serve as refugia.
300–350mm	Moderate	Douglas-fir decline is common, particularly on harsh sites.
250–300mm	Low	Douglas-fir decline observed occasionally, especially on marginal sites, such as those bordering oak woodlands.
Less than 250mm	Very low	Douglas-fir decline is seldom encountered.

Map 5. Predicted Climatic Water Deficit for Ashland municipal forestlands. Red colored area is where CWD is predicted to be over 400mm by the year 2055, or Very High risk.



Douglas-Fir Mortality Rating and Prediction: Site Level

Risk Rating

The risk rating included in the Bennett et al 2023 paper on DF Decline has both site and tree level risk ratings that were mapped in a GIS database and have proved useful thus far, though continue to evolve as more data is collected and more insights are learned about DF decline. The Bennett risk rating is used here with mapping done by Rickey Fite of the City of Ashland GIS division.

Bennett Site-Scale Risk Assessment

The following risk rating system is intended to help assess Douglas-fir mortality risk over the next five years at a given point on the landscape, where higher values represent greater risk. This is most applicable to sites with <45" average annual precipitation and/or Climatic Water Deficit >300m. Risk refers to:

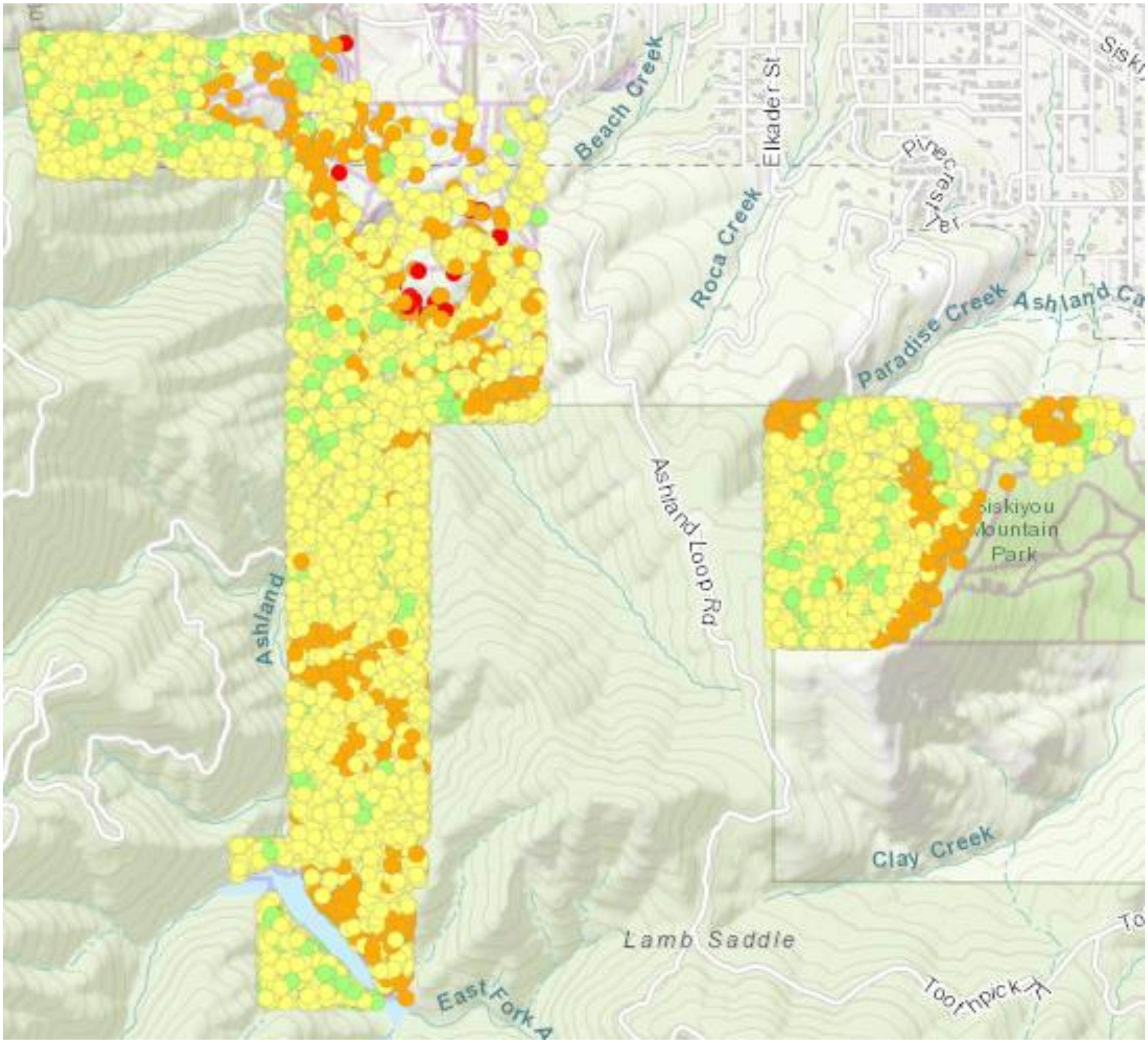
- *The likelihood of observing Douglas-fir mortality in a one-acre plot at a given point on the landscape*
- *The probability that mortality will increase and intensify at this location*
- *The expected severity of mortality, measured as the percentage of the Douglas-fir basal area within a 1-acre area surrounding the sample point that is dead/dying.*

Table 10. DF Site Mortality Rating and Scoring (Bennett et al, 2023)

Points	Risk Factor	Score
Beetle pressure		
6	DF mortality from FFB is abundant within 1-acre plot	
3	DF mortality from FFB is found within 1/2 mile of plot	
0	DF mortality from FFB not found within 1/2 mile of plot	
	Beetle pressure points =	________
Topographic factor (heat load)		
2	SW aspect & one or more of following: >35% slopes, ridge/upper slope position, convex terrain	
1	All others	
0	NE aspect, & one or more of following: lower 1/3 slope position, concave terrain	
	Heat/moisture stress points =	________
Proximity to stand edge		
1	Stand edge is within 100’	
0	Stand interior	
	Edge points =	________
Soil factor		
1	One or more of the following: poorly drained soils, high clay %, very shallow soils, Oregon white oak present/within 50’	
0	All others	
	Soil factor points =	________

Total Points	Relative Risk Category
≥5	Probability of mortality/intensification is very high. Very high severity: >50% of DF basal area in 1-acre plot is/will be dead/dying
4	Probability of mortality/intensification is high. Moderate to high severity: 25-50% of DF basal area in 1-acre plot is/will be dead/dying
2-3	Probability of mortality/intensification is moderate. Low severity: 10-25% of DF basal area in 1-acre plot is/will be dead/dying
0-1	Probability of mortality/intensification is low. Severity: Dead/dying DF few or absent, <10% of DF basal area in plot is/will be dead/dying

Map 6. Green trees risk mapped on city forests using the Bennett et al site factors. All green trees scored between 6 to 9, or very high risk of significant ongoing or future mortality. Soil factor was not mapped due to lack of data.

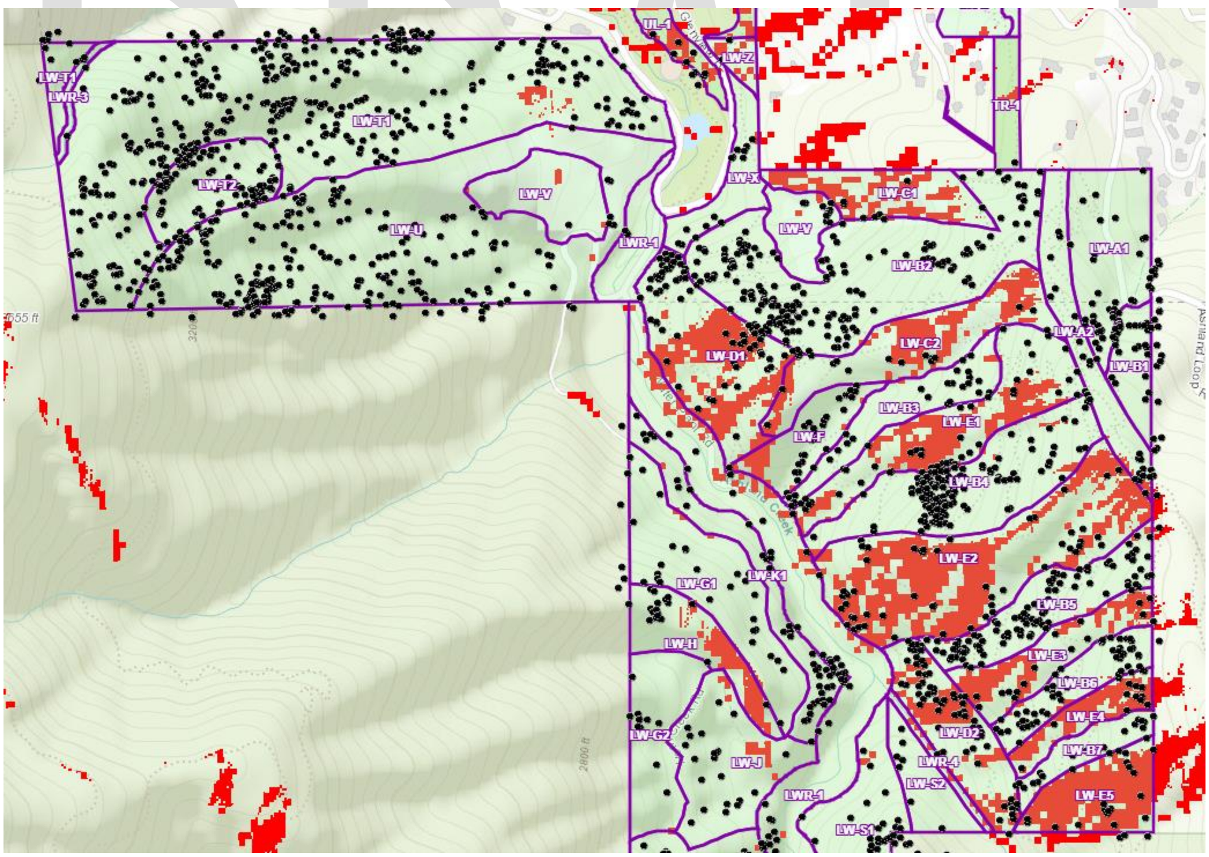


In summary, the site risk analysis from Bennett shows all Ashland lower forestland with high probability of high severity outbreaks of Douglas-fir flatheaded borer in the next five years. The "beetle pressure" score drives the high rating, meaning that beetles are already present and abundant over so much of the area that the vast majority of host trees are unlikely to avoid infestation due to contagion of beetles in close proximity. It's unknown if DF trees will have the ability to recover should rainfall return to normal or above normal due to possible physical harm incurred during periods of extreme temperatures coupled with drought.

Due to the increase in fire danger caused by these waves of mortality and the challenge (financial, logistical, social) of removing dead and dying trees over hundreds of acres, using an approach to "pre-capture" impending mortality is a priority. This would mean cutting more green trees beyond what might be seen as a typical "thin-from-below" where smallest trees are removed to bolster the health of larger trees left behind. That silvicultural strategy is no longer viable in the highest risk settings, except refugia and higher elevations where risk is less severe.

The following figure shows areas in red where topographic factors (slope, slope position, curvature, and aspect) show the places most at-risk in the absence of beetle pressure. Mapped dead and dying trees are black dots. The susceptible sites and current mortality don't match up well, which can be attributed to the widespread presence of beetles, or contagion. There are so many active insects that they "swamp out" the topographic influence, causing at least some mortality in all settings.

Map 7. Existing mortality (black dots) is spread across many settings that are not highly susceptible (in red), showing that beetle infestation has progressed beyond the site assessment model's utility.



Tree-level Risk Assessment

The previous two risk tools look at site level risk, which is useful when looking at the City and APRC properties in the context of the lower Ashland Watershed. However, when making decisions about individual trees, this matrix can be used. Many trees exhibit signs of mortality that were not detectable via aerial survey and this rating system allows for further, refined assessment in the field. A vast majority of trees will be at moderate to high probability of mortality simply due to the beetle pressure factor (where signs of mortality from FFB is found within a one-acre radius), though inspecting each tree for more signs of mortality is needed.

Mortality risk rating for individual Douglas-fir trees (OSU Extension Service)

BEETLE PRESSURE

- Douglas-fir mortality from flatheaded fir borer is found within a 1-acre plot (120-foot radius): 4 points
- Douglas-fir mortality from flatheaded fir borer not found within 1-acre plot: 0 points

CROWN DECLINE

- Severe crown decline: 3 points
- Moderate crown decline: 2 points
- Light crown decline: 1 point
- No recent crown decline: 0 points

ABUNDANCE OF PITCH JEWELS

- Abundant pitch jewels: 3 points
- Light pitch jewels: 1 point
- Pitch jewels absent: 0 points

SCORE

- **6 or more points:** High probability of mortality within two years
- **3–5 points:** Moderate probability of mortality within two years
- **0–2 points:** Low probability of mortality within two years

Predicting future DF die-off is important for many reasons:

1. Efforts to retrieve fuels resulting from DF mortality are expensive. Given the difficulty of accessing most City and APRC lands, helicopter retrieval (yarding) is the most practical method and least disturbing to soils. There is a narrow window to retrieve dead and dying trees where there is still value in the wood at a mill. If large areas of dead rot to the point there is no mill value, mitigating large diameter fuel on site becomes twice the cost, if possible at all. Incurring significant costs is fiscally challenging in any year, and the more work that can be done during one project saves taxpayer funds over longer timeframes given the DF mortality is predicted to continue.
2. Ecologically informed forest thinning reduces tree competition, allowing for higher quality refugia over a longer timeframe. The sooner trees have access to more resources, they experience less stress and are more likely to survive for longer periods.
3. Pre-emptively thinning trees that are predicted to die in the future reduces wildfire risk and exposure. By removing dead, dying, and predicted mortality, future fire risk is lowered by reducing near-term mortality that will become canopy then ground fuel, reducing future fuel accumulation by building resiliency in trees that can survive, and pre-capturing green trees at high risk for mortality.
4. An abundance of dead trees increase risk to firefighters and the community. Trees at high risk of mortality, if not removed promptly, increase risks to firefighters and lower the likelihood of successful fire suppression. Roads and trails are subject to falling branches and eventually larger wood.
5. Maintaining low fuels is essential to maintaining forests. Mass tree mortality followed by severe fire in the Sierra Nevada mountains in California has been shown to drive conversion of forests to non-forest vegetation, degrading landscape carbon storage capability.
6. Thinning green trees at high mortality risk can partially offset dead tree removal costs. The 2004 City Restoration II project captured 1,846 dead trees and 4,322 live trees, the cumulative value of which nearly offset the cost of the helicopter used to yard the trees. Helicopter yarding can only be employed infrequently, so maximizing each entry is economically prudent.
7. Extracting fuels via helicopter is disruptive to recreation and adjacent residents. Pre-capturing anticipated mortality reduces the number of entries and inconvenience of closed trails, closed roads, and noise.
8. Establishing climate change adapted species is time sensitive. Conditions are becoming less hospitable to seedlings, limiting the window available to establish desirable species such as ponderosa and sugar pine. Proactively removing high fuel loads and predictable mortality opens needed canopy gaps for successful transitions to drought and fire tolerant species.

"Although dealing with dead trees has become a focus of forest management on many lands in the western US (and a priority where human safety is compromised), for long-term resilience and adaptation to climate change,

we need to move beyond triage (e.g., removal of dead and dying trees) to making "green" (live) FF (Frequent Fire) forests more resilient to disturbances. Unfortunately, proactively treating forests to reduce density prior to wildfires, droughts, and bark beetle outbreaks is increasingly constrained." --Stephens et al 2018

Refugia: Lifeboats for Sensitive Species

Refugia can be a confusing topic…a refuge for what from what? Refugia for a lichen is different than refugia for a wide-ranging mammal like pacific fisher.

Refugia in this document generally follow this definition:

Refugia are habitats that buffer climate changes and allow species to persist in—and to potentially expand under—changing environmental conditions.
(Wilkin et.al. 2016)

As the landscape becomes more inhospitable to Doug-fir, refugia for that tree species also happens to represent the wettest and coolest places for other species unable to tolerate heat and drought at lower elevations, as shown in Figure X. This is in part because Doug-fir is the bulk of overstory cover and its dense canopy provides shade, maintaining the refugia. When the overstory is lost quickly as is happening now, the refugia quality can degrade quickly.

Cool, moist habitat will increasingly become rare in a hotter, drier, and more fire-prone environment, and are therefore the priority settings to maintain for species experiencing climatic stress. Refugia ideally connect to other refugia, offering pathways for species to migrate. There are many dozens of species of plants, mammals, amphibians, lichen, moss, birds, reptiles, and more that will benefit from cooler and moister conditions in refugia.

Importantly, maintaining refugia isn't a passive process. Several studies make the case for actively managing refugia to keep fire severity low and resist intense disturbance that can drive forest conversion (or at least loss of refugia character). Wilkin et al (2016) underscore the importance of active stewardship in refugia:

"Our landscape scale study suggests that cold-air pools, an important type of small-scale refugia, have unique fire occurrence, frequency, and severity patterns in frequent-fire mixed conifer forests of California's Sierra Nevada: cold-air pool refugia have less fire and if it occurs, it is lower severity. Active management, such as restoration and fuels treatments for climate change adaptation, may be required to maintain these distinctive and potentially important refugia."

