RESTORATION PROJECT EFFECTIVENESS MONITORING PLAN

EAST CASCADES OAK PARTNERSHIP

APRIL 2024

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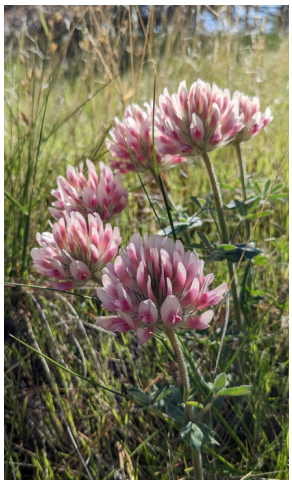

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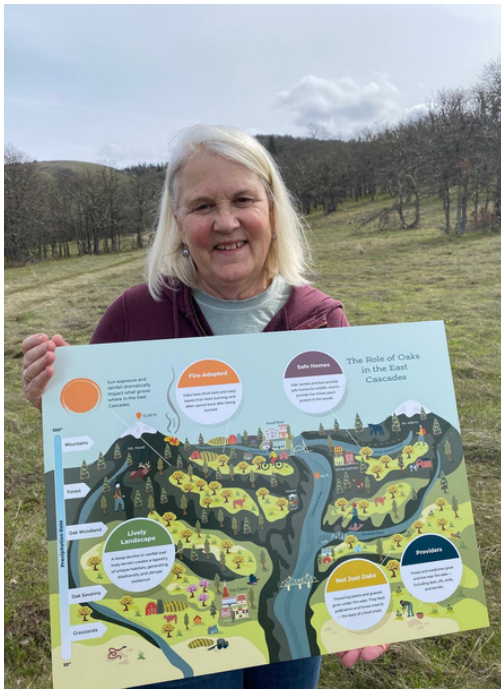
Who We Are

The East Cascades Oak Partnership (ECOP) is a group of people who know and love the Columbia River Gorge and the East Cascades as a place with thriving wildlife, a vibrant economy, and incredible beauty. Over 25 partner organizations make up ECOP including state and federal public agencies, tribes, nonprofits, watershed councils, and conservation districts. Together with several small businesses and dozens of private landowners and interested citizens, we are implementing a strategic plan to ensure Oregon white oak systems are abundant, diverse, and healthy, supporting rich biodiversity and human uses for generations to come.

ECOP Core Partners

Columbia Land Trust
Columbia River Gorge Commission
Confederated Tribes of the Warm Springs
Deschutes Land Trust
Ekone Ranch/Sacred Earth Foundation
Friends of the Columbia Gorge Land Trust
NRCS - Wasco County SWCD
Oregon Department of Fish and Wildlife
Oregon Department of Forestry
Oregon Parks and Recreation
Pacific Birds Habitat Joint Venture
The Conservation Fund
Underwood Conservation District
WA Department of Fish and Wildlife
WA Department of Natural Resources
Yakama Nation
USFS - Mt. Hood National Forest
USFS - Columbia River Gorge Scenic Area

Funding for this plan was provided by the Oregon Watershed Enhancement Board.



Review ECOP's Strategic Plan

www.ColumbiaLandTrust.org/ECOP

Three of the five **primary conservation goals in our strategic plan** will be met by implementing strategies such as restoration, land protection, and adaptive management.

1) The oak landscape is intact and connected
2) The oak landscape is resilient to climate change and disturbance
3) Biodiversity persists

To accomplish these broader goals, conservation strategies should advance the landscape condition toward the desired ecological outcomes described below:

- Oaks are released from conifer encroachment
- Mature oak habitat features are retained and recruited
- Species composition and stand structure indicate resilience to disturbance
- Diverse native oak associated species and pollinators persist

This monitoring plan explains how we will deploy the partnership's resources to implement adaptive management towards these desired ecological outcomes. It will describe how we accomplish adaptive management to ensure restoration actions we invest in as a partnership are advancing us toward these goals.

Why Monitoring?

Though Oregon white oak are genetically similar throughout their range, the ecology of East Cascades oak systems differs from that of the Willamette Valley and Puget Trough where much of the focused research and monitoring of oak systems has been concentrated. As a result, practitioners lack management guidance and tools specific to the East Cascades. By standardizing the way partners collect data on public and private lands and centralizing data management, we create a larger pool of data that can be analyzed at multiple scales to address management uncertainties and inform conservation planning.

ECOP identified the following critical first steps for monitoring oak in the East Cascades

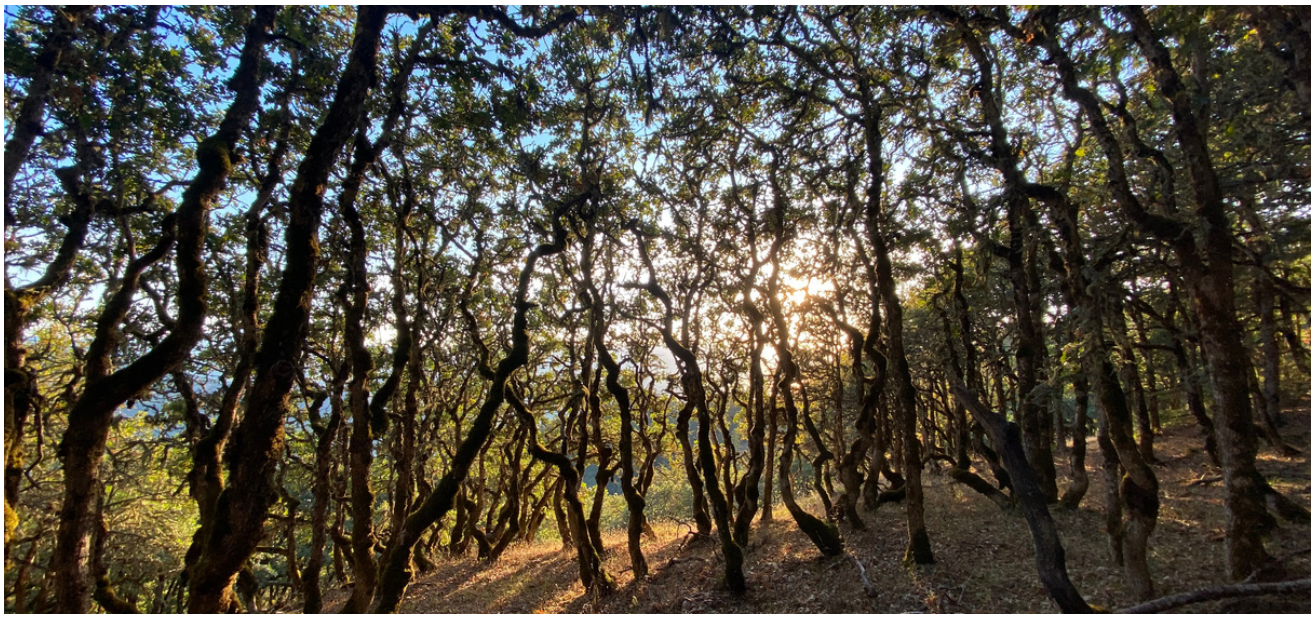
- Articulate restoration objectives and monitoring questions
- Create a plan that identifies metrics, protocols, analysis approach, and spatial and temporal scales for restoration project effectiveness monitoring
- Create an oak-specific restoration effectiveness monitoring tool to inform adaptive management on public and private lands.
- Create monitoring toolkits that remove barriers to implementation
- Train partners and volunteers on the protocol
- Complete adaptive management framework and strategies for sharing results
- Fundraise to expand monitoring potential

Oak and oak pine systems are slow growing, but disturbance events that influence these systems happen over a variety of temporal scales – from immediate, as with wildfire and mechanical thinning, to slow, as with fire suppression, grazing, and climate change. This monitoring plan and the ECOP Disturbance Monitoring Protocol described below are intended to document changes in oak systems across these temporal scales. Permanent plots can be established and then revisited following discrete disturbance events to evaluate system response, before and after restoration to characterize project effectiveness, and over time to evaluate the effects of more chronic disturbance or long term processes. All types of monitoring will inform key management questions.

ECOP Disturbance Monitoring Protocol

Monitoring protocol development

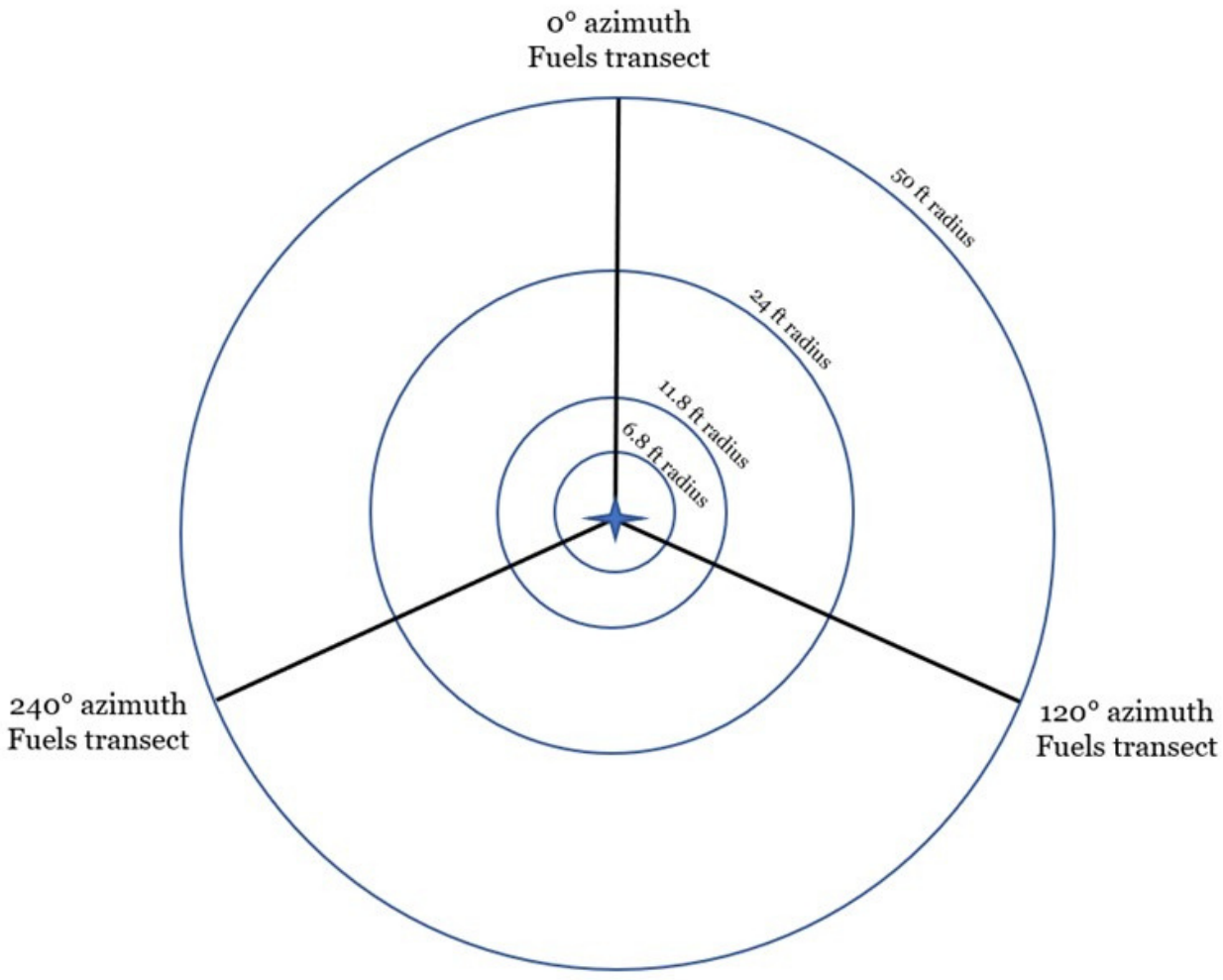
The ECOP Disturbance Monitoring Protocol (Appendix A) was developed in 2021 with extensive ECOP partner input and in collaboration with the Institute for Applied Ecology. The initial foundation of the survey protocol came from the USDA Forest Inventory and Analysis (FIA) methodology used across the nation on both private and public forest lands. FIA provides information on the status and trends in forest area and location; on the species, size, and health of trees; on total tree growth, mortality, and removals by harvest; and on wood production and utilization rates by various products. As the ECOP Disturbance Monitoring Protocol was built and tested, the FIA methods proved to be limited in their ability to capture the unique attributes of oak trees and understory plant communities the partnership was interested in.



After field testing the first draft, ECOP staff and consultants added metrics to the **ECOP Disturbance Monitoring Protocol** specifically for oak systems including:

1) crown position
2) oak morphology and density
3) oak regeneration from root crowns and establishment from acorns
4) oak epicormic branching
5) oak tree insect and disease
6) fire history
7) wildlife features in the trees and snags

As fire is the primary disturbance mechanism in oak and oak-pine habitats, the protocol also uses the Brown's transect method of inventorying downed woody materials. The protocol employs a planar transect method to inventory volumes of downed woody material, fuel depth, and duff depth.



In 2023, we developed the **oak understory module** (Appendix A, pages 12-14) with the goal of documenting effects of restoration on the specific composition of the oak understory plant community, including in response to herbicide treatment for specific invasive species, prescribed fire, mechanical thinning, and mastication. Measurements focus on estimating the cover of plant species and species diversity. This provides higher resolution data than the base Disturbance Monitoring Protocol provides, which simply characterizes percent composition of plants by guild and presence/absence of invasive species.

This module will be completed for projects with understory restoration objectives related to biodiversity, culturally important plants, or weed extent. We also developed a **fire monitoring module** (Appendix B) with the goal of documenting burn severity and tree responses to fire after a prescribed fire. Measurements focus on estimating burn severity of substrate and vegetation as well as measuring scorch and char on trees within the monitoring plot. The fire module will be completed for projects with prescribed fire as a management action or opportunistically after wildfires.

Data for all methods will be captured using the ESRI electronic data collection product, Survey123. We selected Survey123 due to its user-friendly interface, accessibility on standard, low-cost tablet operating systems (Android, IOS), and the Institute for Applied Ecology's past success with this tool. After submission in the Survey123 form, data will be stored on Columbia Land Trust's account and will be available for download from ArcGIS Online in a variety of formats.

