4. Fire Ecology and Management of Lake County Vegetation Types[1]

Fire is a natural and necessary *disturbance factor* for Lake County vegetation. Fire, like rain, soil and sunshine, has shaped the patterns of vegetation on the landscape for eons, determining in part the species composition, *spatial distribution,* age, and physical structure of plants. The process of fire has profoundly influenced most of Lake County's ecosystems. In the Lake County foothills and mountains, fire has historically been a dominating factor in the *disturbance regime* and has been key in the evolution of *plant communities.*

Many of the plant communities within this region are considered *fire-adapted*. Scientists have found that many common plants have very specific fire-adapted traits, such as thick bark and fire-stimulated flowering, sprouting, seed release and/or germination. Fire also affects the amount of duff and litter that accumulates on the ground; the density of trees, shrubs, and other plants; and the cycling of nutrients to soil and plants.

An over accumulation of vegetation has occurred throughout many of Lake County's ecosystems as a result of land management practices such as fire suppression. This has allowed unnatural changes to take place in the balance of plant communities, and caused fuels to build up. Fires burning in this scenario generally occur in large episodic events and release tons of particulate matter into the atmosphere. These fires are also difficult or at times even impossible to fight with existing county resources. Large fires often require a change in weather before they can be put out, or extinguish by themselves when they approach natural fuel breaks such as bodies of water, or recently burned areas.[2]

Fire suppression does not eliminate the carbon emissions caused by wildfire; it just delays them. Because wildfires tend to occur at the driest time of year when dead fuels and vegetation is also driest, they are more completely consumed and typically produce three to five times more emissions than early or late-season prescribed fires.[3] Smoke from these episodic events can threaten public health, cause smoke damage to buildings and materials, and disrupt community activities.[4] Reducing fuels may aid in the reduction of large wildfires that emit tons of carbon into the atmosphere. Thinning trees and other vegetation promotes growth and carbon uptake by remaining vegetation. The effects of wildfires on global warming are not fully clear yet and will have to be considered as new information comes forward. However, by decreasing fuel loads, the size and intensity of wildfires may be reduced resulting in less carbon emissions.

More fire-resilient ecosystems can be produced by using the many tools and approaches mentioned in this CWPP (such as thinning, brush removal, and controlled burning). Greater fire resiliency will actually improve air quality and vegetation. A wildfire burning through a fuel-choked area will produce much more smoke and particulate pollution than in an ecosystem which has been treated with management techniques encouraging fire resiliency. Reducing and restoring fire's ecological role in fire-adapted ecosystems will reverse many adverse trends that serve as important indicators of ecosystem sustainability.[5]

The following pages describe the vegetation types found in Lake County. For each type, the role of fire in shaping the assemblage of plants, the nature of the fire regime, and the common vegetative adaptations to fire are discussed. These features are then considered in the development of management prescriptions that a) are consistent with the natural role of fire expected for each type, b) promote the Conservation Principles identified in Chapter 1, and c) improve the fire resiliency of the vegetation type.

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[1] This section was written primarily by David Jaramillo, based on a previous version by Marko Bey, Lomakatsi Ecological Services, and Susan Britting, PhD. Technical review was provided by Greg Giusti, UC Cooperative Extension, Carol Rice, Wildland Resource Management, and Jeff Tunnell, Bureau of Land Management.

[2] USDA Forest Service. 2000. *Protecting People and Sustaining Resources in Fire Adapted Ecosystems A Cohesive Strategy.* p. 44.

[3] USDA Forest Service. 2000. p. 32.

[4] Sandberg, David, V.;Ottmar, Roger D.; Peterson, Janice L.; Core, John. 2002. *Wildland Fire on Ecosystems: Effects of Fire on the Air.* Gen.Tech Rep. RMRS-GTR-42-vol. 5. Ogden, UT: U.S Department of Agriculture, Forest Service. Rocky Mountain Research Station. p. 79.

[5] USDA Forest Service. 2000. p. 44.

Among the vegetation types, fire regimes and plant adaptations are quite varied. The role that fire plays in each type however, has some common themes. For example, fire burns the vegetation and releases nutrients to the soil and air that can be recycled into new plants or used by surviving plants. Vegetative removal by fire–or by thinning, grazing or other methods–creates space or openings that encourage the regrowth or reseeding of plants, allowing the stand to renew itself. Fire also has historically been able to *fragment* the vegetation and provide for both a vertical and horizontal *heterogeneity* over a given landscape. In addition to these general benefits and consequences of periodic fire, fire has played a unique role in shaping each vegetation type, as the sections below illustrate. Fires today, however, generally burn larger areas, making the volume of vegetation *(biomass),* species distribution, and age classes more uniform in larger patches. Diversity of vegetation, and the mosaic nature in which it grows on the landscape, is key to ecosystem health.

The prescriptions mentioned in this Chapter are meant to be a guideline for fuel modifications. Landowners should always, and in some cases *must*, seek the advice of Registered Professional Foresters or other resource managers regarding fuel-reduction projects. For example, individual plans need to be written for fuel-reduction projects such as shaded fuelbreaks and roadside clearing. The prescriptions found in this CWPP can be used as the basis for ecological fuel-reduction projects. However, due to the great variety among vegetation types, goals, and objectives of fuels treatments, it's always best to ask help from knowledgeable resource professionals.

In all cases, care should be taken to increase fire safety while maintaining, restoring, and/or increasing habitat diversity. Treatments should focus on reducing fire intensity, especially around communities. The following vegetation types have all adapted to wildfire. All of the fuels treatments described have been developed to mimic naturally occurring fire on the landscape, including the use of controlled fire itself, where appropriate. Creating landscapes where fire can occur in low or moderate intensity will help maintain healthy, productive ecosystems.

Please see Map 4-1 at the end of this chapter for detailed vegetation types by Wildlife Habitat Relationship (WHR) classification.

4.1. Grassland

Grasslands are a minor yet important vegetation type within Lake County. At lower elevations in the county, large expanses of grassland are often interspersed with stands of chaparral and oak woodland. Historically, perennial grasses were common in grassland vegetation communities.[6] Today, however, grasslands are dominated by non-native annual grasses that arrived following European settlement. Other introduced grasses and plants such as ripgut brome (*Bromus diandrus*) and yellow star thistle (*Centaurea solstitialis*) have invaded many native grasslands.

