Klamath Siskiyou Oak Network Ecological Monitoring Plan

V 1.0

March 30, 2023

Klamath Siskiyou Oak Network Monitoring Working Group

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Development of this monitoring plan was funded by BLM Secure Rural Schools Act Title II and supported by in-kind match from members of the monitoring working group.

Recommended Citation:
Klamath Siskiyou Oak Network. 2023. Klamath Siskiyou Oak Network Ecological Monitoring Plan v1.0. Rep. No. KBO-2023-0001. Klamath Bird Observatory, Ashland, OR.

On the cover:
Oak Savannah, Photograph by Jaime Stephens

Contents

Glossary

Adaptive management is the intentional practice of adjusting strategies through a cycle of assessing, planning, implementing, monitoring, and evaluation.

A **biophysical factor** is a biological and physical stress that results from a direct threat and influences the health of a conservation target.

A **contributing factor** is a human-induced action or event that underlies or leads to one or more direct threats; contributing factors include indirect threats and opportunities.

An **indicator** is a measurable entity related to the status of a target, change in a threat, or progress towards an objective and that indicates the condition of the target, stress, threat, or progress.

A **key ecological attribute (KEA)** represents a target's biology or ecology that if present, defines a healthy target and if missing or altered, would lead to the outright loss or extreme degradation of that target over time.

Outcomes are short, medium, and long-term ecological results.

Outputs are intermediate, measurable, on-the-ground results from implementing an action.

Project scale as an area typically >10,000 acres which is an aggregation of untreated and treated areas united under an analysis for a particular project

A **results chain** shows the expected outcomes from the implementation of a strategy, a sequence of linked factors in a diagram.

A **strategy** is a broad course of action designed to restore natural systems, reduce threats, and/or develop capacity.

Stand scale - 10’s of acres with relatively homogenous vegetation

A **target** is a suite of species, communities, and ecological systems that are chosen to represent and encompass the full array of biodiversity found in a project area. They are the basis for setting goals, carrying out conservation actions, and measuring conservation effectiveness. The conservation of the focal targets will ensure the conservation of all native biodiversity within functional landscapes.

A **threat** is a proximate agent or factor that directly degrades one or more conservation targets.

A **viability assessment** helps identify what a target’s "healthy state" might look like, identify how the target is doing today, and determine how to measure a target’s "health" over time. A viability assessment results in an overview of the status of each conservation target, a description of the desired conditions that help define short- and long-term conservation outcomes, and measures for monitoring the effectiveness of conservation actions over time.

Executive Summary

The Klamath Siskiyou Oak Network (KSON) envisions healthy and resilient oak ecosystems with intact ecological processes across much of their historic range in the Klamath Siskiyou Bioregion, including diverse landscapes with historic, intrinsic, aesthetic, environmental, wildlife, and economic values that are shared by a wide cross-section of the public. These oak ecosystems are currently threatened with loss and degradation due to fire exclusion, certain agricultural practices, agricultural expansion, and rural and urban residential development.

The partnership recognizes the importance of indigenous cultures and their land stewardship. The oak ecosystems of southern Oregon and northern California were shaped by traditional, time-tested, ecologically appropriate and sustainable indigenous cultural practices. As such, the conservation of these systems must be guided by ecocultural approaches and indigenous traditional ecological knowledge.

The overarching goals of this monitoring plan are to work in partnership to acquire, curate, analyze, and distribute data needed to transparently evaluate performance toward achieving the outputs and outcomes identified in the KSON Strategic Action Plan (SAP). As part of the SAP, the partnership used a viability assessment framework to inform the selection of six Key Ecological Attributes (KEAs) and identified indicators to measure conditions for each target habitat**.**

This ecological monitoring plan includes three monitoring objectives 1) Spatially track treatment planning and project implementation, 2) Measure treatment-induced changes in Key Ecological Attributes, and 3) Measure landscape scale Ecological Outcomes. In combination, this monitoring will evaluate how effectively a restoration treatment shifts a given target habitat from its current to its desired condition. Results will also be examined at the project and landscape scale to measure progress toward improved health and increased target acreage where appropriate. Within each project, the best available science and ongoing monitoring results will be applied to adaptive management through regular implementation review.

Background

The Klamath Siskiyou Oak Network (KSON) envisions healthy and resilient oak ecosystems with intact ecological processes across much of their historic range in the Klamath Siskiyou Bioregion, including diverse landscapes with historic, intrinsic, aesthetic, environmental, wildlife, and economic values that are shared by a wide cross-section of the public. These oak ecosystems are currently threatened with loss and degradation due to fire exclusion, certain agricultural practices, agricultural expansion, and rural and urban residential development. To address these threats, KSON works to protect and restore oak ecosystems on both private and public lands through an effective partnership among non-governmental organizations, local state and federal agencies, the Inter-Tribal Ecosystem Restoration Partnership, as well as the private community members, and other conservation and natural resource user groups.

The partnership recognizes the importance of indigenous cultures and their land stewardship. The oak ecosystems of southern Oregon and northern California were shaped by traditional, time-tested, ecologically appropriate and sustainable indigenous cultural practices. As such, the conservation of these systems must be guided by ecocultural approaches and traditional ecological knowledge. This guidance will ensure the survival of both indigenous ecosystems and cultures.

The broad goal of the KSON Strategic Action Plan (SAP) (Alexander et al. 2020) is to conserve and restore oak habitats and improve target conditions at both site and landscape scales. The KSON geography hosts a gradient of oak habitat types ranging from sparse oak tree coverage to closed canopy. KSON distinguishes four oak target habitats from this habitat gradient: Oak Savannah, Oak Chaparral, Oak Woodland, and Oak Conifer (Figure 1). Enabling and conservation implementation strategies are designed to (1) develop KSON's capacities, partnerships, and community support and (2) reduce highly rated threats (medium and high) and related biophysical factors that stress the four targets. The conservation implementation strategies aim to protect target habitats from conversion by preserving, enhancing, and restoring structural diversity, ecological function, climate resilience, and overall health and persistence of targets.

A Progress Monitoring Framework, outlined in the KSON SAP (Alexander et al. 2020), outlines how we will monitor outputs from the enabling and conservation implementation strategies to quantify both actions to improve organizational, social, and economic conditions and conservation implementation actions. Metrics for strategy indicators and stress reduction indicators will be quantified using Miradi Software. Success will be evaluated against the six-, 12-, and 30-year goals that are the basis of the desired habitat target conditions and the results chains. For each strategy indicator and associated strategy, the metric to measure action outputs of enabling and conservation implementation strategies will be quantified. For each strategy indicator and associated threat, the metric for reduction outputs for conservation action strategies will be quantified. For each stress reduction indicator and associated biophysical factor the metric that results from conservation action strategies will be quantified (Figure 2).

Ecological monitoring is designed to achieve two outputs 1) measured ecological outcomes and 2) adaptive management of conservation outputs toward the outcome of improved conditions for carrying out the core conservation implementation strategies in more effective and efficient ways to address the limiting factor - lack of knowledge of threat impacts and complex ecological interactions influencing treatment effectiveness (derived from the Theory of Change; see KSON SAP for more detail).

The partnership used a viability assessment framework to inform the selection of eight Key Ecological Attributes (KEAs) and identified indicators to measure conditions for each target habitat (Table 1). This ecological monitoring plan details the application of KSON's KEAs to assess the current and desired future condition of the target habitats. Monitoring of these KEAs and their indicators will evaluate how effectively a restoration treatment shifts a given target habitat from its current to its desired condition. Results will also be examined at the project and landscape scale to measure progress toward improved health and increased target acreage where appropriate. Ecological monitoring will include spatial analysis as well as field data collection.