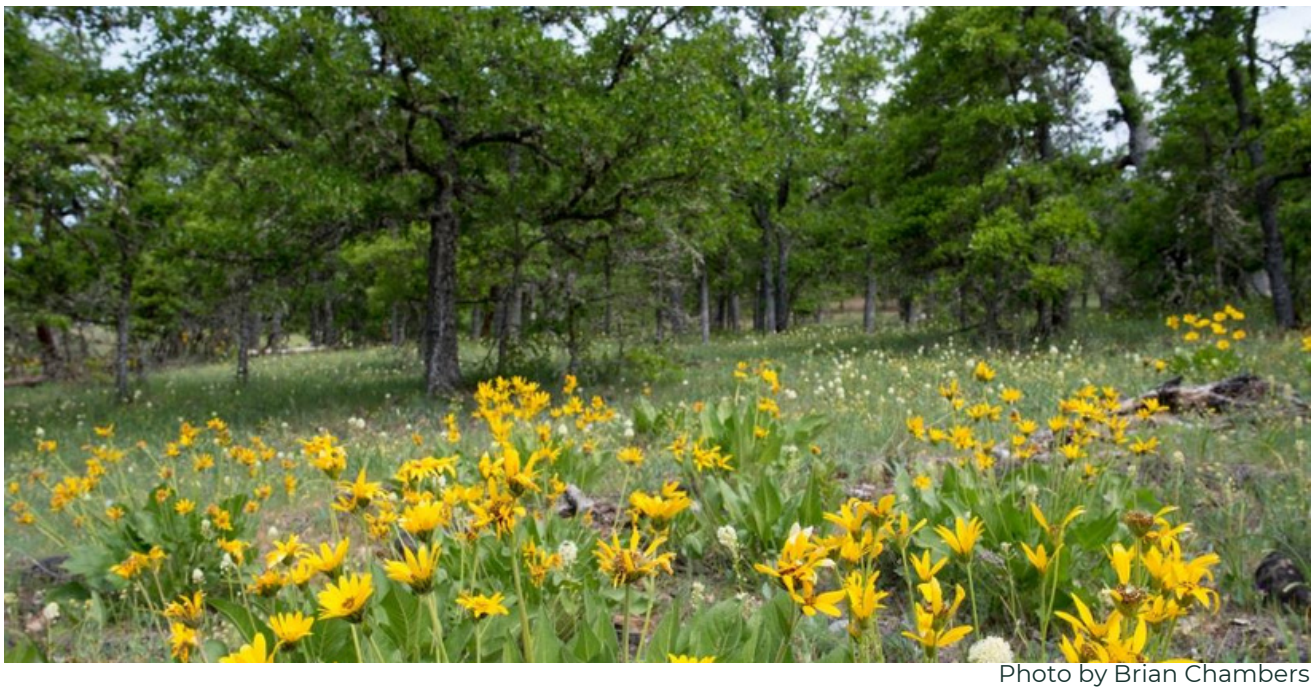


Photo by Brian Chambers

Photo by Lynn Weisenfells

All restoration projects with sufficient monitoring funds will utilize the ECOP Disturbance Monitoring Protocol, enabling the partnering land manager to answer a variety of monitoring questions. Where resources allow, we will also measure the physiological response of oak to treatments to test our assumption that a change in oak crown position and stem density will improve oak tree vigor.

Modifications and improvements to monitoring tools

To maximize comparability of datasets across time, ECOP will seek to limit updates to survey protocols that substantially change what data is collected. We may more readily add new data fields or metrics to address emerging management uncertainties, prioritize the collection of some metrics over others, or implement changes to improve efficiency and accuracy of data collection. We will discuss prioritization of data collection across metrics, projects, and time later in this plan.

Sampling plot number and locations

ECOP monitoring plots are randomly located within project areas using a Geographic Information System (GIS). To identify plot locations, we obtain restoration project area boundaries from partners (e.g., mapped invasive plant areas planned for restoration or a prescribed burn unit), and use the “create random points” tool in ArcGIS Pro to create random points within each project area.

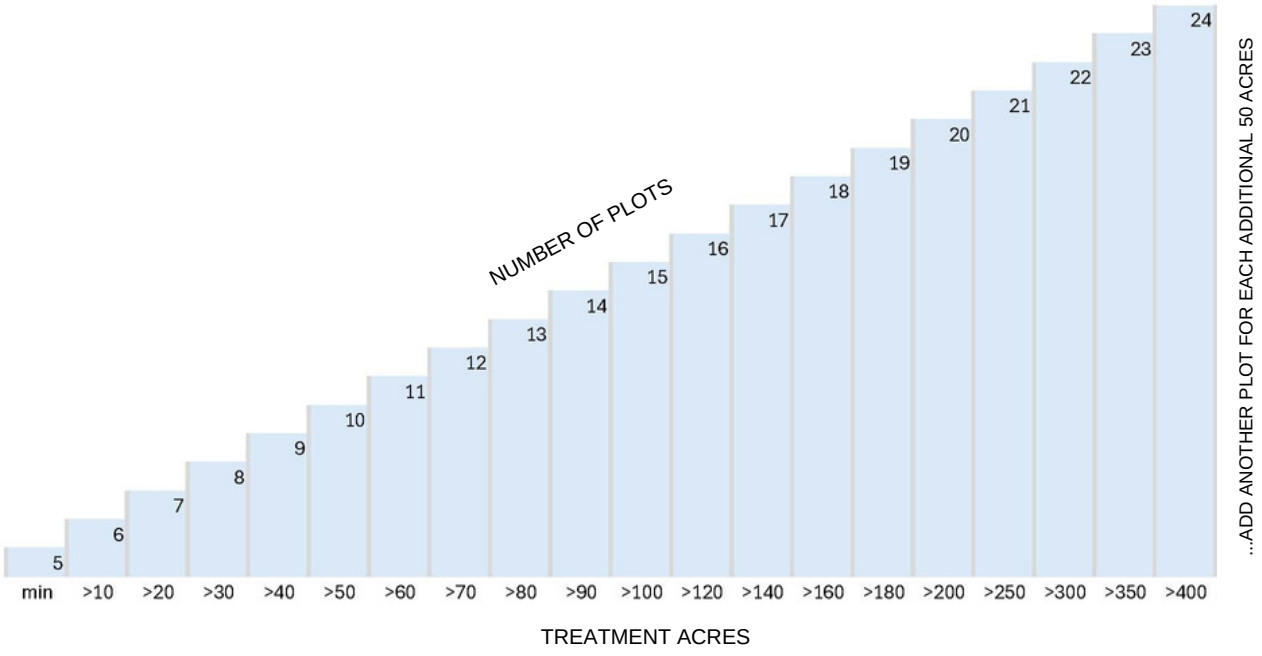
Since the monitoring plots are 50-ft radii circles, we set the minimum distance between them at 100 ft to avoid overlap and include a 50 ft buffer from project area edges. The number of randomly located monitoring plots generated depends on the size and homogeneity of the restoration area (homogenous sites may require fewer plots). To approximate the number of plots needed, use the graphic on the following page.

We recommend that all sites have a minimum of 5 plots installed. Once the minimum acres are included, we suggest an incremental stepwise increase in plots. For each additional 10 acres add 1 plot (up to 100 total acres). For sites between 100 and 200 total acres, add an additional plot for each 20 acre increase. For sites over 200 acres, add an additional plot for each 50 acre increase. The graphic below displays this step by step increase.

If your site is very homogenous, it may not necessitate this many plots. However, if you site is very heterogeneous with big changes in slope, aspect, elevation or the hydrology of the site creates an ecotonal landscape, it may be wise to increase the number of plots you install.

To approximate the number of plots your site will need, use the table below:

Plot Calculation Tool



The total number of plots installed may depend on other factors such as budget and access. Additional plot locations are generated in case field scouting or installation reveals any of the original locations are unsafe or not representative of project area (e.g., middle of road). ECOP members are encouraged to install plots across the landscape and have access to field kits and materials to facilitate monitoring.

Control plots

Control plots will be established, if possible, where response variables are sensitive to climate differences across sampling periods. For example, plant phenology can be variable year-to-year based on weather variables so changes in relative plant abundance can be harder to attribute to the treatment itself without a control group (e.g., **oak understory module** and understory plant guild measurements in **Disturbance Monitoring Protocol**).

Control plots help differentiate changes due to the treatment (causation) versus changes from potential environmental variables (correlation). However, since we are working with multiple partners across different ownerships and objectives, we may not always have control sites established. If this is the case, we will adjust our analysis methodology to compare pre- and post-treatment measurements.

Photo by Paloma Ayala

Monitoring Approach

We will deploy the **ECOP Disturbance Monitoring Protocol** at all monitoring plot locations and tailor the data analysis to the specific ecological objective for each project. This will allow ECOP partners to pool standardized data that informs on key management uncertainties and long term or landscape scale monitoring objectives while simultaneously evaluating treatment effectiveness against specific project objectives.

In this section, we summarize the limiting factors our restoration approaches must address to make progress towards each of the desired ecological outcomes listed below, as well as the monitoring questions, objectives, metrics, sampling frequency, and sample design that will inform on treatment effectiveness. The specific ecological objectives for each monitored restoration project will be tailored to individual site conditions and management goals, which vary across the landscape and across ownerships. We assign the value "X" in objectives where project-specific data will be used to inform targets.

ECOP's desired ecological outcomes:

1) Oaks are released from conifer encroachment.
2) Mature oak habitat features are retained and recruited.
3) Species composition and stand structure indicate resilience to disturbance (fire, mechanical treatments, grazing).
4) Diverse native oak associated species and pollinators persist.

Photo by Lynn Weissenfels

Implementation Monitoring:
Tracking Progress

Monitoring question: Did we do the work we said we were going to do?

While implementing restoration that advances us towards the desired ecological outcomes, we will track numbers of acres treated for each project area (implementation monitoring).

A spreadsheet or database will be utilized to store information for all ECOP-associated restoration treatments and current status. We will also host feature datasets on ArcGIS Online that will show restoration treatments enacted with FIP funding. Documentation of the types and locations of restoration treatments will be coordinated by ECOP's Technical Coordinator. Acres treated information will come from ECOP partners and will be housed on the East Cascades Oak Partnership Data Sharing group on ArcGIS Online. This data tracking will enable ECOP to keep track of the progress towards targeted acres for oak restoration.

Effectiveness Monitoring
Ecological Outcome 1:
Oaks are released from conifer encroachment.

Limiting factors
Fire suppression over the last century has caused changes to forest structure and species composition in the East Cascades, with increased biomass and a shift away from fire adapted species. In more mesic parts of the region, the increase in conifer cover has resulted in overtopping of Oregon white oak, decreased vigor of oak, or even oak mortality. Restoration actions that release oaks from overtopping conifer may reverse this change. Legacy oaks are particularly vulnerable and limited in extent. Legacy oaks are defined as living trees that are more mature, usually with larger diameter, deep furrowed/sloughing bark, large cavities, a variety of lichens, and larger diameter limbs.

Desired restoration outcomes (adapted from Strategic Plan, Figure 26)

- Legacy oaks are released from competition and accumulated live or dead biomass is removed.
- Mature oak habitat features are developing in the landscape.
- Larger oak snags and trees with bole cavities and dead limbs persist through fire activity and fuels reduction efforts.

Restoration Approach: Removing conifers overtopping Oregon white oaks

Monitoring Question: Did removal of conifer change oak crown position in the treatment area to a more dominant position?

- Desired restoration outcome: Legacy oaks are released from competition and fuel loading. Mature oak habitat features are developing in the landscape.
- Objective: X% change in oak crown position from intermediate or overtopped to open grown or dominant after treatment.
- Metric: Oak crown position.
- Sampling design: Pre-treatment and 1-year post-treatment.
- Analysis: Differences in oak crown position will be tested before and after treatments at each site using a Chi square test in R, comparing the proportion of oak trees with an intermediate or overtopped position versus open grown or dominant position.

Monitoring Question: If oak crown position changed, did the vigor of remaining oak trees improve?

- Desired restoration outcome: Legacy oaks are released from competition and fuel loading. Mature oak habitat features are developing in the landscape.
- Objective: Positive growth response (epicormic branching, increase in diameter/height growth ratio, increased stomatal conductance and decrease water stress); decrease in disease/stress indicators observed within 20 years or sooner post-conifer thinning.
- Metric: Oak epicormic branching (number of trees with epicormic branching), oak DBH, oak height, oak stomatal conductance and water stress, tree health indicators (inc. root rot, fungal bodies, leaf damage, cankers or gals, dead limbs or dead limb scars, fallen limbs on ground, fire scars or scorching, cavities, wildlife damage, drought stress).
- Sampling design: 1-, 5-, and 20-years posttreatment. For oak physiology metrics (stomatal conductance and water stress), we will focus on 1- and 2-years posttreatment.
- Analysis: Differences in the number of oak trees with epicormic branching and differences in number of tree health indicators per tree will be tested before and after treatments at each site using a t-test in R. This analysis will be repeated separately for oak DBH and oak height. If multiple years are being compared, we will conduct a repeated-measures ANOVA.

Ecological Outcome 2:
Mature oak habitat features are retained and recruited.

Limiting factors

In oak climax areas, fire suppression may have changed oak successional patterns, leading to increased density of smaller diameter oaks, an increase in biomass more generally, and an increased presence of dead or stressed vegetation. These changes may impact individual tree health or growth, and certainly future fire behavior. They also decrease the incidence of open grown, larger diameter trees, and may contribute to drought stress and/or crowning fire behavior that could kill mature oaks or stimulate stump sprout, potentially locking trees into a shrubbier growth form. Large diameter, open grown oaks are important for their larger central bole cavities, large acorn-producing crowns, and old bark. Recruitment of mature oak habitat features like large snags, large low-growing oak limbs (live and dead), deeply furrowed or sloughing bark that develops over hundreds of years, and trees with cavities could be limited under future fire regimes that cause crown die-back.

Additionally, existing mature oak habitat features might be removed during mechanical fuels reduction or forest health treatments because they are perceived as fire risks. The value of these habitat features is often not considered against the value of their removal for fire risk mitigation. Mature oak habitat features may not be effectively retained or recruited by restoration treatments if thinning efforts result in increased levels of undesired sprouting that lead to continued competition or that serve as ladder fuels into the dominant tree canopy. Limited recruitment may also be triggered by high intensity or more frequent fire return intervals or grazing that decrease reproduction of oak from seed.

Desired restoration outcomes (adapted from Strategic Plan, Figure 26)

- Legacy oaks are released from competition and fuel loading.
- Treated stands show limited mortality of mature oaks and low levels of undesired stump sprouting following treatment or wildfire.
- Mature oak habitat features are developing and persisting in the landscape, including larger oak snags and trees with bole cavities and dead limbs.
- Oak system structure and species composition are within a historical natural range of variability as expected based on physiography, soils, climate, and fire history.

Restoration Approach: Thinning to reduce stem density and improve leave-tree vigor

Monitoring Question: Was oak stem density effectively reduced?

- Desired restoration outcome: Legacy oaks are released from competition and fuel loading.
- Objective: X% reduction in oak stem density after treatment.
- Metric: Trees per acre.
- Sampling design: Pre-treatment and 1-, 5-years post-treatment.
- Analysis: Differences in oak stem density will be tested before and after treatments at each site using a t-test in R. If multiple years are being compared, we will conduct a repeated-measures ANOVA.