Vernal pools associated with wetlands and grasslands are also present in Lake County. They are a minor yet important ecosystem type within the county. Many vernal pools have been altered by agriculture and development**.** Loch Lomond and Boggs Lake are two well-known locations of vernal pools here. The Nature Conservancy manages Boggs Lake Preserve for the natural values of the approximately 120-acre vernal pool. Characteristic of the area are four rare, endemic vernal pool plants: Calistoga popcornflower (*Plagiobothrys strictus*), Loch Lomond button-celery (*Eryngium constancei*), many-flowered navarretia *(Navarretia leucocephala* spp. *plieantha*), and few-flowered navarretia (*Navarretia leucocephala* spp. *pauciflora*).[7]

4.1.1. Grassland Role of Fire

Fire in a grassland system serves to reduce the amount of accumulated dead plant material. This is important for annual grass species, as they often do not germinate well unless some of the plant material has been removed and the bare soil exposed for seed germination. Perennials generally respond well to fire, as an overabundance of thatch inhibits the spread and reproduction of these long-lived plants. In native bunchgrasses, fire often promotes

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[6] Wills, R. 2006. "Central Valley Biogregion." In: Sugihara, N.G., J. van Wagtendonk, K.E. Shaffer, J. Fites-Kaufman, and A.E. Thode, ed. 2006. *Fire in California's Ecosystems.* Berkeley: University of California Press. Pp. 295–320.

[7] Keeler-Wolf, T.; Elam, D.; Lewis, K.; Flint, S. 1998. California Department of Fish and Game. *California Vernal Pool Assessment Preliminary Report.* p. 41.

tillering, or spread from the outside of the clumps, or bunches. Fire can change grass species composition by removing annual grass seed and providing more space for perennial bunch grasses.

4.1.2. Grassland Fire Regime

Grassland fires tend to be of moderate intensity and burn only briefly in a given area, with a low heat output and low severity because of the limited amount of biomass. Historically, fire size was likely highly variable, ranging from dozens to thousands of acres. There is little known about the pre-European fire return interval of grasslands. Burning initiated by natives and early settlers occurred in some areas as frequently as every one to three years (this practice occurred up to the 1960's in some areas of the county).

4.1.3. Grassland Plant Adaptations to Fire

The rapid and early seed germination of many annual grasses is well suited to a fire regime that results in most of the aboveground material being burned. This is true even in the absence of fire for annual grasses. Because grass fires burn quickly over an area, the heat rarely penetrates deep into the soil, leaving the *seed bank* viable. The interior of perennial grass bunches, rootstock, and underground *rhizomes* often survive brief fires. Bunchgrasses insulate the central portion of the bunch, helping to preserve individual plants. These living, interior portions of bunchgrasses, and the underground plant parts are then able to resprout quickly following the next rains. Bunchgrasses may be hundreds of years old, surviving several fires in this manner.

4.1.4. Grassland Conservation and Fuel Modification Objectives

Grasslands contribute to regional diversity and therefore are important to maintain in Lake County. The majority of grasslands here have been converted from native perennial grasses and forbs that carry shorter flame lengths, to annual non-native grasses that produce longer flame lengths and faster spread rates. This change increases the potential dangers of wildfire. Perennial grasses tend to shorten the ignition season and dampen fire intensity and spread.

Short-term fuel-reduction objectives for managing grasslands are to manage them in early to mid summer by methods of *weed-eating,* cutting, or mowing prior to the beginning of fire season. Long-term objectives are to convert back to native grasses (from exotic annuals) through fall or spring grazing or *broadcast burning (see Appendix D)* followed by native seed sowing. This is a very time-consuming task requiring meticulously scheduled seasonal activities and is more appropriate for highly focused areas due to the intensity of the work.

If grass conversion is not the focus, then careful, very temporary, selective, rotational livestock grazing can mitigate annual grass heights, reducing grassy fuels. Timing of fuel treatments is important in grasses. Selectively mow non-native annuals in the spring before seed set to retain and promote native perennials, as well as to enhance fire safety. Convert annual grasslands to perennials; the greater proportion of perennials, the more benign the fire effects.

Fuel-reduction efforts at the edges and within neighboring woodlands and shrublands will be an important activity for fire behavior modification plans. Similar to meadows, grasslands can serve as natural fuelbreaks and fire suppression *anchor points.*

4.1.5. Grassland Fuel Modification Treatment Prescription

- Focus on the perimeter of the grassland, in those areas adjacent to structures, roads and landscaping.
- Mow, graze *(see Grazing section below),* or weed-eat annual grasses prior to the plants going to seed. Before cutting grass, identify patches of native grasses and forbs, as well as any wildlife nests, in order to protect and buffer these locations. When needed, planting of native perennials in the late fall to late winter will help in the conversion back to native grasslands. The cool wet weather during these seasons aids in seedling emergence and root development. *Discing* should be avoided because it promotes non-native invasive weeds and surface soil erosion.
- In a large grassland area, prioritize grass cutting of 100–200 feet between structures, landscaping, and grasslands, and between grass and woodland/shrubland edges, in order to create a fuelbreak. Where grazing is desired in a strip pattern, use proper fencing to contain animals in the proper location.

- Treat fuels along edges and within neighboring woodlands or shrublands in an effort to separate grass and woody plant connections. *(See fuel treatment prescriptions below for whichever vegetation community borders the grassland.)*
- Following the treatment of fuels within neighboring woodlands and shrublands, carefully consider broadcast burning in defined *strip patch* portions of the grasslands, taking into consideration all burning regulations and the health and safety of others *(see Appendix D for more information).* This will refresh the seed bank of wildflowers and other plants that typically only thrive after fire. Prescribed fire experts should be consulted and a fire plan created in conjunction with cooperating agencies.
  Following burning, native grass seeds can be sowed into mineral-rich ashes at varied seeding rates, depending on the vitality of the seed source. When acquiring native grass seed from either a nursery or federal agency it is good to determine how old the seed is; be sure to find grass seed best suited for your specific area and elevation. Older grass seed will have less vitality than more recently harvested seed. It is best to keep grass seed stored in a cool place, preferably refrigerated or stored in a cooler at around 35°F. Successful establishment of native grass will require visual monitoring of the seeding response. Apply a variety of seeding rates in different burn locations, including both heavier (more seed spread) and lighter (less seed spread). Label these treatment areas with rebar and flagging to monitor effectiveness. Keep a journal of these details to assist future efforts. Consult local botanical experts for appropriate ratios and genetic sources.