Each KEA is described for stand or landscape scale measurement, spatial and temporal study design considerations are detailed, and preliminary data analysis methods are suggested. We define the stand-scale as 10's of acres of relatively uniform vegetation condition receiving a given treatment type, and the project-scale as an area typically >10,000 acres which is an aggregation of untreated and treated areas united under an analysis for a particular project. Project scale is thus a semi-arbitrary subset of landscape scale, optimally large enough to account for fire flow in the consideration of wildfire risk and for variation in forest types and conditions for assessing landscape resilience. Stand scale monitoring will measure changes in habitat conditions that result from restoration efforts. Then, these changes will be scaled up to determine restoration success at the project scale, and where appropriate also the landscape scale, using the KEAs, indicators, and desired conditions by habitat in Table 1 and further described in Table 2. This information will be used to evaluate conservation outcomes to ensure the effectiveness of restoration efforts.

We will use the KEAs to measure success of Conservation Implementation Strategies implemented over the next six to 30 years, with the goal of achieving the following Site-level Outputs:

- Maintain and increase the amount of target acres
- Improve the condition of the plant communities by restoring native understory cover, increasing recruitment and diversity of smaller and regenerating oaks; retaining and protecting potential legacy oak trees; and boost acorn yields
- Reduce woody fuel loads and reintroduce low-severity surface fires
- Improve habitat conditions to increase focal bird species diversity

These Conservation Implementation Strategies will also result in the following Threat-reduction Outputs:

- Reduce conifer encroachment
- Reduce fire exclusion effects
- Reduce risk of severe fire

Then, stand level and threat-reduction outputs can be scaled up to measure success and quantify Landscape-level Ecological Outcomes in terms of how many acres of target habitat were moved from their current condition to a desired condition (Figure 2).

Monitoring Goals, Objectives, and Activities

The overarching goals of this monitoring plan are to work in partnership to acquire, curate, analyze, and distribute data needed to transparently evaluate performance toward achieving the outputs and outcomes identified in the KSON SAP. This plan will facilitate consistent monitoring across multiple KSON projects. Within each project, the best available science and ongoing monitoring results will be applied to adaptive management through regular implementation review.

Data attained through KSON-led monitoring will catalyze future research and monitoring investments. Monitoring partners will leverage the monitoring plan and monitoring data to engage with the broader scientific community to attract and facilitate additional research when priorities intersect with those articulated in the monitoring plan.

Objective 1: Spatially track treatment planning and project implementation

Questions: Where is KSON oak restoration planned and what is the current status of each treatment unit? Within a project area, where have other organizations implemented restoration or where has natural disturbance occurred?

While basic in concept, the spatial tracking of restoration treatments provides the foundation for many components of KSON's SAP including ecological monitoring. Well-designed databases will facilitate effective, efficient data collection and timely reporting on KSON metrics and indicators, enabling project management, outreach, engagement, and future monitoring investments. The database will house data for all KSON-associated treatments, relevant project planning feature datasets (e.g., oak target) to facilitate review of project design and project scale impacts. In intensively monitored landscapes (e.g., Little Butte Oak Initiative) we will also work to identify, and map treatments implemented by other organizations and ownerships and natural disturbance to enable landscape scale interpretation. Documentation of the types and locations of restoration treatments will be facilitated by the Rogue All Lands Planning Interagency Mapping Project (Rogue Basin All-Lands Forest Restoration Explorer (arcgis.com) and supporting Memorandum of Understanding. This effort is in partnership with Rogue Forest Partners (see detailed workflow in Fig 3).

Objective 2: Measure treatment-induced changes in Key Ecological Attributes

Questions: Have restoration actions improved oak target condition at the stand and project scale? Specifically, have we 1) Maintained or increased the amount of target acres, 2) Improved the condition of the plant communities by restoring native understory cover, increasing recruitment and diversity of smaller and regenerating oaks; retaining and protecting potential legacy oak trees, and boosting acorn yields, 3) Reduced surface fuel loads and increased the probability of low-severity fire in oak savanna, oak woodland, and mixed-oak conifer targets; reintroduced low severity fire in oak savanna, oak woodland, and mixed-oak conifer targets, 4) Restored fire regimes within oak targets (fire regime I in oak savanna, oak woodlands, and oak conifer and fire regime III in oak chaparral) and 4) Improved habitat conditions to increase focal bird species diversity?

Key ecological attributes (KEAs) and indicators describe and measure the condition of our targets at the stand, project, and landscape scales; at the stand scale they can measure treatment effectiveness (Table 1 and 2). They provide the foundation of our ecological monitoring and will be used to assess the current and desired future status of our four oak habitat targets (Figure 1). For each of the KEA Ecological Indicators this plan provides detailed information on the indicator; metric; sampling design; methodology; and data quality assurance/quality control, management and storage, and analysis.

KEA #1 Size – Amount on landscape

Question: *Have we maintained or increased the amount of target acres?*

To broadly measure success in maintaining or increasing target oak habitats, we will determine the amount of a given target habitat on a landscape using the total area by subbasin as an indicator. Because of the ability of restoration treatments to increase landscape-level heterogeneity and thus species richness (Latif et al. 2020), it is beneficial to evaluate treatment success at multiple scales. Although this metric provides an informative large-scale measure of success, data used to classify habitat is not always accurate. The goal for most target habitats given current threats is to maintain current acreage, while the goal for oak conifer habitat is to increase by 23,000 acres.

Indicator

Total area by subbasin

Metric

Acreage of each target habitat

Sampling Design (scale, temporal, spatial)

This metric will be measured at the project scale and landscape scale. Analysis will be repeated periodically, approximately every 6 years, to allow for updated datasets and landscape-level habitat change.

Methodology

We will monitor target habitat acreage using the most recent LEMMA and LANDFIRE datasets available. LANDFIRE datasets are updated annually, but the timing for updated LEMMA datasets has not been released. We will determine target habitat acreage using the same classification methods described in the Strategic Action Plan (Alexander et al. 2020). Specifically, updated LEMMA GNN Species-Structure maps, available at a 30m pixel resolution, will be used to classify forested area within the geography by oak habitat target, and total area of each oak habitat target will be calculated using Spatial Analyst tools in ArcGIS Pro. LANDFIRE Existing Vegetation Cover (EVC) data is available to assess shrub cover in 10% intervals and is used alongside LEMMA GNN data to classify oak savanna and oak chaparral. We will use the most recent LANDFIRE data to classify shrub cover when classifying changes in oak habitat target area. We will also assess oak habitat canopy cover change at the project scale using regional remote sensing derived datasets (e.g., Fall Foliage Index).

Data

Quality Assurance/Quality Control

All spatial data will maintain a consistent attribute naming convention across years to ensure data can be quickly and easily summarized using available analysis tools in ArcGIS. Ground truthing and/or comparing oak habitat maps with other data sources (e.g., aerial images or other remote sensing datasets) will be performed as needed to assess local conditions for project planning.

Management and Storage

As new LEMMA rasters become available, they will be downloaded from the project site (https://lemma.forestry.oregonstate.edu/data). The most recent LANDFIRE EVC datasets will be downloaded from the project site (https://www.landfire.gov/evc.php). Rasters will then be classified in ArcGIS Pro based on pixel attributes to create a map of oak targets according to the rule set developed the SAP to generate a classified raster of oak targets, which will then be uploaded to an online data repository (e.g., an ArcGIS online hub such as the All Lands Forest Restoration Explorer; https://rogue-all-lands-explorer-osugisci.hub.arcgis.com/) for use in mapping tools and project planning.

Analysis

Total area of oak target habitat will be assessed at project and landscape level scales by comparing total area of target habitat before work began as assessed in the KSON Strategic Action Plan, which used LEMMA raster GNN Species-Structure data based on imagery from 2012 and LANDFIRE EVC data from 2014. When LEMMA analysis is available for post-restoration years, we will apply the same rule set developed for classifying pre-restoration landscape scale oak habitat target amounts to the new data within focused geographies [i.e., at the HUC 8 (subbasin) watershed level] to assess the change in oak habitat target amount at the project and landscape scales.

Lead

Klamath Bird Observatory

KEA #2 Condition – Plant community

Question: Have we improved the condition of the plant communities by restoring native understory cover?