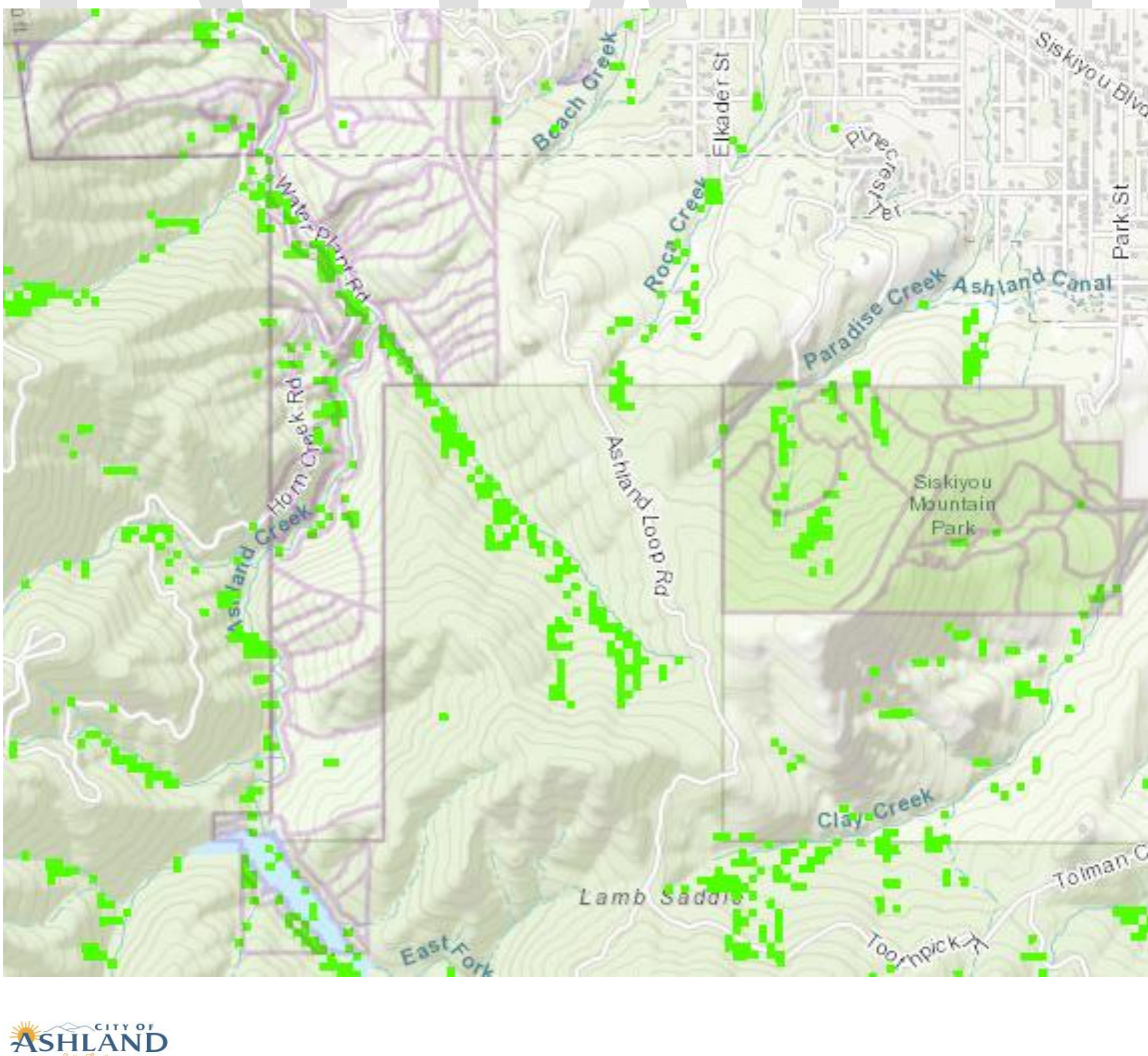
Similarly, Rodman et al (2023) found that fire refugia locations in the Southwest were found in areas with low fuels (often from previous fires or prescribed fire) combined with favorable topographic settings. The authors also underscored the role of active management in maintaining refugia:

Likewise, active forest management (e.g., mechanical treatments, prescribed fire, resource objective fires, and post-fire replanting) may work with the locations of potential refugia to help reinforce and expand refugial networks and maintain critical ecosystem services provided by forest ecosystems. Importantly, this study illustrates that open-canopied forests and fires burning under moderate weather conditions may promote and maintain refugia.

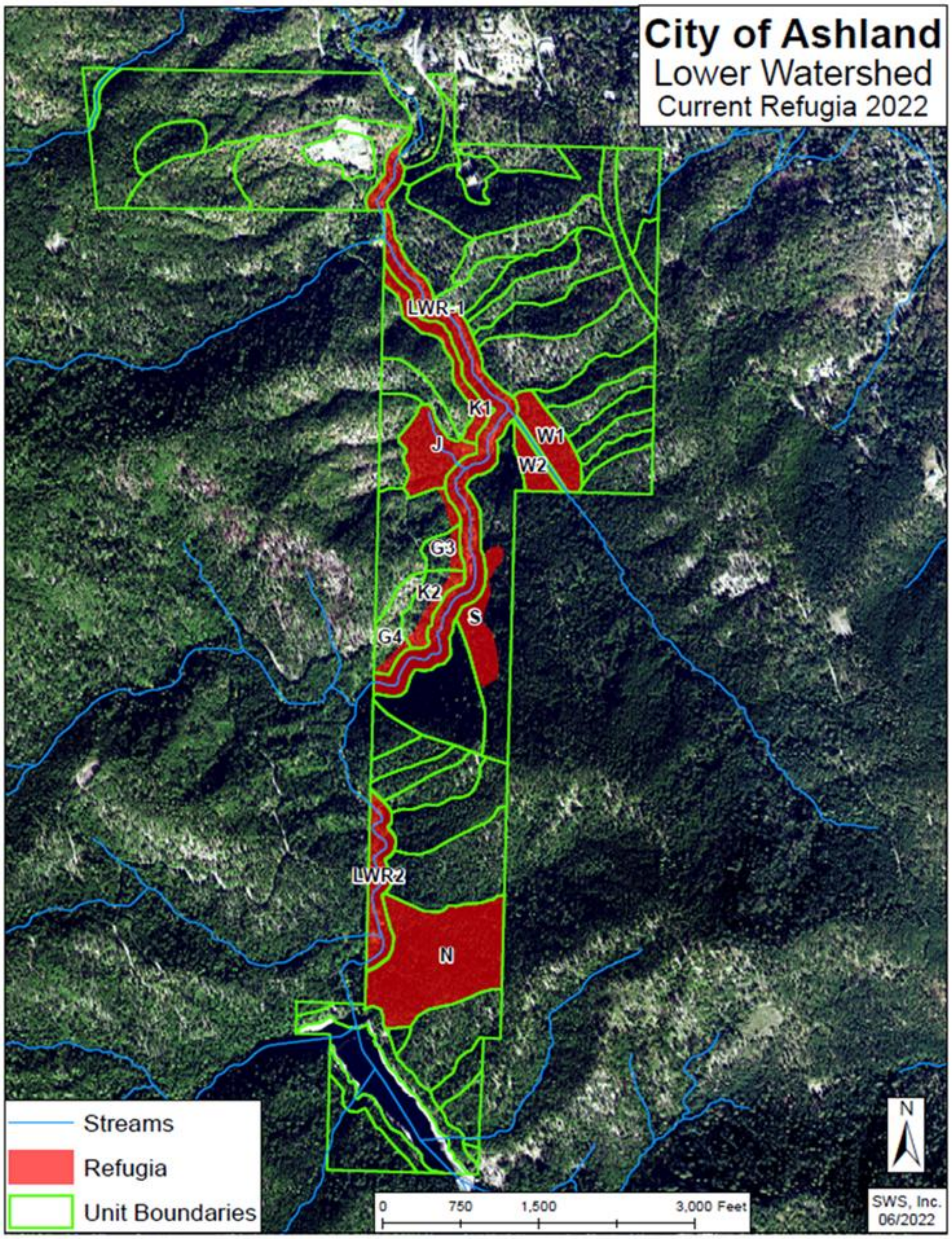
Ashland Forestland Refugia Locations

Mapping refugia is important so we can implement strategies to increase the resiliency of these important landscape features. It's encouraging that topographic factor mapping, which was one element of the Bennett et al (2023) site risk assessment, indicates that predicted refugia closely match previous refugia mapping and the refugia ranking done by Main in 2022.

Map 8. Green pixels are topographic settings most favorable for Douglas-fir (Bennett risk rating score of zero in topographic factor) and likely refugia locations. (City of Ashland GIS)



Map 9. Refugia mapped by Main in 2022 are largely the same today except for unit LW-W1 that has changed drastically in the past year. The southern end of that unit may still be a functioning refugia.



CITY OF ASHLAND
Better Together

Table 11. Refugia rankings by unit and refugia type. Highlighted units decreased in value from 2022 to 2023. Siskiyou Mountain Park units were only rated in 2023.

Ashland Forestlands Refugia

Marty Main, Small Woodland Services Inc. June 2022

(Updated October 2023, Chris Chambers)

Unit	**Aspect**	**Slope Position** (Lower, Mid, Top)	**Slope Steepness** (Gentle, Mod. Steep)	**Original No-Treatment**	**Current No-Treatment**	**Current Refugia**	**Refugia Type and Functionality** (3- high functioning, 1-low functioning)			
							Fire	Climate	Hydrologic	Wildlife
Lower Watershed Parcel										
LW-B1	N-E	M-T	S	yes	no	no				
LW-B2	NW-N	L,M,T	S	yes; Barranca only	no	no				
LW-G1	NE	M,U	S	yes	yes	no				
LW-G4	E	L,M	S	yes	no	yes, in low s.p.	1-2	1-2	1-2	1-2
LW-J	E	L	M	no	no	yes	3	2	3	2
LW-K	E-NE	L,M	S	yes	no	yes; in low s.p.	1	1	2-3	1-2
LK-N	N-NW	L,M,T	S	no	no	yes	2	3	2	2
LW-R	N-NW	L,M,T	S	yes	yes	yes	1	1	1	3
LW-S	W-NW	L,M	S	yes	yes	yes; in low s.p.	2	2	2	2
LW-T	N-NE,S SE	L,M,T	S	yes	yes	no				
LW-W1	W-NW	L	S	no	no	yes	2	1-2	2	2
LW-W2	NE	L	M	no	no	yes	3	3	2	2
LW-Rip		L	G	yes	yes	yes	3	2	2	2
Siskiyou Mountain Park										
SMP-9	N	U,M	M,S	no	no	no	3	2	2	1
SMP-14	N	M	S	yes	no	no	1	1	1	3
SMP-15	N	M	M	no	no	yes	2	2	1	1
SMP-16	N	M	M	no	no	yes	3	3	2	2
SMP-17	N	L	M	no	no	No	2	2	3	2
SMP-18	E	M,L	M	Yes	no	no	2	2	1	2
SMP-19	E	L	M	yes	no	no	2	2	1	2
SMP-R1	N	L	S	no	yes	yes	2	2	2	3

Since Main's analysis in June of 2022, DF mortality has advanced. Of the non-riparian units shown as refugia, all have experienced some degree of accelerated DF decline and mortality, though in units LW-N, LW-J, and a portion of unit LW-S the level of DF overstory die-off remains low and the refugia quality can be maintained (for now). Units labeled on the Main map as LW-W1 and LW-W2 (formerly D2 and S2) are showing signs of decline, especially in LW-W1 on the northern half of the unit where a high proportion of the overstory trees are dead and/or dying. Between the two LW-W units there are still refugia qualities given the cold air drainage and lack of topographic exposure to heat and sun. Note: the topographic model predicts refugia conditions in LW-W2 and the riparian unit LW-R4, though we can expect these to degrade over time as LW-W1 the conditions in LW-W1 degrade and expose more of the core condition to sun and heat.

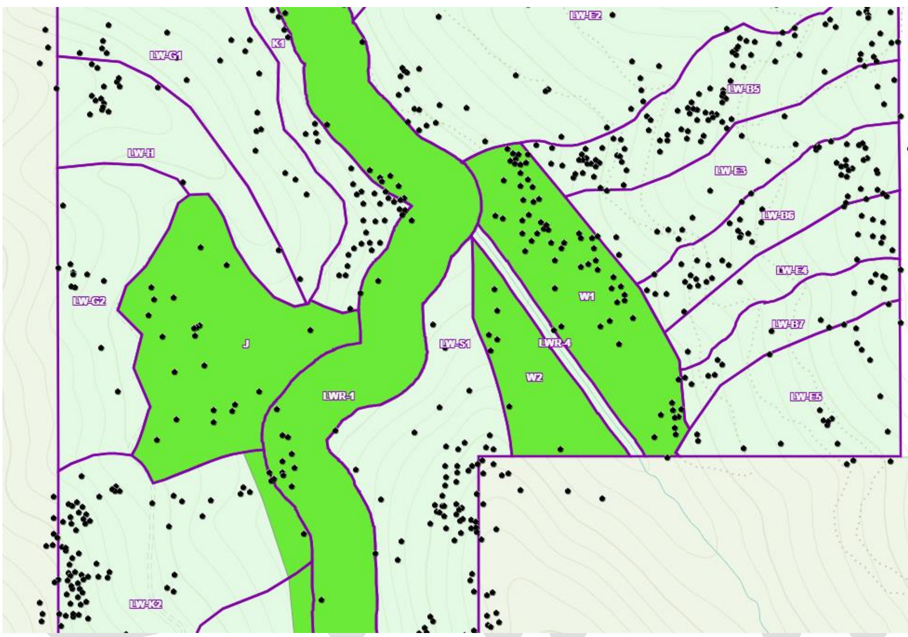
Unit LW-R should be mentioned because while it doesn't offer much refuge from climate impacts in part due to losing much of its larger tree cover, it does have elements of refugia for certain species because it has never been treated and has complex habitats connecting to the riparian management zone. It is not favorable as a fire refugia due to extreme fuel loading and steep topography.

One aspect of refugia quality is the size of the interior habitat that is buffered from external conditions. LW-W1 and LW-W2 have small footprints and their elongated shapes make them more susceptible to external conditions. The riparian units (various LWR units) have the most advantageous topographic location with aquatic habitat and water access, though they are confined to narrow reaches with little interior habitat, and often bordered by a road disrupts habitat quality. Where ridges run down to the riparian areas, there are pockets of heavy mortality very near or even on the creek due to slight aspect changes and convex landform, yet another challenge facing riparian refugia.

Unit LW-N has the best quality in ratio of interior habitat to edge, and its conjoined riparian zone connects it to other refugia above and below. Unit LW-J is also maintaining quality refugia qualities, though with less interior area than LW-N and more pressure from adjacent mortality pushing on its edges, in part due to its lower elevation. The other most significant refugia is SMP-16. Despite being surrounded by significant levels of overstory mortality on all sides, SMP-16 has only a small number of dead or dying due to concave landform, north aspect, and deeper soils. These functioning refugia are priorities for thinning smaller trees to reduce competition and direct site resources to maintain shading via overstory trees for as long as possible.

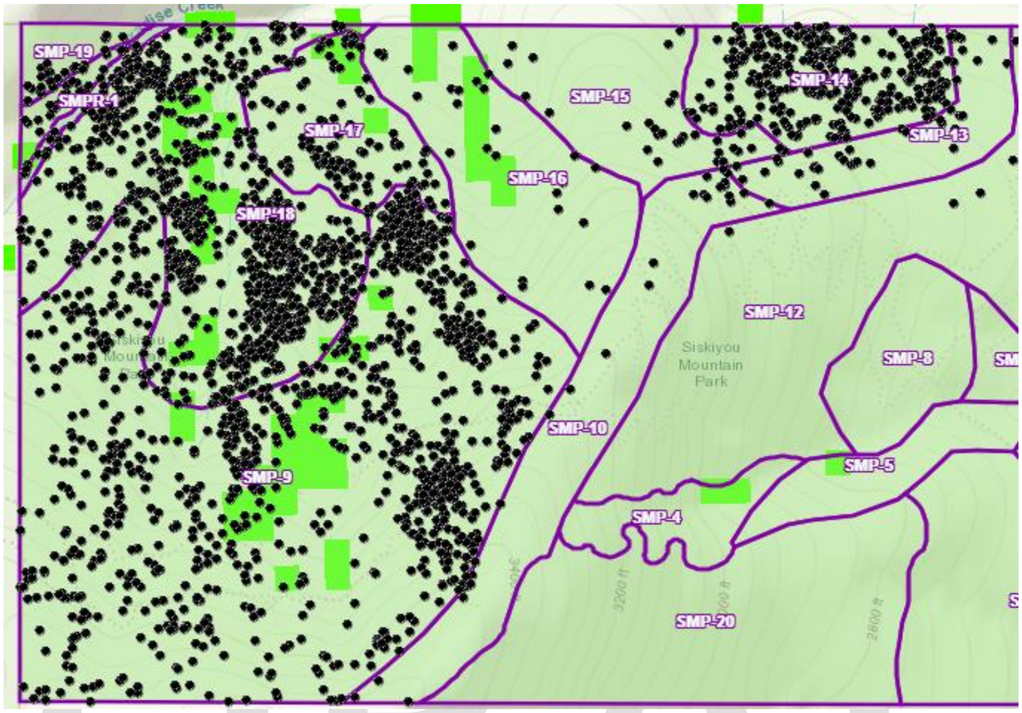
Riparian management zones are incredibly important corridors for migration of species and for shading streams to keep water temperature lower. It is worth mentioning that aquatic habitat benefits from the input of large wood into the creeks, but in the case of Ashland Creek below Reeder Reservoir wood is generally removed due to critical infrastructure (Water Treatment Plant) and downstream culverts and roads that are negatively affected by instream wood during high water events. It is concerning that many large diameter DF in riparian zone refugia are already dead and/or obviously dying, or showing signs of attack such as fading crowns, branch die-back, and pitch jewels mentioned previously in the tree-level risk assessment. Losing dominant tree cover would weaken refugia quality, though riparian zones would still maintain other important refugia qualities.

Map 10. Units W1 and W2 have refugia qualities as represented by topographic factor mapping in green, but are experiencing scattered to severe mortality as shown by black dots representing dead and dying Doug-fir in July, 2023.