4.2. Chaparral and Chamise/Chaparral

Most shrub communities in Lake County are referred to as chaparral. Chaparral often occurs on hot, dry slopes and on sites with less productive soil. Chaparral generally occurs at elevations below 5,000 feet and includes shrubs such as toyon *(Heteromeles arbutifolia),* manzanita *(Arctostaphylus ssp),* scrub oak (*Quercus berberidifolia*), chaparral pea (*Pickeringia montana*), poison oak (*Toxicodenron diversilobum*), *Baccharis spp*., *Ceanothus spp.*, and chamise *(Adenostoma fasciculatum).* Chamise/chaparral often forms pure stands of chamise, but it is identified as any stand with greater than 60 percent chamise cover.[8]

4.2.1. Chaparral Role of Fire

Chaparral has been described as a fire-adapted ecosystem; meaning it benefits from fire. Some chaparral plant species require fire for its regeneration and to reduce competition. In the absence of fire, chaparral forms tall, dense stands of shrubs that have a low diversity of both shrub and herbaceous species. Chamise can form impenetrable, nearly pure stands in the absence of fire. This situation is a high fire hazard, and has less ecological value than a high diversity of younger shrubs. However, the chaparral ecosystem is a productive part of the overall interconnection of Lake County's vegetation types and diversity. This vegetation type benefits greatly from fuel-management treatments.

4.2.2. Chaparral Fire Regime

Tall and mature chaparral generally produces high-intensity fires. Wildfires in chaparral communities often are stand-replacing events; fires burn sufficiently hot to consume all of the surface plant material.

In the past, frequent fire in chaparral communities led to heterogeneity, thereby reducing the continuity of the vegetation throughout the landscape. Generally, where plant cover is discontinuous in chaparral landscapes, fires were characterized as medium-sized, burning at varied intensities. Fires that burn through continuous dense stands of chaparral can lead to enormous high-intensity conflagrations. Fires in chaparral today generally are larger, less scattered, and more uniform than those in pre-settlement times.

Chaparral fires generally occur in summer and fall, depending on the dryness of the year and site. The time between episodes of fire—the fire return interval—in chaparral is highly variable, ranging from ten to more than one hundred years.

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[8] England, A. Sidney. "Chamise-Redshank Chaparral" In: Mayer, K.E., W.F. Laudenslayer Jr., ed. 1998. *A Guide to Wildlife Habitats of California.* p. 166.

4.2.3. Chaparral Plant Adaptations to Fire

Chaparral plant communities have developed important adaptations for fire survival and re-growth. Sprouting from the underground rootstock and the stimulation of seed germination are examples of such adaptations. Some shrub species that usually reproduce by seeds are able to re-sprout from rootstock after fire; these plants are called *facultative sprouters.* Other shrub species either only regrow from seeds *(obligate seeders)* or from rootstock *(obligate sprouters).*

Herbaceous plants in chaparral, which are often "fire followers," usually become conspicuous only during initial post-fire years. The seeds of many herbaceous plants remain dormant in the soil until germination is triggered directly or indirectly by fire. Examples of fire-related stimuli include heating of seeds for a particular amount of time or to a certain temperature in order to scar the seed coat to allow germination and sunlight. Smoke can cause seed germination in some species, whereas it is lethal to other species.

4.2.4. Chaparral Conservation and Fuel Modification Objectives

Chaparral plant communities in Lake County comprise an extremely important niche of regional biodiversity. Statewide chaparral plant communities support approximately 240 species of native plants. This plant community provides habitat for resident and migratory birds, amphibians, and reptiles, as well as food and cover for carnivores, rodents, and insectivores.

Prior to the implementation of fire-suppression policies, chaparral communities were rejuvenated by stand-replacing fires. However, because of the extended length of contemporary fire intervals, coupled with close proximity to WUI communities, fuel mitigation strategies must focus primarily around communities. This will not only increase community wildfire protection, but may also refresh chaparral stands.

Objectives are to retain and protect portions of this valuable habitat while still creatively reducing and modifying fire behavior. This can be achieved by reducing fire intensity through *mosaic thinning* prescriptions. In addition to meeting fuel-reduction objectives, both the retention and reduction of chaparral patches will support wildlife habitat enhancement by restoring a wide variety of plant communities to their *natural range of conditions.* Reinvigorating and maintaining chaparral will be advantageous to species dependent upon this habitat.

Avoid cutting obligate-seeding chaparral species such as hoary manzanita (*Arctostaphylos canescens*). While these plants generally have a long life in the seed bank, they may not continue to be present in the stand and produce more seeds when cut. These plants may be absent from the stand until the next fire. Avoid cutting species that are infrequent or unusual. If there is only one or two of a type of plant in the area, retain those specimens to maintain the present species diversity.

Mosaic or *patch-retention thinning* focuses on separating *fuel continuity* by incorporating fuelbreaks in strategic locations where fire-suppression efforts have a higher chance of effectiveness. Higher levels of chaparral reduction will be concentrated adjacent to structures, along main roads, key ridges, secondary roads, *spurs,* and other strategic areas within treatment boundaries. This will modify fire behavior and achieve increased community safety.

On steep- and mid-slopes where chaparral patches can be isolated, focus efforts on retaining *thickets.* Planning treatments for chaparral reduction or retention need to take into consideration fuel conditions, future desired conditions, and accessibility.

Prescribed fire, where feasible, may be incorporated into chaparral to refresh the species that require fire to perpetuate. Involve agencies, consultants, and/or land-owning resource managers within the community (including neighbors) to help plan, prepare, and implement the burn. All burning needs to conform to local, state, and federal regulations and be done in a safe and responsible manner. *See Appendix D for more on burning.*

For information on spacing between shrubs, see Figure C-2, Plant Spacing Guidelines, in Appendix C.

4.2.5. Chaparral Fuel Modification Treatment Prescription

Treatment Preparation and Layout

Prior to beginning fuel reduction in chaparral plant communities, it is vitally important that the treatment area is pre-designated and flagged. Since chaparral tends to be contiguous and dense, it is easy to "over cut" and greatly reduce the vegetative cover. Remembering the Conservation Principle "you can always take more, but you can't put back what you have cut" is a key guiding concept for treatments in chaparral.