Plant community monitoring will be used to assess how treatments (thinning, burning, and seeding) shift compositional and structural conditions in understory plant communities, including exotic species invasion, rare species responses, and establishment of existing or seeded native species. We will assess understory plant communities using the following indicators: 1) percentage of native understory cover, 2) structural and compositional diversity, 3) the persistence and abundance of rare species, and 4) cover of state or federally listed noxious weeds.

Indicator

>25% native understory cover with high structural and compositional diversity, adequate structural conditions for the persistence of rare species, and minimal cover of state or federally listed noxious weeds

Metric

Diversity, composition, and structure of understory plant communities; extent and abundance of rare species populations; extent and abundance of noxious weed populations

Sampling Design (scale, temporal, spatial)

Effectiveness monitoring is necessarily limited to the stand scale for short-term treatment impacts but will be evaluated at the project scale as sufficient area within projects is treated.

Vegetation conditions will be measured on a series of plots randomly distributed throughout each treatment unit (i.e., the stand), as well as utilizing intuitive-controlled surveys of entire treatment units. All sampling will occur during May and June, unless the phenology of a species of interest requires alternate timing.

Sampling design for the plot-based component of this KEA will follow the methods detailed in Rogue Forest Partners (2021). Plots will be circular and will cover 1/10 of an acre. Sample plots will be located using a spatially balanced random sample design. Random points will be assigned using the Generate Random Points tool, Data Management toolbox, ArcPro 3.0.3 with a minimum distance between plots that allows for good dispersal and fit of plots within the unit. Plots falling on roads or landings will be moved to the interior of the vegetation type by 2x plot radius but plots falling in skips, openings, or other vegetation types within the unit perimeter will be measured. In non-commercial units, plots will sample 10 points for every 100 ac of project area, generally resulting in a 10% frequency sample. The sample frequency in areas with significant diversity in forest types or structures may be increased to 15 points for every 100 ac. For units < 100 ac, a minimum sample threshold of 5 points should be used. In commercial stands, monitoring plots will be located using a systematic sampling approach in accordance with USFS stand exam protocols. In these cases, the sampling density will be 1 plot for 5 acres, with at least 3 plots per unit for smaller units, generally resulting in a 20% frequency sample unless treatments are <100 acres and relatively uniform in nature (e.g., plantations) sample density will be reduced to (10%) one plot for every 10 acres. Plots will be sampled no more than one year prior to treatments, and resampled at least one year after treatments.

During Intuitive Controlled surveys, a botanist will traverse treatment units sufficiently to see a cross section of all topographical, ecological, and hydrological conditions within the unit. The botanist will seek out portions of the unit where conditions are likely to host either rare species or noxious weeds.

Methodology

On plots, understory plant communities will be monitored using a combination of the FIREMON Species Composition Sampling Method (Caratti 2006) and Intuitive Controlled surveys (Whiteaker et al. 1996). On each plot, each tree, shrub, and herbaceous species will be assigned the following: 1) status (live or dead), 2) size class (see FIREMON Species Composition protocol for classes), and 3) cover class (see FIREMON Species Composition protocol for classes). A single species may be assigned more than one size class, in which case each will be assigned its own cover class. Additionally, ground cover types (bare ground, rock, gravel, wood, cryptograms, thatch, litter) will be assigned a cover class.

During Intuitive Controlled surveys, when rare species or noxious weeds are encountered, the botanist will use a mobile GPS application to record the extent and abundance (cover and/or count, depending on the species) of each population. The botanist will note plant phenology (veg, flowering, in seed). The location and status info of noxious weed species (ODA 2022) will be shared with project partners to ensure appropriate actions can be taken prior to treatment; when appropriate, non-native plant populations will be controlled prior to ground disturbing activities or defer actions if necessary; monitoring crews will comply with the RRS National Forest Weed Management plan; populations of invasive non-native plants will be flagged prior to implementation (see RFP 2021 for detail).

Data

Quality Assurance/Quality Control

Quality assurance and quality control of monitoring data takes place before, during and after data collection. Before data collection quality control and assurance is provided by the monitoring working group. This ensures appropriate data are collected and the workflow for data management are sound. During data collection assurance is provided at the data collection and data curation stages. Statistical software will be used to identify outlier values in an iterative data assurance process, enabled by Dashboards linked to Survey123 in the ESRI environment. Quality control standards are under constant development and these updates will be integrated into future versions of this monitoring plan.

Management and Storage

Plot-based plant community sampling will result in a matrix of species abundances by size class and plot. Similarly, plot-based environmental data will be stored in a separate matrix. Intuitive Controlled surveys will result in GIS layers containing points and polygons that represent the spatial distribution of rare species and noxious weeds. Data related to population counts or cover will be contained in the layers' attribute tables.

Community and environmental matrices will be stored as spreadsheets uploaded to a shared drive until integration with a larger database is appropriate/necessary. GIS layers will be stored as ESRI shapefiles and uploaded to a shared drive. These may also be integrated into a larger database as the framework is developed.

Analysis

PERMANOVA will be used to determine whether community composition significantly changes following treatments. Plant species will be classified as either native, exotic, or noxious, and the relative cover of each of these classifications will be assessed for all size classes. Differences in the abundance of individual species and/or functional groups before and after treatments will be tested using ANOVA. Non-metric multidimensional scaling (NMDS) will be used to visualize patterns in plant community composition among treatment units before and after treatment. NMDS will be conducted using the VEGAN package for R. Correlations between plot NMDS scores and environmental variables (canopy cover, relative dominance of tree species, shrub cover, ground cover types, etc.) will be tested using the Envfit function in VEGAN. Spatial data related to rare species and noxious weeds will be summarized and used for adaptive management, but may not be analyzed.

Lead

The Understory Initiative

KEA #3 Condition – Oak trees - Legacy trees

Question: Have we retained and protected potential legacy oak trees?

This metric will measure the presence of encroaching vegetation.

Indicator

Non-encroachment of 90% of existing and potential legacy oaks

Metric

Percent or categorical: encroached, overtopped, or pierced oaks

Sampling Design (scale, temporal, spatial)

Effectiveness monitoring is necessarily limited to the stand scale for short-term treatment impacts but will be evaluated at the project scale as sufficient area within projects is treated.

Sampling design for this KEA will follow the methods in Rogue Forest Partners (2021). Plots will be circular and will cover 1/10 of an acre. Sample plots will be located using a spatially balanced random sample design. Random points will be assigned using the Generate Random Points tool, Data Management toolbox, ArcPro 3.0.3 with a minimum distance between plots that allows for good dispersal and fit of plots within the unit. Plots falling on roads or landings will be moved to the interior of the vegetation type by 2x plot radius but plots falling in skips, openings, or other vegetation types within the unit perimeter will be measured. In non-commercial units, plots will sample 10 points for every 100 ac of project area, generally resulting in a 10% frequency sample. The sample frequency in areas with significant diversity in forest types or structures may be increased to 15 points for every 100 ac. For units < 100 ac, a minimum sample threshold of 5 points should be used. In commercial stands, monitoring plots will be located using a systematic sampling approach in accordance with USFS stand exam protocols. In these cases, the sampling density will be 1 plot for 5 acres, with at least 3 plots per unit for smaller units, generally resulting in a 20% frequency sample unless treatments are <100 acres and relatively uniform in nature (e.g., plantations) sample density will be reduced to (10%) one plot for every 10 acres. Plots will be sampled no more than one year prior to treatments, and resampled at least one year after treatments.

Methodology

Legacy tree monitoring is a component of the Rogue Forest Partners' Vegetation and Fuels Field Protocols (RFP 2021). Species, azimuth, DBH, and competitive environment (encroached, overtopped, pierced) will be recorded for all legacy trees or shrubs (>150 years) within the 0.1 ac plot. Any tree bole falling within the plot will have data collected on its entire canopy. The relative size of competing non-legacy trees will be recorded.