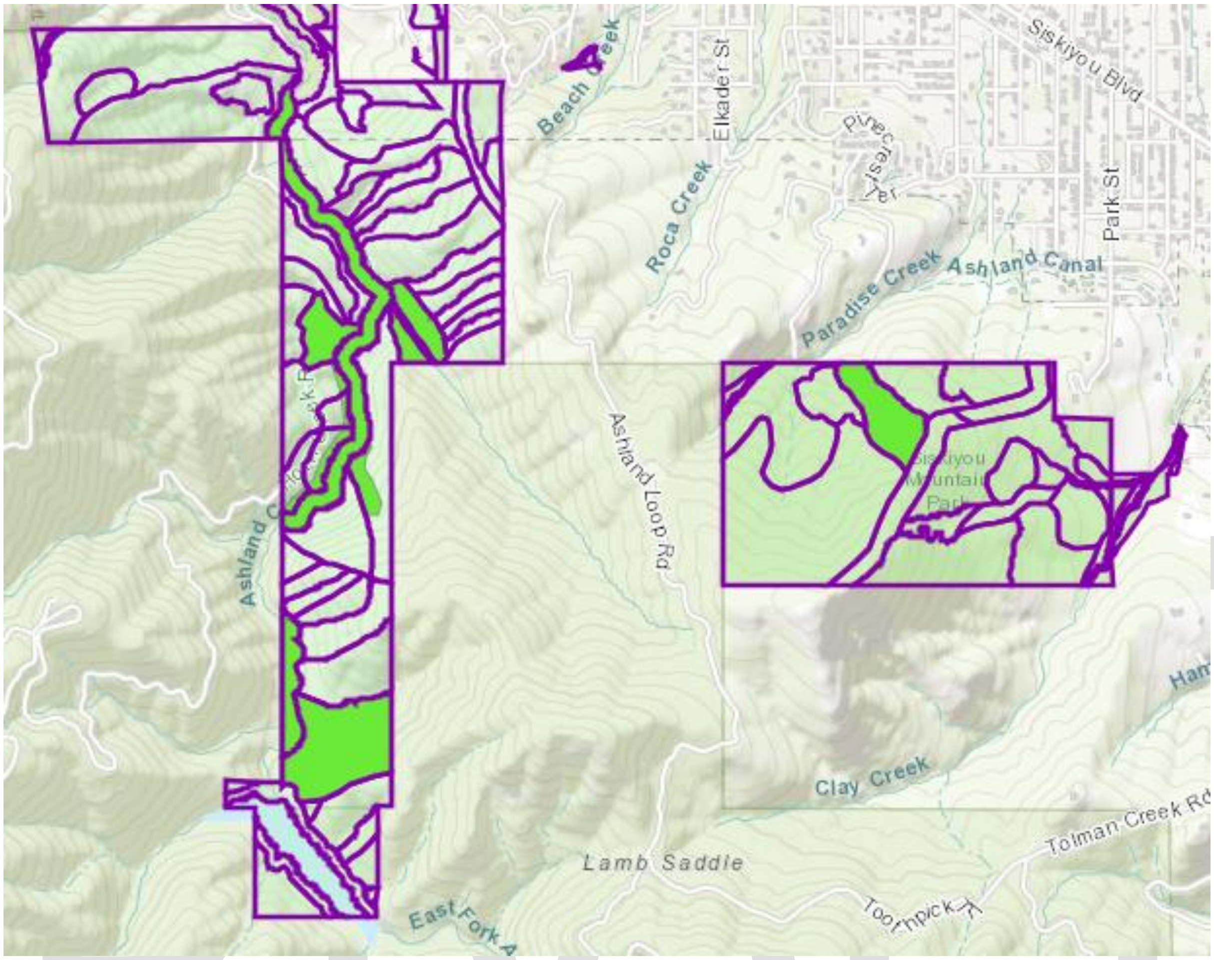


Siskiyou Mountain Park has topographically favorable refugia shown in Map X, though many of those locations already have significant die-off taking place. Of note in SMP is Unit 16 which has very little mortality compared to surrounding areas, functioning as a high priority refugia in an otherwise highly impacted area undergoing significant change.

Map 11. Siskiyou Mountain Park predicted refugia (green pixels) and current dead and dying Douglas-fir (black dots). Units east of SMP-10 were not surveyed due to general lack of Doug-fir cover.



Map 12. Current refugia (in green) on lower Ashland Forestlands, mapped in fall of 2023.



Micro-Refugia

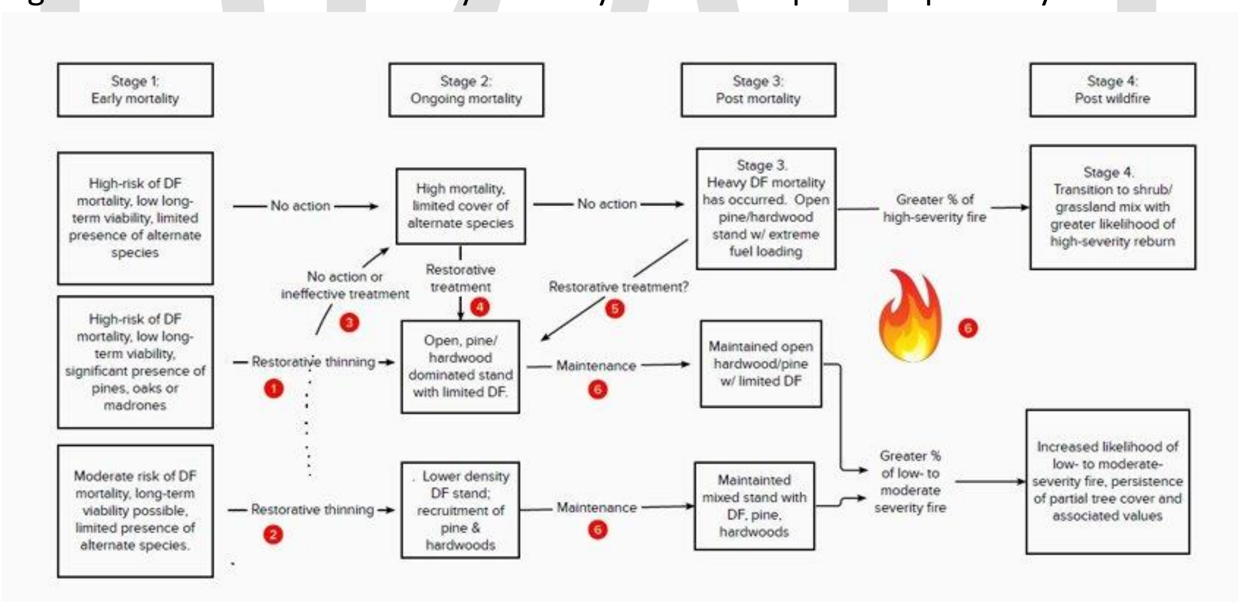
Smaller scale structures like logs, piles of limbs left for habitat, dense tree clumps, rock outcrops, and unique trees can all be “micro-refugia” for certain species and should be prioritized or created in appropriate settings. Where fuels reduction is needed via pile burning, leaving one to two piles per acre unburned without a covering is important outside of fire suppression emphasis areas and especially in mapped refugia.

Climate Change Adaptation Prescriptions By Condition

Prescription by condition is a new approach over prescriptions written by management unit, as has been done in the past. There are several reasons why this approach was taken:

1. Unit or subunit data has become challenging to describe the novel conditions developing under the Doug-fir mortality event. Mortality is often very patchy and multiple silvicultural strategies and targets would have to be described within the same subunit. The heterogeneity being expressed among permanent plot locations is creating a challenge to rely on past inventory (2017 data). Single plots can be used to describe certain conditions where needed.
2. Tree marking will be facilitated by this approach. By having a small number of conditions with prescriptions, markers can work across the entire landscape without pausing between units/subunits or even within the subunits themselves.
3. With pockets of mortality within subunits it will be easier to transition between conditions within short distances and should lead to more site specific marking and time savings.

Figure 3. Model of DF mortality stand dynamics and possible pathways



The flow chart above was created by the Southwest Oregon DF Mortality Working group as a way of conceptualizing various stand conditions and how they progress under expected and continued climate change pressure. This is useful as a guide for prescribing desired future conditions and to help visualize alternative stand outcomes that are desirable or undesirable.

Table 12. Basal Area Stocking Level Ratings (2016 Ashland Forest Plan)

Current Basal Area Stocking Level Rating	Basal Area Stocking Density	Current Basal Area as a Percentage of Desired Basal Area
1	Low	< 40%
2	Moderate	40 to 69%
3	High	70 to 100%
4	Overstocked	101 to 140%
5	Severely Overstocked	> 140%

This table lays out stocking levels as a percent of current basal area. To maintain the best possibility of resistance to future mortality, stands should stay in the low, moderate, or high categories depending on site quality (lower quality sites should have lower stocking density). Site quality can be generally interpreted by tree heights, slope position, aspect, and landform.

Prescriptions By Condition

Conditional prescriptions are broken down into four categories:

1. Thin-from-below
2. Conversion
3. Public Safety
4. Variable Density Thinning

Prescription #1: Thin-from-Below (TFB)

Stand Condition: Douglas-fir dominated, limited mortality, refugia, pine stands

Description: Thinning-from-below (TFB) removes the smaller size class trees (sub-dominant and co-dominant) in a stand to open growing space (above and below ground) for co-dominant and dominant trees to expand their root systems and crowns with the goal of increasing growth and vigor on a tree basis to increase resistance to disturbance at the stand level. TFB has been commonly used on COA lands and in the adjacent AFR Project since 1995.

TFB Conditions

1. Refugia where mortality is limited (Units LW-N, LW-J, SMP-16, SMP-9)
2. Pine Stands (scattered)
3. Upper elevations where DF mortality is comparatively limited (LW-N) and previous treatments have been largely non-commercial.

Landscape Settings: Lower slopes, north-facing aspects, productive stands, pine dominated stands, and riparian areas (though no TFB is prescribed in riparian), and higher elevations not as impacted by DF mortality.

Applicable Units: LW-B2, B4, B5, B6, E4, B7, E5, D2, S, R, K, J, P, N, M, and SMP-16 and portions of SMP-9.

Climate Change Context: Stands (or portions of stands) in these settings have been least impacted by recent mortality, though it commonly exists at the edge of these stands as they grade into mid-slopes, low elevations, poorer soils, and drier aspects. Some of these stands like units LW-J, S, D2, N, and SMP-16 all riparian units can be considered the highest potential for refugia and are high priorities to maintain as long as possible. No green tree thinning is planned in riparian management areas.

Wildfire Management: These are highly favorable stands with excellent height to crown base (vertical discontinuity) and provide shading on fuels. Canopy bulk density is typically high, though crown fire risk is ameliorated by lack of ladder fuels and adjacent stands where crown bulk density is low (minimal chances to initiate and/or sustain crown fire). Thinning will reduce crown bulk density, benefiting wildfire management. Pile and burn all activity fuels.

Current Basal Area: Typical Basal Area (BA) ranges from 100 sq ft to 280 sq ft (can be locally higher).

Prescription: Thin up to 30% of existing BA by marking smallest diameter Doug-fir trees first. Gaps up to one acre, located on planar or convex slopes less than 55% slope and where mortality and/or trees showing signs of imminent mortality can be included for removal after retaining the largest dead trees as CWD/snag habitat where safe to leave (away from infrastructure and POD boundaries).

CWD: These are high priority sites for retaining snags and downed wood. In these areas, based on current inventory numbers for CWD (See Table X) leave dead and dying with up to 30 tons per acre total CWD. 30 tons is equivalent to 32 18-inch snags per acre, which needs to first consider what's pre-existing on site. The highest priority is to leave the largest trees for snags. Snags will be left away from trails, roads, and infrastructure. Leave up to 2 piles per acre for habitat.

Prescription #2: Transition

Description: These stands, or patches within stands, are dominated by dead and dying Doug-fir in settings not conducive to a future DF forest type. Mortality is evident throughout the stand, sometimes locally extreme with 90% or more of the dominant DF cover dead and dying. Plant Associations (individual associations, not PAGs or groups) where transition is already underway are the driest end of the DF series, indicating that Doug-fir should not be a dominant overstory species moving forward, though individual trees may persist.

The goal of PAG transition is to facilitate movement from DF Plant Association Group (PAG) to a Ponderosa Pine PAG, including overstory, shrub, and herbaceous layers as possible to secure appropriate seed and planting stock over time. The legacy of altered ecosystem form and function with climate change as an added overlay will result in novel combinations of species that don't fit the existing Plant Associations. Nevertheless, Plant Associations can still function as a "menu" of species to match to site specific conditions.

Transition Conditions

1. Dry sites experiencing high levels of DF mortality. Some areas are already several acres in size where extensive mortality is taking place and still expanding. Green trees in the vicinity are at very high risk of mortality.

Landscape Settings: PAG transition stands are typically in the most vulnerable settings on ridges, convex slopes, south-facing aspects, upper 2/3 of slopes, and areas of poor site quality as evidenced by shorter trees, more pine, and associated shrubs and forbs typical of driest DF plant associations.

Applicable Units: LW-B2, B3, B4, B5, B6, B7, F, K1, K2, H, T, U, W1, SMP-9, SMP-14, and SMP-18

Climate Change Context: These stands are the hardest hit by the combination of extreme heat and drought. Trees in these locations experienced significant negative effects and mortality is already extensive compared to past outbreaks. Starting the transition to more climate-adapted species is a priority.

Wildfire Management: There are significant implications with fire behavior in the near and longer terms if fuels in these impacted sites are not aggressively managed now. These developing fuel loads are located next to homes, infrastructure, and at the base of the municipal watershed. Fuels management is key to not only safety but to help our forests adapt to climate change by avoiding uncharacteristically severe wildfire. Pile and burn all activity fuels.

Current Basal Area: Mortality patches include all classes of canopy from intermediate to dominant trees. Basal areas range from 60 to over 200 ft^2 . Leave trees are a small fraction of the overall BA, including pine, pacific madrone, and black oak. Leave all non-DF trees.

Prescription: Remove dead and dying DF, leaving largest diameter trees for habitat until a target of between 5 tons and 10 tons of CWD is left on site. Prioritize non-merchantable trees (dead for more than one year) as leave trees if among the largest diameter on the site. If possible, apply prescribed fire before any revegetation efforts.

Leave all madrone, pine, and oak species for diversity, slope retention, and seeding.

CWD: Assess unit by unit the need for additional CWD. Using the Brown recommendations, spell out the number and size of additional snags that should be left to meet CWD goals, but not exceed fire hazard levels. The target range for this condition is 5 to 10 tons of CWD per acre. It's important that transition settings are on the lower end of CWD targets to maximize the ability to keep low intensity fire as a beneficial ecosystem process that will foster fire and heat adapted plant communities. Leave one pile per acre for habitat.

Revegetation: Replant drought tolerant and fire tolerant species of the appropriate seed source. Consider varieties of native plants from hotter and drier climates (this may only be possible with trees species). Before revegetation, create planting plans for each unit with site specific specifications by species. Control competing vegetation, especially non-natives.

Prescription #3: Public Safety

This prescription encompasses roadsides, trails, POD boundaries (fire suppression emphasis areas), and structure interface zones (homes, water treatment plant) with a singular objective of public and firefighter safety. In all these settings there is a low tolerance for leaving standing dead or accumulating ground fuels.

Description: Public Safety condition setting emphasizes safety where people, recreation, and values-at-risk are potentially directly impacted whether by fire, tree fall, or potential for landslides after a severe fire.

Landscape Settings: This prescription applies along roads, trails, and within 500 feet of structures and private property. Fire management emphasis areas include POD boundaries with a buffer of 300 feet on either side and fire management area cluster units on Map 2.

Applicable Landscape Units: Parts of numerous units

Climate Change Context: Protecting critical values is a top priority for community resilience and economic vitality. Recreation is a growing part of Ashland's economy and trail safety and the recreational experience is a piece of both local quality of life and tourism.

Wildfire Management: Having safe and effective zones where fire suppression has the greatest potential for success is crucial. Models predict at least a doubling of acres burned, perhaps a tripling, in the coming decades. Future conditions will be more challenging to successfully manage fire with more exposure to firefighters and the community. Designating and managing fire management areas is essential. For all activities, dispose of slash as soon as possible through piling and burning or chipping.

Prescription: In fire management zones, remove dead and dying trees of all species, keeping the minimum tonnage of CWD in fire management zones, but clustered below major ridgelines. Pile and burn ground CWD up to 8 inches along with any activity fuels and frequently use prescribed burns every 7-10 years to keep fuel levels low.

On either side of roads, remove dead and dying trees that can hit the road (one tree length) with an emphasis on uphill trees. Evaluate downhill trees for lean and leave those that can be safely left. Consider topping trees with high ecological value if budget allows.

Along trails, remove recently dead and trees with signs of insect attack within one tree length upslope from trails and one-half to one tree length below trails depending on the tree's lean and branch pattern.

CWD: This applies only to fire management zones. Leave the minimum required number of snags in fire management zones. If possible, cluster snags below ridgetops to minimize exposure. Keep the minimum tonnage (five tons) of ground CWD for soil protection.

Prescription #4: Variable Density Thinning (VDT)

This prescription applies in stands where thinning from below isn't possible because trees are generally the same strata (dominant) and yet the overstory is in clear need of density reduction due to signs of insect attack and previous stand data analysis. These are in upper elevations of the lower watershed where DFFB is beginning to attack trees, but more productive sites can potentially result in trees being able to fight off ongoing DFFB attacks. Reducing the number of actively infested trees right now can reduce the contagion effect that is swamping lower elevations. If coupled with average to above average precipitation, DF may be able to survive and even build vigor in the coming years.

Description: Variable density thinning creates non-uniform conditions across a stand. VDT is commonly used to create "skips and gaps" in the canopy, facilitate pockets of tree regeneration or understory development, and lessen canopy bulk density and connection. It can also be differing levels of thinning intensity without skips and gaps.

VDT Conditions

Productive sites where DFFB mortality is scattered and may be transient over time. Canopy is dominated by one age and size class. There are areas that are predicted to be more susceptible to DFFB, and those can serve as small gaps especially where DFFB is already active and numbers can be reduced to help lessen overall beetle pressure.

Units: LW-Q1, Q2, Q3, P1, P2, P3, M2

Landscape Settings: Productive sites less susceptible to DFFB pressure and mortality. Northerly and easterly aspects, all slope positions.

Climate Change Context: These stands are high priority for maximizing resistance to DFFB while at the same time recognizing that certain settings are more susceptible and starting a long-term transition to more tolerant pine species is wise due to lack of larger openings that would foster faster establishment and growth of shade intolerant species like pine and oak.

Wildfire Management: These stands already have good wildfire management qualities such as high crown bases, relatively little ground and ladder fuels, and canopy shading. Maintaining these qualities is important over time as stands are stressed by heat and drought. VDT should be used cautiously so as not to trend too quickly toward gaps and openings that can allow for the development of a vigorous and flammable understory and also create conditions more enticing for DFFB (significant stand edge) to invade the stand and add large inputs of CWD.

Prescription:

VDT is hard to prescribe due to the sporadic nature of thinning. VDT is more about the ends of the ranges than averages. Overall, VDT should target 20-30% of the stand basal area for reduction, though thinning is only used in certain settings within the stand. On the scale of one acre, basal area might reduce by 80%, but at the stand level it is only 5% or less.