Begin the *layout* by selecting the strategic areas to clear chaparral and create openings. These areas are not always necessary to delineate with flagging. Select patches with a high proportion of obligate seeders to retain. Pine and oak trees, if established, can be somewhat protected by performing *drip-line thinning* technique described in Appendix D. Continue the layout by selecting the trees to keep and clearing chaparral around them. Planning and layout of fuel treatments in chaparral prior to beginning work will ensure that portions of this diverse habitat are conserved.

Following identification of "cut areas," identify *leave-patches.* These can be of varying sizes based on the site. Make leave-patches bigger at first; their size can be reduced later if needed. When selecting leave-patches, identify natural features that would benefit from retaining vegetation. For example, select leave-patches on steeper areas, or areas where there are native plant groupings, wildlife habitat zones, along ravines, etc. It is important to read the landscape.

For laying out chaparral fuel treatments, determine a leave-patch color; e.g. green. Patches may range in lengths between ten to thirty feet; flag in a random circumference. Be sure that flagging is clearly visible to whoever will be treating the site later. This leave-patch flagging will identify a "no-cut, no-entry" boundary in which all of the material both dead and alive will be retained.

Thinning

- Implement mosaic thinning to reduce the abundance of some chaparral while conserving portions of this habitat. Such thinning creates a diversity of beneficial habitat types by creating islands, corridors, thickets, and open understory shrub and herbaceous communities of random shapes, sizes, and occurrences.
    - In chaparral fields, patches should be retained to enhance structural habitat diversity and to separate fuel continuity. Impenetrable and contiguously dense chaparral should be separated and thinned to create isolated islands, grouping fuels into clumps. Partial chaparral reduction will be created via random mosaics—or strip patches with the long axis oriented along contours—using a variety of spacing between strip patches of ten to thirty feet. Strip patches should be offset from one another so as not to lie directly up and down the slope (to lower fuel connectivity and erosion potential).
- Retain older chaparral individuals by leaving surrounding chaparral intact as a support structure and leave-patch. Within many chaparral zones, tree-form-sized manzanita may be present. Sometimes these individuals exceed fifteen feet in height. Heavy removal of shrubs around these tree-form specimens can result in wind or snow damage such as broken branches and uprooting. Careful consideration should be made to protect these individual locations.
- *Release* larger pines and oaks that have developed within the chaparral community by thinning *excessive stems,* chaparral, and small trees from under *drip lines.* (It's referred to as a drip line because rainfall generally drips from the leaves and branches at this point, creating a circular line around the tree.) Thin back encroaching chaparral beyond the larger pine and oak drip lines, approximately 10 feet. Place special emphasis on pine and oak enhancement during thinning treatments. When thinning or shrub removal is conducted around sun-loving pines, place thinning emphasis on the south and west, because pines thrive in open forest stands with abundant sun exposure. Younger pines and oaks less than eight inches *DBH*[9] can be cut to prevent increased chaparral encroachment. Consider thinning pines on ridge tops to reduce the distance of ember distribution.

[9] DBH: Diameter at Breast Height.

- In order to provide wildlife habitat and structural diversity, retain clumps and groupings of trees where appropriate. Focus thinning around the drip lines of the outer clumps of trees. Thin smaller stems beyond the clumps, and in between and around tree groupings. This will break up fuel connectivity between groups of trees in order to maintain structural diversity. Retain forked trees (another element of structural diversity) for wildlife. *"Limb up" leave-trees* to approximately ten feet from the ground.
- In locations outside chaparral leave-patches, smaller patches of *tip-sprouting* shrub species (e.g. deer brush *[Ceanothus integerrimus]* and buck brush *[Ceanothus cuneatus])* can be isolated from other fuels and cut at chest level (three to four feet from the ground) for the benefit of fresh wildlife browse. To vary this treatment, some root-sprouting shrubs, such as oceanspray *(Holodiscus discolor),* and eastwood manzanita (*Arctostaphylos glandulosa*) can be cut to the ground to encourage diversity through regeneration. Prior to implementing this treatment, research what tip-sprouting or stump-sprouting species grow on the site. Treatment ratios may vary depending on the ratio of sprouting shrubs. Mosaic treatments are recommended.
- Throughout chaparral, areas of trees may need thinning to achieve fuel-reduction goals. When thinning in tree stands—particularly conifers—a *variable density treatment* approach is recommended. Mosaic thinning pertains to areas of brush that are thinned into patches, while variable density or uneven-aged thinning is more specific to stands where representatives of all species and age classes will be retained throughout the treatment areas. Do this in a way that still meets fuel-reduction objectives.
- Smaller snags can be cut and left as downed wood. Leave larger snags standing for wildlife habitat. In areas where snags are not abundant, smaller snags may also be retained.

Mastication

Mastication is a form of fuel reduction that uses heavy machinery with a rapidly circulating head attachment. The head is used to shred, crush, and grind up plant and tree material. The result of a masticated site is small pieces of woody material that lie on the forest floor. This can be a cost-effective, quick way to reduce fuels around community assets and/or to create fuelbreaks. Slope steepness, noise, soil stability, proximity to watercourses, accessibility, cost, and diurnal and seasonal effects on wildlife limit masticator use. Little is known about the affects of mastication on wildlife populations within treated sites. Mastication during the spring can harm ground-nesting birds and other wildlife.

Slash Treatment

Slash accumulated from fuel treatments in chaparral will likely be abundant; the disposal of this material needs to be performed carefully. Regardless of which methods are used for slash treatment, it is important that a portion of the cut material be left on site and placed across the slopes of the treatment area for erosion control and soil productivity. This is often referred to as *lop and scatter.* Preferred materials for scattering on the slopes are the main chaparral trunks greater than four inches in diameter. The fine (smaller) branches are best removed. Ensure the main trunks make contact with the ground and are left as intact as possible, four to ten feet long. Manzanita trunks are generally smaller in diameter; combine them by laying them along the contour of the slope, placing them together (either on top of or below each other) to make ground contact. Lay them as close together as possible. Within a year they will sink into the ground and be naturally anchored. By combining four to six smaller-diameter pieces you can increase their total diameter, replicating a log. Place wood randomly in openings or at the edge of leave-patches. The goal is to have coarse woody material present to act as erosion control, without creating a fuel problem. The majority of the cut material will need to be chipped, utilized for biomass, or burned to adequately reduce fuel hazards.

