Restoring Oregon White Oak and Native Prairie Habitats in McDonald-Dunn Forest

Recommendations to the Forestry Executive Committee, OSU College of Forestry

Prepared by the Legacy Oaks Task Force and Prairie Task Force February 2008

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1. Summary

Following provisional adoption of the Conservation and Restoration Strategy for Native Prairie and Oak Habitats, the College of Forestry established two task forces for evaluating and ranking oak and prairie resources on McDonald-Dunn Forest. Inventories of oaks and prairies were completed in 2007, covering more than 400 acres of oak groves, 138 individual oak trees, and nearly 200 acres of meadows. The task forces developed guidelines and indicators as the basis for recommending which groves, trees and meadows should be restored.

Oak groves
- The Oak Task Force recommends a long-term commitment to active habitat restoration in 9 oak groves encompassing approximately 210 acres. These high priority *"Tier 1"* groves are distributed across the forest and include 3 groves (Carson Prairie, Forest Peak and Jackson Place) that are adjacent to meadows with a native prairie component.
- Restoration goals in Tier 1 groves depend on current conditions and whether the desired future condition is oak savanna or oak woodland. In general, restoration activities include releasing individual trees from competing trees, managing tree spacing, treating and restoring the understory, recruiting future legacy trees, and long-term maintenance and monitoring. It is recommended that restoration of Tier 1 groves begin within 5 years.
- *Tier 2* (moderate priority) status is recommended for another 11 areas comprising 169 acres where oak and madrone trees contribute compositional and structural diversity to the forest. The Task Force recommends release and retention of select oaks and madrones within Tier 2 groves rather than restoration of the entire grove. Release harvests should be timed to coincide with nearby forest operations such as thinning, salvage and road maintenance. Most of the acreage in Tier 2 is in the Oak Creek area.
- The task force recommends no restoration for 26 acres of oak groves in *Tier 3* However, when these areas are harvested, oak and madrone trees should be designated as *character trees* as defined in the Forest Plan.

Oak and madrone trees
- 43 oak trees from the 2007 inventory are recommended for full release within 2 years. Most of these *high-priority* trees are located near but outside the boundaries of Tier 1 groves. All have an open-grown form and are at moderate to high risk of loss to competitive exclusion.
- Full release is defined as removal of all competing trees to expose the full crown to sunlight. For mature trees, a release-gap radius of up to 100 feet is recommended.
- 22 oaks and 2 madrones designated for *moderate-priority release* are less vulnerable to competitive exclusion or were deemed to be lower quality than the high-priority trees. Release harvest could be done when forest harvest operations occur in the vicinity.
- 7 oaks designated for *low-priority release* are high quality but currently are not vulnerable to competitive exclusion. The recommendation is revisit these trees every 10 years to determine the need for release.
- There are an additional 97 oak and 7 madrone trees exceeding 30 inches dbh that have been identified through the Forest's periodic forest inventory and which were not evaluated as part of the oak inventory in 2007. These trees should be assessed using the protocol from the oak tree inventory and assigned a priority level for release.

Prairies

- The Prairie Task Force recommends active restoration in seven meadows of ecological significance based on the presence of remnant "hotspots" of native prairie plants: Carson Prairie (25 acres), Forest Peak (3 acres), Jackson Place (51 acres), Charlie Meadows near Chip Ross Park (14 acres), Oak Creek (37 acres), Hidden Meadows (a series of small meadows in the upper Soap Creek area), and Butterfly Meadows (1.3 acres).
- Currently, only Butterfly Meadows is being actively managed to maintain prairie habitat.
- Prairie habitat in the other six meadows is declining precipitously due to invasion by woody and exotic species, therefore it is critical that restoration begin within 2 years.
- Recommended restoration activities include removal of woody species, control of non-native species, reintroduction of native species through seeding and outplanting, and periodic controlled burning or mowing to remove thatch.
- Restoration of meadows adjacent to oak groves should be compatible and integrated with restoration activities in those groves.

Other recommendations

- Integrate oak-prairie database and GIS layers into Forest planning efforts.
- Develop site-specific restoration plans, prescriptions and harvest analyses for Tier 1 oak groves, prairies and for individual trees recommended for high-priority release.
- Develop marking guidelines for designating oaks and madrones as "*character trees*" and use that designation to identify and release oaks and madrones in conifer harvest units.
- Measure and assess the release potential of legacy trees (oaks or madrones with dbh > 24 inches and an open-grown structure) not documented in the 2007 inventory or periodic inventory, when they are encountered in the forest. Add them to the oak database.
- Utilize the Invasive Plant Species Management Plan developed for McDonald-Dunn Forest to control the spread of invasive species in and near restoration areas.
- Collaborate with the College of Agriculture on inventory, conservation, restoration and research of oak habitats on lands they manage near McDonald-Dunn to broaden the scale and impact of habitat enhancement.
- Develop a funding plan for monitoring and restoration activities in partnership with other organizations. As outlined in the Conservation and Restoration Strategy of the Forest Plan, revenue from release harvests should be used to conduct other restoration activities in oak groves and prairies. Revenues and costs associated with restoration can be used as a match when seeking funding from outside sources.

Research, Teaching and Demonstration

The growing interest in oak-prairie habitat restoration and management in Oregon has created a need for new knowledge in support of applied restoration methods and restoration ecology for these habitats. At the same time, there is increasing demand among college students for classes, field experience and degree programs in restoration ecology. With adoption of the Conservation and Restoration Strategy, and a commitment to oak-prairie restoration, the College of Forestry is positioned well to respond to these needs through research, teaching and outreach. The restoration activities recommended here will provide OSU faculty and students with opportunities to design, develop and implement restoration management practices, research, monitoring and education in a broad and interdisciplinary context. The Task Forces have identified several potential research and education projects toward this end.

2. Introduction

2.1 Background

In 2006 the College of Forestry provisionally adopted the Conservation and Restoration Strategy for Native Prairie and Oak Habitats in McDonald-Dunn Forest (Appendix 3 of the 2005 Forest Plan). The goals of the Strategy are to (1) conserve and restore the ecological functions and cultural values of some of the remnant prairie, savanna and oak habitats in McDonald-Dunn Forest; (2) incorporate research, teaching, and demonstration opportunities with the restoration activities; and (3) establish collaborative partnerships with governmental and non-governmental entities to most effectively accomplish goals 1 and 2.

In 2007 the College established the Legacy Oaks Task Force (LOTF) and the Prairie Task Force (Table 1) which were charged with recommending to the College where on the Forest the Conservation and Restoration Strategy should be implemented. This report summarizes the Task Forces' recommendations and the process that was used to arrive at those recommendations.

Table 1. Members of the Legacy Oaks and Prairie Task Forces.

Legacy Oaks Task Force		
Name	**Area of expertise**	**Affiliation**
Dave Hibbs	forest ecology / hardwood silviculture	OSU, Dept of Forest Science
Al Kitzman	park planning / oak habitat restoration	Benton County Parks
Susan Morre	restoration ecology	OSU, Dept of Forest Resources
Rob Pabst, Chair	forest ecology	OSU, Dept of Forest Science
Dan Rosenberg	landscape ecology/wildlife biology	OSU, Dept of Fish & Wildlife
Dave Vesely	wildlife biology	Oregon Wildlife Institute
David Zahler	media/outreach, forest management	OSU, Forestry Media Center
Prairie Task Force		
Name	**Area of expertise**	**Affiliation**
Matt Blakeley-Smith, Chair	conservation biology	Institute for Applied Ecology
Deborah Clark	prairie and wetland ecology	OSU, Biology Program
Paul Doescher	restoration ecology	OSU, Dept of Forest Resources

2.2 Historical and current day context

At the time of Euro-American settlement, it is estimated that oak savanna and upland prairie habitats occupied more than 1,000,000 acres of the Willamette Basin (Hulse 1998) and about 72% of what is now McDonald-Dunn Forest (OSU College of Forestry 2005). At present, it is likely that less than 5% of those habitats remain, and most are on private land. These habitats evolved under a warmer climatic regime and were maintained by Native Americans through prescribed burning and other practices. Land conversion, population growth, vegetation succession, fire suppression, and the spread of non-native invasive plants have all taken a toll on the oak-prairie habitats, compromising their ecological function. It should be no surprise that several plant and animal species associated with or dependent on these habitats are in decline or listed by state and federal governments as sensitive, threatened or endangered. Furthermore, there is evidence that the Willamette Valley was an Ice Age refugium for Oregon white oak

(Mathewson et al. 2003), lending further urgency to conserving oaks from a perspective of genetic diversity.

Interest in conserving and restoring oak and prairie habitats is growing rapidly among citizens, government agencies and non-governmental organizations. Indeed, more and more public and private landowners are dedicating acreage and resources to oak and prairie habitat restoration in the Willamette Valley, Puget Trough and on Vancouver Island. Some landowners are able to take advantage of conservation incentive programs. In other areas, groups of landowners and organizations such as watershed councils are pooling their resources and knowledge to have a larger impact on habitat restoration. Restoration efforts are also underway on many public lands in the Valley, including Finley and Baskett Slough National Wildlife Refuges, numerous State, County and City parks, and federal lands managed by the Forest Service and Bureau of Land Management. On many fronts there are opportunities for collaboration and partnership that may enhance the ability to leverage funding for restoration. For instance, the recent Declaration of Cooperation between Benton County and Oregon State University for the Benton County Prairie Species Habitat Conservation Plan illustrates one such opportunity, and underscores the importance of an integrated approach to restoration.

The growing commitment to oak-prairie restoration and management in Oregon has created a need for rigorous research, monitoring and outreach in support of applied restoration methods and restoration ecology. Moreover, there is greater demand among college students across the country for classes and degree programs in restoration ecology. With adoption of the Conservation and Restoration Strategy, and a long-term commitment to oak-prairie habitat restoration in McDonald-Dunn Forest, the College of Forestry will be well positioned to meet the needs of this diverse clientele through new research, teaching and outreach.

Legacy oaks form the core of a small grove in a savanna restoration at Bald Hill.

3. Inventory of Oak and Prairie Habitats

3.1 Inventory protocols

The LOTF and College Forest staff developed a two-phase protocol to assess the condition and characteristics of oak habitats in McDonald-Dunn. The protocol for Phase 1 was designed so that one person could collect enough basic descriptive information to permit a rigorous and defensible assessment of oak habitats. Phase 1 was completed in summer of 2007 by Keri Sadler, a student worker majoring in Forest Resources. The protocol for Phase 2 was designed to provide more detailed information, such as the abundance of tree regeneration and non-native invasive plants. These attributes should be incorporated into baseline monitoring, which is scheduled for 2009 but could begin as soon as fall 2008 if classes can be involved.
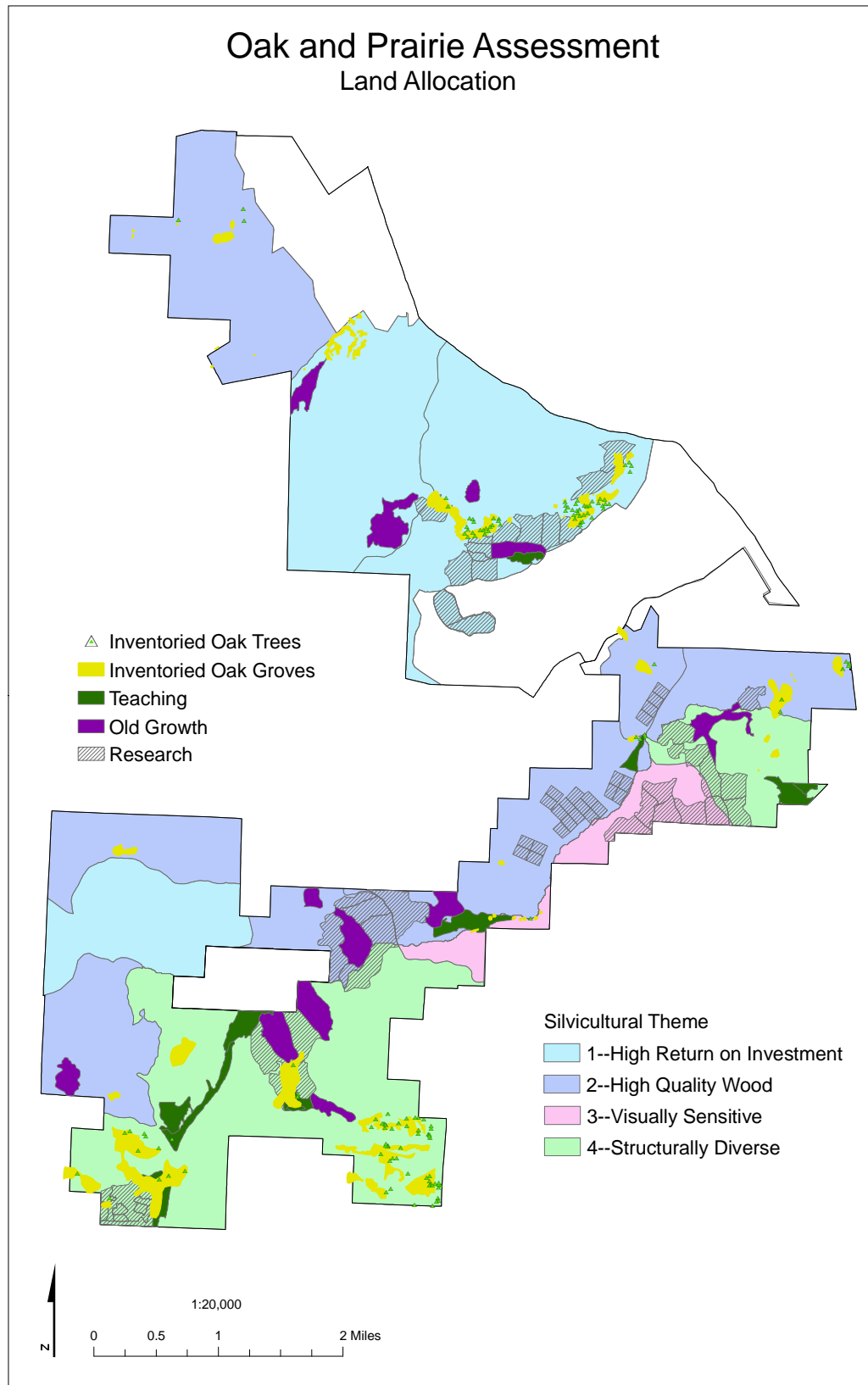
The Phase 1 inventory distinguished clusters of oaks (oak groves) from isolated, individual trees growing within conifer-dominated forest. Oak groves were defined as two or more oaks growing in close proximity; in addition, the inventory included areas with madrone trees because of their importance in early seral habitats and their association with oaks. Some groves were separated into smaller inventory units to facilitate data collection. Attributes recorded for oak groves included grove type (open grown, edge, stand grown), a tally of the number of oaks by diameter class, the number of madrone trees, topographic position, a subjective rating of overall grove quality, and the revenue potential associated with releasing oaks from conifer competition (Appendix 1). Oaks with dbh > 24 inches and with an open-grown growth habit (broad crown and large, low branches) were considered legacy trees (i.e., those establishing prior to Euro-American contact). Legacy oaks were tallied into two diameter classes: 24-36" and >36". All other oaks were considered to have established post-contact and were tallied in three diameter classes (<6", 6-24", >24").

Data collected on individual, isolated trees included diameter, tree form (open grown, semi-open, stand grown), crown class, live crown ratio, crown fullness horizontally and vertically, and ratings on tree quality and vulnerability to loss from competitive exclusion (Appendix 2). These attributes were also recorded for notable individual oaks (mostly legacy oaks) growing within the boundaries of oak groves.

Grove boundaries and tree locations were mapped by Forest staff using GPS so that additional information such as management theme, site class, elevation, and proximity to other features could be extracted from existing GIS layers. Grove acreages were calculated using the geo-referenced boundaries. In addition, digital photographs were taken of each oak grove and nearly all of the individual trees that were measured.