Gaps: Create gaps, or openings, in topographic settings that are not as productive as the rest of the stand or are already seeing DFFB mortality. Gaps should be no larger than .75 acres, located in planar or convex topography, and on slopes less than 50%. Gaps can contain leave trees such as pine, oak, or larger madrone. Gaps should also maintain CWD components, but not at high levels if trying to recruit drought tolerant and fire tolerant species where prescribed burning will be repeated. Basal area in gaps should be 50% or less of the stand basal area.

Skips: Can be located anywhere and maintain existing stand conditions, preferably in an area that is denser than the average condition. Skips can be one to two acres.

General matrix: Use thin-from-below or co-dominant thinning of Douglas-fir to reduce overall density between skips and gaps. Thin between 20-30% of existing basal area.

CWD: Maintain 10 to 20 tons of CWD in gaps. In matrix areas tend toward the upper limit of 20 tons/acre and in skips an even higher level can be maintained, up to 30 tons per acre. Leave up to 3 piles per acre for habitat.

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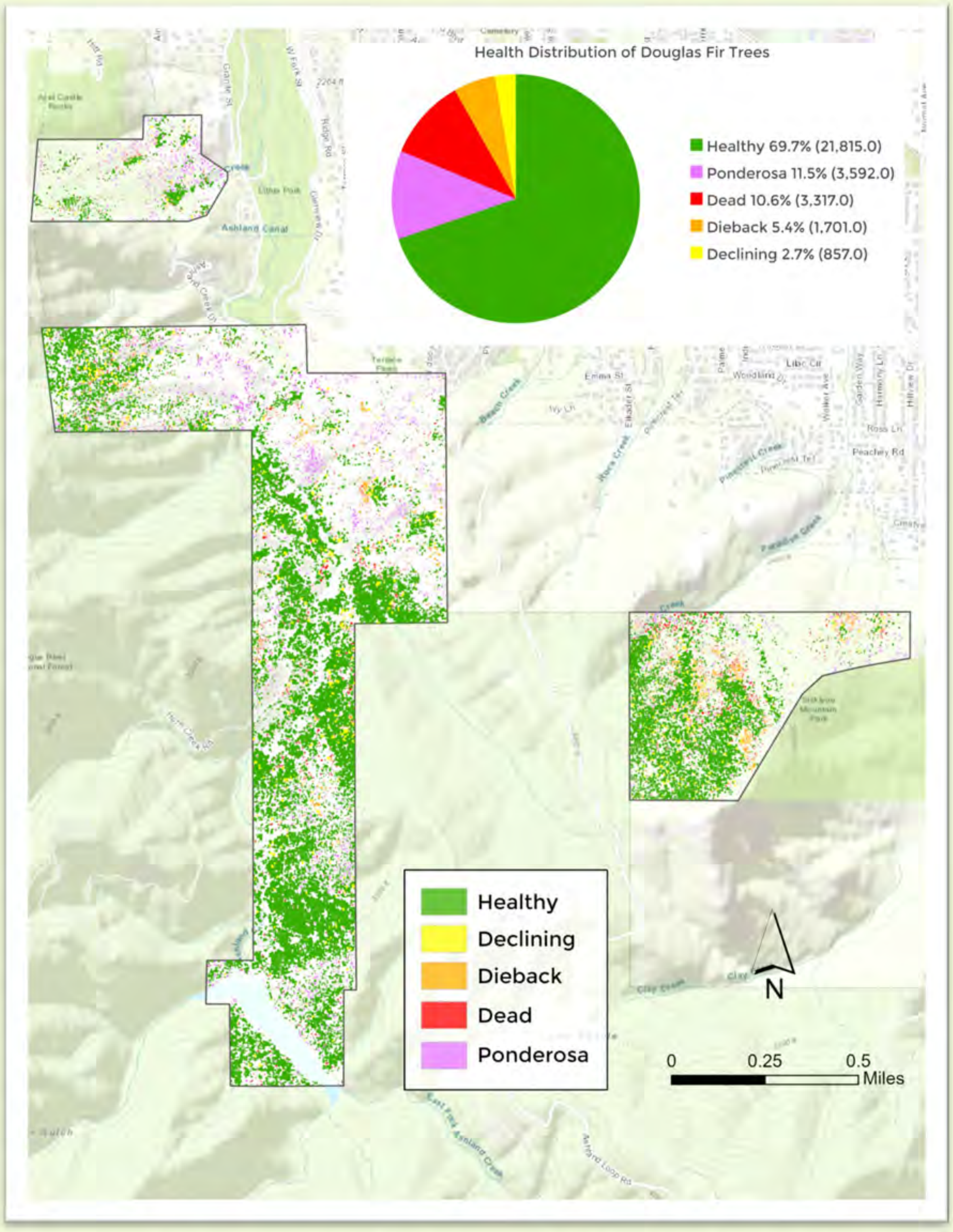
2023 UAS Remote Sensing - Ashland, Oregon

Rogue Reconnaissance collected aerial LiDAR and Multispectral of three areas within the Ashland Watershed and city properties using Uncrewed Aircraft Systems (UAS) to determine the health status of Douglas Fir trees. The areas surveyed were Siskiyou Mountain Park, Acid Castle, and the Watershed area . The data collected in these surveys was then used to generate a comprehensive Geographic Information Systems (GIS) database for the city's forest management use. Douglas Fir and Ponderosa Pine 30 feet in height and above were observed.

- **Aerial Assessment**: UAS equipped with Multispectral, Visible Light (RGB), and Light Detection and Ranging (LiDAR) sensor payloads were utilized to survey designated areas. The LiDAR sensor proved vital for determining accurate tree height and canopy areas, and the Multispectral sensor was essential for determining forest health and distinguishing between tree species.
- **Data Collection**: Trees were categorized into the following classes based on vitality: Dead, Declining, Dieback, Healthy Douglas Fir, and a separate class for Ponderosa Pine. Advanced image analysis techniques were applied in densely forested areas.
- **Data Processing:** A suite of GIS applications was utilized, including ESRI ArcMap Pro, Metashape, Global Mapper Pro, and RStudio. This selection facilitated the processing and refinement of data, aiding in the segmentation of tree canopies and tree top identification. Additionally, deep learning models trained using this software played a pivotal role in accurately identifying tree species, assessing forest health, and producing shapefiles and aerial orthomosaics.



From left to right: Acid Castle, Watershed Parts 1-5, and Siskiyou

Healthy

Declining

Dieback

Dead

Healthy: A Douglas-fir tree that exhibits green foliage from above, with no visible indicators of decline. Trees in this category may still be infested by insects and should be considered "at risk" due to prevalence of nearby insect activity.

Declining: Displays signs of deterioration and stress, characterized by red or discolored needles, a dead or dying top, and possibly other symptoms indicative of disease, pest issues, or unfavorable environmental conditions.

Dieback: Progressive death of twigs, branches. Entire tree consists of red needles, signifying a total loss of chlorophyll.

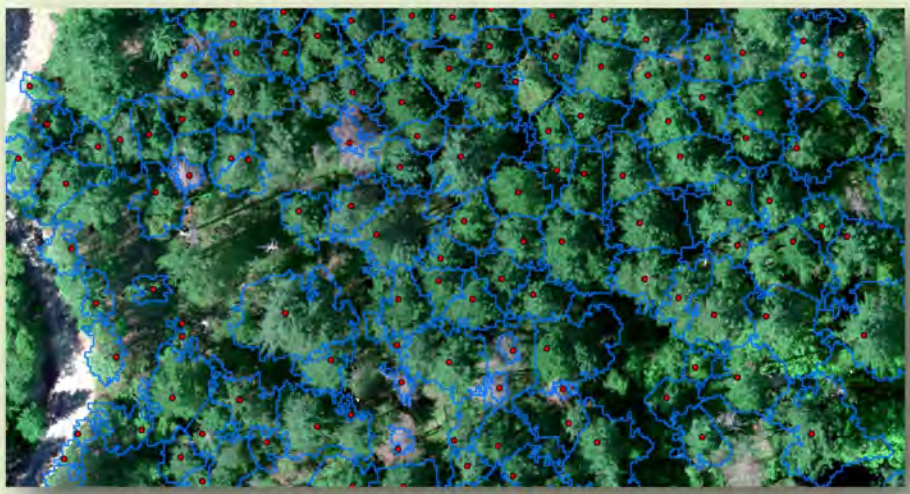
Dead: Exhibits symptoms such as gray, brittle branches, a complete loss of needles.

Deliverables

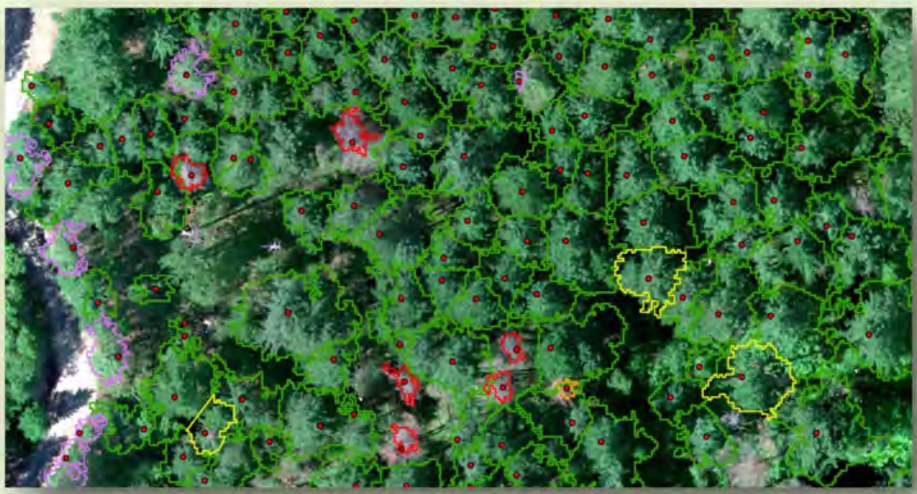
Polygon Shapefile: Includes Canopy Area (square meters), Tree Height (meters), Canopy Perimeter (meters), Lat/Lon (Decimal Degrees), and vegetation health/species classification.

Point Shapefile: Includes Canopy Area (square meters), Tree Height (meters), Lat/Lon (Decimal Degrees), and vegetation health/species classification.

Aerial Orthomosaic: 9cm high-resolution Multispectral 5-band imagery consisting of blue, green, red, red edge, and near infra-red. The aerial imagery featured in this report does not represent the full resolution of the final orthomosaic deliverable.



Multispectral imagery visible light (RGB) with crown polygons and treetop points



Multispectral imagery visible light (RGB) with classified polygons

Resources Deployed

The project involved two FAA Part 107 Pilots, a UASP (UAS Pilot), a UASD (UAS Data Specialist), and several GIS Specialists. The UAS (DJI M300) was equipped with RGB, Multispectral (Micasense MX Multispectral), and LiDAR (Rock Robotic R360) payloads.

Additional Info

To enhance the positional accuracy of our UAS data, we employed a base station connected to a real-time kinematic (RTK) network. This setup provided real-time differential corrections for the UAS LiDAR data, ensuring its spatial data was referenced and aligned with high-precision ground control coordinates collected through the RTK network.

Our team also utilized clinometers to measure tree heights directly, validating our UAS LiDAR and Multispectral data in the field and during processing. This alignment with on-ground observations provided additional verification of our data reliability. Tree height accuracy may vary in areas of dense vegetation where there are sparse ground points.

The compiled dataset delineates four vitality classes of Douglas Fir, complemented by an additional Ponderosa Pine class. These classes were differentiated not only from one another but also from adjacent tree species such as Madrone, Oak, and Manzanita.

Given the large scale of the areas surveyed, coupled with complex topography and varying vegetation/canopy density, achieving a perfect classification accuracy and segmentation can be a significant challenge. This holds true even with our advanced equipment and image analysis methodologies.

Despite the challenges posed, our team succeeded in segmenting and classifying over 31,000 trees with high precision. While the total classification accuracy may fall short of 100% in some cases, the insights gleaned from this data are invaluable, serving as a robust guide for forest management decisions. An accuracy assessment with 500 random tree points was selected and ground-truth methods were performed by verifying tree species and health through high-resolution aerial imagery. The resulting confusion matrix was then utilized in assessing the precision of the data classification.

Confusion Matrix

Class ID	Healthy	Declining	Dieback	Dead	Ponderosa	Total	User Accuracy
Douglas Fir - Healthy	330	1	2	4	7	344	95.93%
Douglas Fir - Declining	1	15	0	1	0	17	88.24%
Douglas Fir - Dieback	0	0	34	0	0	34	100.00%
Douglas Fir - Dead	0	0	0	54	1	55	98.18%
Ponderosa Pine	5	0	0	0	45	50	90.00%
Total	336	16	36	59	53	500	
Producer's Accuracy	98.21%	93.75%	94.44%	91.53%	84.91%		
Overall Accuracy:	95.60%						
Kappa:	91.34%						

Producer's Accuracy: The producer's accuracy is calculated by dividing the total number of classified points that agree with reference data by the total number of reference points for that class.

User's Accuracy: The user's accuracy is calculated by dividing the total number of classified points that agree with the reference data by the total number of classified points for that class.

The Kappa statistic: (or Cohen's Kappa) measures how well the classifier performed compared to how well it would have performed by random chance. It's a more robust metric than simple Accuracy as it considers the possibility of a correct prediction.

Siskiyou Mountain Park—June 29, 2023

Multispectral Imagery—Watershed Part 3

Summary

The project undertaken in the Ashland Watershed stands as a significant achievement in modern forestry management, leveraging the power of UAS remote sensing to bring remarkable efficiency and insight. Our use of LiDAR and Multispectral sensors allowed us to create a detailed and accurate understanding of tree health and landscape features, a critical asset in addressing rapidly changing environmental factors. Given the inherent complexities in forest management, the real-time data provided through this method can been pivotal in enhancing our ability to monitor, educate, and assist in making informed decisions.

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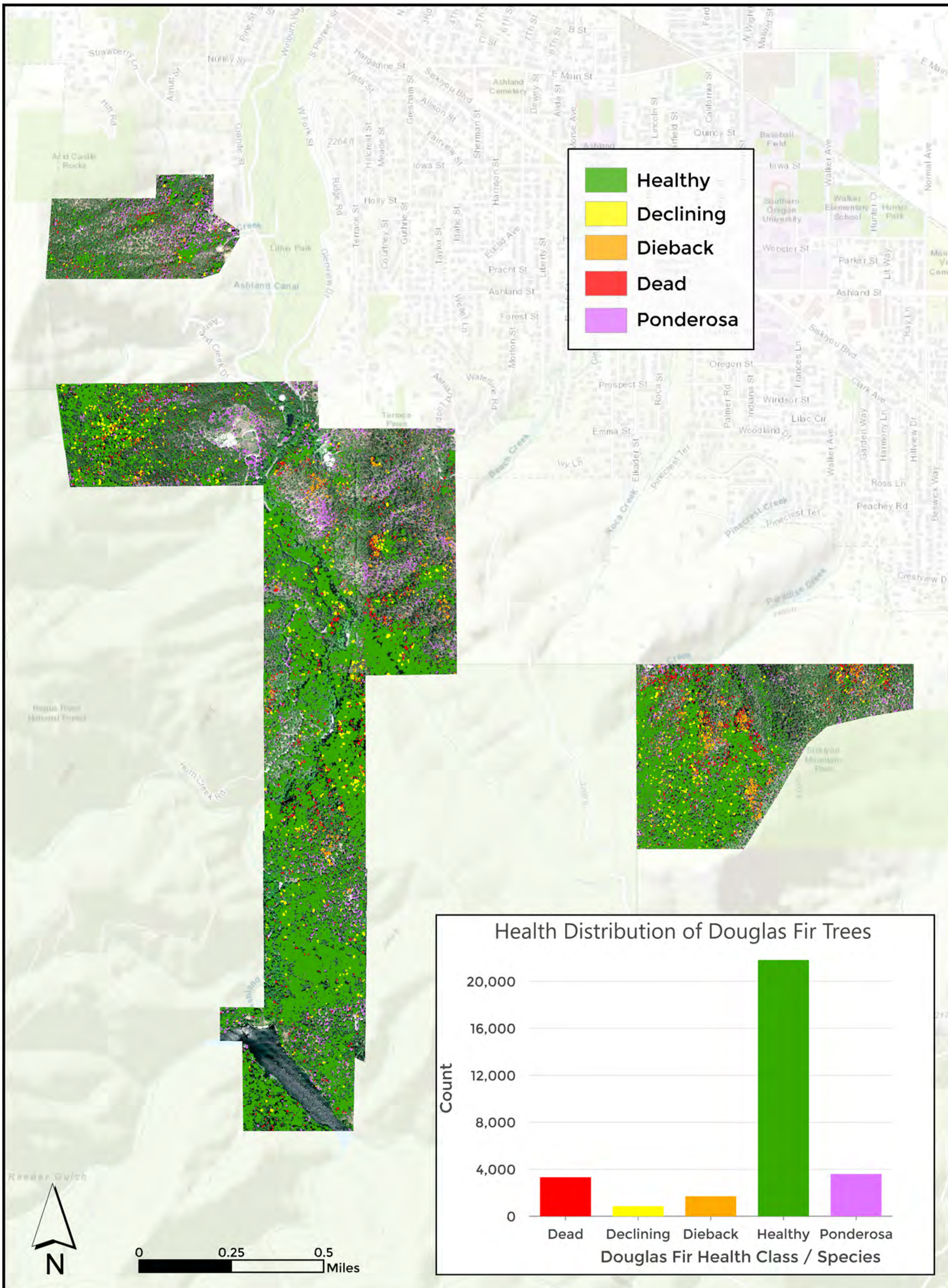