Monitoring Question: Do thinned oaks have more access to light?

- Desired restoration outcome: Legacy oaks are released from competition and fuel loading. Mature oak habitat features are developing and persisting in the landscape, including larger oak snags and trees with bole cavities and dead limbs.
- Objective: Reduced # of oak trees with intermediate and overtopped crown positions after thinning treatment.
- Metric: Oak crown position, leaf area index, basal area
- Sampling design: Pre-treatment and 1-year post-treatment.
- Analysis: Differences in oak crown position will be tested before and after treatments at each site using a Chi square test in R, comparing the proportion of oak trees with an intermediate or overtopped position versus open grown or dominant position.

Monitoring Question: If oak stem density was reduced and/or oak crown position changed, did the vigor of remaining oaks change?

- Desired restoration outcomes: Legacy oaks are released from competition and fuel loading. Mature oak habitat features are developing and persisting in the landscape, including larger oak snags and trees with bole cavities and dead limbs.
- Objective: Positive response (a change in epicormic branching, increase in diameter/height, increase in stomatal conductance, increase in leaf area index); decrease in disease/stress indicators observed within 20 years or sooner post thinning.
- Metric: Oak epicormic branching, oak DBH, oak height, tree health indicators (inc. root rot, fungal bodies, leaf damage, cankers or gals, dead limbs or dead limb scars, fallen limbs on ground, fire scars or scorching, cavities, wildlife damage, drought stress).
- Sampling design: 1-, 5-, and 20-years posttreatment.
- Analysis: Differences in the number of oak trees with epicormic branching and number of tree health indicators per tree will be tested before and after treatments at each site using a t-test in R. This analysis will be repeated separately for oak DBH and oak height. If multiple years are being compared, we will conduct a repeated-measures ANOVA.

Restoration Approach: Mechanical removal of accumulated biomass/reduction in ladder fuels

Monitoring Question: Did fuel reduction treatments (e.g., mastication or removal with chainsaw) effectively reduce fuel loads and ladders?

- Desired restoration outcomes: Oak system structure and species composition are within a historical natural range of variability as expected based on physiography, soils, climate, and fire history.
- Objective: X% reduction in coarse and fine woody debris and shrubs.
- Metric: Amount of fine woody debris (FWD), amount of coarse woody debris (CWD), diameter of CWD, and percent cover of shrubs.
- Sampling design: 1-, 5-, and 15-years posttreatment.
- Analysis: Differences in the number of FWD will be tested before and after treatments at each site using a t-test in R. This analysis will be conducted separately for CWD, diameter of CWD, and percent cover of shrubs. If multiple years are being compared, we will conduct a repeated-measures ANOVA.

Monitoring Question: Did cut oaks in mechanically treated stands (oak release, oak thinning, or fuels reduction) stump sprout?

- Desired restoration outcome: Treated stands show limited mortality of mature oaks and low levels of undesired stump sprouting following treatment.
- Objective: <X% of mature oak trees die; <X% of cut oak trees with sprouting.
- Metric: # of cut oak stumps with fresh sprouts, oak size class distribution.
- Sampling design: Two months after treatment or next growing season.
- Analysis: Differences in the number of oak stems will be tested before and after treatments at each site using a t-test in R. The analysis will be repeated separately for the number of oak trees with stump sprouts.

Monitoring Question: Do stump sprouts or oak seedlings develop into mature oak stems providing legacy oak resources over time?

- Desired restoration outcome: Mature oak habitat features are developing and persisting in the landscape, including larger oak snags and trees with bole cavities and dead limbs.
- Objective: Increase in large DBH clonal oaks with cavities.
- Metric: Oak DBH, # of oaks with cavities.
- Sampling design: Every 25 years (slow-growing oaks).
- Analysis: Differences in oak DBH will be tested before and after treatments at each site using a t-test in R. The analysis will be repeated separately for the number of oak trees with cavities.

Monitoring Question: Were large oak snags or large, low-growing live or dead oak limbs, or oak trees with cavities retained during fuels reduction activities?

- Desired restoration outcome: Mature oak habitat features are developing and persisting in the landscape, including larger oak snags and trees with bole cavities and dead limbs.
- Objective: No change in # oak snags >X" DBH, no change in avg. distance from ground to live or dead limb in trees >X" DBH, no change in # of live trees with cavities >X" DBH.
- Metric: # of oak snags, oak snag DBH, distance from ground to live or dead oak limb, # of oak trees with cavities.
- Sampling design: Pre-treatment and 1-year post-treatment.
- Analysis: Differences in number of oak snags will be tested before and after treatments at each site using a t-test in R. The analysis will be repeated separately for oak snag DBH, distance from ground to live or dead oak limb, and number of oak trees with cavities.

Monitoring Question: Did fuel reduction treatments effectively protect mature oak habitat features during subsequent wildfire or prescribed fire events?

- Desired restoration outcome: Limited mortality of mature oaks and undesirable stump sprouting following disturbance events or fire.
- Objective: Retention of large DBH oaks and snags post-fire.
- Metric: Oak size class distribution, oak snag abundance
- Sampling design: After fuels reduction treatment and 1-year post-fire events (prescribed or wildfire).
- Analysis: Differences in number of oak trees and oak snags will be tested before and after treatments at each site using a t-test in R.

Ecological Outcome 3.1:
Species composition and stand structure indicate resilience to disturbance (fire).

Limiting factors

Changes in forest composition and structure due to fire suppression have resulted in changes to fire regime, intensity, and behavior with an increased risk of high intensity wildfire. Mature oak crowns may be damaged during fire events, stimulating buds in the root crown of damaged trees. These sprouts are both a sign of resilience – the trees are quick to start growing a new crown, facilitating faster recovery of the entire system – and a sign of habitat loss – the features associated with mature tree crowns like thick and sloughing bark, large cavities, and crowns that produce high volumes of leaves, acorns, and flowers. In addition, understory plant composition is pushed toward more shade-tolerant, fire-sensitive vegetation in the absence of fire. Across large landscapes, this shift can compromise biodiversity and change how fires burn when they are not suppressed. Biomass of dead and living plant material accumulates, contributing to changes in fire behavior and intensity that can impact oak tree response to fire.

Desired restoration outcomes (adapted from Strategic Plan, Figure 26)

- Oak system structure and species composition is within a historical natural range of variability as expected based on physiography, soils, climate, and fire history.
- Oak recruitment, snags, and CWD are characteristic of successional state and historic fire regimes.
- No substantial increase of invasive species following disturbance events.
- Regeneration of oaks (i.e., stump sprouts) are appearing following severe fire.

Restoration Approach: Applying prescribed fire to reduce establishment of seedlings, accumulation of fuels, and to stimulate fire-dependent plants

Monitoring Question: Did the fire event kill oaks across all age classes, or initiate stump sprout? How did outcomes differ across fire severities?

- Desired restoration outcome: Oak system structure and species composition are within a historical natural range of variability as expected based on physiography, soils, climate, and fire history. Regeneration of oaks (i.e., stump sprouts) are appearing following severe fire.
- Objective: <X% of mature oak trees die; X% of cut oak trees with sprouting.
- Metric: oak size class distribution, # of cut oak stumps with fresh sprouts.
- Sampling design: Before and after fire events (prescribed or wildfire)- 1, 5 years following.
- Analysis: Differences in the number of oak stems will be tested before and after treatments at each site using a t-test in R. The analysis will be repeated separately for the number of oak trees with stump sprouts.

Monitoring Question: Did the fire event reduce fuel loads, stand density, and ladder fuels, as well as shift composition toward fire-adapted species?

- Desired restoration outcome: Oak system structure and species composition are within a historical natural range of variability as expected based on physiography, soils, climate, and fire history.
- Objective: Decrease in fuel loads, increase in crown base height, decrease in small size class seedlings/saplings, shift in composition to oak/pine.
- Metric: Fuel bed depth, crown base height, oak and other tree size class composition.
- Sampling design: 1-, 10-years posttreatment.
- Analysis: Differences in fuel bed depth will be tested before and after treatments at each site using a t-test in R. The analysis will be repeated separately for crown base height and number of seedlings and small samplings.

Monitoring Question: What were the burn scores of subsequent wildfires following prescribed fire treatments?

- Desired restoration outcome: Oak recruitment, snags, and CWD are characteristic of successional state and historic fire regimes.
- Objective: Low-moderate severity burn scores.

- Metric: Burn score severity.
- Sampling design: **Fire module** will be deployed 2-3 weeks following wildfire when safe to reenter.
- Analysis: The burn severity of substrate and vegetation can be summarized after fire - the categories are unburned, scorched, lightly burned, moderately burned, and heavily burned (Appendix B). The category with the most responses can be highlighted.

Monitoring Question: Has species richness and cover of non-native plants changed after prescribed fire?

- Desired restoration outcome: No substantial increase of invasive species following disturbance events.
- Objective: Decrease or no change in number or cover of non-native plant species after fire.
- Metric: Presence of non-native plant species, cover of non-native plant species.
- Sampling design: Pre-treatment and 1-, 5-years post-treatment.
- Analysis: Differences in number and percent cover of non-native plant species will be tested before and after fire at each site using a t-test in R. If representative, nearby control plots are available that didn't burn, we will compare burned areas to unburned in terms of number and percent cover of non-native plant species.

Ecological Outcome 3.2:
Species composition and stand structure indicate resilience to disturbance (mechanical treatments).

Limiting factors

Mechanical treatments can cause surface soil disturbance creating conditions conducive to the spread of invasive species. Mastication can result in large inputs of woody debris on the forest floor which may alter soil chemistry, water infiltration, seed-soil contact, and emergence of plants.

Desired restoration outcomes (adapted from Strategic Plan, Figure 26)

- Oak system structure and species composition are within a historical natural range of variability as expected based on physiography, soils, climate, and fire history.
- Oak recruitment, snags, and coarse woody debris (CWD) are characteristic of successional state and historic fire regimes.
- No substantial increase of invasive species following disturbance events.

Restoration Approach: Mechanical thinning to reduce stem density and competition

Monitoring Question: Did mechanical thinning reduce fuel loads, stand density, and ladder fuels, as well as shift composition toward fire-adapted species?

- Desired restoration outcome: Oak system structure and species composition are within a historical natural range of variability as expected based on physiography, soils, climate, and fire history.
- Objective: Decrease in fuel loads, increase in crown base height, decrease in small size class seedlings/saplings, shift in composition to oak/pine.
- Metric: Fuel bed depth, crown base height, tree size class composition.
- Sampling design: Pre-treatment and 1-, 10-years post-treatment.
- Analysis: Differences in fuel bed depth will be tested before and after treatments at each site using a t-test in R. The analysis will be repeated separately for crown base height and number of seedlings and small saplings.

Monitoring Question: Did treatment result in soil disturbance?

- Desired restoration outcome: No substantial increase of invasive species following disturbance events.
- Objective: No change in percent cover of bare ground/soil, limited presence of soil disturbance after mechanical restoration.
- Metric: Cover of bare ground, soil disturbance presence, photo monitoring.
- Sampling design: Pre-treatment and immediately following treatment.
- Analysis: Photo points can be inspected visually for changes in visible bare ground before and after treatment. The number of plots with soil disturbance can be compared. Differences in cover of bare ground (estimated in inner 11.8-ft circle) will be tested before and after treatments at each site using a t-test in R.

Monitoring Question: Has species richness and cover of non-native plants changed after machine-based thinning or fuels reduction?

- Desired restoration outcome: No substantial increase of invasive species following disturbance events.
- Objective: Decrease or no change in number or cover of non-native plant species after treatment.
- Metric: Presence of non-native plant species, cover of non-native plant species.
- Sampling design: Pre-treatment and 1-year posttreatment, then annually based on project capacity.
- Analysis: Differences in number and percent cover of non-native plant species will be tested before and after treatment at each site using a t-test in R. If representative, nearby control plots are available that didn't burn, we will compare burned areas to unburned in terms of number and percent cover of non-native plant species.

Monitoring Question: How do varying levels of coarse wood inputs from mastication impact soil and plant communities?

- Desired restoration outcome: No substantial increase of invasive species following disturbance events.
- Objective: Low levels of coarse wood input and no shift in dominant plant guilds towards non-native plants after mechanical restoration activities.
- Metric: Amount of coarse woody debris, cover of plant guilds, photo monitoring.

- Sampling design: Pre-treatment and 2-years post-treatment. Control plots needed.
- Analysis: Photo points can be inspected visually for changes in visible coarse wood inputs pre- and post-mastication. Pearson's correlation coefficient will be calculated to evaluate the relationship (strength and direction) between the amount of coarse woody debris and non-native plant cover.

Ecological Outcome 3.3: Species composition and stand structure indicate resilience to disturbance (grazing).

Limiting factors

High intensity grazing with no consideration to timing, duration, and rotation or rest can cause undesirable changes to plant communities and soils.

Desired restoration outcomes (adapted from Strategic Plan, Figure 26)

- Oak system structure and species composition are within a historical natural range of variability as expected based on physiography, soils, climate, and fire history.
- Annual grasses are cropped before going to seed.
- Oak recruitment, snags, and CWD are characteristic of successional state and historic fire regimes.
- No substantial increase of invasive species following grazing.
- Undesired stump sprouts are controlled by grazing; natural regeneration is occurring from seed.

Restoration Approach: Grazing is strategically deployed to reduce annual grass thatch or cover; timing and duration allow for native plant reproduction

Monitoring Question: Did grazing result in significant amounts of soil disturbance?

- Desired restoration outcome: No substantial increase of invasive species following disturbance events.
- Objective: No change in percent cover of bare ground/soil and limited presence of soil disturbance after grazing.
- Metric: Cover of bare ground/soil, presence of soil disturbance, photo monitoring.
- Sampling design: Pre-treatment and 1-year post-treatment.
- Analysis: Photo points can be inspected visually for changes in visible bare ground pre- and post-grazing. The number of plots with soil disturbance can be compared. Differences in cover of bare ground (estimated in inner 11.8-ft circle) will be tested before and after grazing at each site using a t-test in R.

Monitoring Question: Has species richness and cover of non-native plants changed after grazing?

- Desired restoration outcomes: Oak system structure and species composition are within a historical natural range of variability as expected based on physiography, soils, climate, and fire history. No substantial increase of invasive species following disturbance events.
- Objective: No change or decrease in percent cover of non-native plants in grazed areas.
- Metric: Cover of non-native and native grasses and forb species.
- Sampling design: Pre-treatment and 1-year post-treatment, then annually based on project capacity. In addition to the base protocol, the **understory module**, which measures percent cover of plants and species richness, will be completed for grazing projects.
- Analysis: Differences in number and percent cover of plant group of interest (e.g., non-native grasses, non-native forbs) will be tested before and after grazing at each site using a t-test in R. If representative, nearby control plots are available that didn't get grazed, we will compare grazed areas to ungrazed in terms of number and percent cover of non-native species.