Prior to planning treatments and utilization strategies, take into consideration each specific treatment location and estimate both the ecological and economic implications of your biomass and slash disposal strategies. Slash disposal can have greater impact than the initial treatment, such as steep areas with lengthy haul distances. Plan slash treatments in a site-specific manner. Within a twenty-acre property, three different slash treatment methods may be used. Several different slash disposal options follow.

Burning

The careful, controlled use of fire as a tool to reduce excessive fuel and to help restore ecosystems is highlighted several times in this CWPP. However, it is just one available fuel modification treatment; mechanical removal and grazing are examples of other options. Each site requires analysis to determine which practice is most appropriate. Controlled burning often figures as an important option partly because the local ecosystems have evolved with fire, and in many cases require fire for the system to function properly.

Currently, thousands of acres throughout the county are being burned annually through a joint approach by Lake County Air Quality Management District (LCAQMD), the US Forest Service, local Fire Protection Districts, and CAL FIRE's Vegetation Management Program (VMP). This overall cooperative program is informally known as the Lake County Cooperative Burning Program. In 2008, approximately 6,600 acres were control-burned in the county through this cooperative program. The VMP aids private landowners (and the Bureau of Land Management) in the application of fire on the landscape. Under VMP, landowners are relieved of the risks associated with a possible fire escape and CAL FIRE does the actual burn. This assistance and relief of liability may cause more landowners to use controlled burning (also known as prescribed fire) as a vegetation management tool.

All burning conducted through the VMP or any other controlled fire program must be done in conformance with LCAQMD. Burning activities must be properly permitted by the appropriate local Fire Protection District or LCAQMD if a smoke management plan is needed. These regulatory and protection agencies can help landowners develop the best treatment alternative for a property. Prescribed fire is just one management tool, and before utilizing fire it is always important to consider the air quality health impacts, as well as safety of other residents and the environment. Landowners should consider alternatives such as chipping or mastication, along with desired restoration goals, before planning to burn. If fire is indeed utilized, it must always be done in a safe manner to decrease the risk of the fire escaping, as well as to minimize the amount of smoke put into the air. *(See Appendix D for more information on controlled burning).*

"Wildland fire is an integral part of ecosystem management and is essential in maintaining functional ecosystems, but air pollutants emitted from those fires can be harmful to human health and welfare."[10] However, for decades, Lake County has enjoyed some of the cleanest air in the nation.[11] Because care has been taken, it has maintained this status even with its cooperative burn program. In 2009 the county ranked third cleanest in the nation (better air quality than national parks or the island of Maui, for example) in terms of particulate pollution in the atmosphere.[12] Appropriate fuels reduction and fire use focused on ecosystem restoration can help maintain or enhance the high quality air found here, when done properly. According to a study by the US Forest Service, the relative risk to air quality was projected to decrease by about 25% as a result of improving the resilience of ecosystems.[13]

Prescribed fire, a.k.a. controlled burning, is a management option in chaparral systems. Following *initial-entry* chaparral fuel treatments, burning slash may be the most economical treatment option if planned and executed properly. In areas farther away from roads, burning is often the main method.

Swamper burning is generally the preferred method of burning initial-treatment chaparral slash. However, it has a limited application due to costs, slopes, proximity to watercourses, and diurnal and seasonal timing. It is a prescribed fire method in which fuels are gradually and continually added (over the course of a day) to a hand or machine pile. Ensure that all fuels have had time to properly dry following initial entry (this can take several weeks or more). Pay attention to weather conditions when initiating swamper burning. When possible, burn during or following rain. This is the preferred method to deal with chaparral slash, because material gradually added to the pile provides more control over burn operations. Since chaparral patches contain a high mixture of

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[10] Sandberg, et. al. 2002.

[11] Lake County Air Quality Management District (LCAQMD): www.lcaqmd.net.

[12] American Lung Association. State of the Air Report 2009. p. 24. *See* www.lungusa2.org/sota/2009/SOTA-2009-Full-Print.pdf *for more information*.

[13] Sandberg, et. al. 2002.

dead fuels, prepare burn operations by building small ignition piles with dead materials. Stack smaller fine fuels together (mixing both dead and live). Stack half the pile two feet high then cover the pile with *slash paper (check with Lake County Air Quality Management District at 707-263-7000 for approved slash paper materials).* Complete the task by piling the remaining slash on top of the pile.

An effective method is to burn several piles at once, working in a rotating fashion from pile to pile. After adding slash to one pile, move to the next one, and then return to the first pile where the fuels will have been consumed and it is time to add more slash. This method mitigates the convection columns, so as not to damage the remaining vegetation by scorching it. It also reduces the heat pulse into the soil, preventing possible sterilization of the soil under the burn pile.

Following burning operations, after fires are *dead out,* native grass and wildflowers suited to the site can be sowed into the mineral-rich ashes of the burn spots. This follow-up method encourages herbaceous understory growth and helps prevent non-native grasses from invading and taking over the site.

Broadcast burning is another option for chaparral. Under the right circumstances, and with the appropriate expertise, it can be conducted in chaparral stands following initial entry, when the grass is green and foliar moisture is still low (in the late fall). As with grasslands, always involve agencies, local landowners, resource managers, and private industry to plan and carry out broadcast burning.

For more detailed instructions regarding burning, see Appendix D.

Chipping

Another way to dispose of slash is to chip it. Chipping can be expensive, although very effective, depending on the *site-specific* location of your treatment area. In areas closest to main roads, secondary roads, or trails, chipping can be cost-effective if planned correctly. However, it may not work where materials are generated far away from where a chipper can be located may need to be treated using other methods, such as lopping and scattering (see above), or burning. The added expense of either machine-*yarding* materials or hand-carrying them long distances to chip can be significant.

Choose areas within close proximity of a road or landing (this is where the chipper will be located), preferably on a downhill drag. Avoid carrying materials upslope. Where material must be dragged, remember that the dragging process “sweeps” the ground of all material, particularly in the haul routes. Try to limit the areas subjected to sweeping by designating only a few haul routes. There is a tradeoff between erosion potential and future germination of local native plants. The site will need to be re-covered with chips, other small local materials, or with commercial erosion-control products. Collected material can either be chipped into a truck for removal or blown back into the treated areas. Remaining chips should not exceed more than several inches in depth. In general, areas that are not economically feasible for chipping are usually those areas where activities would increase ecological impacts due to material-extraction difficulties. In these cases, alternatives such as lopping and scattering may be explored. In some cases larger material may be used for firewood. The Westlake Resource Conservation Districts runs a community chipping program in cooperation with the Lake County Fire Safe Council. Call 707-279-2968 to learn more, and to participate in the program.