The assessment of prairie habitats was conducted in spring 2007 through a contract with Salix Associates. Eighteen meadows of interest were identified by McDonald-Dunn staff and a botanical survey was completed for each. A species list was created for each meadow along with cover estimates of dominant species. Each site was assigned a ranking of habitat quality based on the presence or diversity of native prairie species, introduced species, rare or threatened species, and immediate threats. Meadow locations were marked using a GPS and were incorporated into existing GIS maps. Butterfly Meadows, a high-quality remnant prairie co-managed by Starker Forests and the College, was not included in the 2007 survey since its habitat quality and composition were assessed recently by Forest staff.

Figure 1. Oak groves and trees inventoried in 2007.

Oak and Prairie Assessment
Land Allocation

Legend:
- △ Inventoried Oak Trees
- Inventoried Oak Groves
- Teaching
- Old Growth
- Research

Silvicultural Theme
- 1--High Return on Investment
- 2--High Quality Wood
- 3--Visually Sensitive
- 4--Structurally Diverse

1:20,000

0   0.5   1   2 Miles

3.2 Inventory overview

Phase 1 of the oak inventory was focused on areas known to have high concentrations of oaks, including legacy individuals. It is important to recognize, however, that the groves and trees inventoried in 2007 do not constitute the entire oak resource in McDonald-Dunn Forest.

Oak groves were inventoried in 17 areas distributed throughout the forest (Figure 1). In all there were 61 inventory units covering about 405 acres (Appendix 3). The area of individual inventory units ranged from less than an acre to 85 acres. The number of oak trees within these units ranged from two to several hundred; a similar range was found for the number of madrone trees in these areas.

The tree inventory included 138 individual oaks with dbh ranging from 24 to 60 inches. Twenty-six of the oak trees were located outside of grove boundaries (i.e., isolated). There are an additional 97 oaks and 7 madrones greater than 30 inches in diameter that have been identified through the periodic forest inventory. These trees have not yet been evaluated for attributes such as quality, risk rating, crown characteristics or release potential.

Data from the 2007 inventory of oak groves and trees were summarized into spreadsheets, and tree and grove locations were overlaid on various GIS coverages and digital orthophotos (Appendix 4) to facilitate evaluation and ranking.

The inventory of 18 meadows covered approximately 200 acres (Appendix 4). Six meadows contain significant components of native prairie (prairie "hotspots"). The remaining 12 meadows are dominated by introduced species and have very low native species cover. Although these areas function as open space, the native species that form the foundation of a functional prairie may have been lost. No new observations of threatened or endangered species were documented on the Forest.

4. Evaluation and Ranking of Oak and Prairie Habitats

The LOTF established guidelines and indicators for evaluating and ranking oak habitats. The guidelines build on the general principles laid out in the Conservation and Restoration Strategy.

4.1 Guidelines for evaluating and ranking oak habitats

1. Focus on **high-priority habitats**:
   - Oak groves with a legacy component (i.e., former savanna or open woodland)
   - Large, open-grown trees
   - Trees and groves adjacent to remnant prairie or meadows
   - Unique habitat types (e.g., madrone stands)
   - Habitat for sensitive wildlife species (e.g., western bluebird, acorn woodpecker)

2. Maintain options to ensure the **long-term viability** of oak habitats, including the release of existing legacy oaks and recruitment of future legacy oaks.

3. Capture a **representative cross-section** of stand types (open grown, edge, forest grown), topographic positions and site classes.

4. Consider **connectivity** of habitats within McDonald-Dunn and in relation to oak/prairie habitats beyond the forest boundaries (Figure 2).

5. Save the **highest quality** trees and habitats and those that are **most likely to respond** to release and restoration.

6. Build **capacity** for research, teaching and demonstration.

Figure 2. Occurrences of threatened and endangered species near McDonald-Dunn Forest.
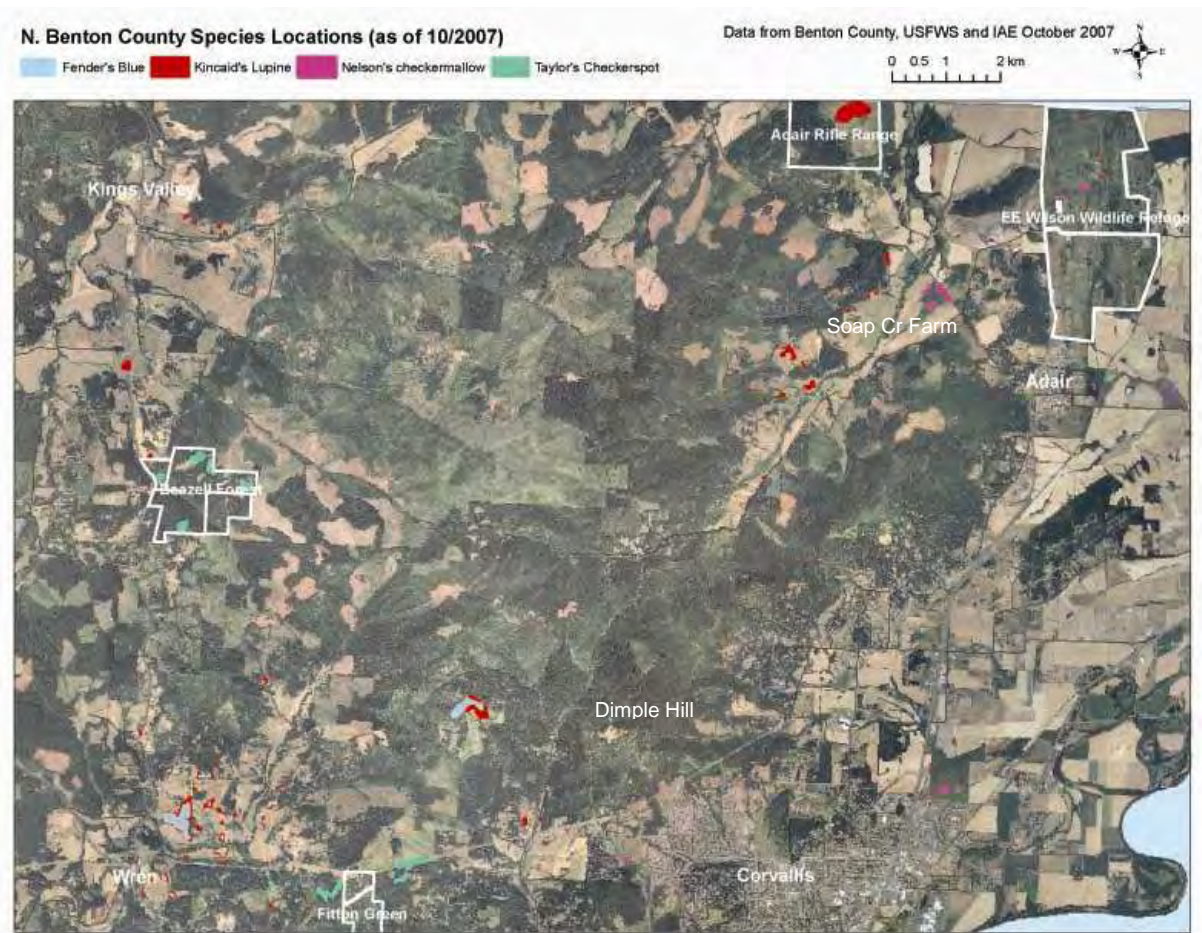
4.2 Indicators for oak habitats

For each indicator (Table 2), simple qualitative categories (e.g., high/medium/low; yes/no) were employed for developing an evaluation matrix of the inventory data.

Table 2. Indicators used for evaluating and ranking oak groves and oak trees.

Indicators for ranking oak groves	Indicators for ranking oak trees
Grove size (acres)	Tree diameter
Grove quality (observer rating)	Tree quality (observer rating)
Presence of legacy oaks	Tree form
Presence of oak regeneration	Crown class
Proximity to remnant prairie or meadow	Crown fullness
Proximity to other oak habitats	Tree vulnerability (risk of loss to competition)
Proximity riparian areas or wetlands	Proximity to remnant prairie or meadow
Proximity to recreation or high-use areas	Proximity to other oak habitats
Access for teaching and demonstration	Proximity riparian areas or wetlands
Land allocation conflict (e.g., research sites)	Access for teaching and demonstration
Revenue potential	Land allocation conflict (e.g., research sites)

4.3 Evaluation and ranking process

The LOTF used a multi-step process to evaluate and rank oak groves and trees. First, team members independently ranked groves and trees on the basis of the guidelines and indicators. The independent rankings were then compiled, after which the Task Force and College Forest staff met to review and discuss the rankings and to develop draft recommendations. At this stage some groves that had been subdivided into smaller inventory units were reconsolidated into larger groves if it could be justified in terms of habitat quality, connectivity and potential management efficiency. Finally, team members made follow-up visits to numerous groves to resolve any remaining uncertainties about grove status and condition. The Task Force then reached consensus on its final recommendations.

The Prairie Task Force assigned a ranking of habitat quality for each meadow based on the presence and diversity of native prairie species, introduced species, rare or threatened species, and immediate threats. Discussions with the inventory contractor also informed the ranking process.

Task Force members discuss guidelines and indicators for evaluating oak groves with College Forests staff.

5. Recommendations

Recommendations are presented separately for oak groves, oak and madrone trees, and prairies. An overview of how the recommendations are structured is shown in Figure 3. More detailed recommendations on management goals, objectives and tasks are provided in Appendix 5.

Figure 3. Overview of recommendations.
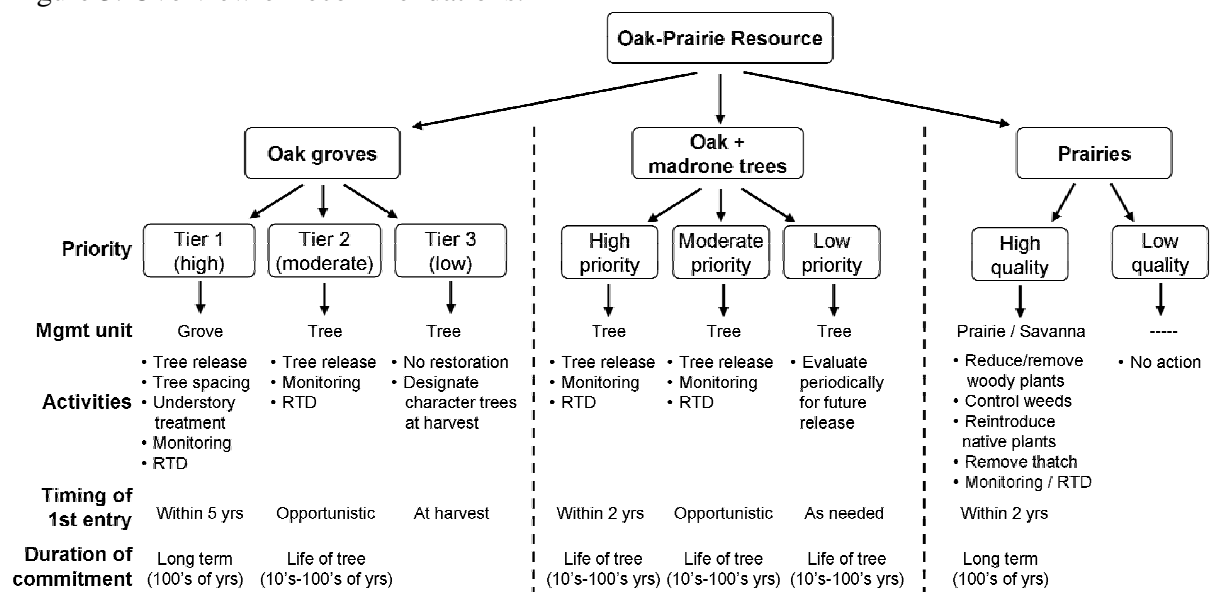
5.1 Oak groves

The Task Force recommends a three-tiered approach for prioritizing oak groves. Each grove is comprised of one or more inventory units (Appendix 3). Brief descriptions of the groves and justifications for their ranking follow the description of each tier.

5.1.1 Tier 1 Groves – Long-term Conservation and Restoration

Nine groves designated as Tier 1 are the highest priority for conservation and restoration (Table 3). These groves currently provide or have the potential to provide high-quality habitat as well as ample opportunities for research, teaching and demonstration. The Task Force recommends that the College begin restoration activities in these groves within five years and maintain and perpetuate these groves for the long term as high-quality oak habitat. Maintaining oak habitats over the long term may provide resilience to conditions imposed by a changing climate, and any management strategy must be adaptable to what those conditions bring (Millar et al. 2007).

The specific management activities undertaken within each Tier 1 grove will depend on current conditions and desired future conditions. In general, restoration should involve the release of oaks from conifer competition, spacing of existing oaks, treatment of understory vegetation, recruitment of future canopy oaks, and long-term grove maintenance. Desired future conditions include oak savanna and oak woodland, both of which may be objectives within a single grove. Oak savanna is defined here as scattered open-grown oaks or small clusters of oaks (multiple trees that have grown together and form a "single" crown) with tree canopy cover ranging from 5 to 30% in an area dominated by native prairie grasses and forbs. Target densities in oak savanna range from 3 to 10 trees or clusters per acre. Desired future condition for oak woodland is

defined as open-grown or forest-grown oaks and madrones with semi-open to continuous canopy cover ranging from 30 to 70% and an understory of native shrubs and herbs. Oak woodland may include other hardwoods and conifers provided they comprise less than 20% of total canopy cover. In some instances it may be desirable to maintain some Douglas-fir in oak woodland to benefit western gray squirrels (Ryan and Carey 1995). Restoration activities in Tier 1 groves that are adjacent to prairies must be integrated and compatible with the habitat goals for those prairies.

The nine groves in Tier 1 total about 210 acres (Figure 4), including 67 acres in Management Theme 1 (short-rotation silviculture), 59 acres in Theme 2 (high-quality timber), 0.5 acres in Theme 3 (viewshed/even-aged silviculture), and 82 acres in Theme 4 (structural diversity) (Figure 4, Table 3). Grove acreages are based on the approximate boundaries delineated at the time of inventory. Actual acreages dedicated to restoration may be higher or lower depending on the net effect of adding buffers around the groves and reductions from refining grove boundaries. All of the Tier 1 groves except one are greater than 5 acres, which is considered the minimum area for viable habitat and management efficiency in California oak woodlands (Bleier et al. 1993). The order of groves in the descriptions below is by Management Theme (1-4) and generally from northeast to southwest through the forest; it does not reflect priority.

> **Carson Prairie** (unit #'s 16, 18-20, 27-29, 56). Large grove in Theme 1 in Dunn Forest with numerous open-grown and forest-grown oaks. Grove is adjacent to meadow and prairie hotspots and is located just uphill from Soap Creek Farm (OSU), thus providing broader connectivity with other oak habitats. Partial patch-cut harvest is currently planned for nearby stands, presenting an opportunity to couple restoration work with that harvest.

> **Forest Peak** (#22). Prominent high-elevation location on south-facing slope in Theme 1 with many legacy and post-contact oaks. The Forest Peak grove is adjacent to native prairie hotspots.

> **Staats Creek** (#1). Northernmost grove in Dunn Forest in Theme 2. The northeast-facing slope with mixed oak and Douglas-fir flattens into wet area with a very nice pocket of open-grown oaks, including a 4-foot diameter legacy oak and a 2-foot diameter madrone. Grove is bordered by recent harvest units. This area is slated for thinning in the current forest plan.

> **Blake Homestead** (#24). A few legacy oaks surround this old homestead in Theme 2. Cultural/interpretive value of the site and its proximity to Adair Village, Adair Park and Highway 99 warrant Tier 1 status. Restoration would need to abide by state historic preservation guidelines, which at this site would include retention of non-native black locust trees.

> **Calloway Creek** (#23). Oak woodland in low-lying terrain on mostly level ground in Theme 2. Opportunity for outreach given the popular trail that runs through the grove. Thinning is scheduled for a stand just to the southwest of this grove in the current forest plan.