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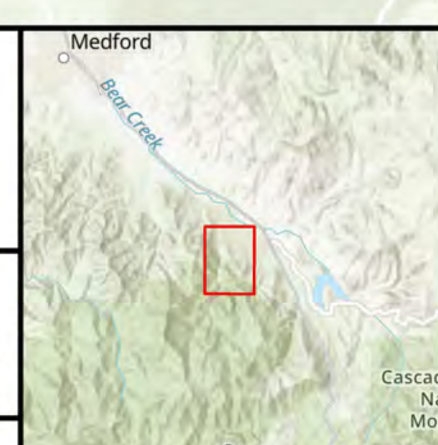
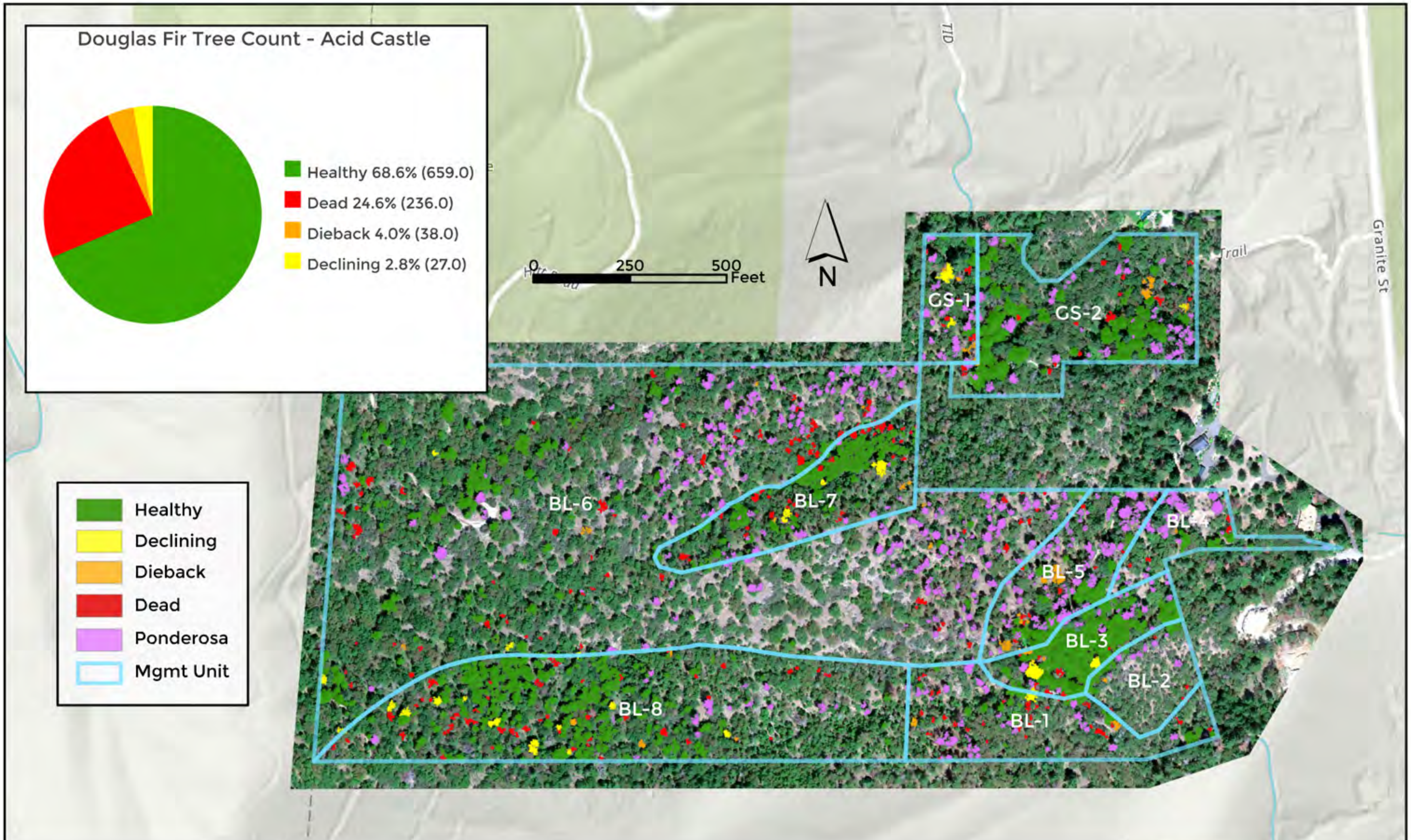
Douglas Fir UAS Forestry Survey

This project was conducted by Rogue Reconnaissance for the City of Ashland utilizing an Uncrewed Aerial System (UAS) with Multispectral and LiDAR technology to assess the health status of Douglas Fir. Supervised by Eli Polsky and Gavin Mcgowan, the forestry survey categorized the trees into four classes: Healthy, Declining, Dieback, and Dead

2023

Coordinate System: WGS 1984 UTM Zone 10N





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Douglas Fir UAS Forestry Survey - Acid Castle

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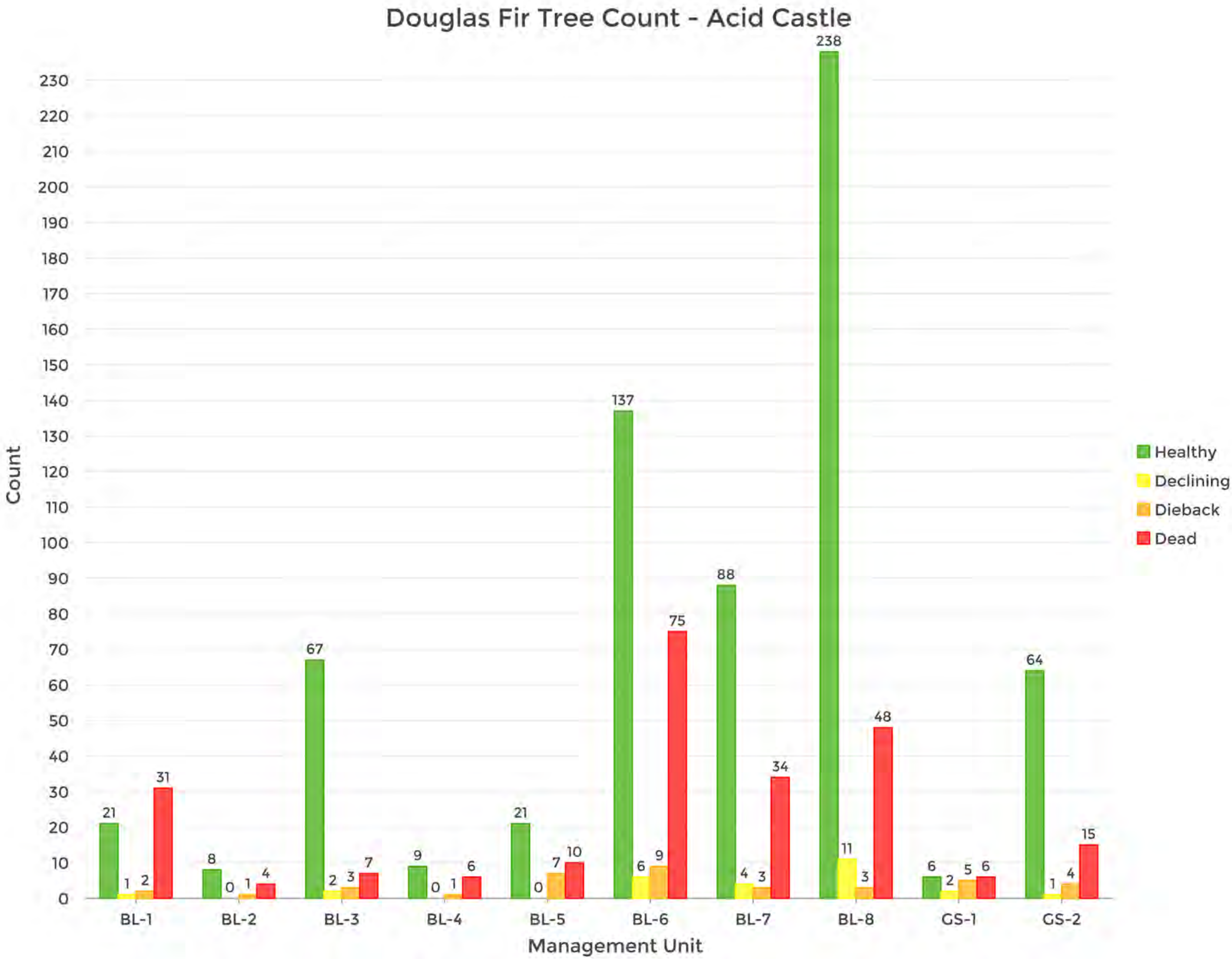
2023

Coordinate System: WGS 1984 UTM Zone 10N



Douglas Fir Tree Count - Acid Castle
Count
Management Unit
Healthy
Declining
Dieback
Dead
BL-1
BL-2
BL-3
BL-4
BL-5
BL-6
BL-7
BL-8
GS-1
GS-2
21
1
2
31
8
0
1
4
67
2
3
7
9
0
1
6
21
0
7
10
137
6
9
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88
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238
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3
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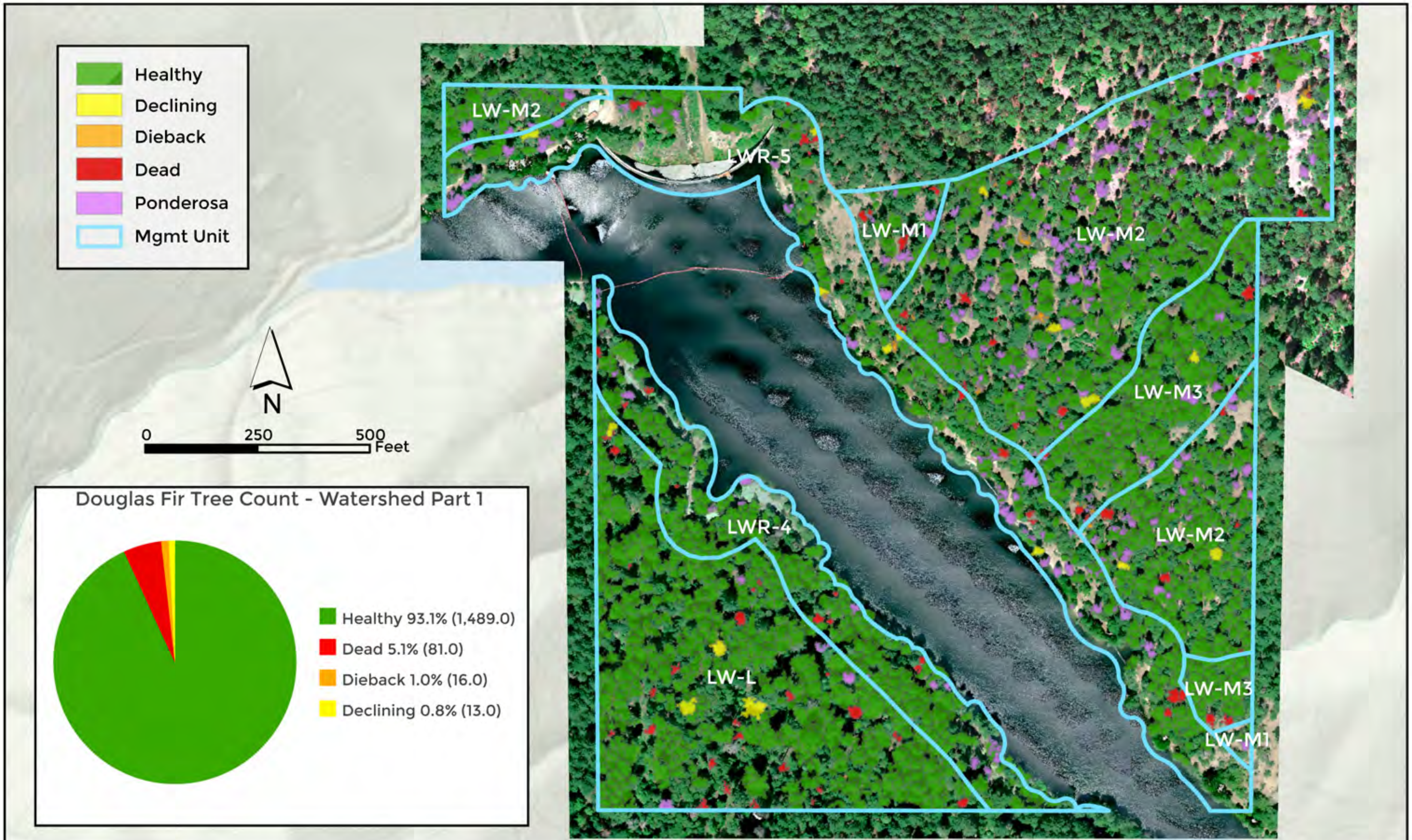
6
2
5
6
64
1
4
15



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Douglas Fir UAS Forestry Survey - Watershed Part 1

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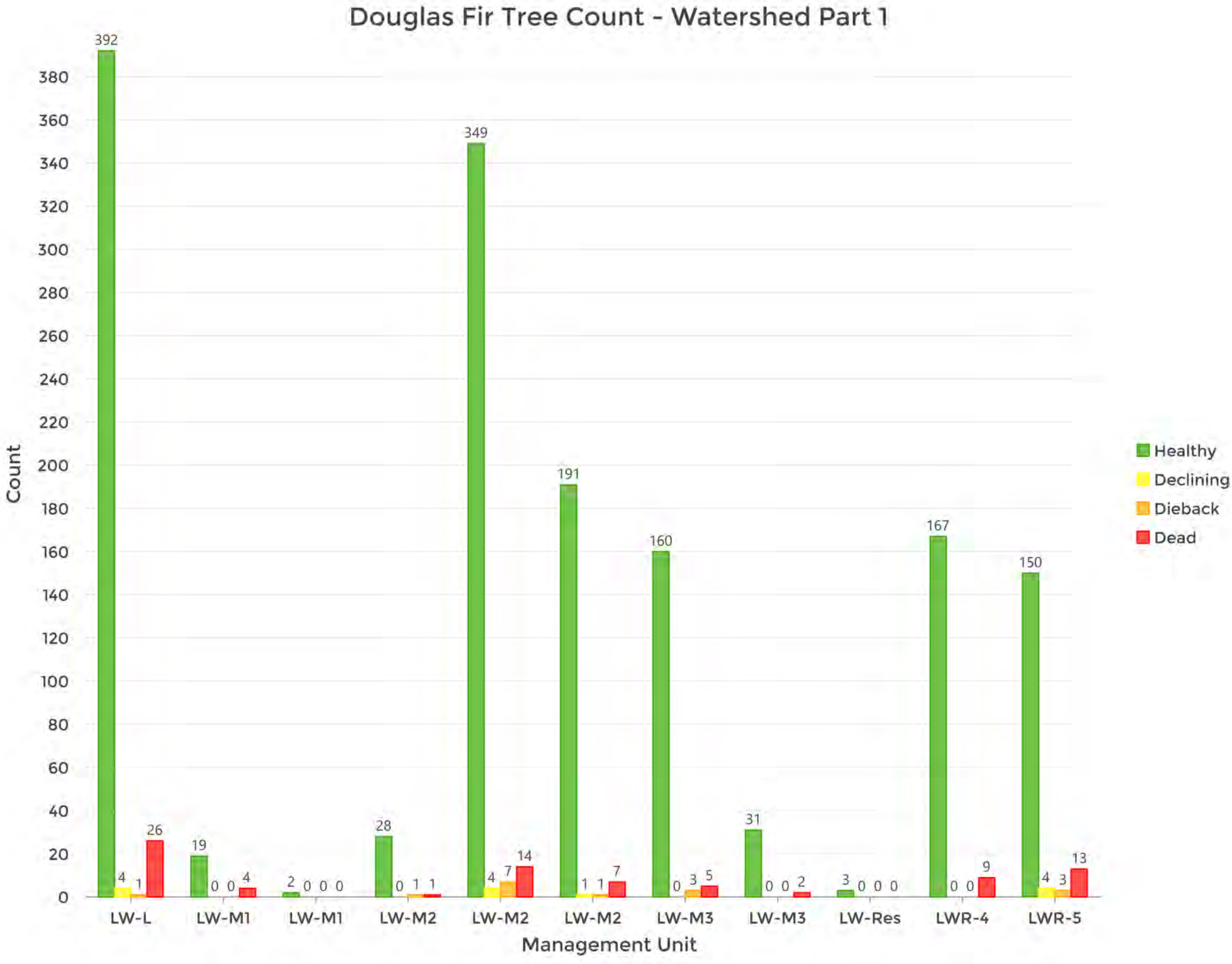
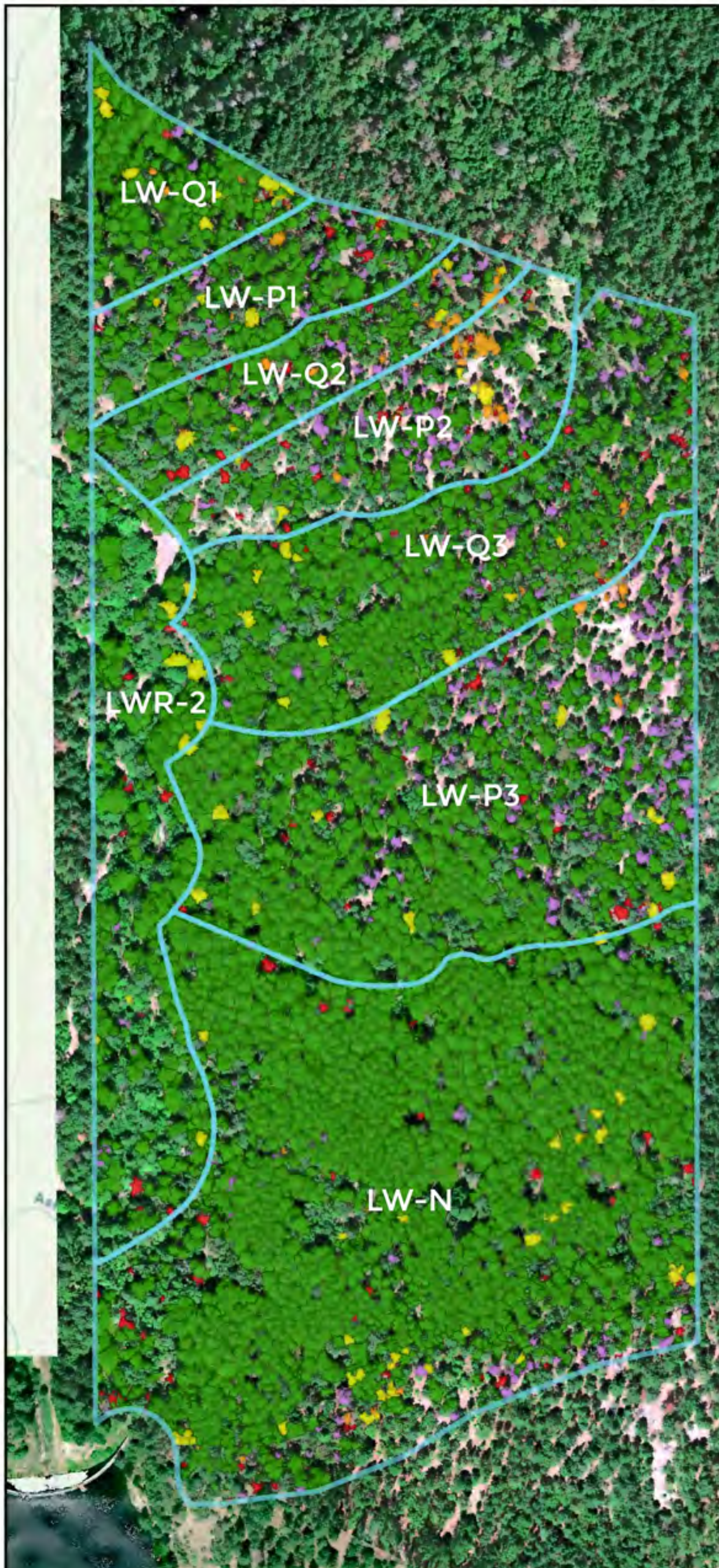
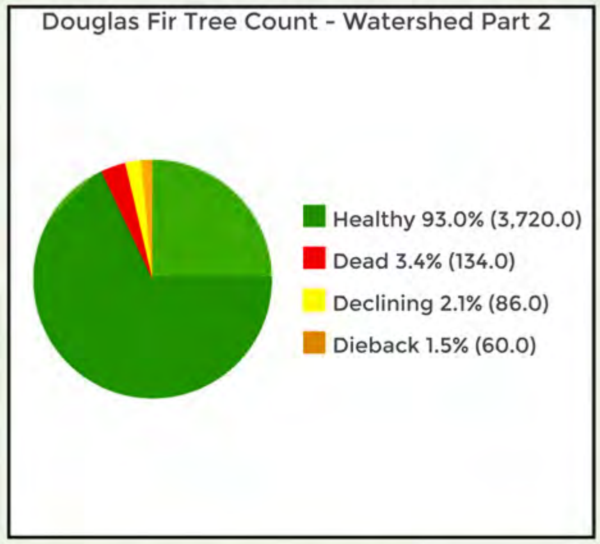
2023