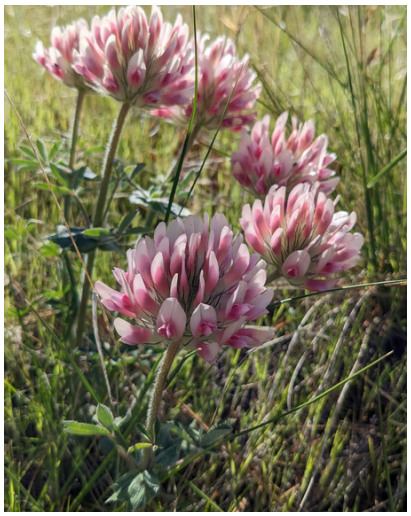
Monitoring Question: Are oak seedlings present? Are they escaping browse as single stem saplings?

- Desired restoration outcome: Oak system structure and species composition are within a historical natural range of variability as expected based on physiography, soils, climate, and fire history. Oak recruitment, snags, and CWD are characteristic of successional state and historic fire regimes. Natural regeneration is occurring from seed.
- Objective: Oak seedlings and larger sized saplings are present after grazing.
- Metric: Abundance of oak seedlings and saplings.
- Sampling design: Pre-treatment and 1-, 5-years post-treatment.
- Analysis: Differences in number of oak seedlings will be tested before and after grazing at each site using a t-test in R. The analysis will be repeated separately for larger sized oak saplings. If representative, nearby control plots are available that didn't get grazed, we will compare grazed areas to ungrazed in terms of number of oak seedlings and saplings.

Monitoring Question: Are oak sprouts escaping browse?

- Desired restoration objective: Oak system structure and species composition are within a historical natural range of variability as expected based on physiography, soils, climate, and fire history. Undesirable sprouts are controlled by grazing.
- Objective: X% sprouts are escaping browse.
- Metric: Presence and form of oak sprouts.
- Sampling design: Pre-treatment and 1-, 5-years post-treatment.
- Analysis: Differences in number of oak sprout clumps will be tested before and after grazing at each site using a t-test in R. If representative, nearby control plots are available that didn't get grazed, we will compare grazed areas to ungrazed in terms of number of oak sprout clumps. The number of plots with recently grazed sprouts will also be assessed to look for active grazing.

Ecological Outcome 4:
Diverse native oak-associated species and pollinators persist



Limiting factors

Non-native plants degrade sites and can outcompete native plants. Oversimplification cascades through food webs and trophic structures, altering species interactions and behaviors.

Desired restoration outcomes (adapted from Strategic Plan, Figure 26)

- Intact understory plant communities are protected from disturbance and displacement.
- Native pollinator floral resources are increasing.
- Native plant species diversity, or Rare, Threatened, and Endangered plant species are increasing.

Restoration Approach: Planting, weed control, and restoration efforts improve native plant composition, particularly of bunchgrasses and flowering forbs

Monitoring Question: How did plant species composition (cover and species richness of native and non-native plants) change following treatment?

- Desired restoration outcome: Intact understory plant communities are protected from disturbance and displacement.
- Objective: Decrease in percent cover of non-native plants; increase in native plant biodiversity (if desired) and cover. Metric: Cover and number of native and non-native plant species.

- Sampling design: Pre-treatment and X-years post-treatment depending on management goal. In addition to the base protocol, the **understory module**, which measures percent cover of plants by species and overall species richness, will be completed for understory restoration focused projects.
- Analysis: Differences in number and percent cover of non-native plants will be tested before and after treatment at each site using a t-test in R. The analysis will be repeated separately for native plants. If representative, nearby control plots are available that didn't get treated, we will compare treated areas to untreated in terms of number and percent cover of non-native and native plant species.

Monitoring Question: Are pollinator floral resources increased following management activities?

- Desired restoration outcome: Native pollinator floral resources are increasing.
- Objective: Increase in native plant species' cover and diversity following restoration treatment.
- Metric: Cover and number of species of native flowering forbs.
- Sampling design: Pre-treatment and 1-, 5-years post-treatment. In addition to the base protocol, the **understory module**, which measures percent cover of plants by species and overall species richness, will be completed for understory restoration focused projects.
- Analysis: Differences in number and percent cover of native forbs will be tested before and after treatment at each site using a t-test in R. If representative, nearby control plots are available that didn't get treated, we will compare treated areas to untreated in terms of number and percent cover of native forb species.

Monitoring Question: Is the abundance of priority species the same or increasing following restoration actions?

- Desired restoration outcome: Native plant species diversity, or Rare, Threatened, and Endangered plant species are increasing.
- Objective: No change or an increase in priority species' abundance after restoration treatment.


Photo by Doug Gorslihe

- Metric: Presence or abundance of priority species within treatment area.
- Sampling design: Pre-treatment and 1-, 5-years posttreatment. In addition to the base protocol, the **understory module**, which measures percent cover of plants by species and overall species richness, will be completed for understory-restoration focused projects to record presence and abundance of any priority plant species.
- Analysis: Differences in priority species' abundance will be tested before and after treatment at each site using a t-test in R.

Scale and Type of Monitoring

All questions listed above are classified as effectiveness monitoring, which is defined as the degree to which expected ecological responses are observed because of implementing restoration actions. Questions also focus on stand scale outcomes; however, if sufficient areas within various projects are treated, a larger landscape scale outcome can also be assessed.

Methodology and Prioritization

We will use the **ECOP Disturbance Monitoring Protocol** to collect data on all listed metrics above. Specifically, the section on Oregon white oak responses to disturbance addresses epicormic branching and stump sprouting (presence, form, and condition). The tree and snag sampling section covers individual oak tree measurements such as DBH, height, crown position, and cavity presence. For understory plant monitoring questions, we will deploy the **oak understory module** that will provide results on individual plant species' presence and cover. Priority species monitoring is still to be developed and is project dependent.

The **ECOP Disturbance Monitoring Protocol** was set up to collect the same metrics across all treatment types. This approach builds a large dataset across a highly variable landscape that may contribute to landscape scale analysis in the future. The metrics collected can inform on stand structure and species composition, tree health and vigor, fuel loads, ground cover, and soil conditions. In addition, projects that interact with fire may be monitored using a burn severity monitoring tool, and those with understory plant community objectives may also include the understory module. In these cases, we intend to have the base monitoring protocol also implemented.

We developed a budget for each project within our FIP portfolio based on an estimated number of plots and a per plot cost. The number of plots will be adjusted up or down based on cost. The ambition is to monitor every project, but if funding does not allow for that, we will prioritize revisiting posttreatment monitoring plots that are already established and then by:

- *Novelty of approach.* Projects testing new approaches or being implemented for the first time in a particular oak system type or geography.
- *Partner opportunity.* Projects implemented by a partner with no other monitoring projects underway or projects well supported by partner resources.
- *Likelihood of replication.* Projects likely to be replicated by a landowner.
- *Cost effectiveness.* Projects with economies of scale or leveraged resources.

Data Analysis and Management

Who will collect the data?

Partners will deploy personnel and volunteers to collect data for non-FIP funded projects. Local contractors and ECOP-dedicated staff will be trained and deployed for monitoring of FIP specific restoration projects. If a partner desires to conduct monitoring above and beyond what is described in this plan, they will be encouraged to share results with the partnership.

When, how, and who will analyze the data and generate reports?

Data will go through a rigorous QA/QC process by the ECOP Technical Coordinator before it is stored in Columbia Land Trust's geodatabase and analyzed or shared with partners. The process includes training field crews uniformly, standardizing the data collection form and manuals with descriptive definitions, using handheld tablets with formatted data fields, maintenance of equipment, verification and validation of data collected through field inspections or check cruises, and including error-checking the Survey123 form after submission. Our planned analysis is a Before-After-Control-Impact (BACI), but since we are working with multiple partners across different ownerships and objectives, we may not always have control sites established. If this is the case, we will analyze the data with a Before-After (BA) by comparing pre-treatment and posttreatment variables. The ECOP Technical Coordinator will analyze data with assistance from the Monitoring Advisory Group as need be.

Where and how will the data be stored?

The data will be housed and retained on ESRI's online data server and hosted and managed by Columbia Land Trust unless specific arrangements are made, as may be the case for data collected on reservations. Long term use of this data will be available for the research and policy communities in perpetuity. A data sharing group is set up on ArcGIS Online for sharing monitoring data with ECOP partners. Columbia Land Trust has designated staff that are responsible for these data management tasks and who ensure that these tasks are adhered to (ECOP Technical Coordinator and Columbia Land Trust GIS Manager).

For questions and more information about ECOP's monitoring efforts:

Oaks@ColumbiaLandTrust.org

East Cascades Oak Systems

Disturbance Monitoring Protocol

Field Instructions[1]

Last Updated: January 11, 2024

[1] The data collection methodology described in this document is intended to be recorded using an ArcGIS form in Survey123. Access to the data collection software can be attained by contacting the ECOP Technical Coordinator, Stacy Simanonok at ssimanonok@columbialandtrust.org . You may also contact the ECOP Technical Coordinator for training on this protocol.

BEGINNING OF OFFICE INSTRUCTIONS - Pages 2-5 intended for office-based preparation.

Before you go into the field

1.1 Read the entire protocol before you go into the field.

Being familiar with it before you go will save time, and help you be prepared when you get to your field location. It is highly recommended that you practice or participate in a training session before embarking on a full-scale monitoring effort. Have questions? Contact Stacy Simanonok at ssimanonok@columbialandtrust.org (971-361-6531) or Lindsay Cornelius at lindsayc@columbialandtrust.org (360-921-1073). Check with Stacy to ensure that you have the most recent version of the protocol. Field monitoring kits are available for ECOP partners to check out.

1.2 Gather and Pack Equipment[2]:

1	Smart phone/pad with Survey123 uploaded "ECOP Oak Disturbance Monitoring Survey" (instructions for accessing the application follow) *charger/backup battery recommended
1	Clinometer (smartphone clinometer apps may be used in place of clinometer)
1	Compass (**declination set to 14.5° East**)
1	GPS unit (Garmin or GPS enhanced smart phone/pad) *extra batteries recommended
1	Rangefinder/Hypsometer *extra batteries recommended
4	Chaining pins
1	DBH tape (10th inches diameter)
3	50-foot reel measuring tapes (standard units - feet and inches)
1	1m^2 quadrat (if completing oak understory module)
1	Go-No-Go gauge for Fuels Transects
1	Clear plastic ruler that measures 1/10-inch increments
1	Small shovel to scrape aside duff and litter for measurement
1	Field Instructions (this document plus reference diagrams + plant ID resources)
varies	Aluminum nails to mark DBH measuring height on each tree >5" DBH in plot, if approved at site
varies	Aluminum nails and tree ID tags to mark trees, if approved at site
1 per plot	Plot markers (large nails or **12" rebar** and plot number markers) (**recommended**)
1	Hammer to pound in rebar
Optional	Wire to affix metal plot number markers to rebar
Optional	3 survey marking whiskers and nails to attach to (for plots without witness trees)
Recommended	Permanent/tree marking paint to mark plot center and witness trees (diamond flashers an alternative option for witness trees depending on land manager)
Recommended	Flagging to tie to plot center to help with relocating

[2] ECOP has monitoring kits available to loan that include all of the tools and materials included on this list.

1.3 Planning out the workflow in the office

Oak and oak pine systems are fairly slow growing, but disturbance events that influence these systems happen over a variety of temporal scales – from immediate, as with wildfire, to slow as with fire suppression, grazing, and climate change. This protocol and the ECOP monitoring project are intended to document changes in oak systems across any of these temporal scales, depending on monitoring objectives. The installation of plots can achieve those goals through several methods. Permanent plots that can be revisited before and after discrete disturbance events and at random time intervals will help us collect the data needed to answer key management questions. If you need assistance with project effectiveness study design, contact ECOP's Technical Coordinator. ECOP has pre-assigned plot locations across the entire eastside oak landscape that can be shared using ArcGIS. If you design your own plot locations, please write up your technique and share it with ECOP.

The following are a few general concepts to consider:

- Take your staffing, budgetary, and project goals into consideration. You can select your plot density based on the resources available, and the type of information that you hope to analyze.
- Staffing hours needed to install each plot varies depending on the experience of the field crew and the condition of the plot. We found that the first sets of plots take more time as crew members learn how to move through the questions. Plots with higher density trees and shrubs also take more time to install. The range of time for each plot is 4 hours when crew is new to the protocol and the density of trees and understory vegetation are high, that time is reduced to 45 minutes per plot with experience and in lower veg density plots.

1.4 Gather information about the survey location

One of the first questions on the Survey123 Form will ask you to select from several future management activities that will happen on or very near your plot. Gather that data/make notes before you go to the field. You will have the option to check all that apply.

- Unknown/None
- Oak removal
- Conifer removal
- Limbing/pruning
- Hand cutting
- Mechanical cutting
- Mechanical mastication
- Prescribed fire
- Pile burning
- Coarse woody debris removal
- Snag creation
- Herbicide application to oaks
- Herbicide application to understory species
- Mechanical weed control
- Understory planting/seeding
- Grazing (provide type of animal, stocking rate, and timing in notes)

- Other

1.5 Establish the naming/numbering of your plots before you begin collecting data.

You are required to enter a unique Plot ID in the Survey123 form when you are in the field. The unique Plot ID will help us manage the data storage, make it possible to analyze the data spatially, and help us organize the photographs that are taken as part of the protocol. Prior to beginning your field work establish your unique Plot ID series. We ask that you use the following naming convention for each of the plots that you establish. If anonymity (property owner, or project) is necessary, please contact ECOP and propose another method of creating a unique Plot ID (still using the 4letters_4Letters_3numbers convention).

- Assign a 4 letter abbreviation ID for the property owner, a 4 letter/number abbreviation ID for the project (name), and a plot number between 001 and 999.
- Use an underscore to separate property owner, project name, and plot number.