- A legacy tree is encroached when there is >30% shrub and/or sub-dominate (relative to legacy tree crown) tree cover within approximately twice the crown radius.
- A legacy tree is overtopped when one or more adjacent non-legacy competitor trees is within the same or taller height strata compared to the legacy tree. This competitor tree(s) is generally within twice the crown radius, or is further away but blocking significant sunlight.
- A legacy tree is pierced when one or more non-legacy competitor trees is intersecting the crown of the legacy tree.

Legacy Tree Identification

Relatively large size is a common feature of legacy trees for a given species on a given site, but actual diameter and size dimensions vary (Table 3). Legacy structures often developed under more open stand conditions and with more frequent fire than younger forest trees. As such, they may have forms or features not found in younger neighbors. Legacy structures may be encroached or overtopped by more recent in-fill of the same, or a more shade tolerant or less fire-adapted species. Hardwood and shrub legacies are typically characterized by a relatively large trunk diameter (or root crown diameter for re-sprouted/ring-form individuals), relatively broad canopy with large and low-branching limbs, deeply furrowed and complex bark patterns, fire scars, and large dead limbs or cavities. Legacy conifers have similar characteristics but are more reliably identified by relative diameter or height rather than canopy form. To assist in identifying legacy trees, a dataset of cored trees from 59 plots in the Ashland watershed and an additional 100 plots distributed through the Rogue Basin was used to develop regression equations predicting the diameter of trees at 150 years old (Table 3). Ring-form resprouting hardwoods are indicative of greater longevity and smaller stem diameters are indicative of legacy status if the root crown of the resprouting rings is >3 feet in diameter.

Data

Quality Assurance/Quality Control

Quality assurance and quality control of monitoring data takes place before, during and after data collection. Before data collection quality control and assurance is provided by the monitoring working group. This ensures appropriate data are collected and the workflow for data management are sound. During data collection assurance is provided at the data collection and data curation stages. Data entry software (Survey123) has dramatically improved data collection for the RFP with quality control checks such as data validation designs (e.g., drop-down lists, formulas, etc.). The use of linked data collection and storage, using ESRI products, has also dramatically reduced the potential for errors stemming from manual data entry and curation. Statistical software will be used to identify outlier values in an iterative data assurance process, enabled by Dashboards linked to Survey123 in the ESRI environment. Quality control standards are under constant development and these updates will be integrated into this monitoring plan.

Management and Storage

Data will be managed and stored within a relational geodatabase on ArcGIS Online (AGOL). These data will be accessible to all partners through shared groups on AGOL.

Analysis

Legacy trees data will be summarized descriptively. Changes in the competitive environment will be summarized at the individual tree and species levels.

Lead

Lomakatsi Restoration Project

KEA #4 Condition – Oak trees - Young trees

Question: Have we increased recruitment and diversity of smaller and regenerating oaks?

This metric will inform the status of oak recruitment, their potential to become legacy trees, presence of encroaching vegetation, and the ability of a site to provide acorns as a first food to indigenous peoples and as forage for wildlife into the future.

Indicator

Abundance of younger age class oaks

Metric

Relative abundance of current compared to modeled age structure (based on size); i.e., count of species by DBH and height

Sampling Design (scale, temporal, spatial)

Effectiveness monitoring is necessarily limited to the stand scale for short-term treatment impacts but will be evaluated at the project scale as sufficient area within projects is treated.

Sampling design for this KEA will follow the methods in Rogue Forest Partners (2021). Plots will be circular and will cover 1/10 of an acre. Sample plots will be located using a spatially balanced random sample design. Random points will be assigned using the Generate Random Points tool, Data Management toolbox, ArcPro 3.0.3 with a minimum distance between plots that allows for good dispersal and fit of plots within the unit. Plots falling on roads or landings will be moved to the interior of the vegetation type by 2x plot radius but plots falling in skips, openings, or other vegetation types within the unit perimeter will be measured. In non-commercial units, plots will sample 10 points for every 100 ac of project area, generally resulting in a 10% frequency sample. The sample frequency in areas with significant diversity in forest types or structures may be increased to 15 points for every 100 ac. For units < 100 ac, a minimum sample threshold of 5 points should be used. In commercial stands, monitoring plots will be located using a systematic sampling approach in accordance with USFS stand exam protocols. In these cases, the sampling density will be 1 plot for 5 acres, with at least 3 plots per unit for smaller units, generally resulting in a 20% frequency sample unless treatments are <100 acres and relatively uniform in nature (e.g., plantations) sample density will be reduced to (10%) one plot for every 10 acres. Plots will be sampled no more than one year prior to treatments, and resampled at least one year after treatments.

Methodology

In addition to recording cover classes by oak species for each size class, oak seedlings (<1” DBH, or <4.5’ tall) will be counted in a circular subplot located at the center point of each vegetation plot using the protocol recommended in the FIREMON Tree Data Sampling Method (Lutes 2006). The subplot size will be determined by the density of tree seedlings, and will range from 0.0025 acre to 0.01 acre (see Lutes 2006 for subplot sizing). Within each subplot, seedlings will be tallied by species and assigned a status (healthy, unhealthy, sick, or dead). Each seedling will also be assigned a size class according to their height (0.2, 1, 2, 3, or 4 feet).

Data

Quality Assurance/Quality Control

Quality assurance and quality control of monitoring data takes place before, during and after data collection. Before data collection quality control and assurance is provided by the monitoring working group. This ensures appropriate data are collected and the workflow for data management are sound. During data collection assurance is provided at the data collection and data curation stages. Statistical software will be used to identify outlier values in an iterative data assurance process, enabled by Dashboards linked to Survey123 in the ESRI environment. Quality control standards are under constant development and these updates will be integrated into this monitoring plan.

Management and Storage

Oak seedling counts according to status and height class will be stored within the same spreadsheet as the environmental variable's matrix described for the Plant Community KEA. Data will be stored in a spreadsheet that will be uploaded to a shared folder until integration into a larger database is possible and necessary.

Analysis

Differences in seedling and sapling counts and cover estimates will be tested before and after treatments using ANOVA in R.

Lead

The Understory Initiative

KEA #5 Condition – Oak trees - Acorn crops

Question: Have we boosted acorn yields?

This metric will measure the ability of a site to provide acorns as a first food to indigenous peoples and as forage for wildlife.

Indicator

Abundant and high-quality acorn crops

Metric

Acorn crop abundance and viability

Sampling Design (scale, temporal, spatial)

To be determined

Methodology

This component of the monitoring plan is under development. A pilot study will be established in collaboration with tribal partners and Southern Oregon University to assess whether acorn quality and quantity is improved by restoration treatments. We are exploring an opportunity to adopt a tribal-lead protocol (under development). If that is not feasible, the KSON Monitoring Working Group will convene interested partners to establish a final protocol. Early discussions suggest monitoring will likely utilize acorn traps to capture fallen acorns (i.e., Greenberg 2000). Acorns would then be tested for viability, and biomass, which will be compared before and after treatments.

Data

Quality Assurance/Quality Control

To be determined

Management and Storage

To be determined

Analysis

To be determined

Lead for pilot study

Klamath Bird Observatory

KEA #6 Condition – Fuel loads

Question: Have surface fuel loads been reduced and the probability of low-severity fire increased in oak savanna, oak woodland, and mixed-oak conifer targets? Has low severity fire been reintroduced in oak savanna, oak woodland, and mixed-oak conifer targets?

We will assess fuel load conditions using a surface fire behavior model as an indicator, with a goal of low surface fuel load. By modeling the impact of current surface fuel loads on fire behavior, we can adaptively manage thinning methods and better predict potential fire severity.

Indicator

Low load surface fire behavior fuel model (based on flame length), fuel continuity (based on surface fuels, canopy base height, and canopy closure)

Metric

Surface Fire Behavior Fuel model; Canopy base height and canopy closure (field metrics)

Sampling Design (scale, temporal, spatial)

Effectiveness monitoring is necessarily limited to the stand scale for short-term treatment impacts but will be evaluated at the project scale as sufficient area within projects is treated.