Grazing

Grazing with goats (or other livestock) is sometimes used to reduce chaparral fire hazard and to remove weeds (they eat them). Within the county there are several goat herds available for fuel reduction. Goats are best used in areas that do not have a large number of plants to be retained, since all plants (other than large trees) will likely be damaged or killed unless protected. Grazing under contract with a large herd of goats is a possibility for larger acreages. One to three goats can be grazed on smaller parcels. In this situation, arrange alternate locations for additional grazing when they have eaten all undesirable plants on the site. Goats can be placed on any steepness of slope and can generally graze any shape or size of parcel. However, be careful on sites with steep slopes, as goats can quickly denude them and cause significant erosion.

4.3. Foothill Woodland

Foothill woodland is a diverse vegetation type associated with species such as gray pine *(Pinus sabiniana)* and California buckeye *(Aesculus californica).* Numerous species of oak such as blue oak *(Quercus douglasii),* interior live oak *(Q. wislizenii),* scrub oak, canyon live oak (*Q. chrysolepis*), and California black oak *(Q. kelloggii)* dominate these woodlands. In many areas this vegetation type is diminishing as a result of conversion for development. The oaks and other tree species found in foothill woodlands often extend up into higher elevations along riparian areas. Foothill woodlands are characterized by a range of tree densities and canopy cover from very sparse (ten percent of the area covered by tree canopy) to dense (one hundred percent cover). A variety of herbaceous plants and shrubs grow in the understory and between the trees here, including poison oak, coyote brush, and toyon. Grass is often co-mingled with shrubs, especially in sparse, deciduous stands.

4.3.1. Foothill Woodland Role of Fire

Periodic fire creates openings in dense stands to allow sprouting and growth of new oaks and other tree species (e.g. gray pine). Periodic fire in foothill woodlands can reduce the competition for water and nutrients by killing shrubs and small trees found in the pine and oak understory. Fire also renews the understory shrub component, providing lush wildlife forage.

4.3.2. Foothill Woodland Fire Regime

Historically, fires in these woodlands were frequent, and usually of low to moderate intensity, with occasional high-intensity areas. Woodland understory strongly influences the intensity of the burn. Those with continuous leaf litter, and those dominated by grass and herbaceous plants, tend to burn less intensely than those dominated by shrubs. Historically, perennial plants dominated the herbaceous understory. Today shorter-lived annuals dominate, primarily being introduced grasses. Annual grasses can promote an earlier onset to burning season because they dry and cure earlier than perennials.

Only a few studies have examined the time between foothill woodland fires. Prior to European settlement, fire return intervals ranged from 8 to 49 years.[14] The shorter fire-return intervals were noted where site conditions were drier and warmer.

4.3.3. Foothill Woodland Plant Adaptations to Fire

Tree response to fire in foothill woodlands is varied. Bark thickness, tree structure, and sprouting response each affect the ability of a given species to resist or recover from fire. For example, canyon live oak and interior live oak have thin bark, and their tops are more sensitive to heat damage from fire. These live oaks however, can vigorously re-sprout from their stumps following fire. California black oak and Oregon white oak have thicker bark and hence are better able to resist the damaging effects of fire. These species, as well as California buckeye, vigorously re-sprout from rootstock following fire. Gray pine is damaged by fire although dependent on it to clear the understory for seed germination. Shrubs and grasses in the understory have similar adaptations as those discussed in the chaparral and grassland sections above.

4.3.4. Foothill Woodland Conservation and Fuel Modification Objectives

Oak woodlands in California provide habitat for more than two hundred vertebrate species, in addition to thousands of species of invertebrates. Oak trees provide shade, fertile organic matter, perches, forage sites, and nesting cavities that together increase wildlife diversity. Understory native plant diversity is abundant within an intact woodland ecosystem. Pines offer increased diversity for those species that require coniferous features.

Objectives for fuel treatments within oak stands should focus on the reduction of excessive shrubs and smaller conifers. In some cases the careful and selective thinning of oaks can take place. Oaks can be carefully thinned when the stands are very dense, there are numerous smaller oaks crowding larger leave-trees (e.g. a larger oak or

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[14] Skinner, C.N., and C. Chang. 1996. "Fire Regimes, Past and Present." Sierra Nevada Ecosystem Project. *Final Report to Congress. Volume II, Assessments and Scientific Basis for Management Options.* Davis: University of California, Centers for Water and Wildland Resources. Pp. 1048–1049.

pine), and/or there are several side sprouts around a dominant stem. In treatment areas, shift species composition to increase proportions of oaks, to reduce flammability and potential ember production and distribution.

Fuel-reduction activities within the foothill woodland zone can be a significant proactive step not only to reduce fire hazard and increase community wildfire safety, but also to aid in the process of ecological recovery for these valuable diminishing ecosystems.

4.3.5. Foothill Woodland Fuel Modification Treatment Prescription

Understory Thinning

- Remove understory shrubs and small trees under drip lines. Prune lower branches of trees to a height of about eight feet when the canopy is dense and closed.
- In some closed-canopy woodland habitats not directly adjacent to a community, select isolated *retention patches* (as under multi-stemmed oaks) of productive shrub habitat and understory vegetation for wildlife. Diversify this mosaic thinning treatment by reducing shrubs and *thinning from below* other closed-canopy areas. In areas adjacent to communities the understory vegetation may be cut under multi-stemmed oaks in order to provide a shaded fuelbreak.
- Incorporate a variety of treatments based on strategic fuel modification locations. For example, if working near a skid road that can serve as an area where firefighters can suppress fire or set a *backfire,* thin the understory more thoroughly. If on a mid slope or more distant corner of the property away from roads, consider retaining more patches of multi-stemmed oaks and brush in large clumps for wildlife habitat.