Examples:

- Mt Hood National Forest Barlow District, Rocky project area, plot number 1, would be labeled: MHBD_RCKY_001.
- Mary Bushman, Forest Health, plot number 1, MJBB_FOHE_001

1.6 Download the Survey123 Form on your device:

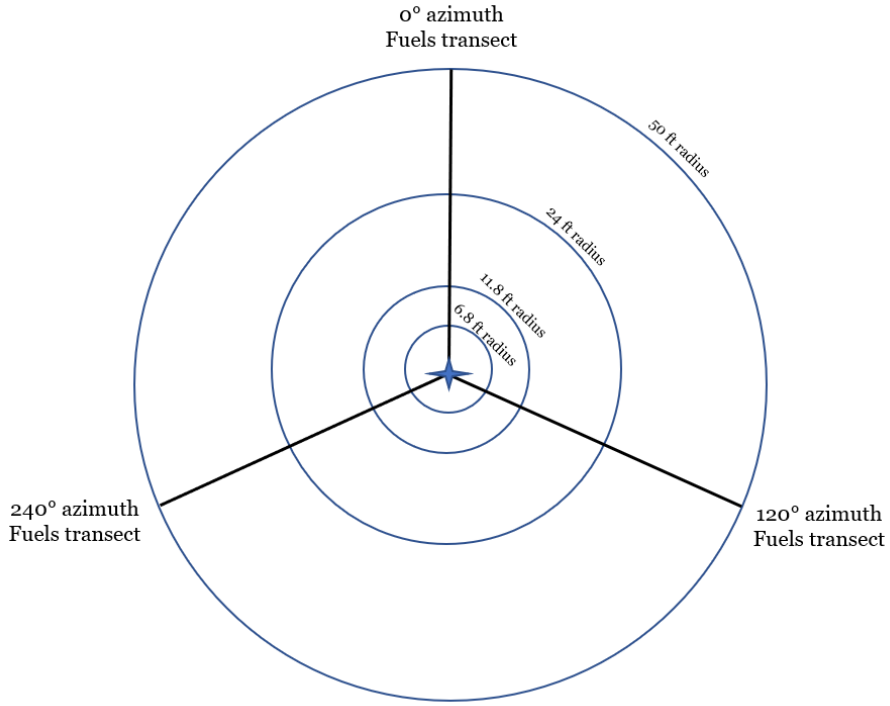
1. If you do not have the Survey123 app on your tablet or smartphone, you can download it from any app store for free. It is an ESRI product that coordinates with ArcGIS products. You do not need a license to use it. You can download it without logging in.
2. Scan QR code to the right or follow this link to download the ECOP Oak Disturbance Monitoring Survey: https://arcg.is/1amazv1
3. Once downloaded, go back to the main screen, My Survey123, and you'll see the survey. To collect data, click "Collect" and follow the survey prompts. There are 11 pages. This instruction manual will walk you through the protocol step by step.
4. Before going into the field throughout the season, check that there are no updates to the form. On the My Survey123 app homepage, there will be a bar at the top that says "Updates Available" if there are any.
5. You are now ready to collect data. It is recommended that you practice using the survey form with this instruction manual. For training or questions, contact Stacy Simanonok at 971-361-6531 or ssimanonok@columbialandtrust.org.
6. Once you are done collecting data, submit data by following the prompts. You may need to do this when you are back in service (save in outbox). If you collected a large amount of data, we advise waiting until you have a Wi-Fi connection to upload data.

You can request a copy of your data by emailing Stacy Simanonok at ssimanonok@columbialandtrust.org.

BEGINNING OF FIELD INSTRUCTIONS - Pages 5-23 are intended for reference in the field. It is strongly recommended that you take a printed copy with you.

Navigate to and layout plot

The data collection design is based on a fixed plot radius of 50' with three linear transects and four concentric circular intervals at 6.8', 11.8', 24' and 50' from plot center.



2.1 Navigate to plot center

Navigate to the randomly assigned plot center using a hand-held GPS or smartphone with enabled navigation application (seeking accuracy <10m). Potential navigation applications include: ArcGIS Field Maps, Avenza, and GPS enhanced iPhone and iPad devices. Once plot center is located, leave all gear (backpacks, lunch, water bottles, dogs, etc) not needed for layout outside of the 50-foot radius plot. Remember to step carefully while establishing the plot. It is important not to trample vegetation and fine fuels that you will measure while collecting data. The order of operations in this protocol is intentional to reduce impacts to the physical condition of the plot.

If there are no oak trees in the plot, assess the general landscape area. If the plot is in a savanna (low oak density) or the site is highly variable, it is acceptable to establish a plot where no oaks are present. Alternatively, you may opt to select another plot center from the randomly generated plot locations in your project area if the landscape surrounding the site does not include oak trees. If in doubt, ask ECOP Technical Coordinator.

2.3 Plot and Transect Layout

Mark plot center and establish three transects each radiating 50 feet in length along the following azimuths: 0°/360° (N), 120° (E/SE), and 240° (W/SW) from plot center[3] (as shown in diagram on page 7).

- Place a permanent metal rebar stake (or something you can find when returning that won't melt in a fire and can be relocated with a metal detector if necessary) into the ground at the center of the plot. Drive the stake in until it is secure. You can paint the top of the stake or pair the metal stake with a painted wooden stake for improved visibility. We recommend painting the marker at the end of data collection, so you don't get paint on you or your equipment.
- Attach a metal tag to the rebar using wire. You may use a customizable tag and write the unique Plot ID directly on it, or you may use a pre-numbered metal tag to cross reference with the Plot ID.
- Starting at plot center, extend a tape 50' along each transect and anchor the far end with a stake or chaining pin. Be careful to place the tape as close to the soil surface as possible without disturbing the surface. Repeat for each transect if you have enough tapes.
- For relocating purposes and if approved at the site by the manager, mark 1 to 3 witness trees with orange tree paint or diamond flashers at eye level. These trees should help future data collectors triangulate to find plot center. Ideally, witness trees are close to plot center, 5+ inch DBH, and not a <8" DBH conifer in case that tree is removed in future conifer thinning treatments. If there are no trees within the 50 ft radius circle, you may mark a tree further outside the plot. The azimuth and distance to each witness tree from plot center will be recorded in the survey.
- While setting up the plot, be aware of the plot conditions and take note of unique attributes or easily disturbed characteristics. You should also look for burn scars, wildlife or livestock impacts, trails or equipment impacts, etc., anything of note that will be captured in the process of collecting data.

2.2 Protocol for revisiting plots

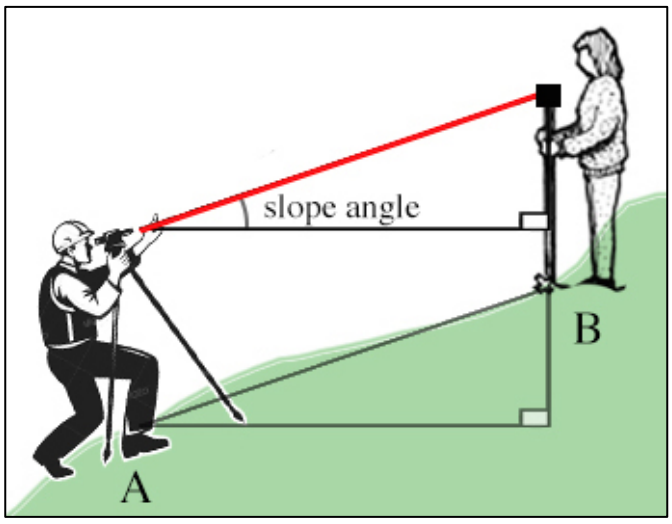
If revisiting a previously established plot, use your GPS device to navigate to the plot center. Look for the painted stake in the ground and use witness trees to help you find plot center. You can also bring a metal detector into the field to help you relocate the rebar. ECOP can generate "Relocating Plot IDs" reports that list key information to finding plot centers like the coordinates, plot remarks, and photos from each photo point. Please contact the ECOP Technical Coordinator for copies of reports you need. If you spend more than 15 minutes of time and can't find plot center, you can decide to put in a new stake where center should be based on witness trees. Remark witness trees if need be. Record information in Plot Remarks.

[3]Some site conditions may constrain the size of the plot and the location of the transects. If landscape features or safety issues (cliff, active yellow jacket nest…) limit the ability to install all three transects on the prescribed azimuths, it is permissible to establish fewer transects or to change the azimuth of any of the three transects – please clearly document your decisions. Remember, Safety First!

Begin data collection

PLOT CHARACTERISTICS – Page 1 of Survey 123 Form

1. **Plot ID**: Use the naming convention from "Before you go in the field, Section 1.5" of these instructions. If you did not assign a Plot ID in advance, please follow this format:
    - 4 initials for the property owner (underscore), followed by 3 or 4 initials for the project name (underscore), followed by plot number 001-999. Example MHBD_RCKY_001. Note the underscore that separates each section.
2. **Optional Tag ID number**: If you are using pre-stamped tags, please enter the pre-stamped number to show that the plot is marked with an identifier that is not the same as the Plot ID. If the metal tag is marked with the Plot ID, type in the word "SAME".
3. **Observer Names**: Record full names of observers.
4. **Monitoring Date**: The day you conducted monitoring for this Plot ID.
5. **Date of Plot Establishment**: If you are revisiting a plot that was previously established, enter the original plot establishment date. Make a note in the plot remarks if there are discrepancies between tags, or you if you must assign a new plot center
6. **Latitude and Longitude (Plot Center Location)**:
    a. In Survey123, tap the GPS (circle with compass lines) symbol to update the reading until you have better than 32 ft (10 m) accuracy. If you must override the GPS in Survey123, note the reason for override.
    b. If you prefer to use a separate handheld GPS, record the location (NAD 83 UTM) and elevation (ft) at the plot center point in plot remarks.
    c. *Note: A GPS enhancement device can be added to smart phones and tablets to increase accuracy.*
7. **Slope (%):** Using a clinometer[4], record the slope along the hillslope azimuth to the nearest percent (0-100) within the plot. Where there are significant variations in slope across the plot, record the average slope of two measurements and note this in the plot remarks. To measure slope: facing downslope, site your clinometer on a person, tree, or other vertical object *at a height consistent with your eye level at that location.* Slope is an



[4] Can download a reliable clinometer app if you don't have a clinometer.

infinite plane, so the object can be located any visible distance from plot center so long as there are no changes in the slope between that object and the observer. If your eyes are approximately 5 ft from the ground, site your clinometer 5 ft from the ground on an object upslope or downslope to accurately calculate percent slope.

8. **Aspect (°):** Point yourself in the direction water would run across the landscape surrounding the plot. Using a compass (declination set to 14.5° East), record the hillslope azimuth in degrees (0-359°). This measures whether the sample location is on a north, south, east, or west facing hillside. If the plot is on a plateau or an expansive flat plain, enter "999".
9. **Elevation (ft):** Use your GPS device or your smart phone/tablet to confirm the elevation of the plot.
10. **Plot remarks**: Use this field to:
    - Describe plot location and layout to help future field crews relocate the plot.
    - Describe plot landmarks. Remember, there may be fire and management activities that would alter the vegetation (trees too). Notes such as distance to nearby road or other permanent features should be included. (Example= Mature stand on gentle N-facing slope ca. 780 meters west of historic homestead, ca. 200 meters east of wetland basin. Some stumps in plot, oak cut long ago. Conifers decline to the west. Deer trails through plot.)
    - If plot center locations are moved, note the reason, and include new GPS coordinates.
    - Record witness tree information here (DBH, azimuth, and distance from plot center), especially if not recorded during tree sampling.

PROPOSED MANAGEMENT ACTIVITIES - Page 2 of Survey123 Form

This section is not observational, it is intended to support future data analysis by creating a relationship between management activities and changes that this protocol is intended to detect. To help us with data analysis, we ask that you use the provided list to indicate any known near-term planned management activities. Select all that apply for the **PROPOSED MANAGEMENT ACTIVITIES** section of the form. Please include any notes if more information is needed to explain management activities that will impact the plot. This section is for activities that are proposed for the site within the next 5 years. There is a selection for none or unknown if that is needed. *Note: Page 4 of this survey will ask for existing conditions in the plot and the surrounding landscape that will reflect disturbances, past management activities, or events that have already occurred.*

PHOTO POINTS – Page 3 of Survey123 Form

Photos provide the opportunity to track qualitative changes at the plot over time. They also help relocate plots for subsequent data collection. Take photos in the landscape orientation and use a monopod or other photo taking device that helps you take consistent photos from one visit to another. Monopod should be set at 5 ft tall. If possible, exclude people, gear, etc. from the photo. Plot ID, date, and azimuth will be recorded automatically in the file name so there is no need for a whiteboard. Standing at the plot center, take three

photos holding the camera at a height of about 5 feet on each transect (0°, 120°, 240°) as described below for a total of nine photos per plot:

1. **Straight forward**: Position the camera device over plot center at a height of 5 feet and aim for about 5 feet above the transect terminus. The camera should be angled if needed so that it is horizontal to the slope (as shown in diagram on page 8 of these instructions). If the ground is sloping 20 degrees, the photo should also be sloping 20 degrees such that the resulting photo is horizontal to the slope at eye level towards the transect end.
2. **Down/Ground Cover:** Position the camera device over plot center at a height of 5 feet and aim for the end of the 50 ft tape in the top of the frame. The photo should include the ground between plot center and, as much as possible, the transect end. It is roughly a 45-degree angle (from slope angle) and make sure feet are not in the photo.
3. **Up/Canopy:** Position the camera device over plot center at a height of 5 feet and looking at the transect end, tilt the camera upwards approximately 45 degrees (from slope angle) towards the upper tree canopy.

PLOT OBSERVATIONS – Page 4 of Survey123 Form

1. **Oak System Type**: Select the oak system type according to ECOP's Oak System Classification[5]. The descriptive metrics are primarily based on canopy structure (% cover) and tree species composition. There is a diagram with photos and oak habitat type descriptions provided in the field instructions reference materials (Oak System Types with Photos).
    a. **Plot:** The oak system type that you choose should be representative of the stand your plot occurs within.
    b. **Surrounding Landscape:** If the plot tree canopy structure and species composition is significantly different from the surrounding stand, you can capture that difference here, or enter the same type as above.
2. **Land Use History**: Check all activities or disturbances you have knowledge of or can observe to have occurred within the footprint of the ***plot itself***. [6]
3. **Land Use and Disturbance Indicators**: Note presence or absence of other disturbances that are visible on the plot.
    a. Human trails or paths: These are obviously constructed and used by people, are related to human infrastructure, or are in recreational areas frequented by people.
    b. Motorized vehicle trails or tire tracks: Are there signs of wheeled vehicles in the plot? These do not have to be actual roads or trails, but obvious sign of vehicular access (this does not include tracked equipment, which is captured below). Bike tire tracks should be included here. Please describe the nature of the tracks in the notes field.

[5] Generalize. We know there is a wide range of variability in oak structure but call it something. If you have experience stand-typing, or delineating polygons around areas with similar structure and species composition, exercise that experience here. You can make notes to explain your reasoning if you feel it was not obvious.
[6] If grazing, timber management, fire or other disturbance happened within the stand but not within the plot, do not include it.

c. Wildlife trails or paths: These may be occasionally used by people or livestock but are characteristic of regular use by wildlife. They commonly develop around water sources, along ridges or other confined corridors.
d. Livestock sign: This can include terracing from compaction and trail development, manure, pugging (hoof marks in the soil), or hoof tracks.
e. Soil compaction: Hard, compact soils, with shallow-rooted or weedy vegetation or no vegetation, pooling water, stunted vegetation growth.
f. Surface disturbance due to tracked machinery: Displacement of soil (rutting) or vegetation due to operation of tracked machinery (not ATV/truck/car but tracked machinery)
g. Fire Evidence: Are there visible signs of fire scars or charring from prior burns? These signs can be on trees, surface fuels, etc. Please characterize the nature and extent of the charring in the notes field (e.g., extensive, one old tree trunk, fire circle, etc.).