Sampling design for this KEA will follow the methods in Rogue Forest Partners (2021). Plots will be circular and will cover 1/10 of an acre. Sample plots will be located using a spatially balanced random sample design. Random points will be assigned using the Generate Random Points tool, Data Management toolbox, ArcPro 3.0.3 with a minimum distance between plots that allows for good dispersal and fit of plots within the unit. Plots falling on roads or landings will be moved to the interior of the vegetation type by 2x plot radius but plots falling in skips, openings, or other vegetation types within the unit perimeter will be measured. In non-commercial units, plots will sample 10 points for every 100 ac of project area, generally resulting in a 10% frequency sample. The sample frequency in areas with significant diversity in forest types or structures may be increased to 15 points for every 100 ac. For units < 100 ac, a minimum sample threshold of 5 points should be used. In commercial stands, monitoring plots will be located using a systematic sampling approach in accordance with USFS stand exam protocols. In these cases, the sampling density will be 1 plot for 5 acres, with at least 3 plots per unit for smaller units, generally resulting in a 20% frequency sample unless treatments are <100 acres and relatively uniform in nature (e.g., plantations) sample density will be reduced to (10%) one plot for every 10 acres. Plots will be sampled no more than one year prior to treatments, and resampled at least one year after treatments.

Methodology

Fuel load monitoring is a component of the Rogue Forest Partners' Vegetation and Fuels Field Protocols (RFP 2021). We will assess KEAs for fuel loading using surface fire behavior models, measured by fuel model (Scott and Burgan 2005) and base height of continuous canopy fuels (canopy base height) using a local photo series to improve fuel model assignment consistency (Perchemlides 2020). Within plots, basic unit conditions of slope, aspect, and canopy closure are recorded. Fuel model and canopy base height are recorded pre/post burn as indicators of fuel reduction and for fire modeling. To visually document the unit and fire effects, a representative photograph of stand conditions is taken pre-treatment and pre-burn, along with a second-low angle photograph of representative surface fuels. The percent live cover of understory trees and shrubs, and herbaceous cover (optional) are each recorded pre/post burn. For tree mortality, the percentage of recently dead trees (needles or fine twigs still present) in each relevant size class is recorded pre-burn and used to correctly assign mortality from fire post-burn. Litter and duff depths can be recorded pre-burn if needed for smoke modeling (optional). During pre-burn monitoring, the unit-scale condition of legacy trees and large down wood or snags are noted (RFP 2021 Fire Effects Monitoring Method).

At a minimum, fire behavior metrics of flame length (average and maximum) and rate of spread (average) quantify representative fire behavior. Observations are updated when fire behavior, weather conditions, or ignitions change rather than at a standard time interval. Peak fire events such as torching, crowning, spotting, or escape, and other descriptive metrics including bole char height, fire type, or flame zone depth are recorded when relevant. The timing, location, and outcome of the test burn are always recorded.

Data

Quality Assurance/Quality Control

Quality assurance and quality control of monitoring data takes place before, during and after data collection. Before data collection quality control and assurance is provided by the monitoring working group. This ensures appropriate data are collected and the workflow for data management are sound. During data collection assurance is provided at the data collection and data curation stages. Data entry software (Survey123) has dramatically improved data collection for the RFP with quality control checks such as data validation designs (e.g., drop-down lists, formulas, etc.). The use of linked data collection and storage, using ESRI products, has also dramatically reduced the potential for errors stemming from manual data entry and curation. Statistical software will be used to identify outlier values in an iterative data assurance process, enabled by Dashboards linked to Survey123 in the ESRI environment. Quality control standards are under constant development and these updates will be integrated into the RFP monitoring plan

Management and Storage

Data will be managed and stored within a relational geodatabase on ArcGIS Online (AGOL). These data will be accessible to all partners through shared groups on AGOL.

Analysis

We will summarize predicted fire behavior metrics in all treated areas and observed fire behavior from prescribed burns. In addition, changes in predicted fire behavior metrics and canopy base height following restoration treatments will be analyzed with ANOVA in program R.

Lead

Lomakatsi Restoration Project

KEA #7 Condition – Fire regime

Question: Have fire regimes within oak targets been restored: Fire regime I in oak savanna, oak woodlands, and oak conifer and fire regime III in oak chaparral?

Fire regimes quantify the spatial, temporal, and characteristic severity of fire disturbance. Dramatic changes to the structure and composition of oak ecosystems have resulted from the interruption of natural fire regimes, effectively beginning in the 1850s, due to fire exclusion resulting from fire suppression, the forcible removal of aboriginal peoples who used fire to manage the land, and agricultural conversion.

To broadly measure progress toward restoring fire regimes, as described by Barrett et. al (2010, Table 2-1) within oak targets, we will model expected fire behavior (surface, passive, or crown fire) as a surrogate for fire severity, grouped by oak targets by subbasin as an indicator. Assessing the post-treatment landscape expected fire severity and disturbance frequency, relative to historic fire regimes will measure treatment success and inform future prescriptions.

Indicator

Proportion of landscape [e.g., subbasin (HUC6)] oak targets within natural Fire Regime [LANDFIRE (Barrett et al. 2010] disturbance frequency interval and severity (actual and predicted), relative to desired KEA fire regime condition for oak targets.

Metric

Landscape proportions of time since disturbance (within recent 30-year timeframe) and associated severity of disturbance relative to natural fire regime, utilizing data amassed from Monitoring Objective #1 (spatially tracking treatments and natural disturbance). A 30-year timeframe has been selected for consistency with LF Fire Regime 1 and typical climatic periods; past disturbance severity and expected proportions of fire severity (surface, passive crown fire, crown fire). We will use indicators and metrics from KEA #6 to model predicted fire type as a surrogate for disturbance severity, where surface fire equates to low severity, passive crown fire to moderate severity and crown fire to high severity.

Sampling Design (scale, temporal, spatial)

This metric will be measured at the project scale and landscape scale. Analysis will be completed on moderate-term intervals and repeated periodically, approximately every 6 - 10 years, to allow for updated datasets and landscape-level habitat changes.

Data

Analysis

We will assess fire regime condition by measuring time since disturbance (mechanical or fire), the severity of actual past disturbances, and proportions of predicted severity classes in the most recent 30-year timeframe and compare to natural fire regime disturbance frequency and severity. We will also include some measure of magnitude of departure from fire regime disturbance return intervals. The fire regime condition will be assessed by reviewing time since fire surrogate disturbance and/or disturbance [mechanical or wildland fire (prescribed or wild)], and associated severity of past disturbance. We will summarize stand-scale changes at the landscape in focal geographies using fire modeling software (IFTDSS, Flammap, etc.) to assess proportions relative to KEA desired conditions (Table 1). We will also generate predictive fire regime modeling (predicted severity classes) at the focal geography landscape and derive additional fire behavior metrics (rate of spread and flame length) around fire hazard.

Lead

Bureau of Land Management

KEA #8 Condition – Breeding birds

Question: Have we improved habitat conditions to increase focal bird species diversity?

We will assess the condition of breeding birds using the presence of focal bird species associated with a given oak habitat as an indicator. By using a suite of focal bird species associated with desired structural and compositional traits of target oak habitats, we can measure success of restoration treatments in their ability to provide habitat features that sustain wildlife.

Indicator

>75% of focal bird species present (6 total Oak Savannah; 5 total Oak Chaparral; 9 total Oak Woodland and Conifer)

Metric

Presence and abundance of focal species; avian community composition

Sampling Design (scale, temporal, spatial)

Effectiveness monitoring is necessarily limited to the stand-scale for short-term treatment impacts but will be evaluated at the project-scale as sufficient area within projects is treated.