Coordinate System: WGS 1984 UTM Zone 10N



Douglas Fir Tree Count - Watershed Part 1
Count
Management Unit
Healthy
Declining
Dieback
Dead
LW-L
LW-M1
LW-M1
LW-M2
LW-M2
LW-M2
LW-M3
LW-M3
LW-Res
LWR-4
LWR-5
392 4 1 26
19 0 0 4
2 0 0 0
28 0 1 1
349 4 7 14
191 1 1 7
160 0 3 5
31 0 0 2
3 0 0 0
167 0 0 9
150 4 3 13





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Douglas Fir UAS Forestry Survey - Watershed Part 2

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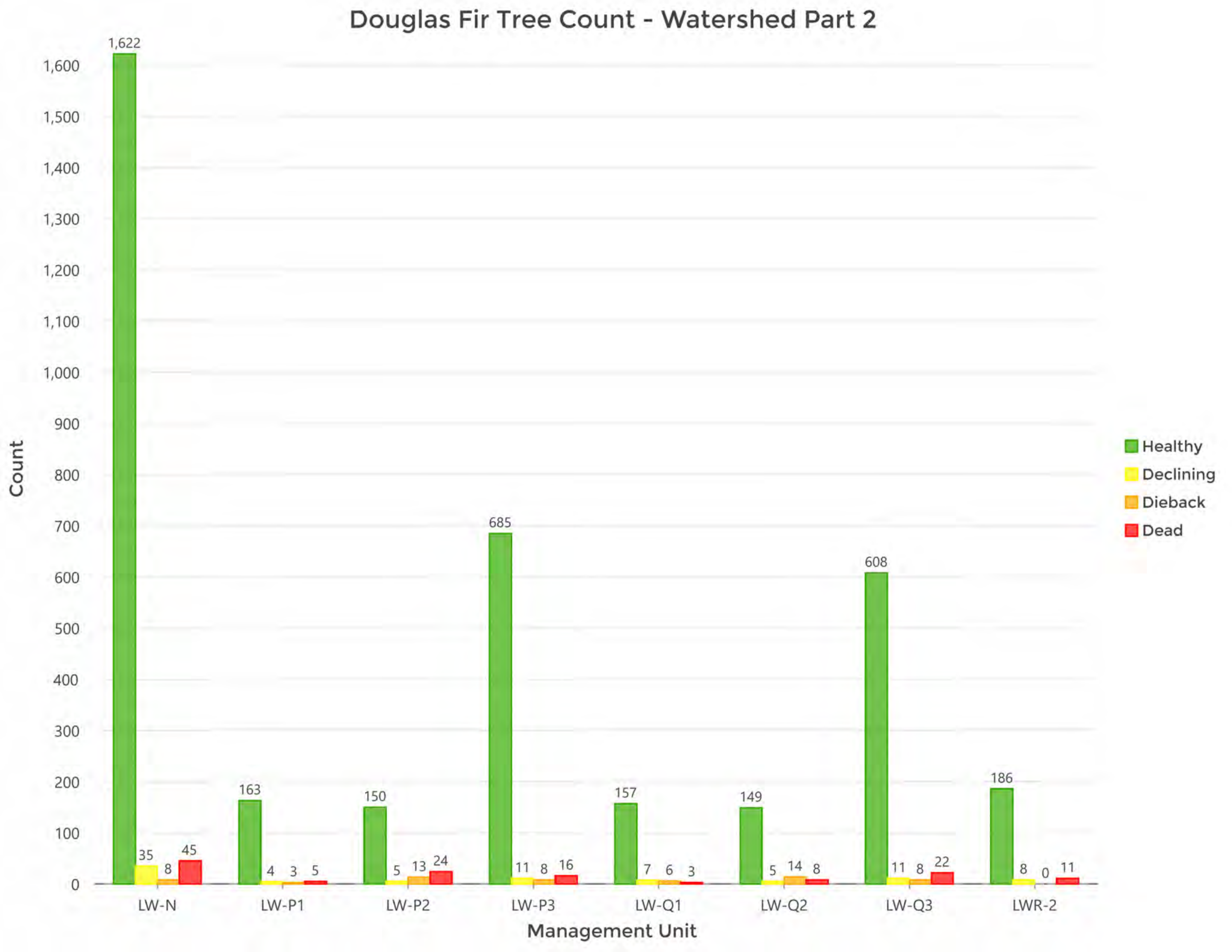
2023

N

0 250 500 Feet

Coordinate System: WGS 1984 UTM Zone 10N



Douglas Fir Tree Count - Watershed Part 2
Count
Management Unit
Healthy
Declining
Dieback
Dead
LW-N
LW-P1
LW-P2
LW-P3
LW-Q1
LW-Q2
LW-Q3
LWR-2
1,622
35
8
45
163
4
3
5
150
5
13
24
685
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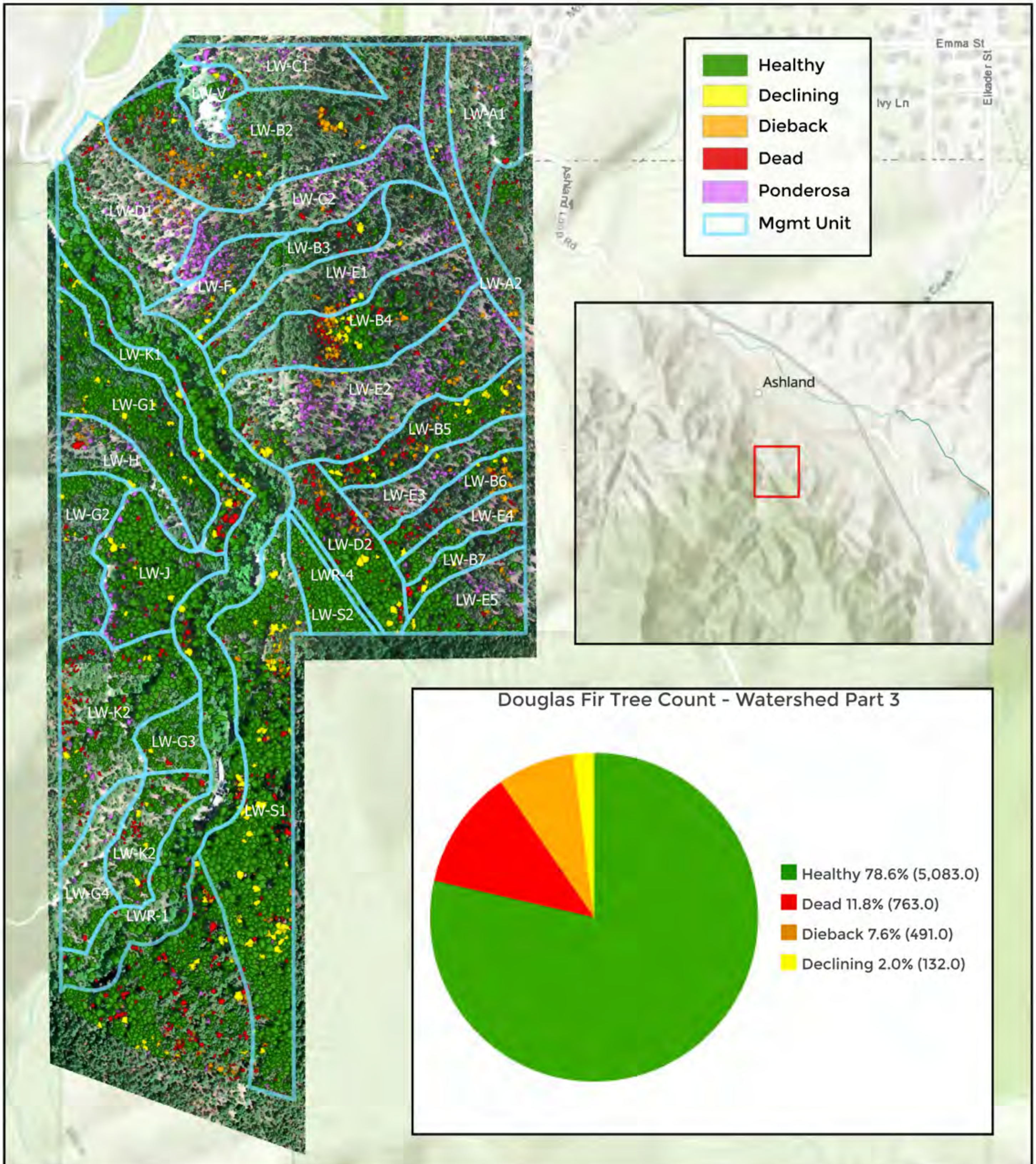
22
186
8
0
11



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Douglas Fir UAS Forestry Survey - Watershed Part 3

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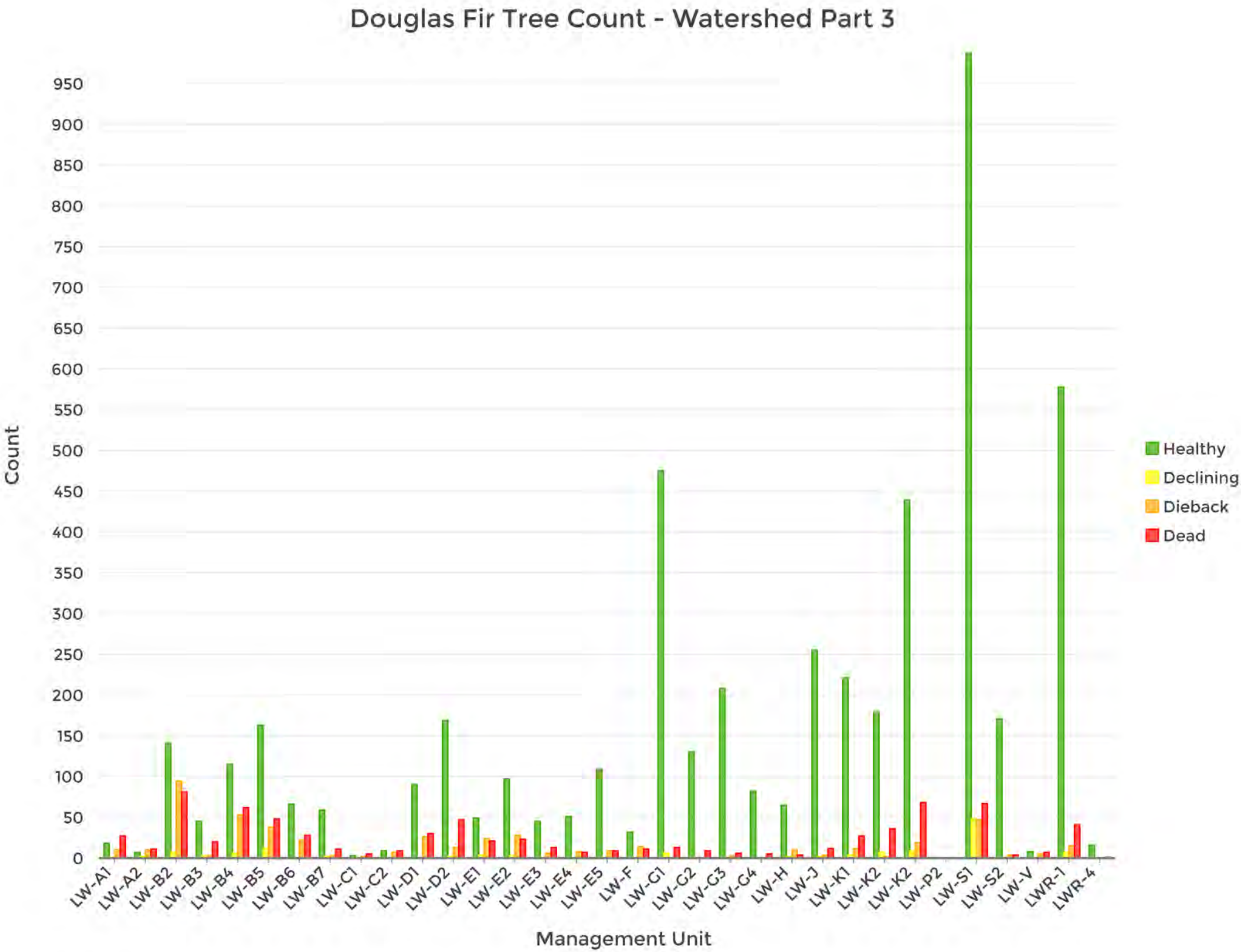
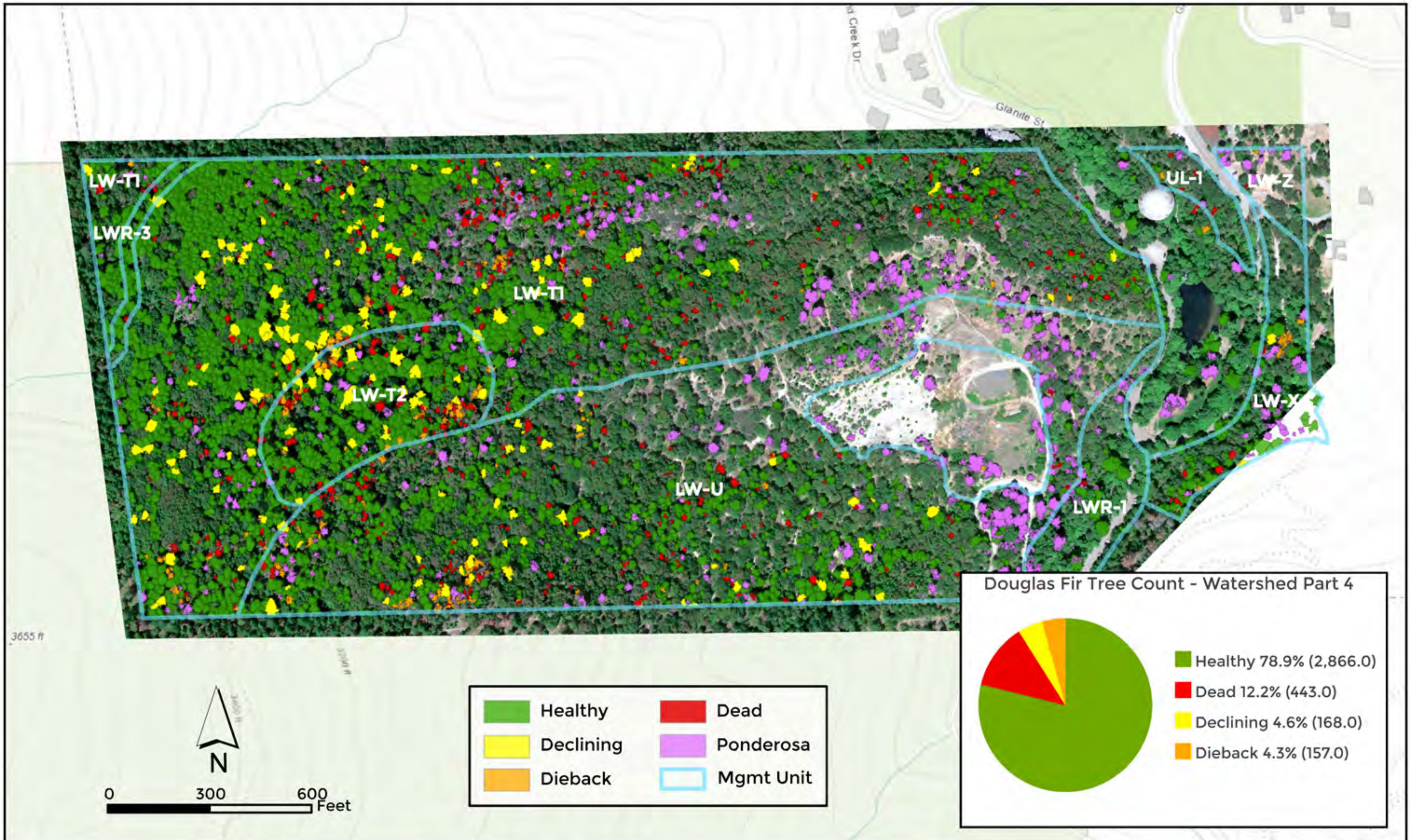
2023