BASIC UNDERSTORY PLOT – Page 5 of Survey123 Form

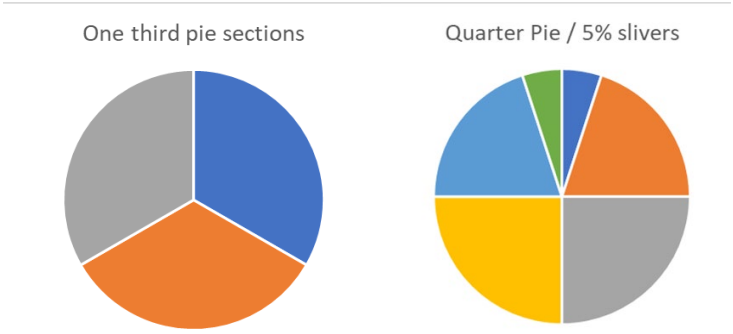
Ground Cover Guilds - Measured within the 11.8-foot radius concentric plot

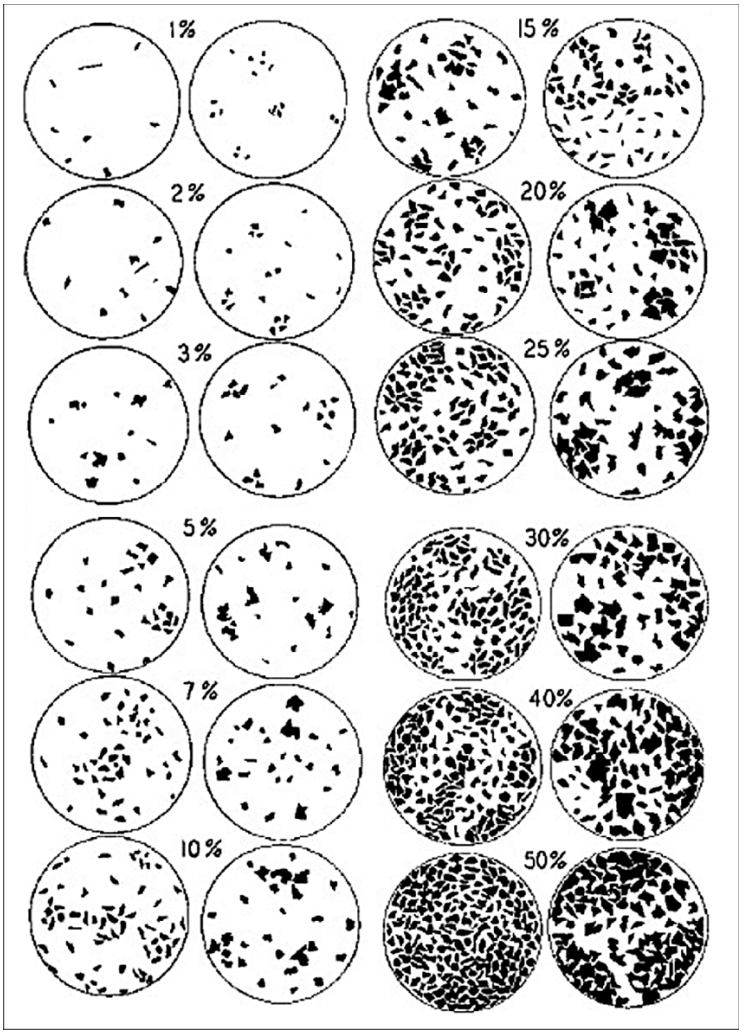
The understory vegetation sampling plot includes all organic and inorganic materials that are not trees within the 11.8-foot radius of plot center. It may be helpful to have crew members stand facing each other at the 11.8-foot point on the transect tapes and work through the cover class of each ground cover guild together. There are 15 possible guilds to evaluate. For each guild present in the 11.8-foot radius circle, select a cover class and then click the + button to add another guild. The "Guilds Entered" field will display guilds that have been entered so far to help you keep track. There may be multiple canopy layers present, so total percent cover may exceed 100. Any guilds without an entry will be assumed as absent/0% cover.

1. In the drop-down menu, select each present guild as follows:
    - Graminoids (grass and grass-like plants)
        - Non-native (examples include cheatgrass, ventenata, medusahead, and bulbous bluegrass)
        - Native
    - Forbs (herbaceous flowering plant that is not a grass)
        - Non-native (examples include rush skeletonweed, spotted knapweed)
        - Native
    - Lichens, mosses, and liverworts
    - Climbers (vines and epiphytes)
    - Shrubs
    - Bare ground
    - Ash/charcoal
    - Trash or debris (from two legged visitors)
    - Litter (leaf litter, decomposing plant material)
    - FWD (fine woody debris)
    - CWD (coarse woody debris)
    - Rocks

- Woodchips (mechanically shredded or chipped wood)

2. Using the visual aids included in the field instructions here, work with your team to establish an ocular estimate of the best fit for the cover class bin that represents the quantity of that material within the 11.8 ft radius of plot center. Cover class bins are as follows:
   - None
   - Trace (0.01-0.99%)
   - 1: 1-5%
   - 2: 6-25%
   - 3: 26-50%
   - 4: 51-75%
   - 5: 76-95%
   - 6: 96-100%





OAK UNDERSTORY MODULE- separate survey!

The oak understory module is meant to be completed in tandem with the ECOP Disturbance Monitoring Protocol, as requested by the ECOP Technical Coordinator. Not all plots will require the in-depth oak understory module.

If you are instructed to conduct the oak understory module, it is ideal to conduct the module at this time, before vegetation is trampled too much in further sections of this protocol. Please complete the understory module if needed, then return to the base Disturbance Monitoring Protocol. This module was created to document any effects on the oak understory plant community that certain restoration practices may have, such as herbicide treatment for specific invasive species. Measurements focus on estimating the cover of plant species and estimating species diversity. The oak understory module is a separate survey- please download this survey on your device before going into the field (https://arcg.is/10WjWO1).

Decision point on plot marking

If you are in a project area that is primarily grassland or oak savanna with no to few trees, you can mark the 50 ft ends of each transect with a survey marking whisker (in addition to the center rebar marker). In other more treed areas, witness trees will be marked for easy plot relocation (assuming site manager permission to mark trees).

Data fields

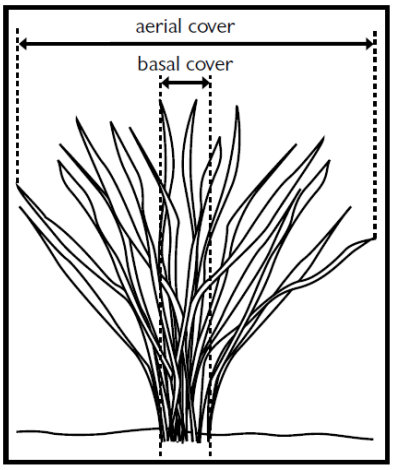
1. **Plot ID**
2. **Oak Understory Monitoring Date**
3. **Observers**
4. **General understory notes.** Record any noteworthy remarks about the herbaceous understory plant community for this plot.
5. **Understory plant species in frames.** Identify each graminoid, forb, and shrub to species that is rooted within the 1-meter square quadrat. Use the dropdown menu to search for USDA Plant Code or common name to enter plant species into the form. If unable to identify a specific plant to species, use USDA Plant Codes for the genus (typically first 5 letters of genus). If unable to identify at all, you may search for “UAG” for unknown annual grass, "UPG" for unknown perennial grass, "UAF" for unknown annual forb, "UPF" for unknown perennial forb, and "USHRUB" for unknown shrub.
    a. **USDA Plant Codes**
    b. **Cover Estimate**
6. **Diversity walk.** After completing all quadrat locations for estimating cover, walk around the entire 50 ft radius circle and record any additional graminoid, forb, and shrub species found that were NOT recorded within the quadrats. Enter each species separately using the + button. Max time is ~15 minutes.

Estimating aerial cover

Along each 50 ft transect, starting with the 0-degree azimuth, estimate aerial cover of each live species rooted within a 1-m^2 quadrat (current year's growth). Place the quadrat at 11.8 ft (equivalent to 11 ft and 9.6 inches) and 38 ft on the right-hand side of the transect. Bottom left corner of quadrat should be at the specified 11.8 or 38 ft locations. Identify each graminoid, forb, and shrub to species and use the dropdown filter to select the appropriate **USDA Plant Code** and common name to enter the species into the form. Using consistent codes for plant names is essential for proper data analysis and is restricted to the list. If unable to identify a specific plant to species or it is not on the list, use USDA Plant Codes for the genus. If unable to identify at all, you may search for UAG, UPG, UAF, UPF, or USHRUB where U=unknown, A=annual, P=perennial, G=graminoid, and F=forb. Estimate cover according to the following **cover class** bins:

- Trace: 0.01-0.99%
- 1: 1-5%
- 2: 6-25%
- 3: 26-50%
- 4: 51-75%
- 5: 75-95%
- 6: 96-100%

Click the + button to add more species.



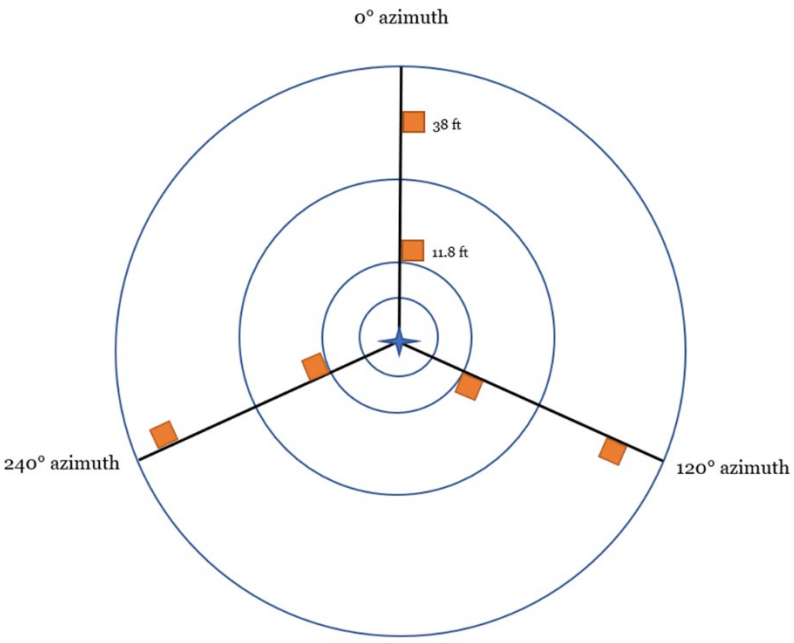
Cover definition: Cover is the vertical projection of vegetation from the ground as viewed from above. There are two types of cover – basal and aerial. We are focusing on aerial cover in this protocol which can be visualized by considering a bird's-eye view of the vegetation. See diagram.

Notes: It may be helpful to write all species present within the frame on a piece of paper first, then enter plant codes and cover classes into the Survey123 form. If a species is only partially rooted within the quadrat, only estimate cover for the portion rooted within the quadrat. Since plants overlap and vary in structure, it is acceptable for the total cover of all species to be more than 100. Only include current year's growth and not previous growing seasons (like old medusahead thatch).

Quadrat locations

Quadrat locations can be notated as follows:

- 0 degrees, 11.8 ft= 0A
- 0 degrees, 38 ft= 0B
- 120 degrees, 11.8 ft= 120A
- 120 degrees, 38 ft= 120B
- 240 degrees, 11.8 ft= 240A
- 240 degrees, 38 ft= 240B



Please be careful when sampling at the 11.8 ft marks since these overlap with the fuels transect. Do not trample or move fine woody debris along the tape.

Diversity walk

After completing all six quadrat locations for estimating cover, walk around the entire 50 ft radius circle and record any additional graminoid, forb, or shrub species found that were NOT recorded within the quadrats. Use USDA Plant Codes as before and click the + button to add more than one species. There is a section "Plants entered for diversity walk" that will list what you have entered so far. Again, be mindful not to trample along the tape lines for the fuels transects. You do not need to estimate cover. Spend ~15 minutes on this.

Suggested plant identification resources

- Flora of the Pacific Northwest by C. Leo Hitchcock & Arthur Cronquist
- Plants of the Inland Northwest and Southern Interior British Columbia by Roberta Parish
- Wildflowers of the Pacific Northwest by Mark Turner and Phyllis Gustafson
- Field Guide to the Rare Plants of Washington by Camp & Gamon
- Field Guide to the Grasses of Oregon and Washington by Roche, Brainerd, Wilson, Otting, and Korfhage
- Washington Wildflowers (smartphone app)
- Oregon Wildflowers (smartphone app)

OREGON WHITE OAK RESPONSES TO DISTURBANCE - Page 6 of Survey123 Form

Oregon white oak will often display unique growth responses to changes in available resources such as water or light. Initial responses are seen as epicormic branching or stump sprouting. We are interested in documenting the presence of these features within the 50-ft radius plot. See definitions and examples below.

1. **Oak Epicormic Branching**: Present or absent.
2. **Oak Stump Sprouting**: Present or absent.
3. **Oak Stump Density:** If oak stump sprouts are present (checked yes above), count number of oak in a clonal/sprouting morphology with stems <2.5" DBH within plot (count clumps, not number of individual stems). If the sprouts you observe are associated with a mature oak stem >2.5" DBH, do not count here.
4. **Stump Sprout Form**: Indicate the growth form of the stump sprouts or clones in the plot. Select all that apply.
5. **Stump Sprout Condition**: Indicate the condition of sprouts including fresh, woody, failing, or recently grazed or mown. Select all that apply. These features can be detected by physical investigation.
6. **Stump Sprout Origins**: Look for clues about the origin of the tree stem failure that incited the stump sprouts. Select all that apply. Where there are shrubby oaks, peer or feel within to locate cut stumps, burnt stumps, rotted stumps, or no obvious origin.

Definitions:
Epicormic branches: Epicormic branches are shoots arising from adventitious or dormant buds on the trunk, stem, or branch of a woody plant. Epicormic branches look like new growth and can grow in dense clusters (reminiscent of mistletoe), or along the trunk of the tree. Epicormic branches are formed following the release of dormant buds in response to increased light, or injury.