> **Poison Oak Road** (#52). Patch of nice of oaks and madrones surrounded on three sides by recent harvest units in Theme 2. Regenerating/resprouting madrone on east side of spur road should be incorporated in the restoration plans for this grove, which provides a stepping stone of connectivity down to Soap Creek and across to Carson Prairie.

> **720 Road / Soap Creek** (#62). Unique stand with a high concentration of madrone and documented high diversity of salamanders (D. Vesely, pers. comm.), likely due to its shallow,

rocky soils. This area, in Theme 2, was not included in the 2007 inventory but was singled out as exemplary in the Conservation and Restoration Strategy of the Forest Plan.

Vineyard Mountain / Peavy Cabin (#38). Small cluster of legacy oaks in Theme 3. Recommend expanding the restoration unit to include (a) smaller oaks at the edge of the heavy thinning unit ("seed cut") to the northwest; and (b) several large, formerly open-grown Douglas-fir to the east.

Jackson Place (#'s 42-49, 57). Large grove in Theme 4 contains a wide variety of habitats, from riparian and wet prairie to upland prairie, oak savanna and oak woodland. Good access and excellent outreach opportunities given the popularity of the area with recreationists. Good connectivity with Chip Ross to the east and the Brandis oak restoration area to the south. Thinning is scheduled for the conifer-dominated stands surrounding the Jackson Place grove complex.

Figure 4. Acres of oak groves by Restoration Priority Tier and Management Theme.
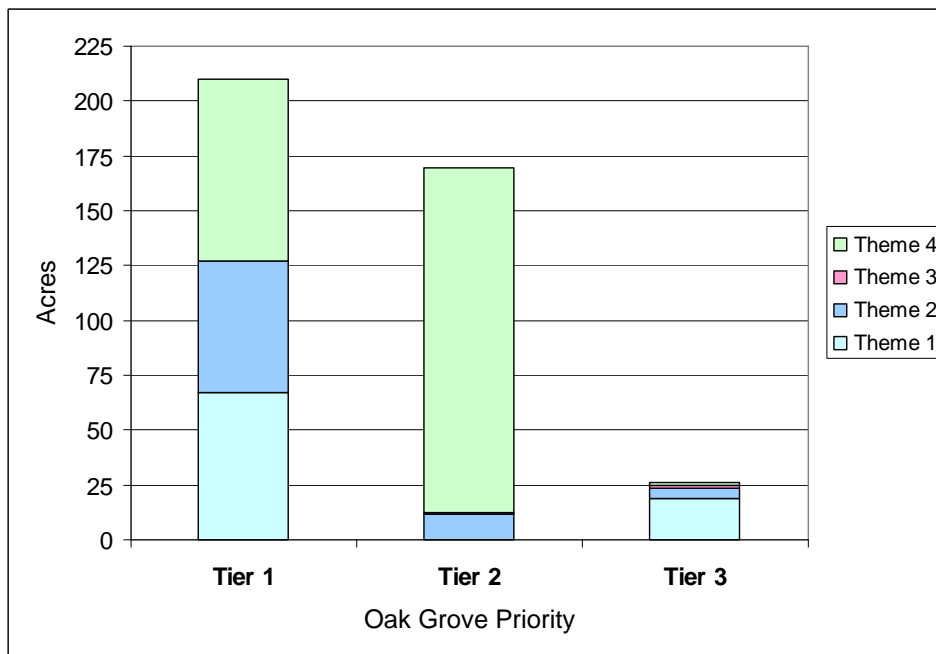
5.1.2 Tier 2 Groves – Special Management Consideration

Tier 2 groves provide important habitat elements but not of the quality that warrants Tier 1 status. The Task Force recommends release and retention of select oaks and madrones within Tier 2 groves rather than restoration of the entire grove. Release activities (as described in Appendix 5 and in Section 5.2 below) should be opportunistic so as to coincide with other forest operations such as regeneration harvest, thinning, salvage and road maintenance that occur nearby. There are 169 acres designated as Tier 2, with the majority of those acres occurring in Theme 4 in the Oak Creek area (Figure 4). Specific recommendations for each grove and the individual trees recommended for release are described below.

Carson Prairie (#17). This small unit is on the other side of road and ridge from other units in the Carson grove, thus was excluded from that Tier 1 grove. However, two legacy trees here should be released given their proximity to the main Carson grove. Release should coincide with other restoration work at Carson Prairie.

Calloway Creek (#26). Unit is isolated from main Calloway grove (#23, Tier 1) but has two high-quality legacy oaks that should be released at the same time that release harvests are conducted in the main Calloway grove.

Powderhouse (#54). Four large legacy oaks along a popular trail and road intersection should be high-priority targets for release from conifers. Oak regeneration in the nearby clearcut could be nurtured to maintain long term compositional diversity in this area.

580 Road (#31). Vein of madrone with scattered oaks along both sides of road. Release harvest could be conducted from the road when nearby stands are thinned as currently scheduled.

760 Road / Soap Creek (#61). Oaks straddle the road on steeply sloping ground with shallow, rocky soils. Oaks are densely clustered and scrubby above the road where they are being encroached upon by Douglas-fir. Oaks are more scattered below the road where there are also some maple, Douglas-fir and nice madrones surrounding a meadowy opening. Release of oaks and madrone could coincide with thinning which is scheduled for this area in the current forest plan.

Clancy Homestead (#58). Four legacy oaks, at least two of which are high-quality specimens in need of release from large Douglas-fir. Easy access from the 770 Road. Historical value (e.g., chestnut and plum trees, grapes) imposes restrictions according to historic preservation guidelines.

Vineyard Mountain / Peavy Cabin (#35, 36). These two units have several legacy oaks that could be released as individual trees when restoration work takes place in Vineyard unit #38 (a Tier 1 grove) or during the course of upcoming scheduled thinning operations.

Arboretum (#41). This grove just north of the nursery is highly visible and has two large, majestic madrones that should be released and retained when nearby units are thinned as scheduled in the current forest plan.

Zobel / 660 Road (#39). This ridgetop grove along the 660 Road north of Dimple Hill was originally ranked as Tier 1 because of its legacy oaks, but was ranked as Tier 2 because much of the grove is part of a study unit for the College Forest Integrated Research Project (CFIRP). Principal investigators for CFIRP have confirmed that releasing and maintaining legacy oaks in this grove are compatible with the CFIRP designation for uneven/multi-aged treatment. Several oaks in this area have already succumbed to competition and others are struggling, so the next round of cuts under CFIRP, scheduled for 2009 or 2010, could be done in time to rescue these trees. Oaks outside the CFIRP boundary should be released at the same time.

681 Road / Extendo (#59). Scattered pockets of forest-grown oaks on both sides of the 681 Road, with the highest concentration of mature oaks at the forest edge next to a young plantation of ponderosa pine and Douglas-fir. Within the plantation are numerous regenerating oaks (5-10 ft tall) that could be future legacy trees. Recommend releasing the larger oaks at the forest edge and maintaining open conditions for the young oaks in the plantation, all of which could be timed with the partial thinning slated for this area in the current forest plan.

Oak Creek (#55). This is the largest single grove in the inventory with scattered open-grown oaks, pockets of forest-grown oaks within conifer forest, a heavy infestation of false brome, and a riparian corridor with a rich mix of native hardwoods and some conifers. It's location along popular roads and trails creates a good opportunity for outreach around release of individual trees and prairie restoration. The task force recommends maintaining wide riparian buffers along the creeks, and releasing individual oaks in and around the meadow and scattered through the forest. Mixed patch cuts and thinning are scheduled for nearby stands in the current forest plan.

Oak Creek (#50, 51) Primarily forest-grown oaks retained in areas that had been thinned or patch cut near the southwest boundary of McDonald Forest. The stand encompassing unit #50 is slated for partial clearcutting in the current harvest schedule, providing an opportunity to maintain the oaks in this stand.

5.1.3 Tier 3 Groves – No Restoration

Oak groves in Tier 3 are average to poor in quality or are currently at little risk of loss to competition from other tree species (e.g., Berry Creek grove). The Task Force recommends no restoration in these groves. However, individual trees in these groves could be designated as "*character trees*" during future harvest operations to retain structural and compositional diversity. As defined in the Forest Plan (2005), character trees are "*unusual or unique in structure, or are rare in the context of the current or future stand conditions. They are generally larger, older trees of any species, and were often established in pre-Euro-American times.*" Of the 26 acres in Tier 3, most are in Management Themes 1 and 2 (Figure 4).

Berry Creek (#'s 6-15). This area near Berry Creek Farm has oak and madrone leave trees in a recent harvest unit that was planted to conifers, providing an opportunity to examine (a) the response of individual oaks to release from conifers, and (b) the effect of overstory oak on development of planted conifers. Oak/madrone crowns probably will be not be impacted by conifers for two decades.

Forest Peak (#21). Small (< 1 acre) patch isolated from main Forest Peak grove (#22).

Staats Creek (#'s 2-5). Staats Creek units 3-5 are small and isolated. Staats #2 is an old homesite with a few scattered, open-grown oaks and vinca in the understory. Large legacy oaks nearby, two of which are recommended for release as high-priority individuals.

Poison Oak Road (#53). A stringer of small oaks plus two or three larger oaks along the edge of a thinned unit, as well as two nice open-grown oaks across the road. Revisit this grove in 10 years to reevaluate the need for oak release.

Calloway Creek (#25). Small unit north of main Calloway grove without a legacy component.

Vineyard Mountain / Peavy Cabin / (#'s 32-34, 37). Scattered oaks losing out to conifers.

Arboretum (# 30,40). Small units without legacy component but numerous oak and madrone trees.

Oak release on private land near McDonald Forest.   Conifers encroach on legacy oak at Forest Peak.

Table 3. Task Force recommendations for oak groves.

Tier	Grove	Inventory units[1]	Acres	Mgmt theme	DF SI$_{50}$ (ft)[2]	# of Oaks Legacy	# of Oaks Post[3]	# of Madrone	Wtd. quality[4]	Revenue potent[5]
1	Carson Prairie	16, 18-20, 27-29, 56	30.8	1	95-125	76	1241	1	3.7	H
1	Forest Peak	22	36.7	1	95-115	33	285	11	5.0	H
1	Staats Creek	1	6.6	2	115-125	3	100	3	5.0	M-H
1	Blake Homestead	24	5.7	2	105-115	4	150	1	4.0	L-M
1	Calloway Creek	23	19.5	2	<95	3	454	11	4.0	M-H
1	Poison Oak Rd	52	5.6	2	95-105	1	290	300	3.0	H
1	720 Rd / Soap Cr.	62	22.0	2	105-115	N/A[6]	N/A	N/A	N/A	N/A
1	Vineyard Mtn	38	0.5	3	115-125	6	20	4	3.0	H
1	Jackson Place	42-49, 57	82.5	4	95-135+	97	2261	176	4.3	M-H
2	Carson Prairie	17	0.2	1	115-125	2	18	0	3.0	M
2	Calloway Creek	26	0.1	2	115-125	2	5	0	5.0	H
2	Powderhouse	54	1.3	2	105-125	6	20	50	3.0	H
2	580 Road	31	0.8	2	105-115	0	10	52	3.0	H
2	760 Rd / Soap Cr.	61	6.5	2	95-105	0	26	0	3.0	L
2	Clancy Homestead	58	2.5	2	125-135	4	30	0	4.0	H
2	Vineyard Mtn	35, 36	1.0	3	95-115	5	35	0	3.0	H
2	Arboretum	41	2.0	4	115-125	0	13	21	5.0	M
2	Zobel / 660 Rd	39	34.7	4	95-105	9	145	5	4.0	H
2	Extendo / 681 Rd	59	16.9	4	95-105	0	96	0	3.0	H
2	Oak Creek	50, 51, 55	103.2	4	95-135	10	1023	25	3.8	M-H
3	Berry Creek	6-15	18.6	1	115-125	11	370	9	3.6	L-M
3	Forest Peak	21	0.5	1	115-125	0	18	3	2.5	H
3	Staats Creek	2-5	1.3	2	105-115	0	71	1	2.0	M
3	Poison Oak Rd	53	2.9	2	105-115	0	203	0	2.0	M
3	Calloway Creek	25	0.1	2	115-125	0	6	1	4.0	H
3	Vineyard Mtn	32-34, 37	1.4	3	95-125	1	31	0	2.0	H
3	Arboretum	30, 40	1.2	4	115-125	0	85	13	3.0	M

[1]/ See Appendix 3 for unit-level inventory data and Appendix 4 for mapped locations of each unit.

[2]/ Douglas-fir site index from overlay of grove location on site index map of the forest.

[3]/ Trees estimated to have established after Euro-American contact based on size and form.

[4]/ Weighted quality = grove-level weighted average of the quality ratings (1=poor to 5=excellent) assigned to each inventory unit within a grove, weighted by the acreage for each unit.

[5]/ Revenue potential: Observer estimate of potential revenue from release of oaks within grove (low, moderate, high). Rating in table reflects the revenue potential for the majority of acres in the inventory units within the grove.

[6]/ N/A: not assessed during 2007 inventory.

5.2 Individual oak and madrone trees

Oak and madrone trees contribute ecological, cultural and historic value to the forest. Even isolated individuals can provide unique habitat and forage for a suite of organisms including vertebrate wildlife (Gumtow-Farrior 1994), invertebrates (Ohsawa 2007) and bryophytes (Merrifield 2000). Large, open-grown oaks and madrones are particularly beneficial to primary and secondary cavity-nesting birds (Hagar and Stern 2001; Raphael 1987). Oaks released from competition will have increased diameter growth, and produce more acorns and epicormic branches than if left untreated (Devine and Harrington 2006).

The Task Force assigned individual trees to one of three priority levels for release (Tables 4, 5). All of these individual trees are located outside the boundaries of Tier 1 groves. Others are either within the boundaries of Tier 2 groves or are isolated entirely from groves. Full release of these trees is recommended to expose the whole crown to light, based on the findings of Devine and Harrington (2006). Full release involves removal of all competing trees within a radius of up to 100 feet of the designated tree or tree cluster. The actual extent of the release harvest should account for the stature of the surrounding trees, access, economic feasibility, as well as the potential for soil compaction, damage to leaves and crown, and disturbance to wildlife. In Washington, Oregon white oak trees did not experience growth shock following full release, while trees with substantial crown recession (e.g., live crown ratio as low as 10 or 20%) still responded positively to release (Devine and Harrington 2006). Release harvests could be repeated over time to maintain tree vigor.

5.2.1 High Priority Release
The 43 oaks recommended by the Task Force for "*high priority release*" (release harvest conducted within 2 years) (Table 4) have an open-grown form and are at moderate to high risk of loss to competitive exclusion. Most received a rating of very good to excellent for quality, although some trees of average quality or at lower risk of loss were also recommended as high priority if they bordered a Tier 1 grove or were adjacent to a meadow. About 2/3 of the high-priority release trees are near the Jackson Place and Carson Prairie groves, therefore release of these high-priority trees should coincide with other restoration work within these Tier 1 groves.

5.2.2 Moderate Priority Release
There are 24 trees designated for *moderate priority release* (Table 5). All are within Tier 2 groves except several trees along the Bonzi Trail in McDonald Forest which were not included in the 2007 inventory. Release of moderate-priority trees could be timed to coincide with other forest harvest operations when they occur nearby.

Legacy oak in Tier 2 "Zobel" grove (CFIRP unit).

5.2.3 Low Priority Release
Seven trees designated for *low priority release* (Table 5) are open grown and very good to excellent in quality, but because they currently are not vulnerable to competitive exclusion their priority status is low. These trees should be reevaluated every 10 years and released if necessary to reduce crowding by neighboring trees.