Thinning

- Consider the necessity to thin within the canopy of oak woodlands where there are many small trees or sprouts. However, if the canopy is closed or nearly so, thinning may encourage undesirable understory growth, necessitating more frequent maintenance. If you decide to thin the canopy, be conservative and use the Precautionary Principle. You can always thin more later on, but you can't put back what you've taken, especially where oak regeneration is problematic.
- In order to restore this ecosystem type, favored leave-trees in decreasing order of preference should be: California black oak, blue oak, canyon live oak, interior live oak, and gray pine. Large trees and vigorous oaks with full crowns will be the main targets to be protected, retained, and released. Release by clearing encroaching conifers, shade-tolerant species (e.g. Douglas-fir and incense cedar), and shrubs from below the drip line of desired leave-trees.
- Reducing oak density will follow the removal of less-desirable species and should be performed carefully. Ecological fuel treatments will typically remove twenty percent of the oaks under eight inches DBH for a given treatment area. Spacing in between oaks can vary while still effectively reducing overall fuel hazards. This should only be considered where there is adequate regeneration.
- Within oak stands that have a diversity of size and age classes, select a variety of trees to leave, considering dominant trees, snags, and clumps to persist in the stand. Thin smaller oaks under approximately eight inches from beneath the drip line of larger leave-trees. The practice of *mixed-structural thinning* can be accomplished by a diversified treatment where clumps of oaks are retained as a group, and fuels are reduced by thinning outside these groups, beyond their drip lines. This practice combines the selection of individual oaks and clumps to be released. Both groups and individual trees are retained as habitat. This practice should take into consideration the proximity to communities, as high intensity fire can burn through retained clumps, threatening communities.
- Retain as much canopy closure as possible in ephemeral and *perennial* stream corridors.
- Many oak trees will sprout from the stump after being cut. This can result in an even greater fuel hazard because they form multi-stemmed brush patches requiring frequent maintenance. To minimize this, focus your actions on cutting up to twenty percent of the oak density. Portions of *stump sprouting* areas from previously cut oaks will benefit wildlife by creating fresh nutritious browse. Over-cutting of oaks should always be avoided. Areas designated for wildlife browse should be placed under gaps in the tree canopy.

- Closed-canopy, multi-stemmed, even-aged woodlands are often diverse biological strongholds for understory plant communities. Therefore, thinning within these oak groups can be detrimental to these native plant communities. This can cause a decline in productive native vegetation, which can lead to the introduction of noxious and invasive species. In certain locations select and maintain (i.e. don't cut) the closed-woodland habitat type within the treatment area by isolating these clusters and *thinning away (vertically and horizontally) contiguous fuels* around the outside perimeter of your chosen patch. Similar to chaparral treatments, this can be performed by encircling these locations and creating a mini fuelbreak around them.
- Maintain the important diversity created by openings and edges within woodland zones. The ladder fuels on the edges of these *ecotones* should be eliminated to reduce the potential for torching. Ecotone edges are where oak groves transition into grassy openings. As a result of fire suppression, many of these valuable openings are being closed in by the encroachment of shrubs and, to a lesser extent, conifers. Hardy shrub species will take hold and over time eliminate these valuable ecological niches. Prescriptions for these areas will be site-specific based on slope and aspect. However, aggressive vegetation reduction for these sites will both maintain them and create a natural fuelbreak. Such sites can serve as a location for prescribed fire ignition for the long-term maintenance of fuel hazards in neighboring oak groves, as well as anchor points for fire-suppression activities.
- Considerations should be made to protect oak seedlings within a stand. Young oaks are a valuable resource for expanding the oak stand and replacing older trees. In some areas, regeneration can be limited due to a number of factors. As with any ecological fuel prescription, retaining a diversity of ages will support the long-term health of the stand. Maintain vertical discontinuity by reducing ladder fuels while retaining seedlings.
- Snags—standing dead trees—are critical components of a functional woodland. Therefore special emphasis should be placed on retaining a diversity of age classes of standing snags. *Cavities* present in oak snags serve as long-term habitat for many wildlife species. In those areas where snags are less abundant, you can cut oaks ten to fifteen feet above the ground to create valuable snag habitat. Select conifers for snag creation by *girdling*.
- Reduce ladder fuels by *high-pruning* branches eight feet above the woodland floor. Reduce excessive ground fuels and surface fuels. Trees less than twenty-four feet high should be pruned up from the ground for one-third the total height (i.e. leave two-thirds of the total height in canopy). This treatment will reduce the possibility of fire spreading into tree crowns. In young trees, prune branches on the lower one-third of the tree (e.g. if a tree is ten feet, prune the lower three to four feet and keep the understory plant material to less than one foot in height. As the tree grows up to twenty-four feet, it can achieve the eight-foot distance from the ground, and the understory plant material can reach 2½-feet high.).
- Treatment emphasis will focus on thinning from below (i.e. understory thinning) in an effort to reduce and separate both vertical and horizontal fuel layer continuity.
- Canopy thinning is recommended only if the fire hazard cannot be reduced adequately through treating the surface and ladder fuels. Understory thinning is the preferred treatment.[15,16]

Slash Treatment

Burning

- Follow initial entry into foothill woodlands zones with a combination of swamper burning or hand-pile burning, where slash is gathered into piles and located in open areas and burned *(see "Burning" in Chaparral section above, or Appendix D for more information)*. Following this reduction of initial treatment slash, broadcast burning can be a beneficial tool for the long-term management of woodlands.
- In combination with burning, the practice of lopping and scattering slash at different locations (away from tree canopies and the burning) throughout the treatment area can facilitate the construction of wildlife piles. Create a wildlife pile by using slash from the fuel treatment and stacking it at a density of two per acre. Best locations for wildlife piles are within natural pits caused by tree blowdown, along nurse logs, or at the edge of retained

[15] Stephens, S.L. 1998. "Effects of Fuels and Silviculture Treatments on Potential Fire Behavior in Mixed Conifer Forests of the Sierra Nevada, CA." *Forest Ecology and Management.* 105: Pp. 21–34.

[16] Stephens, S.L. and J.J. Moghaddas. 2005a. "Experimental Fuel Treatment Impacts on Forest Structure, Potential Fire Behavior, and Predicted Tree Mortality in a Mixed Conifer Forest." *Forest Ecology and Management.* 215: Pp. 21–36.

vegetation patches. Wildlife piles can be made of various sizes (ranging from ankle or knee height to five feet high), keeping in mind fuel-reduction objectives.