N

0 500 1,000 Feet

Coordinate System: WGS 1984 UTM Zone 10N


Douglas Fir Tree Count - Watershed Part 3
Count
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
LW-A1
LW-A2
LW-B2
LW-B3
LW-B4
LW-B5
LW-B6
LW-B7
LW-C1
LW-C2
LW-D1
LW-D2
LW-E1
LW-E2
LW-E3
LW-E4
LW-E5
LW-F
LW-G1
LW-G2
LW-G3
LW-G4
LW-H
LW-J
LW-K1
LW-K2
LW-K2
LW-P2
LW-S1
LW-S2
LW-V
LWR-1
LWR-4
Management Unit
Healthy
Declining
Dieback
Dead



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Douglas Fir UAS Forestry Survey - Watershed Part 4

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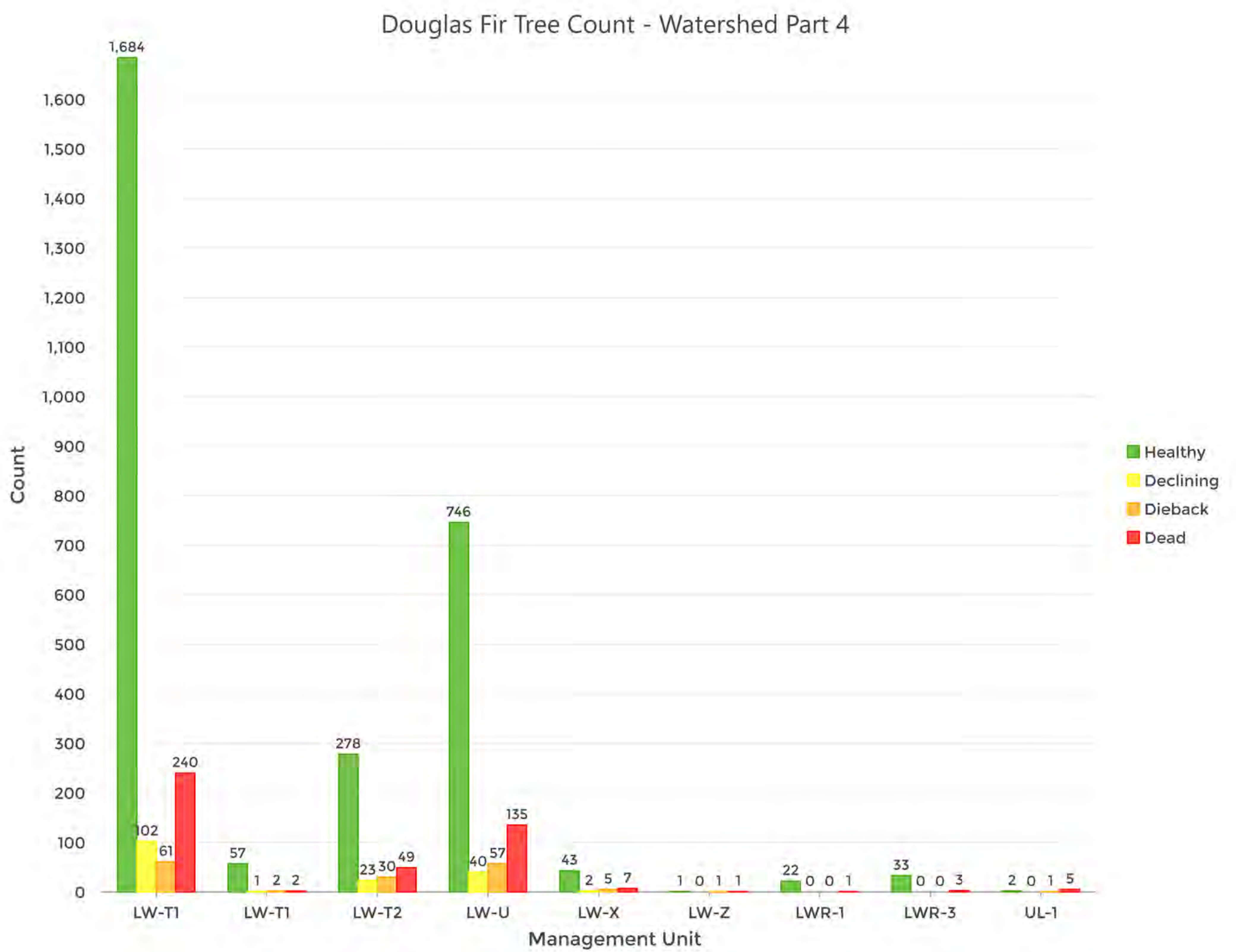
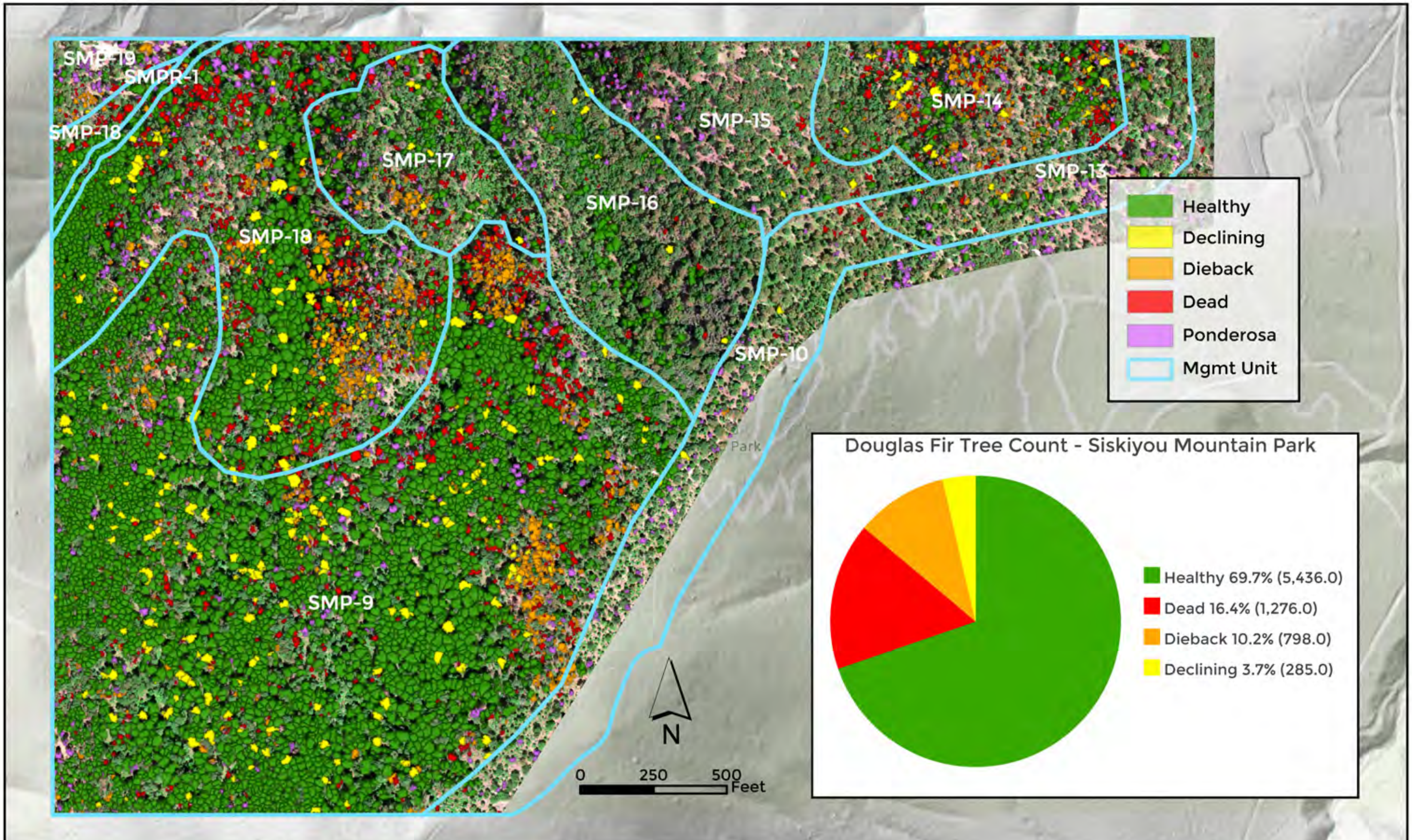
2023

Coordinate System: WGS 1984 UTM Zone 10N


Douglas Fir Tree Count - Watershed Part 4
1,684
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
Count
746
240
102
61
57
1
2
2
278
23
30
49
40
57
135
43
2
5
7
1
0
1
1
22
0
0
1
33
0
0
3
2
0
1
5
LW-T1
LW-T1
LW-T2
LW-U
LW-X
LW-Z
LWR-1
LWR-3
UL-1
Management Unit
Healthy
Declining
Dieback
Dead



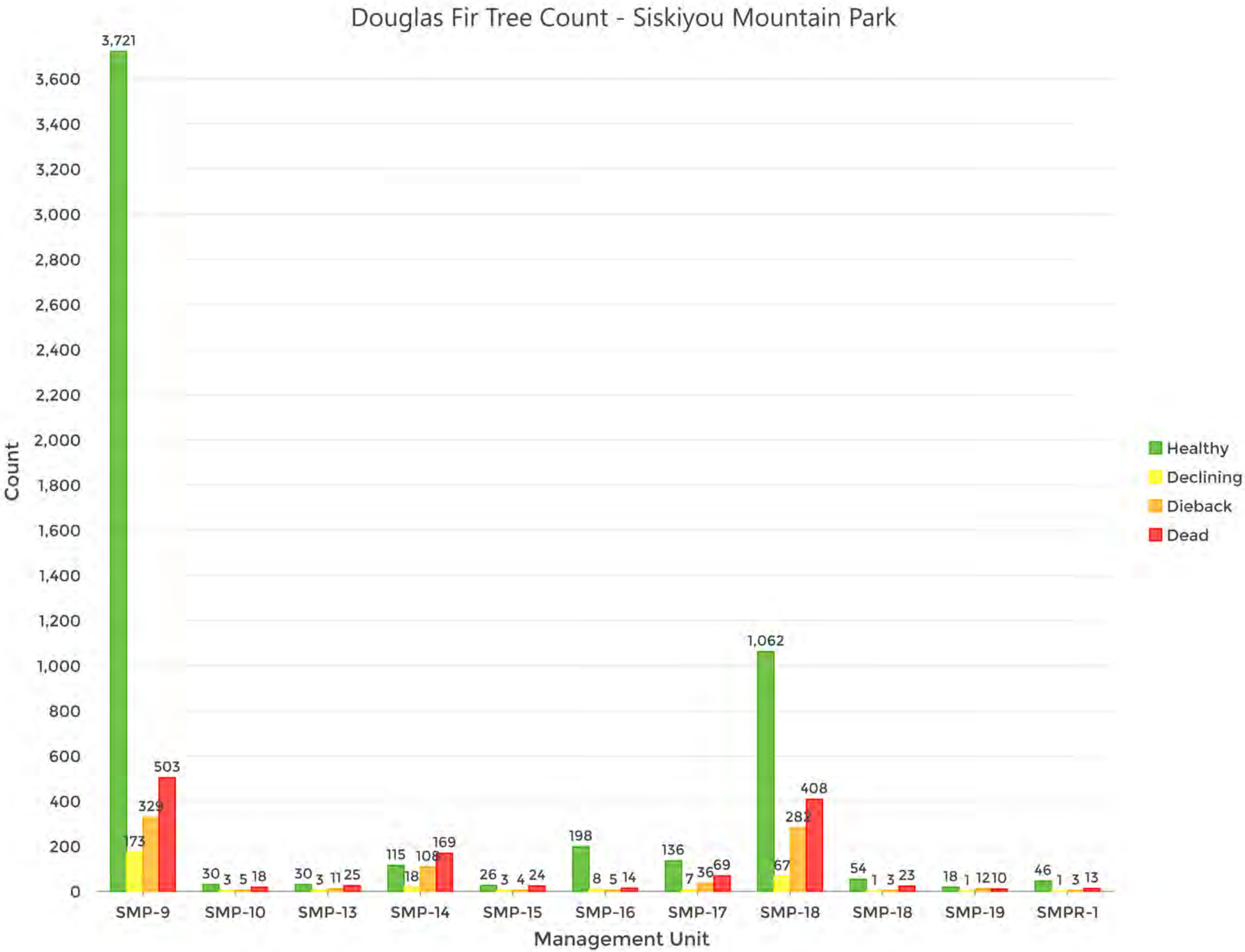
Douglas Fir UAS Forestry Survey - Siskiyou Mountain Park

ROGUE RECONNAISSANCE
• AERIAL IMAGING • GEOSPATIAL SOLUTIONS
www.roguerecon.net

This project was conducted by Rogue Reconnaissance for the City of Ashland utilizing an Uncrewed Aerial System (UAS) with Multispectral and LiDAR technology to assess the health status of Douglas Fir. Supervised by Eli Polsky and Gavin Mcgowan, the forestry survey categorized the trees into four classes: Healthy, Declining, Dieback, and Dead

2023

Coordinate System: WGS 1984 UTM Zone 10N



Douglas Fir Tree Count - Siskiyou Mountain Park
Count
Management Unit
Healthy
Declining
Dieback
Dead
SMP-9
SMP-10
SMP-13
SMP-14
SMP-15
SMP-16
SMP-17
SMP-18
SMP-18
SMP-19
SMPR-1
3,721
173
329
503
30
3
5
18
30
3
11
25
115
18
108
169
26
3
4
24
198
8
5
14
136
7
36
69
1,062
67
282
408
54
1
3
23
18
1
12
10
46
1
3
13

man_unit	Aspect	Plant_Asso	Fuel_Model	Acres2	Healthy/At-Risk	Declining	Dieback	Dead	Pines	DF Mortality	% DF Mortality	UNIT
TR-1	wnw	Ponderosa Pine	Fuel Model 9	2.10169904	1	0	0	1	0	1	50.0%	TR-1
SMPR-1	NE	Dry Douglas-fir	Fuel Model 8	0.81014966	46	1	3	13	4	17	27.0%	SMPR-1
SMP-9	N	Dry Douglas-fir	Fuel Model 8	66.81854879	3720	173	331	503	186	1007	21.3%	SMP-9
SMP-7	25	Dry Douglas-fir	Fuel Model 10	0.91697464	0	0	0	0	0	0		SMP-7
SMP-19	E	Dry Douglas-fir	Fuel Model 10	1.99452078	18	1	12	10	34	23	56.1%	SMP-19
SMP-18	N	Dry Douglas-fir	Fuel Model 8	26.78058945	1065	67	280	407	113	754	41.5%	SMP-18
SMP-18		Dry Douglas-fir		1.26563235	54	1	3	23	8	27	33.3%	SMP-18
SMP-17	N	Dry Douglas-fir	Fuel Model 10	7.96740754	136	7	36	69	37	112	45.2%	SMP-17
SMP-16		Dry Douglas-fir		14.88677501	198	8	5	14	36	27	12.0%	SMP-16
SMP-15		Dry Douglas-fir		9.83251654	26	3	4	24	33	31	54.4%	SMP-15
SMP-14		Dry Douglas-fir		9.92694799	115	18	108	169	31	295	72.0%	SMP-14
SMP-13		Dry Douglas-fir		6.88907539	30	3	11	25	42	39	56.5%	SMP-13
SMP-12		Ponderosa Pine		28.84075634	12	0	1	5	42	6	33.3%	SMP-12
SMP-10		Dry Douglas-fir		14.16947752	30	3	5	18	54	26	46.4%	SMP-10
LW-Z	sw	White Oak	Fuel Model 6	1.01995722	1	0	1	1	9	2	66.7%	LW-Z
LW-X	wnw	Dry Douglas-fir	Fuel Model 10	3.37947458	56	3	5	7	33	15	21.1%	LW-X
LW-V		Highly disturbed		5.61045002	0	0	1	0	21	1	100.0%	LW-V
LW-V				2.76469299	7	2	4	6	17	12	63.2%	LW-V
LW-U	E	Dry Douglas-fir	Fuel Model 9	31.41259785	772	40	50	125	169	215	21.8%	LW-U
LW-T2	ne	Dry Douglas-fir	Fuel Model 10	5.19442808	288	23	27	42	14	92	24.2%	LW-T2
LW-T1	ene	Dry Douglas-fir	Fuel Model 10	44.06503939	1713	102	56	220	168	378	18.1%	LW-T1
LW-T1				1.33803739	58	1	1	2	4	4	6.5%	LW-T1
LW-S2	nne	Dry Douglas-fir	Fuel Model 8	4.63018542	172	0	4	3	0	7	3.9%	LW-S2
LW-S1	wnw	Dry Douglas-fir	Fuel Model 10	16.08621664	986	51	47	66	13	164	14.3%	LW-S1
LWR-5	sw	Dry Douglas-fir	Fuel Model 10	8.14455509	151	4	3	13	41	20	11.7%	LWR-5
LWR-4				0.79893372	16	0	0	1	0	1	5.9%	LWR-4
LWR-4	ne	Moist Douglas-fir	Fuel Model 9	4.26257616	167	0	0	9	15	9	5.1%	LWR-4
LWR-3				0.63614451	33	0	0	3	0	3	8.3%	LWR-3
LWR-2				7.66187806	192	8	0	8	7	16	7.7%	LWR-2
LWR-1	n	Moist Douglas-fir	Fuel Model 8	26.75889816	574	13	14	40	9	67	10.5%	LWR-1
LWR-1				2.93267684	26	0	0	1	26	1	3.7%	LWR-1
LW-Q3	wnw	Dry Douglas-fir	Fuel Model 10	11.58525282	614	7	8	21	30	36	5.5%	LW-Q3
LW-Q2	wnw	Dry Douglas-fir	Fuel Model 10	4.90961049	149	5	14	8	19	27	15.3%	LW-Q2
LW-Q1		Dry Douglas-fir	Fuel Model 8	3.4857332	157	7	6	3	4	16	9.2%	LW-Q1
LW-P3	s-w	Dry Douglas-fir	Fuel Model 8	14.3855913	693	10	7	16	115	33	4.5%	LW-P3
LW-P2	wnw	Dry Douglas-fir	Fuel Model 10	5.03775734	152	5	13	23	36	41	21.2%	LW-P2
LW-P1	wsw	Dry Douglas-fir	Fuel Model 10	3.60948831	165	4	3	5	26	12	6.8%	LW-P1
LW-N	nnw	Moist Douglas-fir	Fuel Model 8	31.4411904	1641	24	8	44	48	76	4.4%	LW-N
LW-M3	nnw	Dry Douglas-fir	Fuel Model 8	0.61418171	31	0	0	2	0	2	6.1%	LW-M3
LW-M3	nnw	Dry Douglas-fir	Fuel Model 8	3.04456284	160	0	3	5	12	8	4.8%	LW-M3
LW-M2	sse	Dry Douglas-fir	Fuel Model 10	0.80672946	28	0	1	1	5	2	6.7%	LW-M2
LW-M2	wsw	Dry Douglas-fir	Fuel Model 8	11.00624322	350	4	7	14	97	25	6.7%	LW-M2
LW-M2	wsw	Dry Douglas-fir	Fuel Model 8	3.18994561	191	1	1	7	24	9	4.5%	LW-M2
LW-M1	sw	White Oak		0.84955848	19	0	0	4	8	4	17.4%	LW-M1
LW-M1	sw	White Oak		0.11762118	2	0	0	0	1	0	0.0%	LW-M1
LW-L	nne	Moist Douglas-fir	Fuel Model 10	8.9690524	392	4	1	26	4	31	7.3%	LW-L
LW-K2	ese	Dry Douglas-fir	Fuel Model 10	5.04072312	179	7	2	36	4	45	20.1%	LW-K2
LW-K2	ene	Dry Douglas-fir	Fuel Model 10	14.28857825	440	9	19	68	27	96	17.9%	LW-K2
LW-K1	ene	Dry Douglas-fir	Fuel Model 10	5.36025836	217	12	10	25	4	47	17.8%	LW-K1
LW-J	ene	Dry Douglas-fir	Fuel Model 8	6.96556398	253	6	3	12	34	21	7.7%	LW-J
LW-H		Dry Douglas-fir		4.51242814	63	3	10	4	21	17	21.3%	LW-H
LW-G4		Dry Douglas-fir	Fuel Model 4	4.93713624	82	0	0	5	5	5	5.7%	LW-G4
LW-G3	ene	Dry Douglas-fir	Fuel Model 8	2.89934152	208	1	3	6	0	10	4.6%	LW-G3
LW-G2	ese	Dry Douglas-fir	Fuel Model 6	5.54903027	128	4	0	7	15	11	7.9%	LW-G2
LW-G1	ne	Dry Douglas-fir	Fuel Model 10	9.71517517	466	16	0	12	4	28	5.7%	LW-G1
LW-F	ssw	Dry Douglas-fir	Fuel Model 8	4.34161686	30	5	13	10	52	28	48.3%	LW-F
LW-E5	wsw	Dry Douglas-fir	Fuel Model 8	5.14963969	110	2	8	9	30	19	14.7%	LW-E5
LW-E4	wsw	Dry Douglas-fir	Fuel Model 9	2.31082496	51	0	8	7	10	15	22.7%	LW-E4
LW-E3	sw	Dry Douglas-fir	Fuel Model 9	3.47385607	47	1	6	12	32	19	28.8%	LW-E3
LW-E2	sw	Ponderosa Pine	Fuel Model 9	14.52542466	99	5	27	22	204	54	35.3%	LW-E2
LW-E1	wsw	Ponderosa Pine		9.88362552	49	4	23	21	61	48	49.5%	LW-E1
LW-D2	wsw	Dry Douglas-fir	Fuel Model 8	8.00210213	169	6	12	45	8	63	27.2%	LW-D2
LW-D1	wsw	Dry Douglas-fir	Fuel Model 9	9.93901782	99	2	29	39	66	70	41.4%	LW-D1