5.3 Prairies

The Prairie Task Force recommends active restoration in seven meadows of ecological significance based on the presence of remnant "hotspots" of native prairie plants. These meadows comprise about 132 acres and include Carson Prairie (25 acres), Forest Peak (3 acres), Jackson Place (51 acres), Charlie Meadows near Chip Ross Park (14 acres), Oak Creek (37 acres), Hidden Meadows (a series of small meadows in the upper Soap Creek area), and Butterfly Meadows (1.3 acres). Currently, only Butterfly Meadows is being actively managed to maintain prairie habitat. Prairie habitat in the other six meadows is declining precipitously due to invasion by woody and exotic species, therefore it is critical that restoration begin within two years. Recommended restoration activities include removal of woody species, control of non-native species, reintroduction of native species through seeding and outplanting, and periodic controlled burning or mowing to remove thatch. Restoration activities in meadows adjacent to oak groves should be integrated with restoration efforts in those groves.

Carson Prairie (25.0 acres). Carson Prairie was assigned a high habitat value in 1996 (Wilson 1996), but over the course of the past 11years has declined sharply as a result of invasion by woody and exotic species. A management plan was developed for this site but has not been implemented. Removal of encroaching vegetation is the first action that should be undertaken.

Jackson Place (50.6 acres). Jackson Place does not contain the highest levels of diversity, but its location makes it an ideal site for restoration activities. Unlike Butterfly Meadows and Carson Prairie, Jackson Place can be accessed easily by the public and offers many opportunities for education and outreach. This oak-prairie complex also borders an ash swale with native camas.

Forest Peak (3.0 acres). This meadow is located close to Carson Prairie, creating the potential for habitat connectivity. The elevation, aspect, and thin soils of this site make it a good candidate for prairie restoration.

Charlie Meadows (13.7 acres). Located just west of Chip Ross Park and just north of the Brandis (Timberhill) open space/restoration project, Charlie Meadows offers an opportunity to collaborate with public and private landowners to increase the impact of each other's conservation activities.

Native prairie flowers near McDonald-Dunn.

Hidden Meadows (unknown acreage but small). This collection of three small meadows is located in the upper sections of the Soap Creek drainage. They are isolated from other prairies and surrounded by Douglas-fir forest. This isolation, however, has resulted in a moderately intact native community, with invasive species posing less of a threat than in other meadows. Recommendation is to maintain openings by cutting back Douglas-fir if necessary and taking steps to reduce risk of invasion by aggressive non-native species.

Oak Creek (37.3 acres). Oak Creek is the most frequently visited area on the McDonald-Dunn Forest and therefore offers excellent opportunities for outreach and education. The meadow here contains a series of small openings bordered by Douglas-fir and riparian forest. Openings such as

these are significant since they appear to be resistant to invasion by false brome, creating an opportunity for students and researchers to investigate the mechanisms behind invasion. One of the openings harbors an uncommon native species, *Trifolium eriocephalum* (woollyhead clover). Lodgepole pine planted in the meadow west of Oak Creek has begun regenerating and should be removed. This meadow once hosted a population of Taylor's checkerspot butterfly, an endangered species whose nearest current population is at Fitton-Green Natural Area, less than 3 miles to the southwest (Figure 2).

Butterfly Meadows (1.3 acres). Considered by many as the best example of upland prairie on the McDonald-Dunn Forest, Butterfly Meadows has long been observed and studied. Over the past five years McDonald-Dunn Forest staff, Starker Forests, OSU researchers and non-profit organizations have been collaborating on managing this meadow and the adjacent meadow owned by Starker to optimize habitat for the threatened Kincaid's lupine and the endangered Fender's blue butterfly. Management of this special prairie should continue under the existing plan, and the collaborative approach employed should be extended to the other six meadows listed above.

5.4 General recommendations

- Integrate oak-prairie inventory data and GIS layers into Forest planning efforts.
- Develop site-specific restoration plans, prescriptions and harvest analyses for Tier 1 groves, prairies and for individual trees recommended for high-priority release. Consult published information to guide this process (Campbell 2004; Vesely and Tucker 2004; Harrington and Devine 2006), some of which has been incorporated into Appendix 5.
- Develop planting guidelines for replacing oaks that die in Tier 1 groves if natural regeneration is not sufficient or in the desired location (see Campbell 2004).
- Develop marking guidelines for designating oaks and madrones as "*character trees*" and use that designation to identify and release oaks and madrones in harvest units.
- Assess dbh, crown characteristics, competition and overall quality of high-priority and moderate-priority trees which were not inventoried for those attributes in 2007 (Table 5).
- Evaluate crown characteristics, vulnerability, overall quality, and assign a release priority level to the 97 oak and 7 madrone trees greater than 30 inches dbh that have been identified through the periodic forest inventory but were not included in the 2007 oak inventory.
- Measure and assess the release potential of legacy trees (oaks or madrones with dbh > 24 inches and an open-grown structure) not documented here, when they are encountered in the forest. Add them to the oak database.
- Collaborate with the College of Agriculture on inventory, conservation, restoration and research of oak-prairie habitats on lands they manage near McDonald-Dunn to broaden the scale and impact of habitat enhancement.
- Develop a funding plan for monitoring and restoration activities in partnership with other organizations. As outlined in the Conservation and Restoration Strategy of the Forest Plan, revenue from release harvests should be used to conduct other restoration activities in oak

Savanna oaks on lands managed by the College of Agriculture.

groves and prairies. Revenues and costs associated with restoration can be used as a match when seeking funding from outside sources.

- Utilize the Invasive Plant Species Management Plan developed for McDonald-Dunn Forest to control the spread of invasive species in and near restoration areas.

6. Integrating Oak-Prairie Restoration with Research, Teaching and Demonstration

The interest in oak-prairie habitat restoration and management in Oregon has created a need for new knowledge in support of applied restoration methods and restoration ecology for these habitats. With adoption of the Conservation and Restoration Strategy, and a commitment to oak-prairie restoration, the College of Forestry is positioned well to respond to that need through research, teaching and outreach.

There is growing demand among college students across the country for classes, field experience and degree programs in restoration ecology. The restoration activities recommended here will provide OSU faculty and students with opportunities to design, develop and implement restoration management practices, research, monitoring and education in a broad and interdisciplinary context.

Faculty and students in the College of Forestry benefit from many well designed research and demonstration projects established by our predecessors. Some, such as the thinning studies at Black Rock, reflect 50 years of management and data. No such research legacy exists in oak-prairie habitats. Restoration activities undertaken on the McDonald-Dunn Forest provide unique opportunities to develop such educational infrastructure to further our educational mission while informing future restoration managers.

This has added significance because, while public lands such as wildlife refuges and research forests can provide important habitat, most of the former oak-prairie ecosystem in the Willamette Valley is on private land. Therefore, restoration on a meaningful landscape scale must involve private as well as public land. The restoration activities recommended here are very relevant to a wide audience in our landscape through the University's Extension mission.

In the course of developing the restoration recommendations, the Task Forces generated ideas for potential research and education projects that could be integrated with oak-prairie restoration in McDonald-Dunn Forest. Some are listed below.

6.1 Research
- Response of oaks to release (growth, crown, branching, windthrow, acorn production).
- Development of conifers planted under an oak overstory (e.g., Berry Creek stand).
- Response of understory vegetation, including non-natives, to restoration treatments.
- Invasibility of the understory following release harvest in oak savanna and woodlands.
- Mechanisms underlying resistance of remnant native prairie to invasion by false brome.
- Changes in soils following invasion by false brome – implications for restoration.
- Composition of the seed bank in remnant prairies, oak savanna and oak woodlands.
- Effective seed mixes and sowing sequences for restoring native prairie species.
- Responses of vertebrate and invertebrate wildlife species to oak-prairie restoration.

- Oak regeneration in relation to competition, herbivory and soil/litter chemistry.
- Long-term trends in growth, mortality and regeneration of Oregon white oak.
- Develop site index tables for Oregon white oak and improve models of oak tree and stand development to simulate potential outcomes of oak restoration and management.
- Utilization of and markets for value-added wood products from oaks, including those harvested in restoration projects.

6.2 Teaching
- Continue involving students in the development of restoration plans for oaks and prairies on the Forest (as Drs. Doescher and Gregory have done in their Ecological Restoration class). Expand to include development of monitoring protocols. Integrate these planning efforts into the actual restoration work recommended and prioritized in this document.
- Involve students in collecting and analyzing monitoring data (e.g., FOR 321, Mensuration).
- Involve students in the logging training program in restoration activities, creating the opportunity for crew members to apply their skills, and learn new ones, within the context of oak woodland management and restoration.
- Engage students majoring in Resource Recreation Management in the development of signage and interpretive materials.
- Support M.S. thesis projects in Natural Resources Education and Extension: (1) develop an interactive web site of restoration projects in McDonald-Dunn Forest; (2) document the process of, and learning opportunities in, restoring oak-prairie habitats, which could lead to the development of an outreach program.
- Raise native plants in greenhouses for out-planting in restoration treatments through the Department of Horticulture or through current efforts such as those at Philomath High.

Landowners and citizens learn about oak release and restoration in the Willamette Valley.

Students from Crescent Valley High School sow seeds of Kincaid's lupine at Fitton Green Natural Area (photo courtesy of RARE Partnership).

6.3 Outreach / Demonstration (with CoF Extension faculty)
- Host landowner tours explaining and illustrating management practices and progress throughout the restoration process.
- Provide interpretive materials (brochures, signage) at trailheads and in the forest.
- Develop an interactive web site of restoration projects in McDonald-Dunn Forest.
- Involve community members, including students, in monitoring efforts and in maintaining restoration sites.
- Facilitate outreach through various media (TV, web, video, radio, newsprint, special publications).

Table 4. Individual oak trees recommended for high priority release. *All are outside the boundaries of Tier 1 oak groves. Trees without an ID were not measured during the inventory either because they were (a) within an inventoried oak grove, or (b) found since the time of the inventory; they should be assessed using the individual-tree protocol. The list does not include trees from the systematic forest inventory. (Footnotes explained on following page.)*

Priority	Tree ID	Nearest inventory unit	Mgmt theme	Tree form[1]	Dbh (in)	Crown[2]				Risk[3]	Qual[4]	Adjacency[5]	
						Class	LCR	Hor	Vert			Mead	Rip
H	5	Carson #17	1	O	26	C	70	P	F	5	5	Y	
H	---	Carson #17	1	O	N/A[6]	N/A	N/A	N/A	N/A	N/A	N/A		
H	6	Carson #16	1	O	42	C	75	P	B	5	4	Y	
H	8	Carson #16	1	O	31	D	80	F	F	5	5	Y	
H	9	Carson #56	1	O	25	D	95	F	F	3	5	Y	
H	10	Carson #56	1	O	30	C	80	F	F	3	5	Y	
H	11	Carson #56	1	O	32	D	85	F	F	3	5		
H	12	Carson #56	1	O	38	D	90	F	F	3	4	Y	
H	15	Carson #19	1	O	33	D	90	F	F	4	5		
H	16	Carson #17	1	O	53	C	50	P	B	5	4	Y	
H	17	Carson #16	1	O	36	C	60	P	B	5	4		
H	19	Carson #56	1	O	30	D	85	P	F	3	5	Y	
H	23	Carson #56	1	S	28	C	75	P	B	4	4		
H	24	Carson #56	1	O	28	C	90	P	F	4	5		
H	25	Carson #56	1	O	24	D	80	F	F	3	5		
H	26	Carson #29	1	O	24	C	80	P	B	5	4		
H	28	Carson #29	1	O	29	D	90	F	F	3	5		
H	29	Carson #29	1	O	28	D	95	P	P	4	4		
H	1	Staats Cr #2	2	O	55	D	80	F	F	3	5		
H	2	Staats Cr #2	2	O	35	D	50	F	F	3	5		
H	---	Calloway #26	2	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
H	---	Calloway #26	2	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
H	127	Powder #54	2	O	38	S	90	S	B	5	3		
H	128	Powder #54	2	O	32	C	80	P	F	4	4		
H	129	Powder #54	2	O	38	S	85	S	B	5	4		
H	67	Vineyard #35	3	O	40	C	90	S	B	4	4		
H	75	Jackson #47	4	O	34	C	75	F	F	4	5		
H	77	Jackson #48	4	O	41	C	95	F	F	4	5	Y	Y
H	85	Jackson #48	4	O	40	D	90	F	F	4	5	Y	Y
H	86	Jackson #48	4	O	37	D	95	F	F	4	5	Y	Y
H	87	Jackson #48	4	O	32	C	80	F	F	4	5	Y	Y
H	107	Jackson #49	4	O	31	C	85	P	B	5	5	Y	Y
H	119	Jackson #49	4	O	31	D	80	F	B	3	5	Y	
H	120	Jackson #49	4	O	27	C	85	F	B	4	3	Y	
H	121	Jackson #49	4	O	35	D	95	P	B	4	4	Y	
H	122	Jackson #49	4	O	36	D	95	F	F	3	5	Y	
H	---	Jackson #57	4	O	N/A	N/A	N/A	N/A	N/A	4	4		
H	68	Zobel/660 Rd	4	O	34	C	85	P	B	5	4		
H	69	Zobel/660 Rd	4	O	43	C	95	F	B	5	5		
H	71	Zobel/660 Rd	4	O	45	C	95	F	B	5	5		
H	131	Oak Cr #55	4	O	33	C	75	F	F	4	4		
H	134	Oak Cr #55	4	O	42	C	75	F	B	4	4		
H	135	Oak Cr #55	4	O	30	C	60	P	B	5	4		

Table 5. Individual oak and madrone trees recommended for moderate or low priority release. *All are outside the boundaries of Tier 1 oak groves. Trees without an ID were not measured during the inventory either because they were (a) within an inventoried oak grove, or (b) found since the time of the inventory; they should be assessed using the individual-tree protocol. The list does not include trees from the systematic forest inventory.*

Priority	Tree ID	Nearest inventory unit	Mgmt theme	Tree form[1]	Dbh (in)	Crown[2]				Risk[3]	Qual[4]	Adjacency[5]	
						Class	LCR	Hor	Vert			Mead	Rip
M	---	Clancy #58	2	O	N/A	N/A	N/A	N/A	N/A	4	5		
M	---	Clancy #58	2	O	N/A	N/A	N/A	N/A	N/A	4	5		
M	---	Bonzi Trail	2	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
M	---	Bonzi Trail	2	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
M	---	Bonzi Trail	2	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
M	---	Vineyard #35	3	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
M	---	Vineyard #35	3	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
M	---	Vineyard #35	3	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
M	---	Vineyard #36	3	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
M	---	Vineyard #36	3	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
M	*Arme*[7]	Arboretum#41	4	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
M	*Arme*	Arboretum#41	4	O	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
M	123	Oak Cr #50	4	O	30	D	90	P	B	4	4		
M	124	Oak Cr #51	4	O	35	C	95	P	B	4	3		
M	132	Oak Cr #55	4	O	39	S	95	P	B	4	3		
M	138	Oak Cr #55	4	O	39	D	90	P	B	4	5		
M	139	Oak Cr #55	4	O	31	D	80	F	F	3	5		
M	---	Oak Cr #55	4	O	N/A	N/A	N/A	N/A	N/A	3	4		
M	---	Oak Cr #55	4	O	N/A	N/A	N/A	N/A	N/A	3	3		
M	---	Oak Cr #55	4	O	N/A	N/A	N/A	N/A	N/A	3	4		
M	---	Oak Cr #55	4	O	N/A	N/A	N/A	N/A	N/A	3	4		
M	---	Oak Cr #55	4	O	N/A	N/A	N/A	N/A	N/A	3	4		
M	136	Oak Cr #55	4	F	38	C	75	B	P	5	4		
M	137	Oak Cr #55	4	F	27	C	60	F	B	4	4		
L	7	Carson #19	1	O	24	D	90	F	F	2	4	Y	
L	20	Carson #56	1	O	32	C	80	P	F	2	5	Y	
L	21	Carson #56	1	O	43	D	80	F	F	1	5	Y	
L	3	Staats Cr #3	2	O	38	D	80	F	F	1	5		Y
L	126	Powder #54	2	O	38	D	95	F	F	1	5		
L	130	Oak Cr #55	4	O	---	D	95	F	F	2	5		Y
L	133	Oak Cr #55	4	O	60	D	98	F	F	2	5		

[1]/ O = open-grown growth form; S = semi-open-grown; F = forest grown
[2]/ Tree crown

       Class: C = co-dominant; D = dominant
       LCR = live crown ratio (%)
       Hor = horizontal crown fullness (P = partial, B = broken, F = full)
       Ver = vertical crown fullness (P = partial, B = broken, F = full)

[3]/ Risk: vulnerability to mortality from competitive exclusion (1=low risk, 5=extreme)
[4]/ Quality: 1 = poor, 5 = excellent
[5]/ Adjacent to meadow (Mead) or riparian area (Rip)
[6]/ N/A: not assessed during 2007 inventory.
[7]/ Arme (Arbutus menziesii) = Pacific madrone

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8. Acknowledgments

Appendix 1. Phase 1 inventory protocol for oak groves.