Because bird populations fluctuate annually, and many are experiencing range wide declines, a study design that can differentiate treatment effects within that expected variation is needed. For this reason, the breeding birds KEA will apply a Before-After-Control-Impact (BACI) study design to monitor changes in the bird community in response to oak restoration. We will apply a hierarchical sampling design where points are individual survey locations, stands are relatively homogeneous plant communities with a similar structure, and sites are spatially independent (generally >1 km apart); the stand is the sampling unit (Figure 4). We will pair each restoration stand with a nearby control stand (generally within 500–1,000 m) that is the same oak habitat type and has similar canopy and understory cover. Point count and vegetation survey points will be established as subsamples within each stand (Figure 4). We will generate random points located at least 150 m apart and >50 m from the edge within each stand in ArcGIS using the Create Random Points tool. Within a project area, if possible, we survey ~150 treatment and control survey points within 25 treatment stands and 25 associated control stands. Bird communities will be assessed on plots that do not conform to the size of vegetation plots but are spatially aligned, where the stand is the sampling unit. Bird surveys will be completed prior to treatments, and resampled, preferably for two years following treatments and again incrementally into the future (e.g., years 5-6 post treatment and again 10-11 years post treatment).

Field Methodology

Within this plot network, breeding season (mid May-June) point counts will be conducted to characterize bird communities and determine the presence and abundance of focal species. Observers will follow a standardized point count protocol (Stephens et al. 2010). Point count surveys begin within 15 minutes of sunrise and are completed within 4 hours. All birds detected by sight or sound during a 5-minute period are identified to species and recorded by the minute, along with the initial detection cue, and horizontal distance to each bird, estimated to the nearest meter. Estimating distance to the meter minimizes common biases with methods that place individuals in distance bins; e.g., the tendency to include birds that are close to the distance cut-offs as within the bin. This method gathers information on relative abundance and density of individual bird species, as well as species richness and community composition.

Data

Quality Assurance/Quality Control

Breeding bird point count data will be entered in the Avian Knowledge Network (see below), and undergoes a series of QA/QC queries, first during data entry to prevent common entry errors. When entered, data is first proofed by the biologist, and then checked by the project manager, who runs a series of queries designed to identify outliers and other data anomalies. When data has been checked, the project manager updates the data sharing levels to indicate that the data is clean and available for analysis.

Management and Storage

Avian data is entered and stored in Avian Knowledge Northwest, a regional node of the Avian Knowledge Network and a part of the Point Blue Science Cloud, a fedramp certified warehouse of avian data that supports the entry, storage, and analysis of data collected through diverse bird monitoring protocols.

Analysis

The KEA for breeding birds condition will be assessed using the percentage of focal bird species present, with greater than 75 percent of species present on at least 50 percent of the landscape indicating a “good” condition.

Treatment effectiveness will be evaluated by measuring changes in focal species presence and/or bird community composition. Data will include metrics pre and post restoration on treatment and control sites and early reporting (pre-restoration) will summarize results at the stand scale, such as a list of species detected and anticipated response of select focal species to treatment at the stand-scale. At the culmination of a project-scale study (~5-7 years) data will be analyzed to identify whether songbird community composition differed before and after treatments or differed on treated and untreated stands. We will use a community matrix of abundance or density estimates for focal species and test for an interaction between time (before or after) and treatment (treatment vs. control) using a PerMANOVA in R. PerMANOVA tests provide a pseudo F-ratio and p value similar to a multivariate analysis of variance and are thus useful in a BACI design to test the interaction between control and treatment groups before and after treatment. To interpret the results, it is often followed by additional analysis such as nonmetric multidimensional scaling and indicator species analysis to explore the potential causes of differences among groups; metrics collected for the other KEAs will be incorporated as potential explanatory variables.

Lead

Klamath Bird Observatory

Objective 3: Measure landscape scale Ecological Outcomes

Indicators described in Table 1 will be used to provide a landscape scale measure of KSON's progress towards the SAP's conservation implementation strategy outcomes for each KEA specific to a given target habitat. Acre-based stress reduction outputs, given adequate abundance and strategic placement, will scale up to landscape level conservation outcomes. To broadly measure success in maintaining or increasing target habitats ("Size - Amount on landscape" KEA; Table 1), we will determine the amount of a given target habitat on a landscape using the total area by region as an indicator. The goal for most target habitats given current threats is to maintain current acreage by preventing further conversions.

Successful conservation actions will lead to the desired short-, medium-, and/or long-term ecological outcomes:

- Increase the amount of the Oak Conifer target by 22,896 acres (7%); maintain the current amount of the other targets
- Increase the amount of Oak Savanna so that >26,250 acres (>25% of the target's total landscape) are characterized by >25% cover of high diversity native understory; maintain the amount of Oak Woodland acres with >25% native understory cover
- Increase the amount of Oak Woodland and Oak Conifer acres characterized by an abundance of younger age class oaks, 90% of legacy oaks retained, and abundant, accessible, and high-quality acorn crops to 142,759 and 159,552 acres respectively (>50% of each target's total landscape)
- Increase the amount of Oak Woodland and Oak Conifer that are characterized by a low load surface behavior model to 143,759 and 171,000 acres respectively (>25 % of each target's total landscape)
- Increase the amount of Oak Savanna, Oak Woodland, and Oak Conifer acres that have burned within the last 36 years at low-mixed severity (Fire Regime Class I) or would be expected to burn at low-mixed severity to 26,250, 71,379, and 65,500 respectively (>25 % of each target's total landscape); increase the amount of Oak Chaparral that have burned within the last 100 years at mixed-severity (Fire Regime Class III) to 19,904 acres (>50% of the landscape)
- Increase the amount of Oak Woodland and Oak Conifer that have >75% of the focal bird species present to 14,259 and 171,000 acres respectively (>25 % of each target's total landscape); maintain the amount of the Oak Savanna and Oak Chaparral acres that have >75% of the focal bird species present

Literature Cited

Alexander, J. D., C. R. Gillespie, S. Evans-Peters, and B. Brown. 2020. Klamath Siskiyou Oak Network Strategic Conservation Action Plan version 1.0. Klamath Siskiyou Oak Network and Klamath Bird Observatory, Ashland, OR.

Barrett, S., D. Havlina, J. Jones, W. Hann, C. Frame, D. Hamilton, K. Schon, T. Demeo, L. Hutter, and J. Menakis. 2010. Interagency Fire Regime Condition Class Guidebook. Version 3.0. Homepage of the Interagency Fire Regime Condition Class website, USDA Forest Service, US Department of the Interior, and The Nature Conservancy.

Caratti, J. F. (2006). Species Composition (SC). In: Lutes, Duncan C.; Keane, Robert E.; Caratti, John F.; Key, Carl H.; Benson, Nathan C.; Sutherland, Steve; Gangi, Larry J. 2006. FIREMON: Fire effects monitoring and inventory system. Gen. Tech. Rep. RMRS-GTR-164-CD. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. SC-1-10, 164.

Conservation Measures Partnership (CMP). 2020. Open standards for the practice of conservation (Version 4.0). Conservation Measures Partnership, Washington, DC.

Greenberg, C. H. 2000. Individual variation in acorn production by five species of southern Appalachian oaks. Forest Ecology and Management 132:199–210.

Latif, Quresh S., Richard L. Truex, Robert A. Sparks, and David C. Pavlacky Jr. 2020. Dry Conifer Forest Restoration Benefits Colorado Front Range Avian Communities. Ecological Applications 30 (6): e02142.

Lutes, D., R. Keane, J. Caratti, C. Key, N. Benson, S. Sutherland, and L. Gangi. 2006. FIREMON: Fire Effects Monitoring and Inventory System. Gen. Tech. Rep. RMRS-GTR-164-CD, Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Perchemlides, K., Metlen K. L., and Duwal, P. 2020. The Ashland Forest all-lands restoration supplement to the 2005 Scott and Burgan standard fuel model photo guide. The Nature Conservancy, Ashland, OR.

Rogue Forest Partners. 2021. Multiparty Monitoring Plan 2021: Rogue Basin Cohesive Forest Restoration Strategy.

Scott, J. H., and R. E. Burgan. 2005. Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ft. Collins, CO.

Stephens, J. L., S. R. Mohren, J. D. Alexander, D. A. Sarr, and K. M. Irvine. 2010. Klamath Network Landbird Monitoring Protocol. Fort Collins, CO: U.S. Department of Interior, National Park Service, Natural Resource Report NPS/KLMN/NRR-2010/187.