LW-C2	SW	Ponderosa Pine	Fuel Model 9	8.15854031	9	0	7	9	143	16	64.0%	LW-C2
LW-C1	SW	Ponderosa Pine	Fuel Model 9	3.99962442	3	0	2	5	41	7	70.0%	LW-C1
LW-B7	nnw	Dry Douglas-fir	Fuel Model 8	3.11152396	59	3	3	10	2	16	21.3%	LW-B7
LW-B6	wnw	Dry Douglas-fir	Fuel Model 8	5.32454922	63	4	20	28	11	52	45.2%	LW-B6
LW-B5	wnw	Dry Douglas-fir	Fuel Model 8	7.41602343	159	19	34	47	10	100	38.6%	LW-B5
LW-B4	nw	Dry Douglas-fir	Fuel Model 8	10.6907451	112	14	49	60	22	123	52.3%	LW-B4
LW-B3	wnw	Dry Douglas-fir	Fuel Model 10	4.3834613	43	3	3	20	7	26	37.7%	LW-B3
LW-B2	N-W	Dry Douglas-fir	Fuel Model 10	20.81138909	143	10	90	80	55	180	55.7%	LW-B2
LW-B1	nne	Dry Douglas-fir	Fuel Model 8	3.93587586	28	0	6	22	0	28	50.0%	LW-B1
LW-A2	ne	Dry Douglas-fir	Fuel Model 8	6.18442812	7	2	10	11	47	23	76.7%	LW-A2
LW-A1	ne	Dry Douglas-fir	Fuel Model 8	5.01058761	18	1	10	27	40	38	67.9%	LW-A1
GS-2	264	Dry Douglas-fir	Fuel Model 8	4.44363995	64	1	4	15	43	20	23.8%	GS-2
GS-1	286	Dry Douglas-fir	Fuel Model 9	1.08729668	6	2	5	6	23	13	68.4%	GS-1
BL-8	NE	Dry Douglas-fir	Fuel Model 8	8.6218419	238	11	3	48	18	62	20.7%	BL-8
BL-7	56	Dry Douglas-fir	Fuel Model 6	2.7423243	88	4	3	34	20	41	31.8%	BL-7
BL-6	84	Dry Douglas-fir	Fuel Model 9	26.99448099	137	6	9	75	206	90	39.6%	BL-6
BL-5	E	Dry Douglas-fir	Fuel Model 10	2.18931226	21	0	7	10	77	17	44.7%	BL-5
BL-4	ENE	Dry Douglas-fir	Fuel Model 4	1.19506759	9	0	1	6	20	7	43.8%	BL-4
BL-3	61	Dry Douglas-fir	Fuel Model 4	1.57589338	67	2	3	7	16	12	15.2%	BL-3
BL-2	84	White Oak	Fuel Model 9	1.22382159	8	0	1	4	9	5	38.5%	BL-2
BL-1	E	Dry Douglas-fir	Fuel Model 10	3.01391322	21	1	2	31	31	34	61.8%	BL-1
				712.0	**19400**	**769**	**1529**	**2902**	**3013**	**5200**	**21.1%**	
			Dead/Dying per	7.303791217				Range of "Healthy" Infes		5720	10.0%	
			10-60% additior	8.0 to 11.7				per Lowery data		8320	60.0%	

CITY OF ASHLAND
Better Together

Final Climate Change Addendum to the 2016 Ashland Forest Plan

Approved by Ashland City Council in April 2023

I. Introduction

The 2016 Ashland Forest Plan (AFP) contained a chapter on climate change, but it was general in nature and limited by uncertainty as to the impact climate change would have on the approximately 1,200 acres of forest lands managed by the City of Ashland and Ashland Parks and Recreation Commission (APRC). The increased research and rapid rate of climate change induced impacts on Ashland's forest lands over the past six years have added considerably to the Forest Lands Commission's (FLC, now a management advisory committee) understanding of the urgent need to address climate change impacts through recommendations to the Ashland City Council for planning direction and management actions over the next 25 years. Current drought and temperature-related changes to vegetation on municipal forest lands warrant an improved and more comprehensive analysis of climate-adaptive planning and management beyond what was addressed in the AFP. Adaptive management is a key overarching strategy addressed throughout this addendum to assess both new and changing resource conditions and land management goals, as well as those that remain unchanged at this time.

Specific examples of necessary adaptive management updates in planning direction and management actions that this addendum will add to the AFP include:

- Shifting from the restoration paradigm that guided previous forest planning and management to an enhanced adaptive management strategy that incorporates new science and technology to effectively address climate change-induced forest land conditions that are likely without historic reference.
- Utilize existing data from attribute tables and encourage contractors to both review data and update it as appropriate.
- Maintaining and promoting refugia conditions and stand characteristics to buffer against climate change impacts to allow diverse habitats to persist. Develop a finer scale approach to refugia[1] delineation, where appropriate.
- Enhance a variable mosaic of forest structure conditions and fuel loads. For example, creating openings in the forest canopy to reduce potential crown or ground fire intensity from continuous tree canopies or surface fuels. Growing shade intolerant and fire tolerant species would be balanced with higher tree densities and fuel loading in other areas such as riparian areas.
- Managing to promote and maintain healthy, functional, and productive soil conditions. This addendum will add soils as a stand-alone chapter with equal standing with other resources addressed in the AFP.
- Planning for increasing frequency and intensity of extreme precipitation events that could negatively impact soils and aquatic resources, resulting in the loss of ecosystem services in Ashland's built environment including road systems, trails, infrastructure, and other downstream assets and values.

1 Refugia: Locations that experience less severe or less frequent disturbances than the surrounding landscape.

- Anticipating and proactively treating tree mortality events to reduce excessive fuel accumulations. Additionally, implementing a rapid response for the strategic and timely removal of dead and dying trees will reduce overall costs of treatment, enhance public safety, and contribute to the local timber supply (only as a by-product of ecosystem management).
- Mitigating the increasing impact of habitat loss on wildlife populations from wildfire, weather pattern changes, insects and disease outbreaks, and pressures from recreational use on city forest lands because of climate change while considering adjacent land ownerships.
- Monitoring, evaluation, and regulation of recreation resource users to protect ecosystems from the additive stressors of climate change and to protect the recreation resource itself.
- Improving coordination and partnerships between various city departments, APRC, the Rogue River-Siskiyou National Forest, neighboring communities, volunteer and advocacy organizations, and various stakeholder groups.

II. Ashland Forest Plan Climate Change Addendum Development

The FLC has a long history, dating back to the mid-1990s, of public engagement and the development of professional and implementable planning and management documents listed below:

- City Forestlands Restoration Phase II (2004)
- Coordination and contribution to the Ashland Forest Resiliency Community Alternative on U.S. Forest Service lands in the Ashland Watershed under the Ashland Forest Resiliency Stewardship project (2004)
- City Forestlands Restoration Phase III for the City's Winburn parcel (2009)
- Ashland Forest Plan (2016)

To create this addendum to the AFP for climate change-specific adaptative management recommendations on City and APRC forest lands, the FLC took the following steps to research, author, review, and prepare this document for presentation to the City Council:

- Consultant Marty Main of Small Woodland Services, Inc. compiled and presented an extensive literature review of predicted climate change impacts on vegetation, wildfire behavior, soils, hydrology, wildlife, recreation, and carbon storage to the FLC, within the context of 25 years of past management. Main suggested changes to the AFP based on his assessment of existing research compared to policy and science in the 2016 Ashland Forest Plan.
- Forest Lands Committee members reviewed and discussed each recommendation to determine if a change to the AFP was needed or if current direction in the AFP was sufficient.
- Planning direction and management actions to adapt or change are described in this addendum.
- A public review period of the draft addendum occurred prior to finalization and presentation to the City Council.

III. Ashland Forest Plan Climate Change Addendum

This section describes recommendations by the FLC for changes to planning direction and management actions for the city's forest lands and resources. Unless otherwise stated, guidance in the 2016 AFP (www.ashland.or.us/forestplan) remains in effect.

A. Vegetation

- Increase individual tree and stand-level resilience and diversity of Plant Association Groups (PAGs) more tolerant of climate-induced high-severity disturbance and predicted future conditions.
- Identify unique vegetation types that are currently under stress and implement management strategies to maintain them within a refugia framework. Promote refugia to buffer against climate change impacts and to allow at-risk species to persist and expand.
- Emphasize fuel treatments adjacent to refugia to minimize risk of high severity fire in refugia.
- Consider adding deferred or untreated units to the refugia framework.
- Rate the refugia potential of units based on temperatures, moisture, aspect, and site productivity. Consider refugia subtypes to rate units across multiple refugia categories. Develop a finer scale approach to refugia ratings and delineation.
- Modify silvicultural prescriptions to produce a more variable structural mosaic including more open forests to reduce density-related tree stress and mortality. Emphasize uneven-aged stand structure to encourage vigor in multiple crown classes and seral stages, without compromising hardwood development and ground shading.
- Prioritize pre-emptive treatment of vulnerable and mortality-prone sites to avoid outbreak-level mortality using Main's risk rating system.
- Increase scope and intensity of fuels reduction treatments on and adjacent to AFP parcels for more wildfire management effectiveness, (as referred to in the Potential Operational Delineations (PODs) analysis) during predicted increasing higher-severity wildfire disturbances. Emphasize area-wide treatments taking advantage of control features over linear treatments (fuel breaks) to maximize suppression success and footprint of climate-adapted forests.
- Identify and reduce potential vectors for invasive species. Aggressively monitor, inventory, and manage invasive species using an integrated pest management approach.
- Use prescribed burning to reduce stand density, increase heterogeneity of vertical and horizontal stand structure and fuel loading, and promote tree species and individuals better adapted to predicted climate change and the resulting disturbance regimes.
- When updating the AFP and for future project documents:
  - Define and discuss the term refugia.
  - Define and discuss the term pyrosilviculture.
  - Define and discuss the PODs rating system.
  - Update existing plant list.

B. Soils

- Add a stand-alone soils chapter to the AFP during the next update.
- Reduce erosion potential by maintaining higher root-holding capacity on sites vulnerable to excessive erosion through increased occupancy of vegetation.

- On sites vulnerable to erosion, consider alternative management such as radial thinning only around vigorous retention trees, thinning in strips across the contour, and creating small openings (< 1 acre).
- Manage for endemic, rather than outbreak, levels of tree mortality to maintain sufficient amounts of Coarse Woody Material (CWM) for soil health while avoiding an excess of snags and CWM which may result in long duration fires.
- Increase protection and enhancement of below-ground soil functions and processes, particularly for enhancement of water and carbon retention.
- Reduce the likelihood of slope failure and landslides by applying site-specific management strategies in areas designated as landslide hazards by the State of Oregon.
- Increase the scale and intensity of prescribed underburning to decrease possibility of soil loss from high-severity fire. Reduce the likelihood of erosion by implementing mosaic burns to retain unburned patches and minimize large areas of bare soil exposure.
- Increase the creation and retention of partially burned CWM and biochar through light underburning.
- Define and discuss biochar when updating the AFP.

C. <u>Carbon Sequestration and Storage</u>

- Consider carbon sequestration and storage as a resource to be managed.
- Develop CWM budgets based on management priorities and PAGs.
- Assign two CWM budgets for PAGs within riparian areas: (1) streamside moist PAG and (2) upland dry PAG.
- Explore options to generate revenue from carbon sequestration and storage while recognizing that lower elevation dry forests are predicted to lose carbon as vegetation type shifts. Carbon storage is more appropriate in the wettest Plant Association Groups in riparian areas and the Winburn Parcel.
- Though the Ashland Climate Energy Action Plan calls for carbon neutrality, we recognize that this may not be possible on City forestlands, where goals of community wildfire safety and maintaining forested ecosystems intact are higher priorities.

D. <u>Hydrology</u>

- Monitor changes in stream condition classes and focus management on perennial and intermittent streams. Update inventory if climate change causes alterations to stream condition classes.
- Evaluate, upgrade, and maintain forest road system (7 lane miles) in partnership with U.S. Forest Service. Improve drainage systems and increase culvert sizes where needed in anticipation of likely increase in peak flows. Minimize sediment discharge from roads and ditches into the hydrologic network.
- Create and maintain more canopy openings for longer retention of snow at the ground surface, where appropriate.
- Manage organic matter amounts, specifically CWM and biochar, to increase water holding capacity.
- The combination of the projected extension of the dry season and the fire season, and more extreme precipitation events during the wet season with higher peak flows, presents an urgent need for adaptive management in Riparian Management Areas (RMA).
    - Target stands for thinning and promote more shade intolerant species higher in hydrologic

networks (regardless of elevation) in intermittent and ephemeral portions of streams.
  - Utilize RMAs as corridors connecting mid- and late-seral habitats across all land ownerships.
  - FLC recommends that APRC designate the Ashland Ponds parcel as anadromous fish critical habitat to manage for salmon and steelhead spawning and rearing habitat.
  - Manage for terrestrial and aquatic RMA communities, based on PAGs and stream class.
  - Prioritize the reduction of fuel continuity adjacent to major riparian areas (especially along Ashland Creek) to discourage high-severity disturbance from occurring within RMAs.

E. <u>Wildlife</u>

- All management actions, including refugia enhancement, will consider vulnerable and at-risk species and their habitat as identified by federal and/or state agencies such as coho salmon and pacific fisher.
- Increase public awareness of wildlife moving into the city to seek water sources during the dry season. Establish and maintain water sources away from the city to reduce human/wildlife conflicts.
- Maintain landscape level habitat connectivity as ranges shift by implementing broader landscape level analysis and partnerships with adjacent landowners, especially along RMAs connecting with cooler aspects.
- Reduce pressures on wildlife species from additive sources other than climate change.

F. <u>Recreation</u>

- Protect recreation resources from the additive stressors of climate change.
- Establish and codify the relationship between FLC and APRC to further define roles and responsibilities for planning direction and management actions. Specifically, develop procedures for FLC to maintain AFP consistency and provide advisory input to APRC when modifications or additions to the city trail network is proposed.
- Increase public awareness of potential human-caused high-severity disturbance that can be exacerbated by climate change in order to protect amenity values, user experience, public safety, and access.
- Recommend that city emergency evacuation plans are updated to include trail users in the watershed.
- With higher predicted summer temperatures, expect increased demand for recreational use of city lands in cooler locations and along RMAs. In other areas, higher summer temperatures may modify the amount, timing, or seasonality of some recreation uses.
- Improve user awareness of:
  - climate change
  - wildfire safety
  - potential ignition sources
  - forest management objectives
  - trail etiquette
  - invasive species
  - reducing negative resource impacts

- Through partnerships, manage recreation to reduce negative impacts to vulnerable species, climate refugia integrity, and forest lands stressed by climate change.
- Increase monitoring, inventory, and management of invasive species introduced by recreation, especially along trails and parking areas.
- Plan for increased maintenance of access roads, parking areas, trails, and other recreational infrastructure due to more frequent and intense extreme precipitation events and increased use during the wet season.