<u>Oak Groves</u>

<u>Grove type</u>
- Open grown trees with broad, rounded crowns on at least one side
- Semi-open grown with vase-like shape and large live or dead branches >10 ft from ground
- Forest grown trees with narrow crowns and no large lower branches
- Regenerating: small oaks establishing in open area

<u>Grove quality</u>
- Subjective rating from 1 (poor) to 5 (excellent) based on tree form and vigor

<u>Tree tally</u>
- Legacy oaks (trees > 24" dbh with broad crown and large, low branches)
  - 24-36" dbh
  - >36" dbh
- Post-contact oaks
  - <6" dbh
  - 6-24" dbh
  - 24-36" dbh
- Madrones

<u>Location</u>
- GPS coordinates of grove or inventory unit boundary

<u>Topography</u>
- Slope position
  - RT (ridge top)
  - US (upper slope)
  - MS (mid slope)
  - LS (lower slope)
  - UB (upland bench)
  - RA (riparian area)
- Slope
- Aspect

<u>Access</u>
- Good
- Moderate
- Poor

<u>Revenue potential</u> (from removing competing trees up to 1 mature tree height radius (100 ft))
- Low
- Moderate
- High

Appendix 2. Phase 1 inventory protocol for individual oak trees.

Individual oak trees

Tree form
- Open grown: broad, rounded crown with large branches within 10 ft of ground
- Semi-open grown: vase-like shape and large live or dead branches >10 ft from ground
- Forest grown: narrow crown and no large lower branches

Tree size
- Diameter at breast height (DBH) (inches)

Tree crown
- Crown class
  - Dominant
  - Co-dominant
  - Intermediate
  - Suppressed
  - Regenerating: small tree growing in gap or open area
- Live crown ratio (%)
- Horizontal crown fullness
  - Full crown: live branches around > 70% of tree
  - Partial crown: live branches around 30-70% of tree)
  - Sparse crown: live branches around < 30% of tree)
- Vertical crown fullness
  - Full: live branches throughout the vertical extent of the crown
  - Broken: – branchless spaces greater than 1/2 the crown ratio

Neighborhood
- Number of other oak trees within 30 meters (approximate height of a mature oak)
- Number of madrone trees within 30 meters

Tree quality
- Subjective rating from 1 (poor) to 5 (excellent) based on tree form and vigor

Risk rating
- Vulnerability to loss from competitive exclusion: 1=low risk to 5=high risk

Location
- GPS coordinates of oak tree if it's an isolated individual

Topography
- Slope position
  - RT (ridge top)
  - US (upper slope)
  - MS (mid slope)
  - LS (lower slope)
  - UB (upland bench)
  - RA (riparian area)
- Slope
- Aspect

Appendix 3. Data summaries from inventory units in oak groves (NA = data not collected). *(key to column headings on next page)*

Mgmt theme	Photo area	Inven unit #	Grove area	Tier	Acres	Patch type	Legacy oaks 24-36"	>36"	Total	Post-contact oaks <6"	6-24"	24-36"	Total	Madrone Pre	Post	Quality	Location/adjaceny Mead	Grove	Rip	Recr	Rev pot	Access	Aspct	% slope	Slope posit
1	1	6	Berry Creek	3	0.07	F	---	---	0	---	---	---	4	0	0	3			Y		L	G	134	40	LS
1	1	7	Berry Creek	3	0.17	F	---	---	1	---	---	---	30	0	5	3					H	M	172	5	MS
1	1	8	Berry Creek	3	0.22	F	---	---	0	---	---	---	9	0	3	2					M	M	115	10	LS
1	1	9	Berry Creek	3	0.05	F	---	---	0	---	---	---	2	0	1	2					M	M	0	0	UB
1	1	10	Berry Creek	3	0.67	O/F	---	---	3	---	---	---	20	0	0	5			Y		L	G	344	5	LS
1	1	11	Berry Creek	3	1.16	F	---	---	0	---	---	---	27	0	0	3					L	G	40	15	LS
1	1	12	Berry Creek	3	1.03	O/F	---	---	2	---	---	---	8	0	0	3.5			Y		L	G	330	10	LS
1	1	13	Berry Creek	3	3.31	O/F	---	---	2	---	---	---	40	0	0	5					L	G	350	20	MS
1	1	14	Berry Creek	3	2.20	F	---	---	3	---	---	---	30	0	0	4					L	G	334	20	MS
1	1	15	Berry Creek	3	9.75	E/F	---	---	0	---	---	---	200	0	0	3			Y		M	G	300	10	RA
1	2	16	Carson Prairie	1	0.32	F	---	---	1	---	---	---	10	0	1	3					H	G	106	5	UB
1	2	17	Carson Prairie	3	0.15	O/F	---	---	2	---	---	---	18	0	0	3					M	G	262	10	RT
1	2	18	Carson Prairie	1	0.02	O/F	1	0	1	0	4	0	4	0	0	3	Y	Y			M	M	120	35	MS
1	2	19	Carson Prairie	1	0.03	O/F	0	0	0	0	8	0	8	0	0	3	Y	Y			M	M	120	35	MS
1	2	20	Carson Prairie	1	0.04	O	0	0	0	0	10	0	10	0	0	3					H	G	130	40	US
1	2	27	Carson Prairie	1	1.44	F	1	0	1	0	75	0	75	0	0	3					H	G	334	45	MS
1	2	28	Carson Prairie	1	8.53	F	5	2	7	100	400	10	510	0	0	4					H	G	334	50	MS
1	2	29	Carson Prairie	1	6.94	F	0	0	0	0	100	0	100	0	0	3		Y			H	G	120	50	LS
1	2	56	Carson Prairie	1	13.46	O	48	18	66	55	439	30	524	0	0	4	Y	Y			H	G	130	40	MS,RT
1	2	21	Forest Peak	3	0.54	O/F	0	0	0	0	18	0	18	0	3	2.5					H	G	156	10	UB
1	2	22	Forest Peak	1	36.68	O/F	24	9	33	0	275	10	285	1	10	5	Y		Y		H	M	160	50	MS
2	4	31	580 Road	2	0.82	F	0	0	0	0	10	0	10	2	50	3					H	G	264	45	MS
2	7	62	720 Road	1	22.00	F	NA	NA	NA	NA	NA	NA	NA	NA	NA	5					NA	NA	NA	NA	NA
2	7	61	760 Road	2	6.55	O	0	0	0	0	26	0	26	0	0	3					L	P	140	62	US
2	3	24	Blake Homestead	1	5.69	O/F	0	4	4	0	100	50	150	1	0	4	Y			Y	M	G	0	0	LS
2	3	23	Calloway Creek	1	19.53	F	3	0	3	200	250	4	454	1	10	4	Y		Y	Y	H	G	0	5	LS
2	3	25	Calloway Creek	3	0.11	F	0	0	0	0	6	0	6	0	1	4				Y	H	G	0	5	LS
2	3	26	Calloway Creek	2	0.09	F	2	0	2	0	5	0	5	0	0	5				Y	H	G	0	5	LS
2	6	58	Clancy Homestead	2	2.49	O	4	0	4	0	30	0	30	0	0	4	Y				H	G	152	20	MS
2	3	52	Poison Oak Rd	1	5.63	O/F	0	1	1	200	85	5	290	0	300	3			Y		H	G	0	0	MS
2	3	53	Poison Oak Rd	3	2.94	O/F	0	0	0	50	150	3	203	0	0	2			Y		M	G	0	0	LS
2	3	54	Powderhouse	2	1.35	O/F	4	2	6	10	10	0	20	0	50	3				Y	H	G	0	0	MS
2	1	1	Staats Creek	1	6.62	O	---	---	3	---	---	---	100	0	3	5		Y				M	0	0	LS
2	1	2	Staats Creek	3	1.06	E/F	---	---	0	---	---	---	17	0	1	2		Y	Y		L	G	60	25	LS
2	1	3	Staats Creek	3	0.06	F	---	---	0	---	---	---	8	0	0	3					H	M	69	15	UB
2	1	4	Staats Creek	3	0.10	F	---	---	0	---	---	---	10	0	0	2			Y		H	M	179	10	UB
2	1	5	Staats Creek	3	0.10	F	---	---	0	---	---	---	36	0	0	2					H	G	256	0	UB

Appendix 3 (continued). Data summaries from inventory units in oak groves (NA = data not collected).

Mgmt theme	Photo area	Inven unit #	Grove area	Tier	Acres	Patch type	Legacy oaks 24-36"	>36"	Total	Post-contact oaks <6"	6-24"	24-36"	Total	Madrone Pre	Post	Quality	Location/adjacency Mead	Grove	Rip	Recr	Rev pot	Access	Aspct	% slope	Slope posit
3	4	32	Vineyard Mtn	3	0.48	F	0	0	0	0	5	0	5	0	0	2					H	M	0	0	US
3	4	33	Vineyard Mtn	3	0.34	F	0	0	0	0	10	0	10	0	0	2					H	M	0	0	US
3	4	34	Vineyard Mtn	3	0.35	O/F	0	1	1	0	6	0	6	0	0	2					H	H	0	0	US
3	4	35	Vineyard Mtn	2	0.63	O/F	3	0	3	0	15	0	15	0	0	3					H	G	0	0	US
3	4	36	Vineyard Mtn	2	0.40	O/F	2	0	2	0	20	0	20	0	0	3					H	G	0	0	US
3	4	37	Vineyard Mtn	3	0.24	F	0	0	0	0	10	0	10	0	0	2					H	G	0	0	US
3	4	38	Vineyard Mtn	1	0.49	O	6	0	6	0	20	0	20	0	4	3					H	G	248	5	RT
4	6	59	Extendo / 681 Rd	2	16.95	F	0	0	0	0	50	46	96	0	0	3				Y	H	G	90	15	US
4	3	30	Arboretum	3	0.06	F	0	0	0	6	4	0	10	1	7	3			Y		M	G	130	5	LS
4	3	40	Arboretum	3	1.10	F	0	0	0	0	75	0	75	0	5	3			Y	Y	M	G	106	5	LS
4	3	41	Arboretum	2	1.98	F	0	0	0	10	3	0	13	1	20	5				Y	M	G	84	5	LS
4	5	42	Jackson Place	1	7.47	O/F	9	3	12	60	70	8	138	0	0	5		Y	Y	Y	M	G	0	5	RA
4	5	43	Jackson Place	1	14.23	O/F	7	2	9	0	275	7	282	0	0	4	Y	Y	Y	Y	M	G	0	5	RA
4	5	44	Jackson Place	1	3.27	F	1	0	1	20	100	5	125	0	5	3		Y	Y	Y	H	G	0	5	RA
4	5	45	Jackson Place	1	4.31	O/F	1	0	1	20	75	0	95	0	5	3		Y			H	M	0	10	US
4	5	46	Jackson Place	1	7.42	F	3	1	4	60	130	2	192	0	15	3		Y			H	M	0	15	MS
4	5	47	Jackson Place	2	5.15	F	4	0	4	0	150	24	174	0	20	4		Y		Y	H	G	290	15	RA,LS
4	5	48	Jackson Place	1	9.12	O/F	17	7	24	100	220	10	330	1	30	5	Y	Y	Y		H	G	0	0	RA,LS
4	5	49	Jackson Place	1	19.75	O/F	20	1	21	500	150	10	660	0	100	5	Y			Y	M	G	0	0	Various
4	5	57	Jackson Place	1	11.77	O/F	13	8	21	100	150	15	265	0	0	4	Y	Y	Y	Y	H	G	0	0	MS
4	6	50	Oak Creek	2	2.07	F	0	0	0	0	30	0	30	0	5	3					M	G	0	0	LS
4	6	51	Oak Creek	2	15.59	O/F	2	0	2	0	160	2	162	0	5	3			Y		M	G	0	0	LS, R
4	6	55	Oak Creek	2	85.49	F	5	3	8	125	700	6	831	0	15	4	Y		Y	Y	H	G	0	0	LS,MS
4	5	39	Zobel / 660 Rd	2	34.72	O/F	6	3	9	75	50	20	145	0	5	4				Y	H	G	0	0	US

<u>Key to column headings</u>

Photo: photo area corresponding to maps in Appendix 4

Tier: 1 = high priority, 2 = moderate priority, 3 = low priority

Patch type: O = open grown, F = forest grown

Legacy or Pre = estimated to have established prior to Euro-American contact

Post = estimated to have established after Euro-American contact
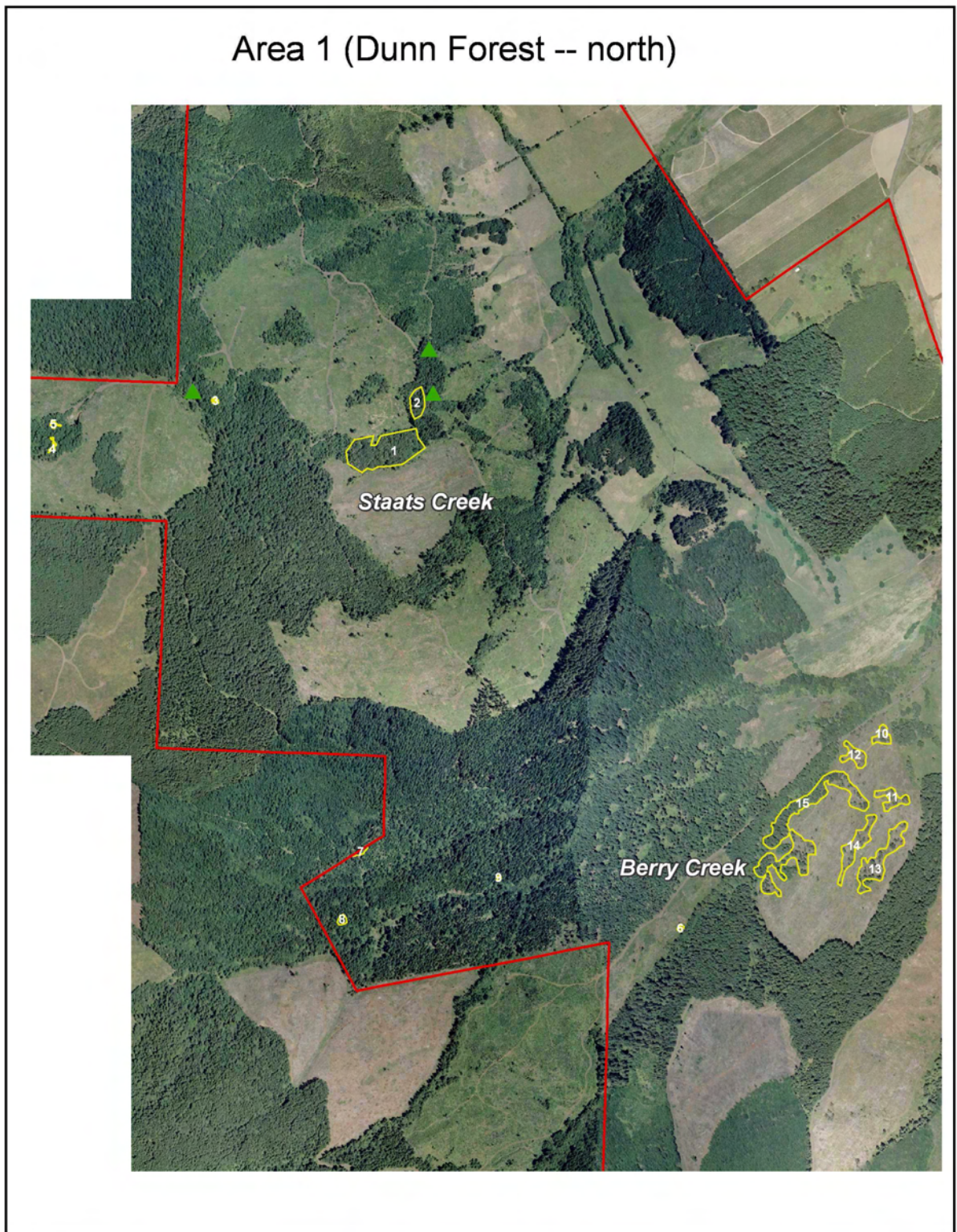
Quality: 1 = poor, 5 = excellent