Epicormic branching

Stump sprouts: Stump sprouts emerge from the collar of a cut, burned or dead tree stump usually just below ground level. You will see numerous oak sprouts stemming from the root crown at the base of a tree or its residual stump. There is generally a radial pattern to the architecture of the sprouts (a circle around the old stump) that persists after the stump has rotted away.

Check to be sure shrubby oaks are emerging from stumps rather than from browsed single stem seedlings and if you can't tell, make your best guess. (Note: stump sprouted oaks also experience browse).
Mature Stump Sprouts/Clones: Mature stump sprouts are greater than 2.5 inches DBH. Mature stump sprouts can grow to be massive trees, with stems sometimes merging together over time at the base. We're calling these clones (photo below). Watch for the radial aspect of their root base, and often a mound of soil where the previous stump has rotted.

Woody stump sprouts at base of tree

Mature clone stump sprouts

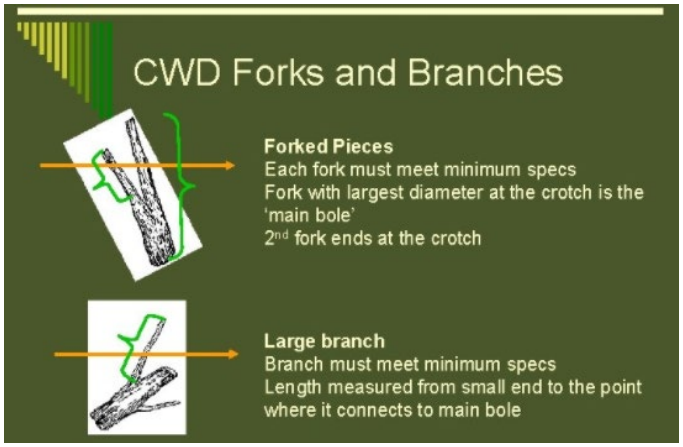
Fresh, short shrub stump sprouts

FUELS TRANSECT – Page 7, 8, and 9 of Survey123 Form

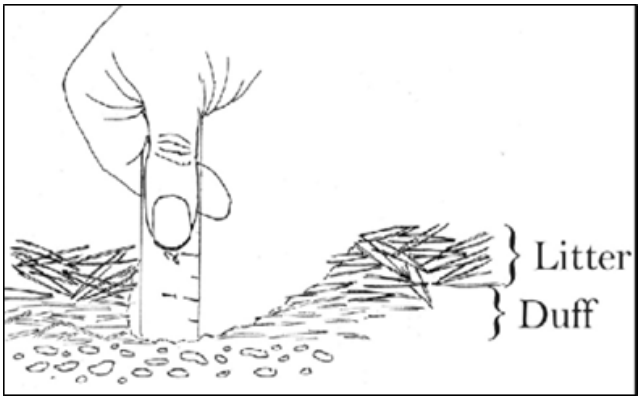
The Fine Woody Debris (FWD) and Coarse Woody Debris (CWD) fuel measurements are taken ***along all three transects*** established for the plot. Page 8= 0° transect. Page 9= 120° transect. Page 10= 240° transect.

Measurements:

1. **Fine Woody Debris (FWD) Measurements:** See page 19 for definitions.
   a. Between 14-20 ft along the transect, use your clear ruler or Go-No-Go gauge to tally the **0.1-to-0.24-inch** diameter material that cross the transect tape.
   b. Between 14-20 ft along the transect, use your clear ruler or Go-No-Go gauge to tally the **0.25-to-0.99-inch** diameter material that cross the transect tape.
   c. Between 14-24 ft along the transect, use your clear ruler or Go-No-Go gauge to tally the **1.0-to-2.99-inch** diameter material that cross the transect tape.
2. **Coarse Woody Debris (CWD) Measurements**
   a. Diameter: Between 0 and 24 feet along the transect, note the diameter at the tape intersection of each qualifying piece (all material greater than 3" in diameter for at least 3' of its length). The piece must meet the minimum diameter requirement (3") where it intersects the tape. If a piece is forked, consider each fork separately to see if the piece qualifies. The larger fork is considered the main bole. The smaller fork must all meet minimum requirements from the fork to its terminus to be included as its own piece. If no CWD in plot, enter 0 for both diameter and decay class.



   b. Decay Class: Assign a decay class (1-5) to each piece of qualifying coarse wood and then find the average value of those decay classes and enter that value on the data form (you will only enter one number for decay class in the plot: the average of all pieces). See special size requirements for wood that is decay class 5 below. See page 20 for decay class definitions.
3. **Litter, Duff, and Fuelbed Measurements**
   a. Depth of Litter and **Depth of Duff**: Measure the depth of litter and duff at the 24-foot hash mark. Using a trowel, knife or other sharp edge try to expose a flat faced hole in the ground. Measure the depth of both duff and litter in inches to the tenth of an inch. When finished cover the hole.



b. Fuelbed Depth: At the 24-foot mark, measure and record the height of the accumulated mass of dead woody material from the top of the duff layer (do not include duff in this measurement) to the highest point of the fuel bed. Units of measurement are inches to the nearest tenth of an inch. Include: litter, FWD, CWD, and dead woody shrubs. Do not include dead wood hanging from trees. If the fuel crosses the tape in the air, it counts as long as the fuel is attached to dead and downed woody debris (the piece is resting at a 45° angle or less erect and is not herbaceous). Only count material less than 6' from the ground.

4. Repeat measurements for Step 1 (FWD), Step 2 (CWD), and Step 3 (Litter, Duff, and Fuelbed) for each transect.

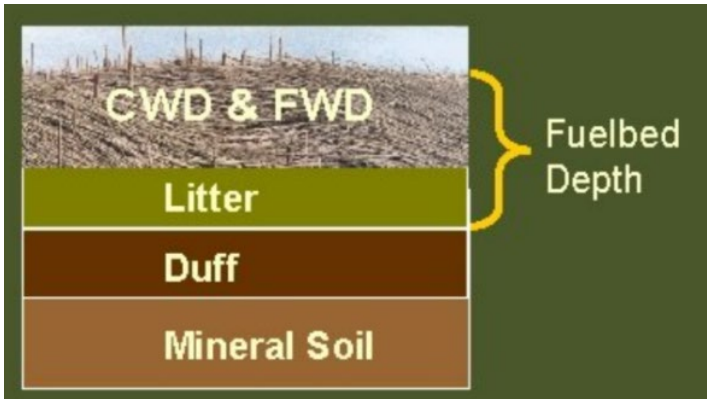
The nitty gritty of fuel transects

The fuels transect method used here is based on the USFS Forestry Inventory Analysis method. Understanding the woody makeup of the understory of a plot provides key insight into makeup of both organic and non-organic materials in the plot, which impact fire behavior and intensity. Data on fuels and other variables will enable users to better understand woodland and forest system/ecological response to disturbance events such as wildfire, prescribed fire, thinning, and fuels reduction.

Definitions

FWD: fine woody debris is less than 3" in diameter, is NO longer connected to a live or standing dead tree or shrub, and does not include dead foliage, needles, or bark. Could include chipped wood.

CWD: coarse woody debris is greater than 3" in diameter ***for at least 3.0' of its length.***



Litter: Mainly dead plant organic material present on top of the mineral soil surface. It is composed of debris in different stages of decomposition where the organic materials (twigs, leaves, pine needles, etc.) are still identifiable.

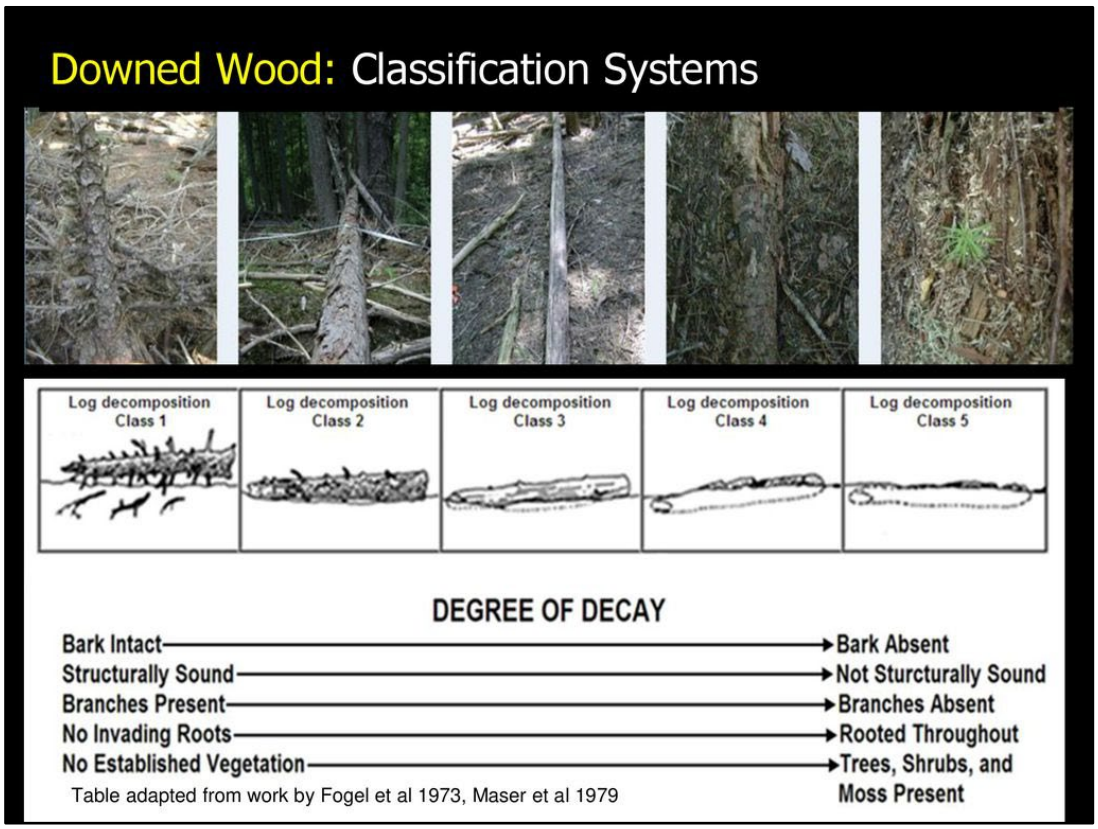
Duff: The organic material layer between the uppermost soil mineral horizon and the litter layer. It is composed of decomposing organic material to the point at which there are no identifiable organic materials (twigs, leaves, pine needles, etc.).

Assorted Details

- For all measurements: only include dead, uprooted material less than six feet from the ground and leaning more than 45° from vertical (i.e. falling or fallen over)
- Sticks that are obscured by litter where they intersect the tape should not be counted.
- Material that is counted once then bends to cross the transect again should be counted at each point it crosses the tape (one stick may be counted twice).

- All materials are counted only if the piece meets the qualifying criteria ***where it intersects the tape line.***
- Do not attempt to count material that is piled, in windrows, or are part of a “jumble” or debris jam (note the presence and size/content of these features in the notes section).
- Tally a piece if its central longitudinal axis intersects the transect. Tally dead trees and tall stumps that are leaning > 45 degrees from vertical. Do not tally live trees or standing dead trees and stumps that are still upright and leaning < 45 degrees from vertical. Most CWD will be laying on the ground. The minimum length of any tally piece is 3.0 feet. When CWD pieces are close to 3 feet total length measure the length to the nearest 0.1 foot to determine if it is >3.0 feet. CWD TOTAL LENGTH is the length of the piece that lies between the piece's recorded DIAMETER AT THE SMALL END AND DIAMETER AT THE LARGE END.
- The decay class of the piece determines whether or not the piece is tallied. **For decay classes 1 to 4:** tally a piece if it is > 3.0 inches in diameter at the point of intersection with the transect. The piece must be > 3.0 feet in length and > 3.0 inches or more in diameter along that length. If the intersect diameter is close to 3.0 inches, measure the diameter to the nearest 0.1 inch to determine if the piece qualifies. For decay class 5: tally a piece if it is > 5.0 inches in diameter at the point of intersection and > 5.0 inches high from the ground. The piece must be > 3.0 feet in length and > 5.0 inches or more in diameter along that length.
- The reason for **treating decay class 5 pieces differently** is because they are difficult to identify, especially when heavily decomposed. Only pieces that still have some shape and log form are tallied, humps of decomposed wood that are becoming part of the duff layer are not tallied. Tally pieces created by natural causes (examples: natural breakage or uprooting) or by human activities such as cutting only if not systematically machine piled. Do not record pieces that are part of machine-piled slash piles or windrows, or that are part of a log "jumble" at the bottom of a steep-sided ravine in which individual pieces are impractical to tally separately. A slash pile or windrow consists of broken logs, limbs, and other vegetative debris.

Decay Class	Structural Integrity	Texture of Rotten Portions	Color of Wood	Invading Roots	Branches and Twigs
1	Sound, freshly fallen, intact logs	Intact, no rot; conks of stem decay absent.	Original color	Absent	If branches are present, fine twigs are still attached and have tight bark
2	Sound	Mostly intact; sapwood partly soft (starting to decay) but can't be pulled apart by hand or sapwood absent.	Original color	Absent	If branches are present, many fine twigs and are gone and remaining fine twigs have peeling bark
3	Heartwood sound; piece supports it't own weight	Hard, large pieces; sapwood can be pulled apart by hand or sapwood absent	Reddish brown or original color	Sapwood only	Branch stubs will not pull out
4	Heartwood rotten; piece does not support it's own weight, but maintains its shape	Soft, small blocky pieces; a metal pin can ge pushed into heartwood.	Reddish or light brown	Throughout	Branch stubs pull out
5	None, piece no longer maintains it's shape, it spreads out on ground	Soft; powdery when dry	Red-brown to dark brown	Throughout	Branch stubs and pitch pockets have usually rotted down.



SEEDLINGS AND SAPLINGS- Page 10 of Survey123 Form

Within the inner 6.8 ft radius plot, complete a tally of all seedlings and saplings, by species. Seedlings are defined as <1" DBH or shorter than DBH height. Saplings are defined as 1-2.49" DBH. It is not necessary to include oak stump sprouts in either tally, as they have been accounted for in the Oregon white oak observation section.

SNAG SAMPLING – Page 11 of Survey123 Form

SNAGS: Snags of any tree species with a DBH are inventoried **within the 50-foot radius plot**. A snag is defined as a standing dead tree, or what remains of a dead tree, that is at least 4.5 ft tall. Dead tree should be leaning less than 45 degrees from vertical as measured from the base of the tree to 4.5 ft. If there are any live branches, then they are inventoried as live trees and not snags. If a tree splits below DBH and one bole is alive while the other is dead, count the dead bole as a snag and the live bole as a live tree.

Tally the number of deciduous and coniferous snags with a DBH of <5 inches. For snags ≥5" DBH, record the species, DBH, azimuth and distance from plot center, height, number of cavities, and snag decay class. As you complete the measurements and assessments for each snag, click the + button and the form will provide you with the opportunity to enter data for the next snag as you move around the plot.