Whiteaker, L., J. Henderson, R. Holmes, L. Hoover, R. Lesher, J. Lippert, and N. Wogen 1998. Survey Protocols for Survey & Manage Strategy 2, Vascular Plants. Unpublished report. United States Department of Agriculture, Forest Service and United States Department of the Interior, Bureau of Land Management. On file with the Regional Ecosystem Office, PO Box, 3623.

Tables

Table 1. A viability assessment of the KSON geography including current condition ratings and desired future condition ratings for each target habitat based on key ecological attributes (KEAs) and indicator measures; this viability assessment identifies what the "healthy state" of each target looks like, how the target is doing today, and how to measure a target's "health" over time. Table from Alexander et al. (2020).

		Oak Savannah		Oak Chaparral		Oak Woodland		Oak Conifer	
KEA	Indicator	Current	Desired	Current	Desired	Current	Desired	Current	Desired
Size - Amount on landscape	Total area by region	Fair 249k acres	Fair 249k acres	Good 40k acres	Good 40k acres	Fair 286k acres	Fair 286k acres	Fair 319k acres	Good 342k acres
Condition - Plant Community	>25% native understory cover with high diversity	Poor <25% of landscape	Fair >25% of landscape			Fair >25% of landscape	Fair >25% of landscape		
Condition - Oak trees	Abundance of younger age class oaks					Fair >25% of landscape	Good >50% of landscape	Fair >25% of landscape	Good >50% of landscape
Condition - Oak trees	90% potential legacy oaks					Fair >25% of landscape	Good >50% of landscape	Fair >25% of landscape	Good >50% of landscape
Condition - Oak trees	Abundant, accessible, & high quality acorn crops					Fair >25% of landscape	Good >50% of landscape	Fair >25% of landscape	Good >50% of landscape
Condition - Fuel Load	Low load surface fire behavior model					Fair >25% of landscape	Good >50% of landscape	Fair >25% of landscape	Good >50% of landscape
Condition - Fire regime	Fire frequency within regime class interval (*1)	Poor < 25% of landscape as Fire Regime I	Fair >25% of landscape as Fire Regime I	Fair >25% of landscape as Fire Regime III	Good >50% of landscape as Fire Regime III	Poor < 25% of landscape as Fire Regime I	Fair >25% of landscape as Fire Regime I	Poor < 25% of landscape as Fire Regime I	Fair >25% of landscape as Fire Regime I
Condition - Breeding Birds	>75% of focal bird species present (*2)	Fair >25% of landscape	Fair >25% of landscape	Good >50% of landscape	Good >50% of landscape	Fair >25% of landscape	Good >50% of landscape	Fair >25% of landscape	Good >50% of landscape

Poor - Restoration increasingly difficult, may result in extirpation of target; **Fair** - Outside acceptable range of variation, requires human intervention; **Good** - Within acceptable range of variation, some intervention required to maintain

*1: Fire Regime I - <36 years since low severity fire; Fire Regime III - 36-100 years since mixed severity fire

*2: Four of six Oak Savannah focal species; Four of six Oak Chaparral focal species; Eight of 11 Oak Woodland focal species; Eight of 11 Oak Conifer focal species

Table 2. Metric, scale, and protocol proposed for monitoring each KEA/Indicator (see additional details in Table 1).

KEA	Indicator	Metric	Scale
Size - Amount on landscape	Total area by subbasin	Acreage of each target habitat	Landscape
Condition - Plant community	>25% native understory cover with high structural and compositional diversity, adequate structural conditions for the persistence of rare species, and minimal cover of state or federally listed noxious weeds	Diversity, composition, and structure of understory plant communities; extent and abundance of rare species populations; extent and abundance of noxious weed populations	Stand
Condition - Oak trees	Abundance of younger age class oaks	Relative abundance of current to modeled age structure (based on size)	Stand
Condition - Oak trees	Non-encroachment of 90% of existing and potential legacy oaks	Percent or categorical: encroached, overtopped, or pierced oaks	Stand
Condition - Oak trees	Abundant and high-quality acorn crops	Acorn crop abundance and viability	Stand
Condition - Fuel load	Low load surface fire behavior model (based on flame length, radial spread, suppression difficulty)	Fuel model; Canopy base height and canopy closure (field metrics)	Stand
Condition - Fire regime	Proportion of landscape (e.g., subbasin (HUC6)) oak targets within fire frequency interval (existing) and severity (actual and predicted), relative to desired KEA fire regime condition for oak targets	Time since disturbance and/or fire; severity of past disturbance and proportions of severity classes	Landscape
Condition - Breeding birds	>75% of focal bird species present (6 Oak Savannah; 5 Oak Chaparral; 9 Oak Woodland and Conifer)	Presence and abundance of focal species; avian community composition	Stand

Table 3. Diameter at breast height (DBH) of trees 150 years old based on regressions between age and DBH in the Ashland Watershed. Estimates for ponderosa pine and Douglas-fir included DBH, canopy position and the two-way interaction term. Canopy position was classified as suppressed (intermediate or suppressed trees) and free growing (dominant, co-dominant, or open grown trees).

Species	N	r^2	Canopy position	DBH (inches)	Lower 95%	Upper 95%
White fir (*Abies concolor)*	120	0.22	All	30	25	41
Pacific madrone (*Arbutus menziesii)*	132	0.31	All	29	25	35
Incense cedar (*Calocedrus decurrens)*	79	0.63	All	25	22	28
Tanoak (*Notholithocarpus densiflorus)*	47	0.15	All	36	25	104
Sugar pine (*Pinus lambertiana)*	93	0.60	All	28	26	31
Ponderosa pine (*Pinus ponderosa)*	211	0.47	Free growing	22	20	24
			Suppressed	17	15	22
Douglas-fir (*Pseudotsuga menziesii)*	622	0.47	Free growing	30	29	31
			Suppressed	19	18	21
Canyon live oak (*Quercus chrysolepsis)*	15	0.18	All	22	14	--
Oregon white oak (*Quercus garryana)*	15	0.81	All	9	7	10
California black oak (*Quercus kelloggii)*	67	0.62	All	13	12	15

Figures

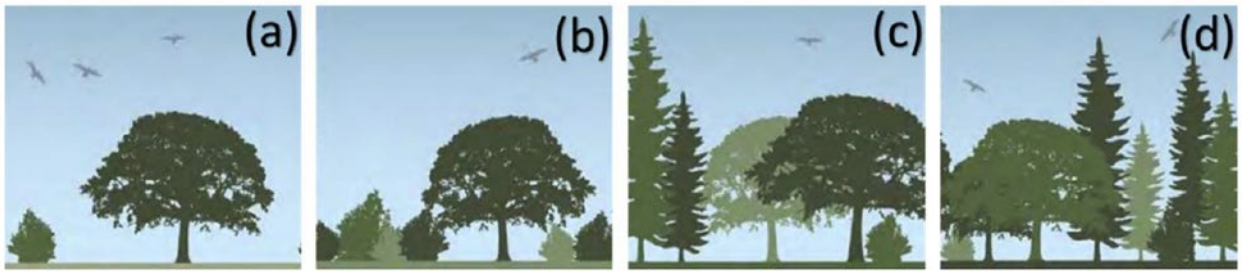

Figure 1. The four KSON strategic action plan target habitats -- Oak Savanna (a), Oak Chaparral (b), Oak Woodland (c), and Oak Conifer (d) [SAP Fig 2 from Alexander et al. (2020)].