Location/adjacency: Mead = meadow, Grove = oak grove, Rip = riparian area, Recr = recreation site or trail

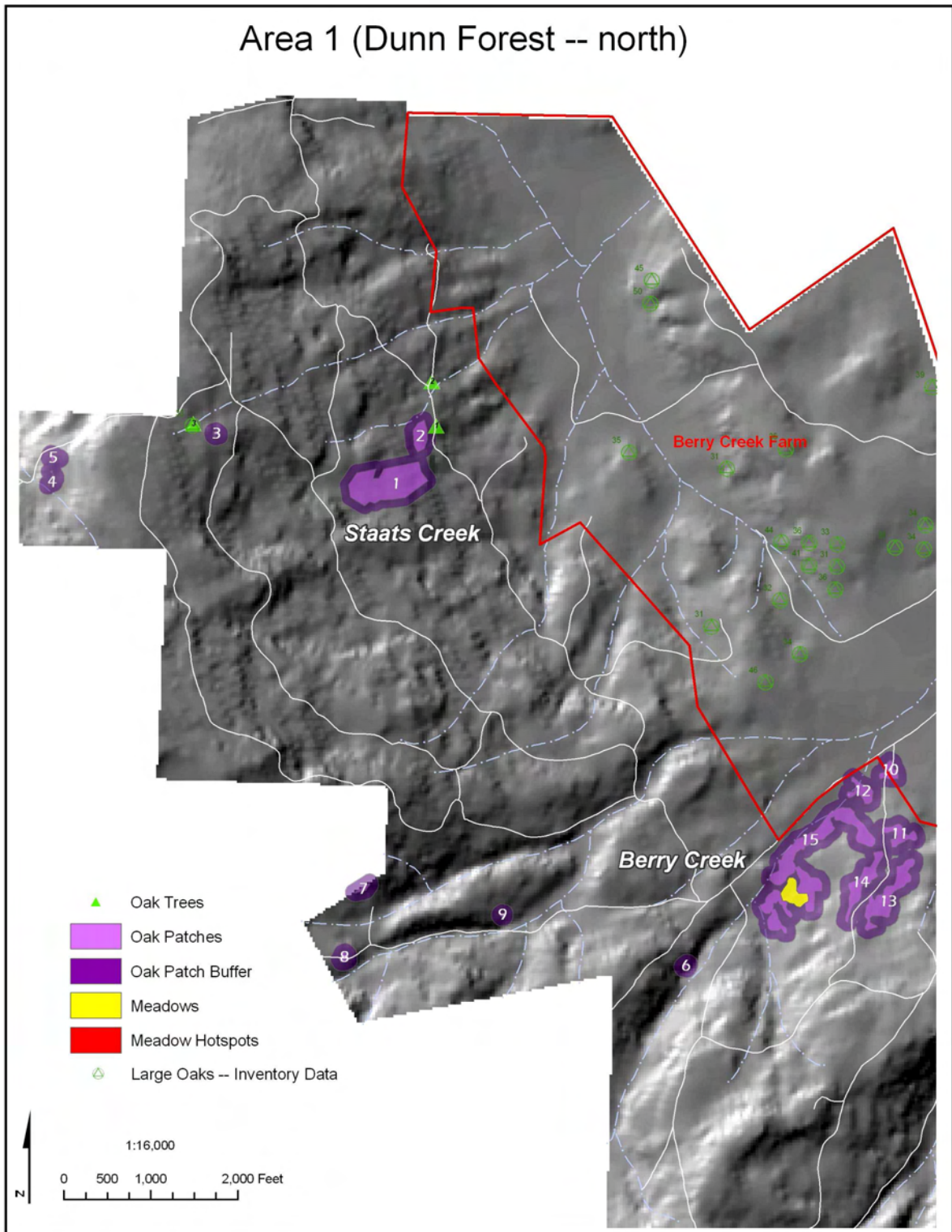Rev pot = revenue potential from release harvest

Access for logging: G = good, M = moderate (some constraints)

Slope position: LS = lower slope, MS = mid slope, US = upper slope, RT = ridge top, RA = riparian area, UB = upper bench
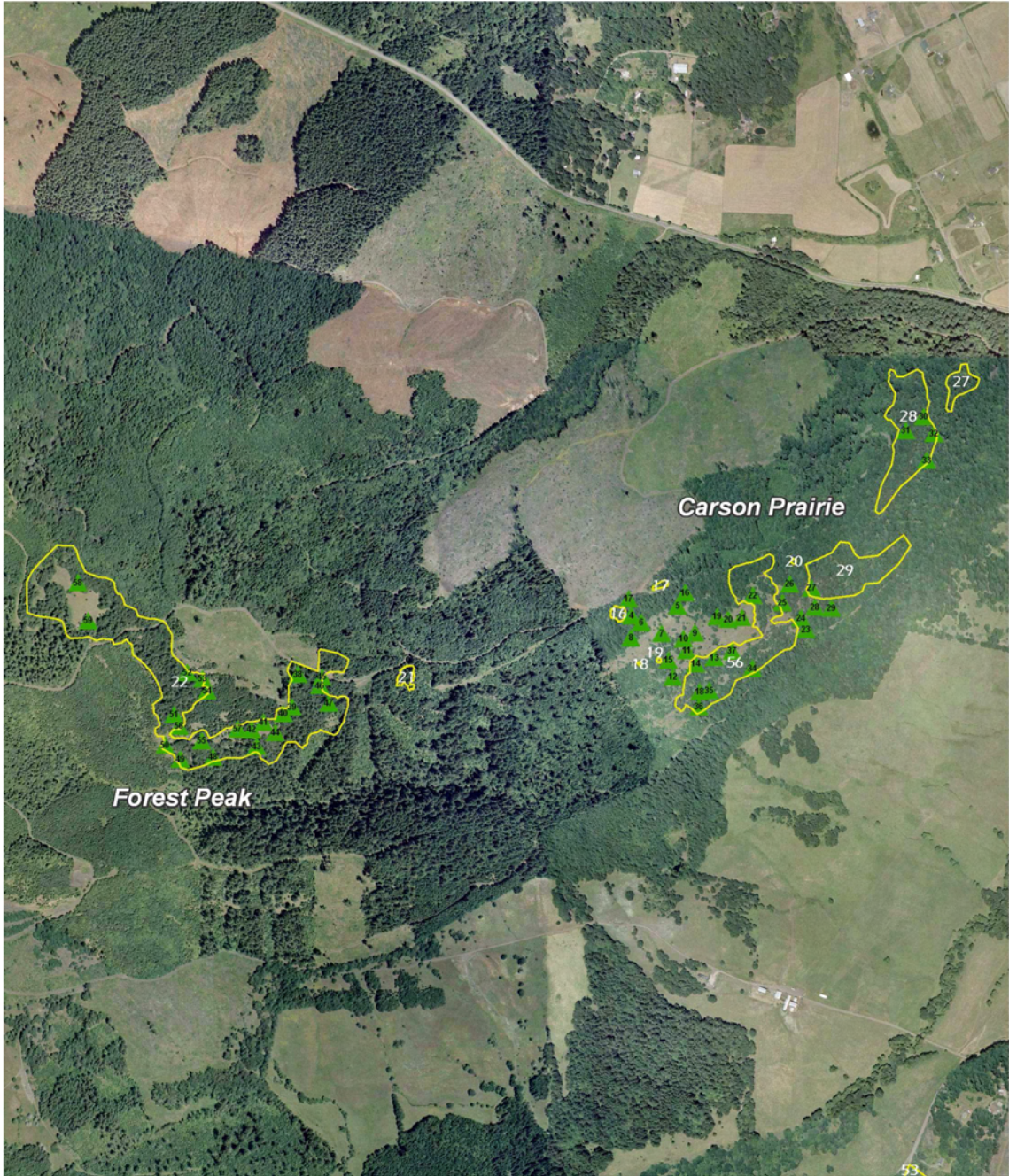
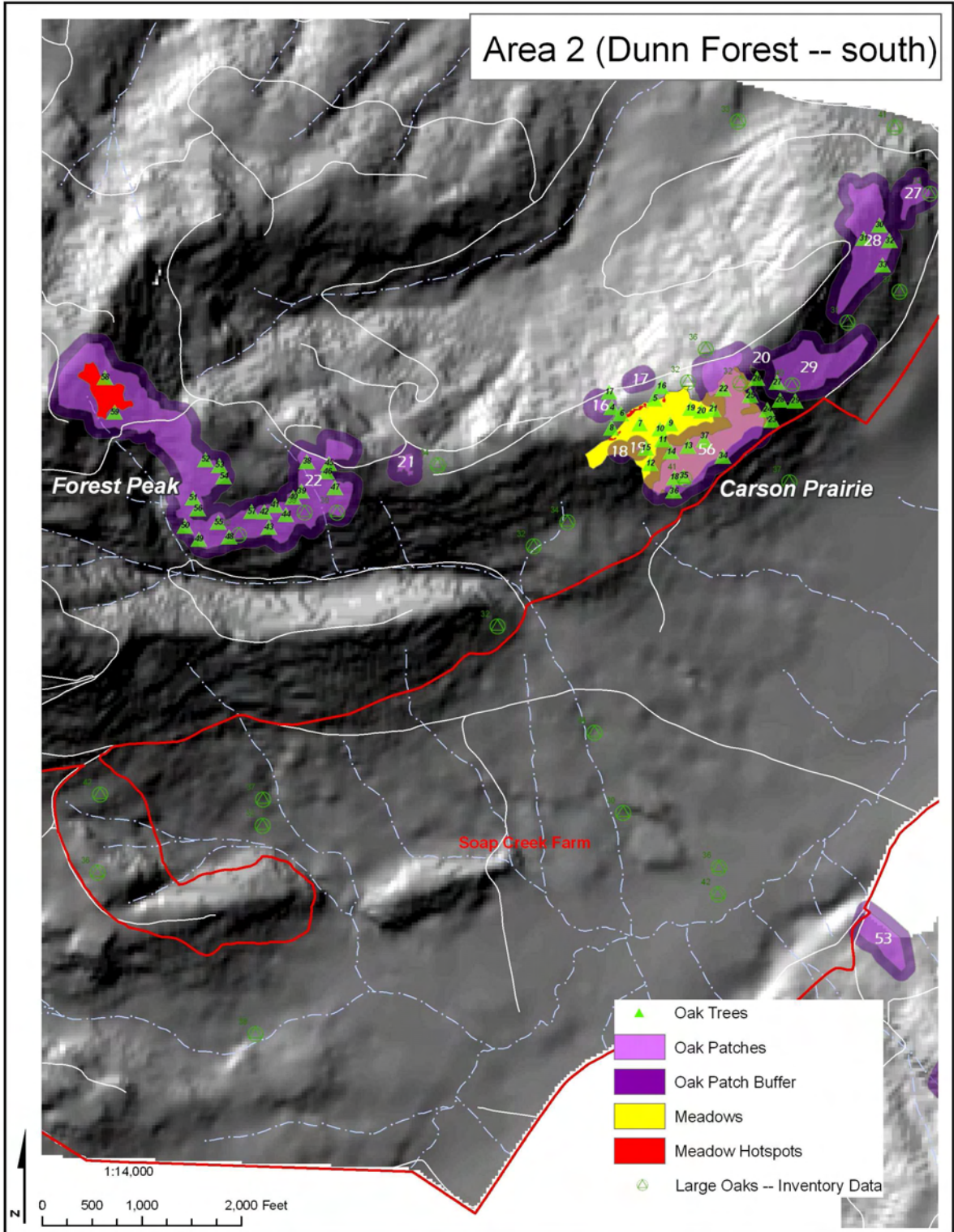**Appendix 4. Maps of oak inventory units, oak trees and meadows inventoried in 2007.**
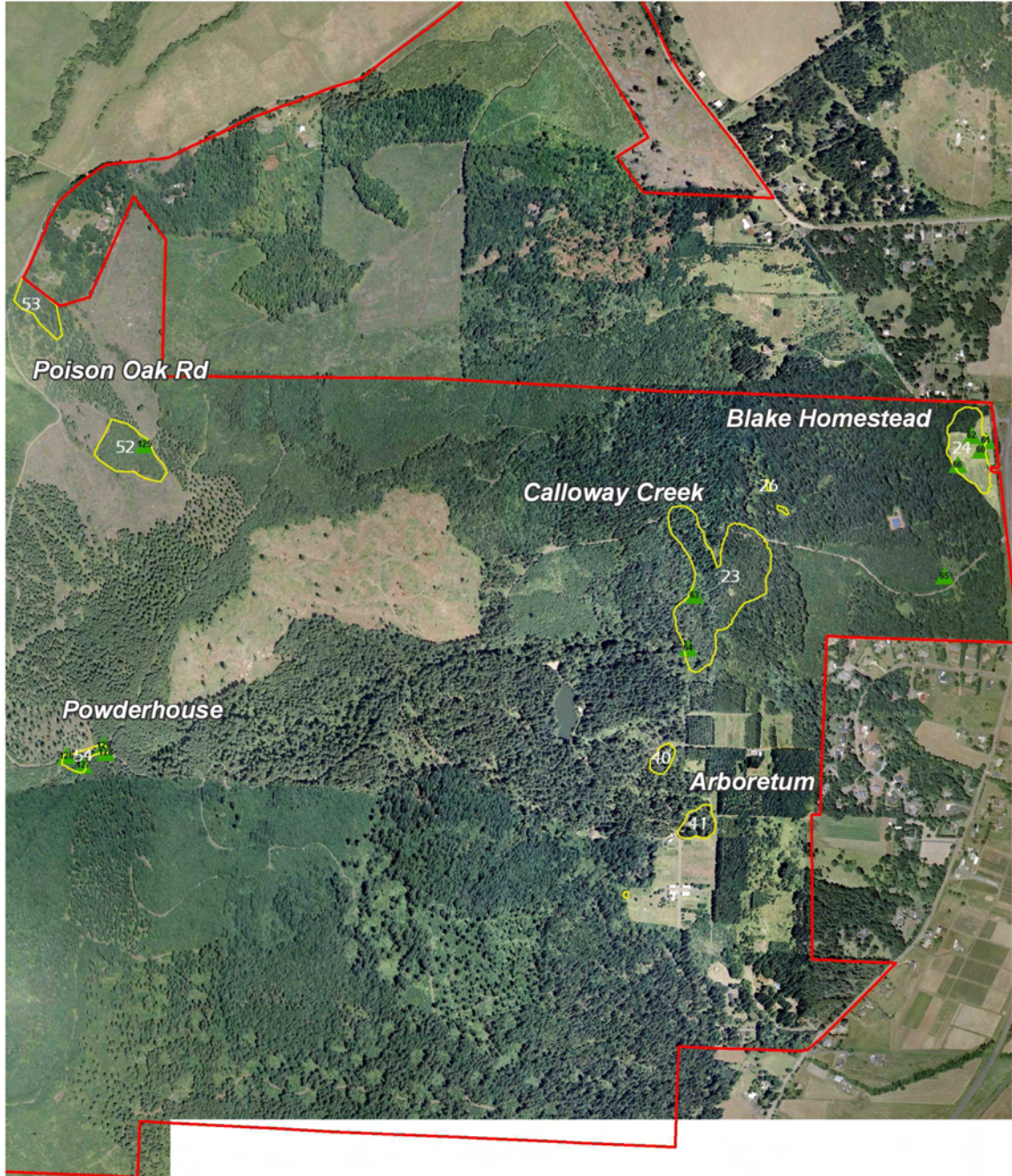