TREE SAMPLING – Page 12 of Survey123 Form

Using concentric plot radii (11.8, 24, and 50 feet), collect data for trees that qualify for inclusion based on the stated criteria for each concentric plot. It is strongly recommended that you use a rangefinder to take the distance and height measurements. ECOP has purchased some rangefinders that can be loaned with the field monitoring kits.

Measurements of tree species
As you move through the measurements, begin at the 0-degree azimuth and move clockwise through the area, ending where you began. Do this for each concentric circle, looking for trees that meet the target DBH. This will ensure that you do not double count any trees or miss any due to confusion/disorientation. If approved by the site manager, you may install DBH nails (aluminum) at measurement height on the uphill side of each tree >5" DBH. This will ensure repeatable measurements in subsequent years.

Is this one tree or two (or more!)? If the tree bole splits below the 4.5-ft height where you measure DBH, then count each bole as a separate tree. If it splits above the DBH measurement point, then count that tree as one individual.
Which trees are "in"? Standing at the center of the plot, use the following guidelines for determining if a tree or snag should be considered "in" (not all trees within the 50' radius will qualify to be measured):

Trees are measured within a range of plot sizes as described below:

- Within the **11.8 ft radius** from plot center:
    - Trees 2.5 to 4.9-inch DBH are inventoried where at least half of the diameter of the tree stem is within the 11.8-foot plot.
- Within the **24 ft radius** from plot center:
    - Trees 5.0 to 24-inch DBH are inventoried where at least half of the diameter of the tree stem is within the 24-foot plot.
- Within the full **50 ft radius** from plot center:
    - Trees over 24-inch DBH are inventoried where at least half of the diameter of the tree stem is within the 50-foot plot.

DATA COLLECTION – Measurements for all species of live trees

1. **Tree species** (select a tree species from the drop-down list). If you select "None" then you will move on to the next size class.
    - None
    - *Quercus garryana* (Oregon white oak)
    - *Pinus ponderosa* (Ponderosa pine)
    - *Pseudotsuga menziesii* (Douglas fir)
    - *Alnus rubra* (red alder)
    - *Juniperus occidentalis* (western juniper)
    - *Populus trichocarpa* (black cottonwood)
    - *Abies grandis* (grand fir)
    - *Robinia pseudoacacia* (black locust)
    - *Prunus virginiana* (chokecherry)
    - *Taxus brevifolia* (Pacific yew; rare)
    - *Acer glabrum* (Rocky mountain maple)
    - *Acer circinatum* (vine maple)
    - *Acer macrophyllum* (bigleaf maple)
    - Unknown Tree
2. **Tree ID** (optional to install a tree tag ID number based on land manager preferences, install at base of tree with aluminum nail leaving room for tree to grow)
3. **DBH** (inches)- diameter at breast height (4.5 ft) measured on the uphill side
4. **Azimuth from Plot Center**
5. **Distance from Plot Center** (feet; measure to the nearest side of the tree)
6. **Tree height** (feet; we strongly encourage the use of a hypsometer or a rangefinder to measure tree height and crown base height)- measure height as distance from ground to highest point of tree.
7. **Tree status** (tree condition - assess living and dead branches)
8. **Crown base height** (feet; height from the ground to the lowest live branch in the tree's crown)
9. **Percent live crown ratio** (nearest 10%) – this is the percentage of the tree's stem that is occupied by live branches. You can calculate this by subtracting the tree's crown base height from the total height and then dividing by the total height. (Example: a 100-foot-tall tree with a 25-foot crown base height has a 75 % live crown ratio.)

10. **Crown position**: Select the crown position based on the descriptions in survey and reference materials ("Crown position from USFS FIA").
11. **Tree health indicators:** Select all that apply and that you can diagnose.
12. **Is this marked as a witness tree?** Yes or No. (Question shown for trees greater than 5.0-inch DBH)

As you complete the measurements and assessments for each tree, click the + button and the form will provide you with the opportunity to enter data for the next tree as you move around the plot. This is repeated for each of the concentric plots. When you have completed the tree inventory you can cross reference the tally on the form with the number of trees in the plot.

DATA COLLECTION – Measurements specific to Oregon white oak trees

When you select Oregon white oak as the tree species, you will be asked to characterize observations specific to this species. Refer to reference materials for pictures of oak crown shape and morphology ("Oak Structure and Morphology Graphic").

a. **Distance between ground and lowest point of the lowest attached live limb** (feet).
b. **Distance between ground and lowest point of the lowest attached dead limb** (feet).
c. **Oak crown shape** (choose one)
    - Mushroom
    - Mushroom Composite
    - Columnar
    - Columnar Composite
    - Inverted Vase
d. **Oak morphology** (choose one)
    - Clonal Oak: Stems radiate from the root collar of an old stump.
    - Clump Oak: Stems emerge from densely spaced germinating acorns.
    - Single Stem Oak: Stem emerges from widely spaced germinating acorns
e. **Notes:** Include any notes or comments about trees here.

ECOP Fire Monitoring Module Field Instructions
(Immediate post-burn measurements)

Last Updated: January 11, 2024

Supplies needed:

- Data collecting device (phone or tablet with Survey123 form 'ECOP Fire Monitoring Module' downloaded on your device (https://arcg.is/11OnyK0)
- Datasheets- burn severity and tree scorch/char (not needed if using Survey123 app, which is preferred)
- Report for ECOP monitoring plot data collected pre-treatment (this has information on trees and snags measured; obtain from ECOP Technical Coordinator)
- Compass
- Candy canes and three 50-ft tapes
- Laser rangefinder
- DBH tape
- 1-m² PVC frame

1-m² PVC frame used to measure burn severity of substrate and vegetation.

Collect the following data as soon as possible after plot cools, which is generally within two to three weeks post-fire.

Plot Information:

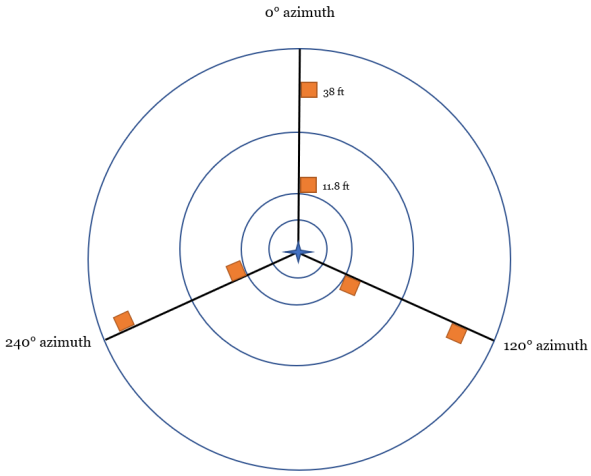
- Plot ID
- Observer Names
- Monitoring Date
- Plot Center Location
- Fire Date
- Fire Remarks

Photo Points:

Same methodology as in the ECOP Disturbance Monitoring Protocol– take a photo straight on, landscape orientation, facing the ends of the 0, 120, and 240 degree transects. Take photos in the landscape orientation and use a monopod or other photo taking device that helps you take consistent photos from one visit to another. Monopod should be set at 5 ft tall. If possible, exclude people, gear, etc. from the photo. Plot ID, date, and azimuth will be recorded automatically in the file name so there is no need for a whiteboard. There is also an option to take additional photos of unique fire effects within the plot.

Example of correct positioning for photo point.

Burn severity:



- Measure at 11.8 ft and 38 ft on each transect (six, 1-m² quadrats total per plot). Place the quadrat at 11.8 ft (equivalent to 11 ft and 9.6 inches) and 38 ft on the right-hand side of the transect. Bottom left corner of quadrat should be at the specified 11.8 or 38 ft locations.
- Use Table PD-12 from the FIREMON protocol (shown below) to assign each 1-m² quadrat a fire severity code for substrate and vegetation (use Forest vegetation column). Not applicable is an option for where there was no organic substrate present pre-burn (large rock covers entire quadrat surface) or if there was no vegetation present pre-burn.

Table PD-12—Use these fire severity class to determine the fire severity across the FIREMON macroplot.

Fire severity code	Substrate	Forest vegetation	Shrubland vegetation	Grassland vegetation
Unburned (5)	Not burned	Not burned	Not burned	Not burned
Scorched (4)	Litter partially blackened; duff nearly unchanged; wood/leaf structures unchanged.	Foliage scorched and attached to supporting twigs.	Foliage scorched and attached to supporting twigs.	Foliage scorched
Lightly burned (3)	Litter charred to partially consumed; upper duff layer may be charred but the duff is not altered over the entire depth; surface appears black; where litter is sparse charring may extend slightly into soil surface but soil is not visibly altered; woody debris partially burned; logs are scorched or blackened but not charred; rotten wood is scorched to partially burned.	Foliage and smaller twigs partially to completely consumed; branches mostly intact.	Foliage and smaller twigs partially to completely consumed; branches mostly intact; typically, less than 60 percent of the shrub canopy is consumed.	Grasses with approximately two inches of stubble; foliage and smaller twigs of associated species partially to completely consumed; some plant parts may still be standing; bases of plants are not deeply burned and are still recognizable.
Moderately burned (2)	Litter mostly to entirely . consumed, leaving coarse, light colored ash (ash soon disappears, leaving mineral soil); duff deeply charred, but not visibly altered; woody debris is mostly consumed; logs are deeply charred, burned out stump holes are evident.	Foliage twigs and small stems consumed; some branches still present.	Foliage twigs and small stems consumed; some smaller branches (0.25–0.50 inches) still present; typically, 40 to 80 percent of the shrub canopy is consumed.	Unburned grass stubble usually less than 2 inches tall, and mostly confined to an outer ring; for other species, foliage completely consumed, plant bases are burned to ground level and obscured in ash immediately after burning.
Heavily burned (1)	Litter and duff completely consumed, leaving fine white ash (ash disappears leaving mineral soil); mineral soil charred and/or visibly altered, often reddish; sound logs are deeply charred, and rotten logs are completely consumed.	All plant part consumed, leaving some or no major stems or trunks; any left are deeply charred.	All plant parts consumed leaving only stubs greater than 0.5 inch in diameter.	No unburned grasses above the root crown; for other species, all plant parts consumed.
Not applicable (0)	Only inorganic material on site before burn.	None present at time of burn.	None present at time of burn.	None present at time of burn.

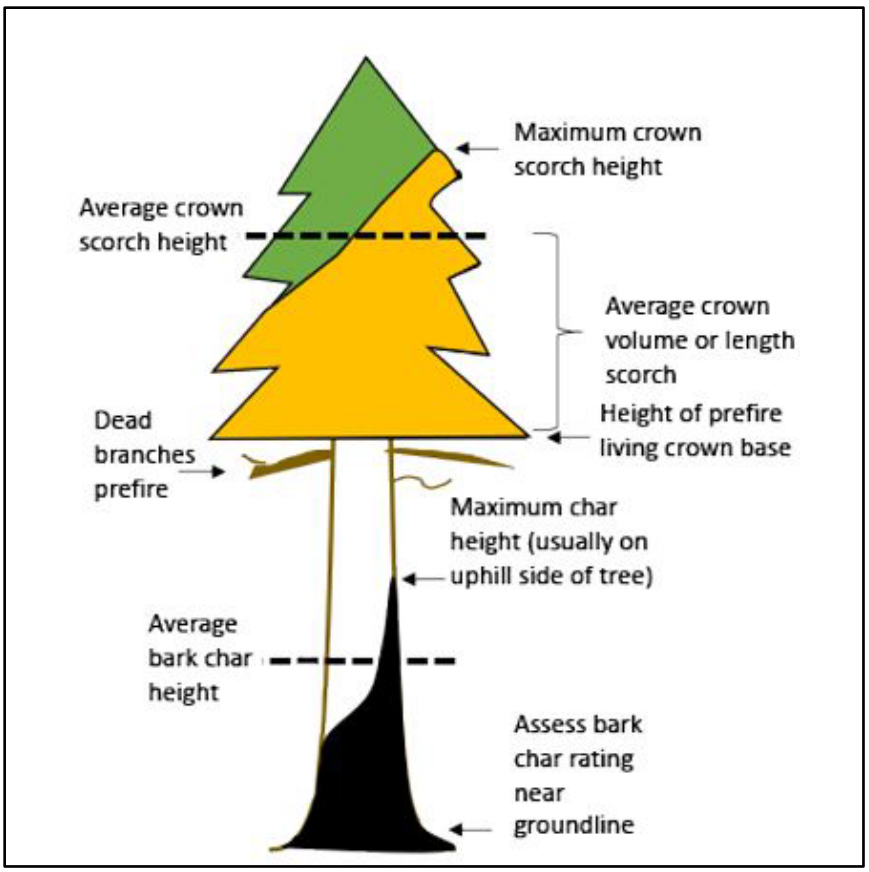
Tree scorch and char:

Scorch is a result of radiant or convective heat from a fire and is represented by browning of needles or leaves. It may be difficult to distinguish between unburned dead foliage and scorched foliage on dead or near-dead trees. Scorched needles tend to be droopy or curled, rather than upright or straight. Char results from flames and is represented by blackened tree boles and blackened soil/litter layers. See figures on page 5 for graphical illustration.

For each tree in the plot that was measured pre-fire, record:

- Tree Species
- Tree ID (optional, if tree has tag from previous measurements)
- Azimuth from Plot Center
- Distance from Plot Center (ft)
- Tree Status: Options include standing tree, consumed or down tree, cut stump, and freshly resprouting oak. Standing tree would include a standing dead tree- the tree may have been alive in previous survey but is now dead and would be recorded as 100% scorched in following sections. If tree is standing, the following scorch and char measurements will also be taken.
- Crown Base Height (nearest ft): Height from the ground to the lowest live branch in the tree's crown.
- Percent Crown Scorched (nearest 5%): Percent of tree crown with browning needles or leaves caused by the heat from a fire.
- Maximum Scorch Height (nearest ft): The maximum height at which leaf mortality occurs due to heat generated by a fire. Below this height, most or all needles are brown and dead; above it, they are live and green.
- Percent Stem Base Charred (nearest 10%): Percent of tree base circumference (ground level) that is charred from fire.
- Maximum Char Height (nearest 0.5 ft): The maximum height of charred bark. Note that the maximum height is measured even if the char is patchy.
- Notes: Include any notes on the tree, recording interesting fire effects such as major branch loss, cavity consumption, etc.

Click submit and survey is complete! It is recommended to re-measure ECOP monitoring plots using the full Disturbance Monitoring Protocol at least one growing season after fire to observe the full effects of fire. At that point, any new snags will be measured fully.



Crown scorch and bark charring visual taken from OSU Extension Service.

Crown scorch and bark charring on ponderosa pine.

Maximum char height on oak tree.