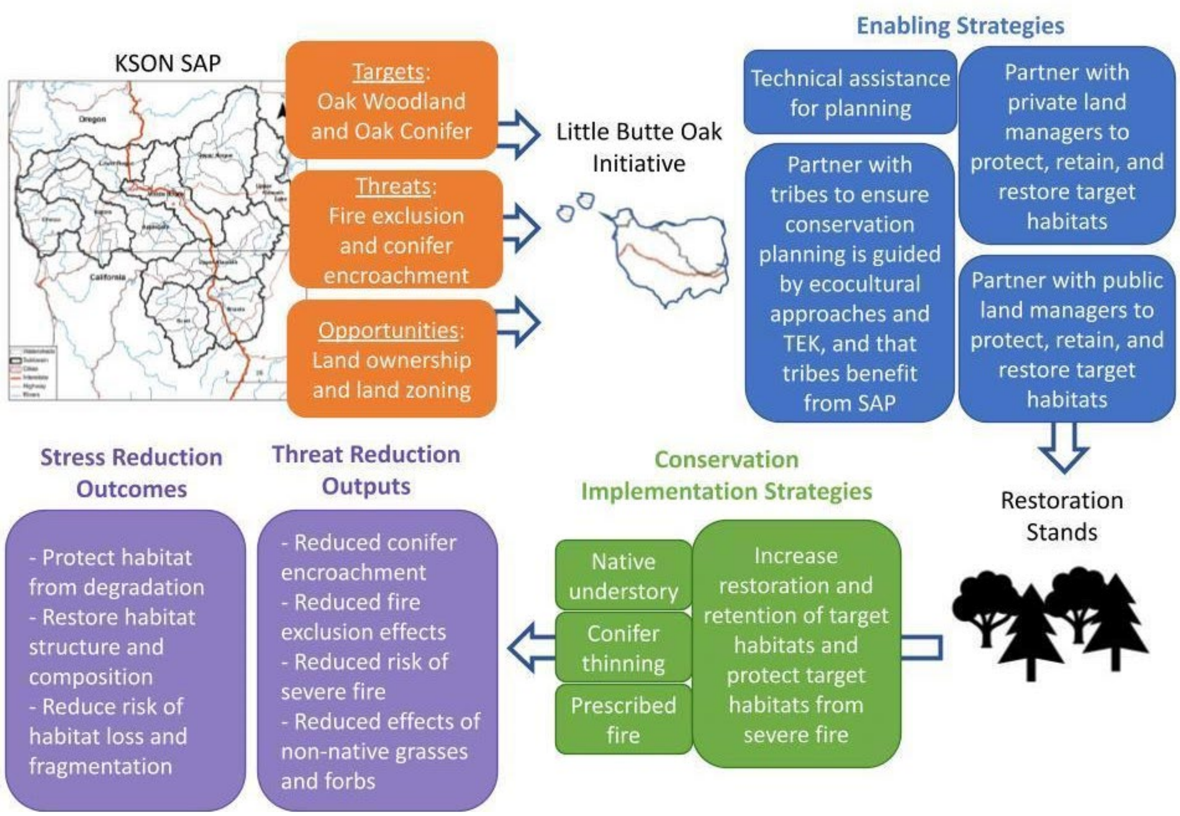

Figure 2. Decision making process and workflow leading from the KSON geography to a focal geography (i.e., LBOI), and ultimately sites where on-the-ground work will be implemented to produce threat reduction outputs and stress reduction outcomes.

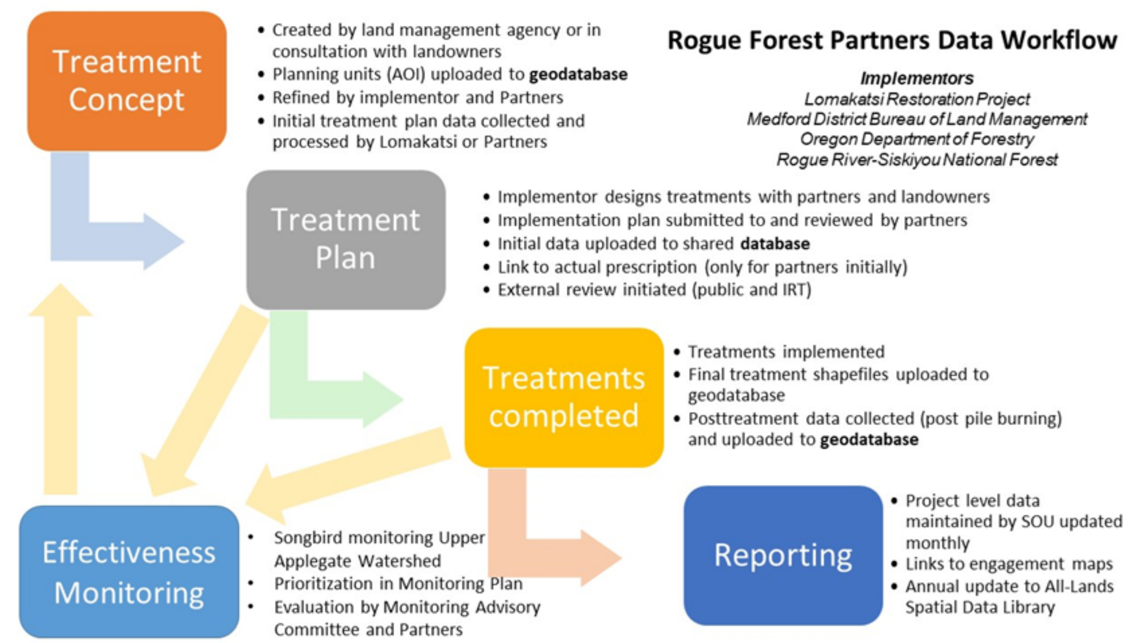

Figure 3. Workflow of data associated with Rogue Forest Partners. KSON will integrate the components of this monitoring plan as appropriate into the same data workflow.

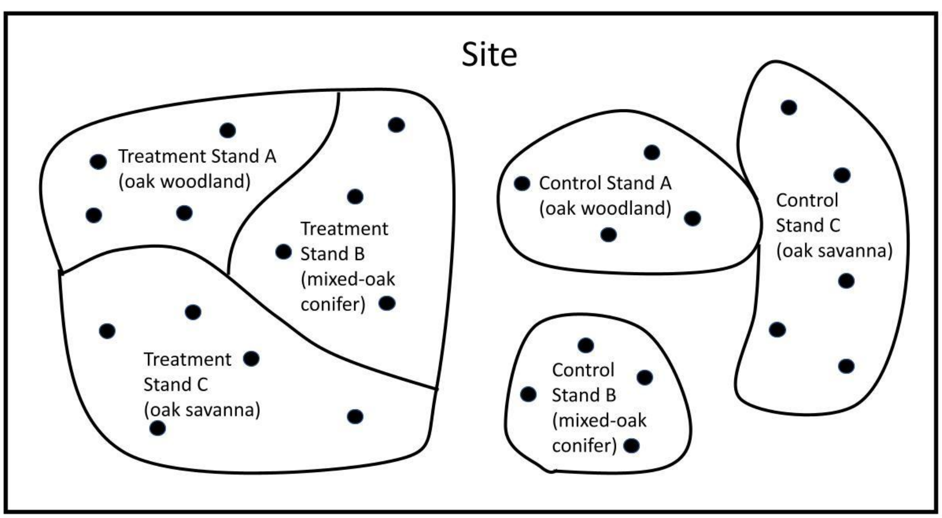

Figure 4. The Breeding Bird KEA will apply a hierarchical sampling design where points are individual survey locations, stands are relatively homogeneous plant communities with a similar structure, and sites are spatially independent (generally >1 km apart); the stand is the sampling unit.

Appendices

Appendix 1. Caratti (2006) FIREMON: Fire effects monitoring and inventory system.

Appendix 2. Greenberg (2000) Individual variation in acorn production by five species of southern Appalachian oaks.

Appendix 3. Lutes et al. (2006) FIREMON: Fire Effects Monitoring and Inventory System.

Appendix 4. Perchemlides et al. (2020) The Ashland Forest all-lands restoration supplement to the 2005 Scott and Burgan standard fuel model photo guide

Appendix 5. Rogue Forest Partners (2021) Multiparty Monitoring Plan 2021: Rogue Basin Cohesive Forest Restoration Strategy

Appendix 6. Stephens et al. (2010) Klamath Network Landbird Monitoring Protocol

Appendix 7. Whiteaker (1998) Survey Protocols for Survey & Manage Strategy 2, Vascular Plants