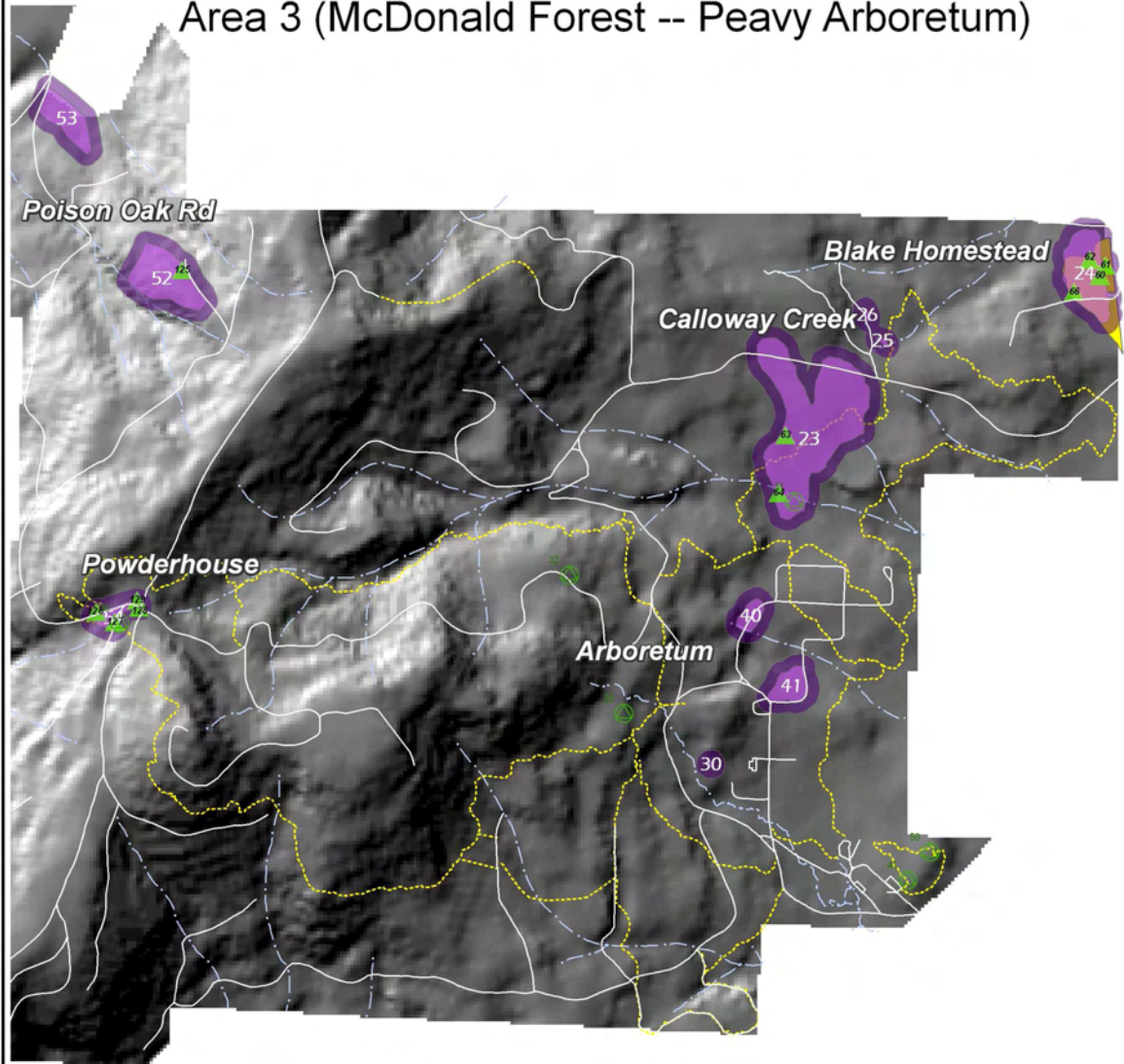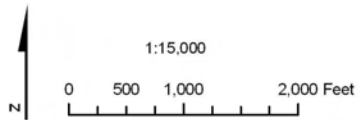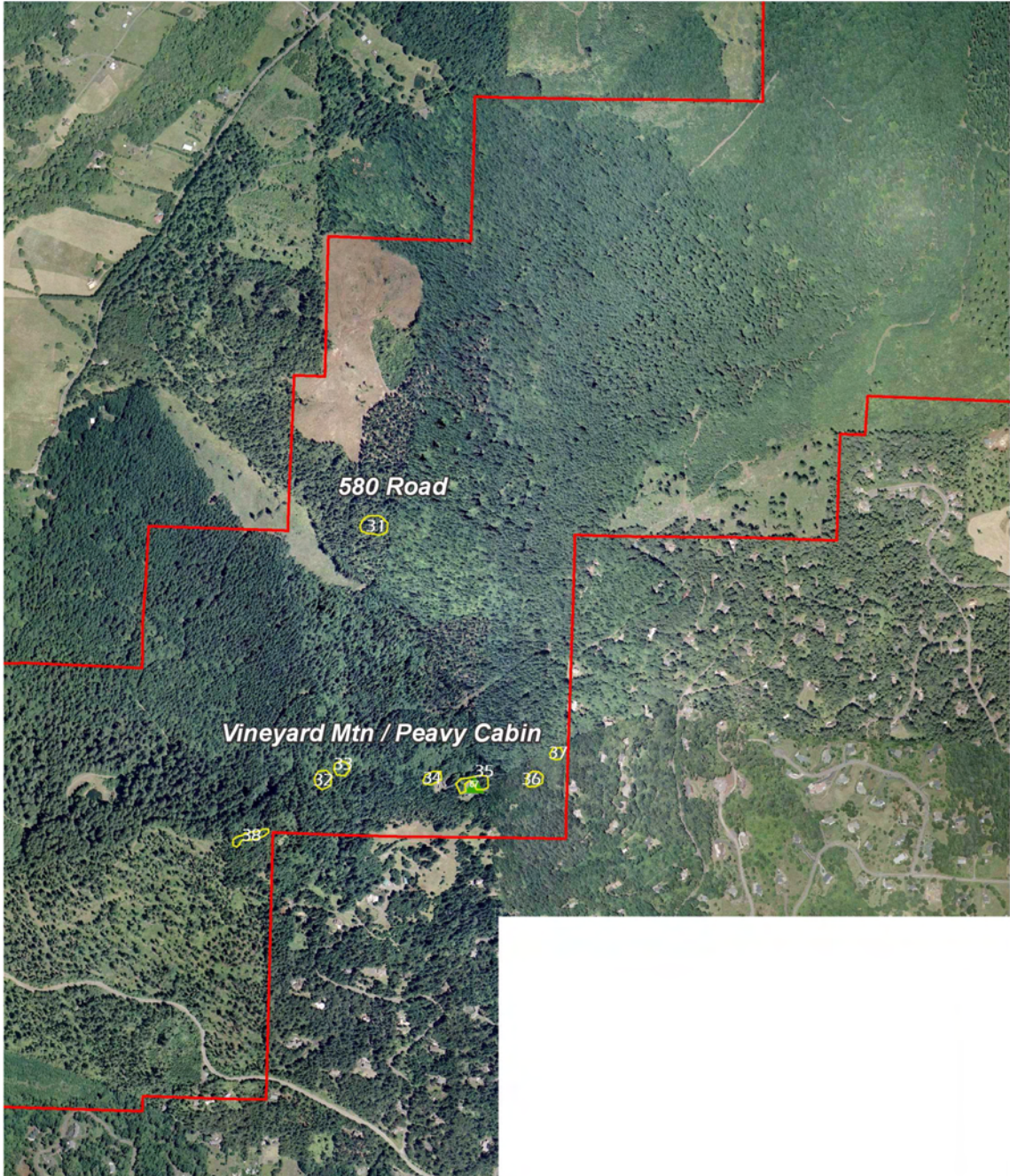Area 1 (Dunn Forest -- north)

Area 1 (Dunn Forest -- north)

Oak Trees
Oak Patches
Oak Patch Buffer
Meadows
Meadow Hotspots
Large Oaks -- Inventory Data

1:16,000

0   500   1,000   2,000 Feet

Area 2 (Dunn Forest -- south)

Forest Peak

Carson Prairie

Soap Creek Farm

Oak Trees
Oak Patches
Oak Patch Buffer
Meadows
Meadow Hotspots
Large Oaks -- Inventory Data

1:14,000

0   500   1,000   2,000 Feet

Area 3 (McDonald Forest -- Peavy Arboretum)

Area 3 (McDonald Forest -- Peavy Arboretum)

53

Poison Oak Rd

52

Blake Homestead

Calloway Creek
26
25

62 61
24 60
66

23

Powderhouse

40

Arboretum

41

30

Legend

▲ Oak Trees

Oak Patches

Oak Patch Buffer

Meadows

Meadow Hotspots

⌂ Large Oaks -- Inventory Data

- - - Trails

1:15,000

0   500   1,000   2,000 Feet

N

Area 4 (McDonald Forest -- Vineyard Mountain)

580 Road

31

Vineyard Mtn / Peavy Cabin

32 33 34 35 36 37

38

Area 4 (McDonald Forest -- Vineyard Mountain)

580 Road

31

Vineyard Mtn / Peavy Cabin

32 33   34 35 36 37

38

Oak Trees
Oak Patches
Oak Patch Buffer
Meadows
Meadow Hotspots
Large Oaks -- Inventory Data
Trails

1:14,000

0   500   1,000   2,000 Feet

N
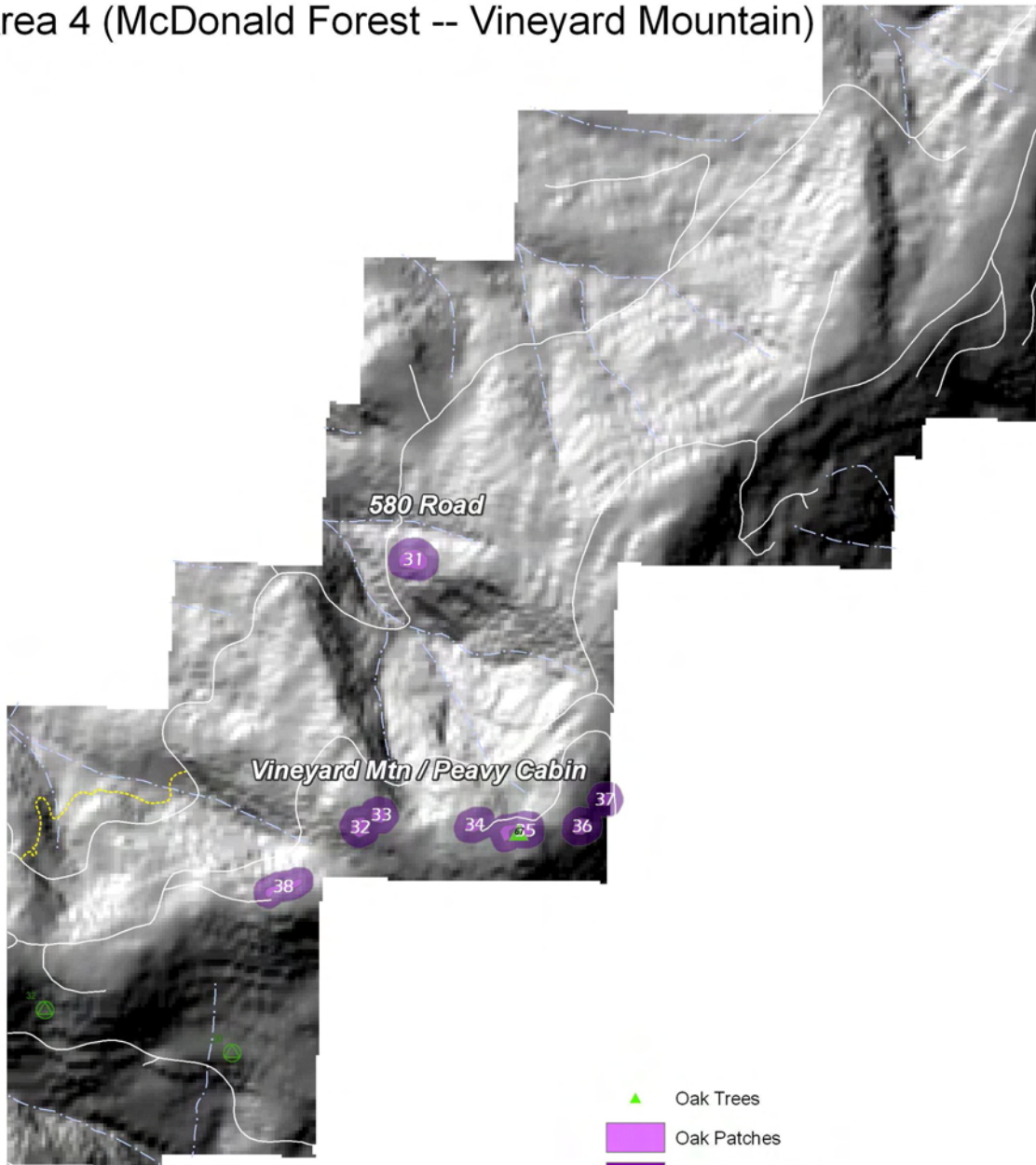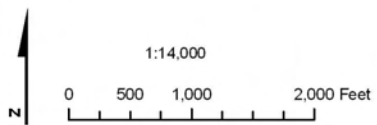
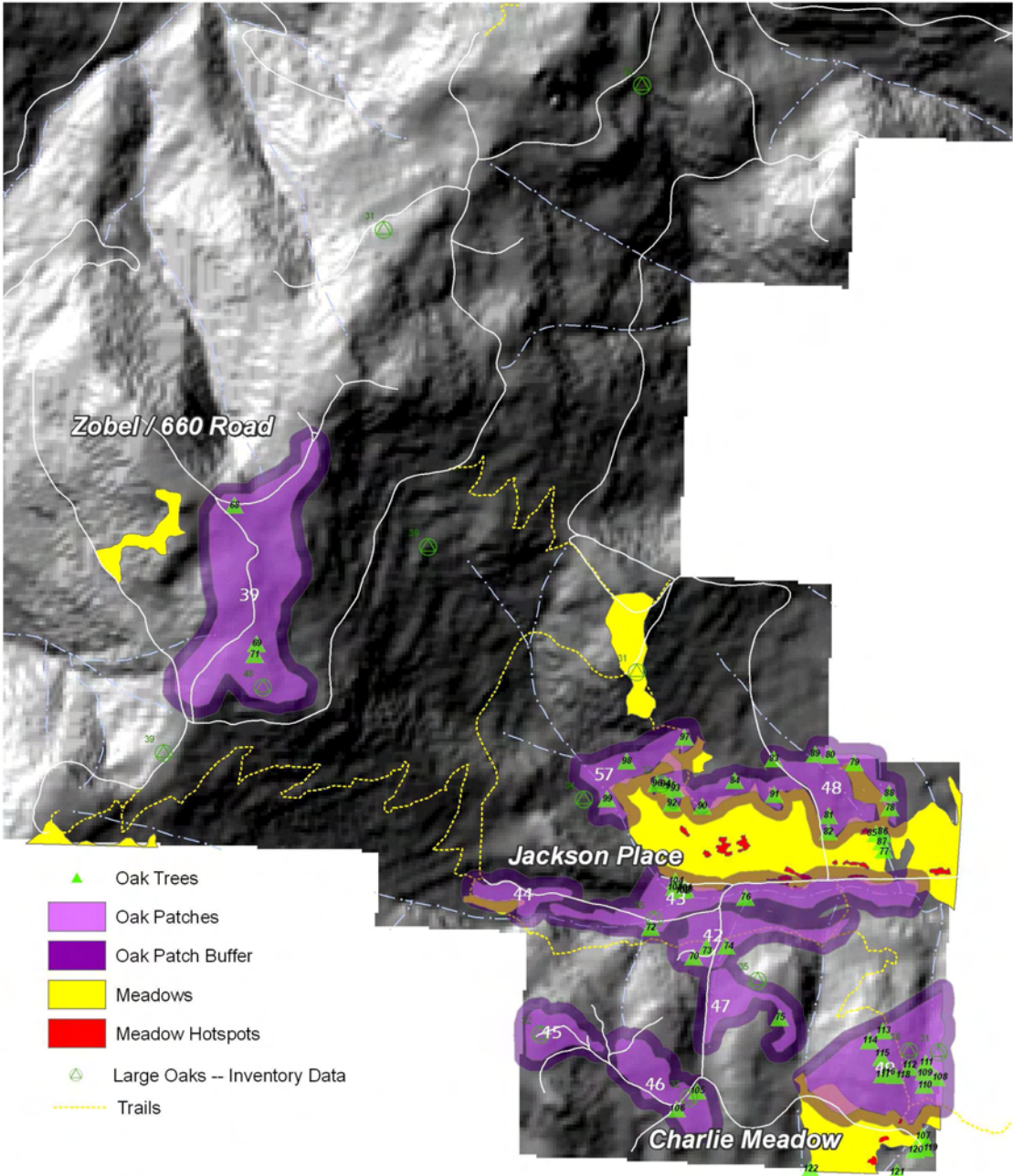# Area 5 (McDonald Forest -- Jackson Place)

Area 5 (McDonald Forest -- Jackson Place)

Legend:
- ▲ Oak Trees
- Oak Patches
- Oak Patch Buffer
- Meadows
- Meadow Hotspots
- ⬠ Large Oaks -- Inventory Data
- Trails

1:14,000

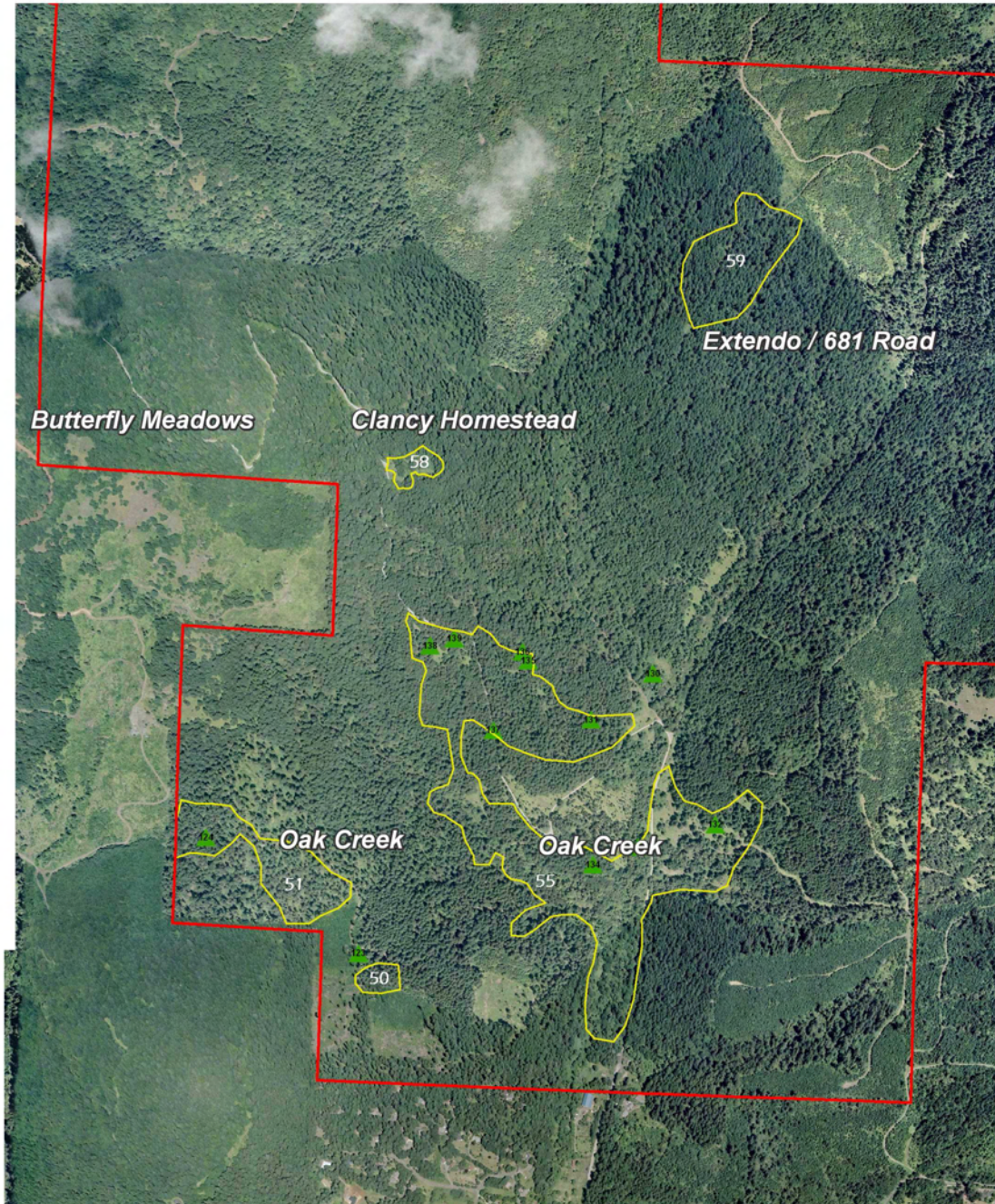0   500   1,000   2,000 Feet

Area 6 (McDonald Forest -- Oak Creek)

Extendo / 681 Road

Butterfly Meadows

Clancy Homestead
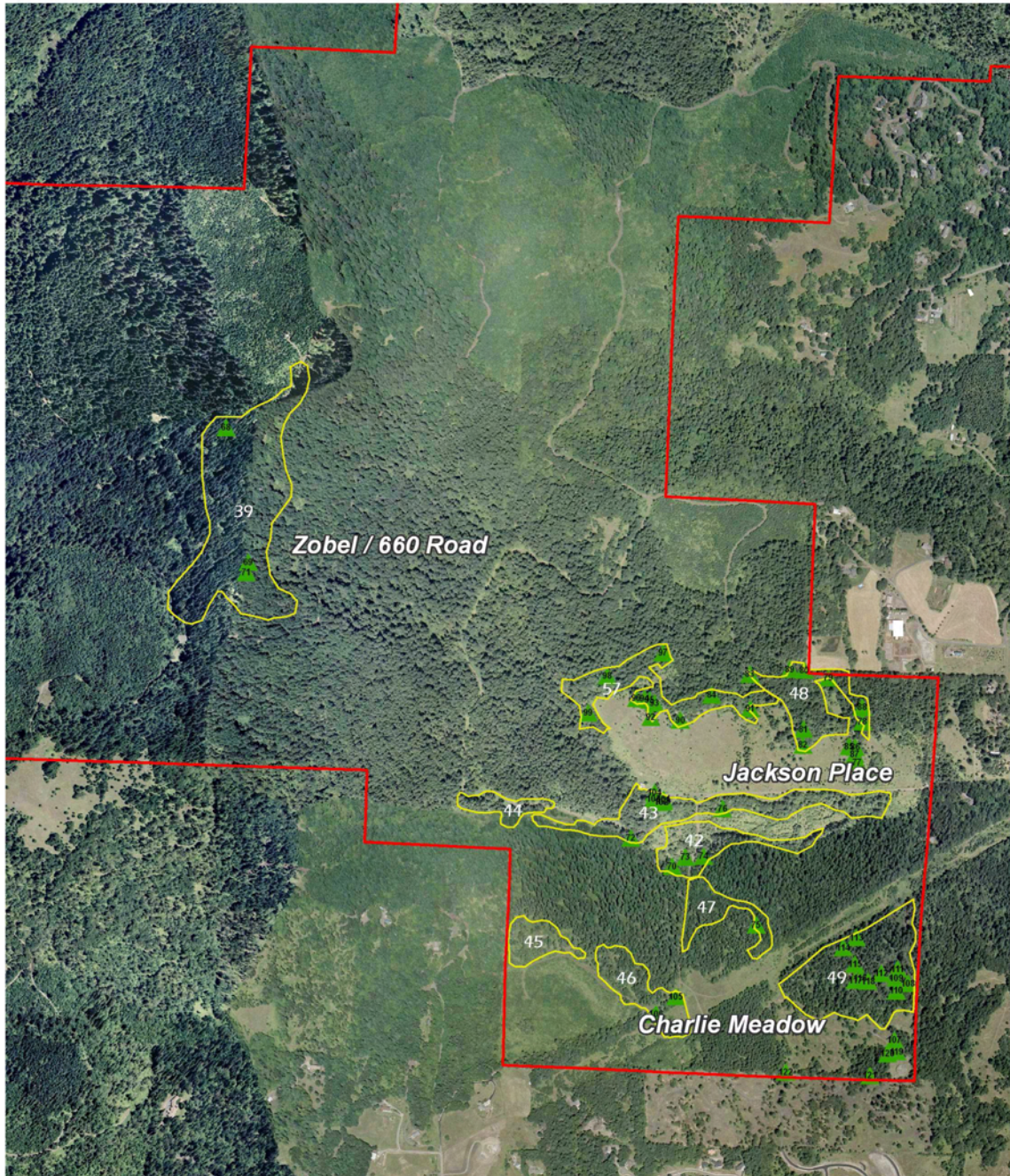
Oak Creek

Oak Creek

Area 6 (McDonald Forest -- Oak Creek)

Extendo / 681 Road

Clancy Homestead

Butterfly Meadows

Oak Creek

Oak Creek

59

58

138

136

67

135

127

133

132

55

134

124

51

37

123

50

35

32

Legend

▲ Oak Trees

Oak Patches

Oak Patch Buffer

Meadows

Meadow Hotspots

⊿ Large Oaks -- Inventory Data

····· Trails

1:14,000

0   500   1,000   2,000 Feet

N

Area 7 (McDonald Forest -- Soap Creek)

760 Road / Soap Creek

720 Road Madrone

61

62

Area 7 (McDonald Forest -- Soap Creek)

720 Road Madrone

760 Road / Soap Creek

61

62

59

1:14,000

▲	Oak Trees
	Oak Patches
	Oak Patch Buffer
	Madrone Area
	Meadows
	Meadow Hotspots
△	Large Oaks -- Inventory Data
	Trails

0   500   1,000   2,000 Feet

N

Appendix 5. Restoration management guidelines for oak groves and trees.

Tier 1 Grove Management
Perceived grove quality = High
Perceived grove value = High
Perceived risk to remnant resource = High
Desired future condition: Oak Savanna and/or Oak Woodland

- Goal 1. Improve tree growth of individual oak trees within 5 years
  - Objective 1: Remove all canopy-level competition by conifers and bigleaf maple.
    - Task: remove all conifer trees within grove boundary/buffer designation except for those large Douglas-fir and grand fir that clearly pose no competitive risk to the residual oak and madrone trees.
  - O2: Adjust oak spacing to meet targets for desired future condition.
    - Task: perform density management cuts on residual oak trees as consistent with desired future condition.
  - O3: Maintain crown spacing over time.
    - Task: revisit groves for consideration of active management every 10 years to maintain desired habitat condition.
- Goal 2. Ensure long-term viability of oak grove
  - O1: Recruit future legacy oaks.
    - Task: assess mortality in oak groves every 5 years.
    - Task: protect naturally regenerating oaks to maintain tree density targets.
    - Task: plant acorns or seedling oaks from local seed sources if natural regeneration of oaks is not present to maintain density and spacing targets.
  - O2: Remove non-native plant competitors.
    - Task: control false brome as necessary, in each of the 2 years prior to overstory treatment
    - Task: reduce risk of further spread of non-native plants into treated areas by cleaning equipment, tires and boots during restoration activities
    - Task: revisit grove annually to use integrated weed management techniques to control non-native herb, shrub, and tree regeneration
- Goal 3. Enhance oak habitat features
  - O1: Improve composition and structure of native plant community according to desired future condition.
    - Task: control/remove woody species if oak savanna is desired condition
    - Task: control undesirable plant species without negatively impacting desirable native plants
    - Task: retain desired species during treatments
    - Task: purchase or collect seeds/seedling of desirable native plants and reseed or plant over time (see Campbell (2004) for guidelines)
  - O2: Meet targets for woody debris loads according to desired future conditions.
    - Task: evaluate loading of woody debris and slash after release harvest.
    - Task: reduce slash if woody debris loads exceed targets.
- Goal 4. Build capacity for research, teaching and demonstration
  - O1: Increase oak habitat/restoration research on College Forests
  - O2: Create opportunities for teaching and demonstration regarding this unique habitat, and the practice of oak habitat restoration.

Tier 2 Grove Management
    Perceived grove quality = Moderate
    Perceived grove value = Moderate
    Perceived risk to remnant resource = Moderate to High
    Desired future condition: Oak woodland or retention of individual oak and madrone trees

- See management strategies for Tier 1 groves and high priority trees. Actively manage Tier 2 groves when forest operations such as regeneration harvest, thinning, salvage, and road maintenance occur in or near Tier 2 groves as per current forest management plan.

Individual Legacy Tree Retention, High Priority
    Perceived tree quality = Moderate to High
    Perceived tree value = High
    Perceived risk to tree = High

- Goal 1. Improve individual oak tree growth within 2 years
  - O1: Assess capacity of tree to respond to release (no apparent damage to tree base or roots)
  - O2: Remove all canopy-level competition by conifers and bigleaf maple.
    - Task: Remove all conifers and bigleaf maples within a radius of up to 100 feet of designated tree. If tree removal is deemed too hazardous or is likely to snap major portions of the oak/madrone crown, girdle the competing tree.
    - Task: remove sufficient softwood to make a commercially viable harvest; stress conifer harvest on southerly and westerly aspect from legacy oak; do not replant conifer seedlings within release gap.
  - O3: If > 1 oak or madrone, adjust oak spacing to where residual tree crowns no longer touch one another unless trees have grown closely together and form a unified crown.
    - Task: Perform density management cuts on residual oak trees.
  - O4: If > 1 oak or madrone, maintain crown spacing over time
    - Task: Revisit trees for consideration of active management every 10 years.
  - O5: Minimize disturbance
    - Task: Limit soil disturbance and soil compaction around tree.
    - Task: Take measures to protect oak/madrone crown during release harvest.
    - Task: Take measures to protect oak/madrone regeneration during release harvest.

Individual Legacy Tree Retention, Moderate Priority
    Perceived tree quality = Moderate to High
    Perceived tree value = Moderate to High
    Perceived risk to tree = Moderate

Nearly all trees in this category are located within Tier 2 groves. Management same as high priority trees, under the assumption that Tier 2 groves will not be managed and restored as entire units.

Individual Legacy Tree Retention, Low Priority
    Perceived tree quality = High
    Perceived tree value = High
    Perceived risk to tree = Low

- Goal 1. Monitor oak tree vigor and competition.
  - O1: revisit trees every 10 years to determine need for active management.
    - Task: Assess and administer a risk rating, and if risk rating changes to high, actively manage tree as per management description for a high priority trees.