Chipping

See Chipping in chaparral section 4.2.5 above.

Mastication

See Mastication in chaparral section 4.2.5 above.

4.4. Ponderosa Pine/Mixed Conifer

Ponderosa pine and mixed-conifer forest types contain a variety of conifer species, including ponderosa pine *(Pinus ponderosa),* incense cedar *(Calocedrus decurrens),* sugar pine *(Pinus lambertiana),* Douglas fir *(Pseudotsuga menziesii),* California black oak*,* canyon live oak*,* tanoak (*Lithocarpus densiflorus*), and Pacific madrone (*Arbutus menziesii*), with herbaceous and shrub species intermixed.

4.4.1. Ponderosa Pine/Mixed Conifer Role of Fire

Fire in this forest type is particularly important for maintaining species composition. Pine species are generally *shade-intolerant.* Therefore, fire that creates gaps or openings in the vegetation can support pine germination and growth. With early logging practices that removed the large, fire-resistant tree species (e.g. pine), and the general exclusion of fire, shade tolerant species (i.e. Douglas fir and to some extent white fir *[Abies concolor]*) have become more abundant in many of Lake County's forests. This has often resulted in overly dense stands of trees with many surface and ladder fuels. Some conifer species (e.g. ponderosa pine) also germinate best when there are low amounts of litter and duff; periodic fire keeps these levels low enough to support germination. Fire kills understory trees and top-kills shrubs, simplifying the structure to consist of a tree overstory with an herbaceous understory.

4.4.2. Ponderosa Pine/Mixed Conifer Fire Regime

These forest types are often characterized by a historic regime of frequent fires of low to moderate intensity. Exceptions to this have been noted where topographic position, vegetation, and other site factors led to more severe fires. A great deal of variation in fire intensity and effect has been noted among similar sites, even within a single fire. Fire return intervals for these types range from two to forty years, with median values ranging from five to twenty years. Variability in fire return intervals is linked to the species composition of the stand, disturbance history, and landscape location (i.e. types dominated by pine, as well as hotter and drier sites, often have shorter fire-return intervals).

4.4.3. Ponderosa Pine/Mixed Conifer Plant Adaptations to Fire

Ponderosa pine is especially well adapted to periodic fire. Adaptations for seedlings include the rapid development of thick insulating bark, deep taproots, and high moisture content of living needles.[17] Similarly, mature trees have thick bark, deep roots, and *crown structures* that are less vulnerable to flames. This pine is also more tolerant of crown scorch than other conifer species such as incense cedar, and Douglas fir.[18] Ponderosa pine also has an effective wound response in which resin is produced to seal off any wounds that are made in the bark.

4.4.4. Ponderosa Pine/Mixed Conifer Conservation and Fuel Modification Objectives

Treatment activities within ponderosa pine/mixed conifer stands will result in the reduction of tree density and volume of understory and mid-story fuels. It will also work toward the restoration of natural plant composition and structure. Recruitment of forest stands with older characteristics is another recommended

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[17] Fitzgerald, Stephen A. 2005. *Fire Ecology of Ponderosa Pine and the Rebuilding of Fire-Resilient Ponderosa Pine Ecosystems.* Gen. Tech Report PSW-GTR-198. Redmond, OR. Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture. p. 246.

[18] Stephens S.L., and M.A. Finney. 2002. "Prescribed Fire Mortality of Sierra Nevada Mixed Conifer Tree Species: Effects of Crown Damage and Forest Floor Combustions." *Forest Ecology and Management.* 162: Pp. 261–271.

objective for long-term fire safety and ecosystem health. One of the main objectives for the long-term maintenance and health of this forest type is the reintroduction of low- to moderate-intensity fire. This is based on the work of Brown, Agee, and Franklin (2004) who state:

> "A forest that is fire-resilient has characteristics that limit fire intensity and increase the resistance of the forest to mortality. The first principle is to manage surface fuels to limit flame length…The second principle is to make it more difficult for canopy torching to occur by increasing the height to flammable crown fuels...The third principle is to decrease crown density by thinning overstory trees, making tree-to-tree crowning less probable. This will not be necessary on all sites and will be effective only if linked to the application of the first two principles."[19]

4.4.5. Ponderosa Pine/Mixed Conifer Fuel Modification Treatment Prescription

<u>Thinning</u>

- Treatment emphasis should focus on thinning from below (i.e. understory thinning) in an effort to reduce and separate both vertical and horizontal fuel layer continuity.
- Canopy thinning is recommended only if the fire hazard cannot be reduced adequately through treating the surface and ladder fuels. Understory thinning is the preferred treatment.
- Favored trees to leave in decreasing order of preference are: California black oak, Pacific madrone, ponderosa pine, incense cedar, Douglas fir, canyon live oak, and tanoak. Thinning treatments will focus on the retention of species diversity, making allowances for favoring species best suited to a given location.
- Create overall structural characteristics (arrangement of live and dead fuels) appropriate for restoration of the historical fire regime of frequent, low- to moderate-intensity forest *underburns.* This structure includes an overstory with low fuel volumes and a sparse understory with patches of interspersed even-aged young trees, shrubs, and native perennial grasses. This structure will facilitate maintenance by future low-intensity fires by creating gaps where fuel connectivity is low (both horizontal and vertical).
- Pine and oak leave-trees can be released by thinning small trees and brush from under the drip lines. Emphasis will be placed on thinning on the southern and western exposures because pines thrive in open forests stands with abundant sun.
- Variable density treatment is a thinning practice to create diversity in a forest stand, leaving portions of the stand un-thinned, with other areas thinned more thoroughly. It can be implemented within mixed-conifer forest types by reducing both understory and crown density within the stand. Separate fuel continuity through the creation of *repeating skips and gaps* of varying sizes and shapes. Treatments will emphasize the retention of randomly spaced tree groupings by identifying the largest recruitment trees, moisture retention, and wildlife habitat. Release around the drip lines of groupings and some individual trees by thinning excessive stems, pole-sized trees, and shrubs. The objectives are to release individual trees, limit competition, reduce fuel loads around groupings (clumps) of trees, and enhance site structural diversity.[20]
- To reduce the possibility of beetle infestation, consider not cutting pines until autumn. Beetles are attracted to the scent of fresh-cut pine and could infest the stand. Mark pines to be cut when implementing fuel treatments earlier in the year, then return between October to May to remove pines and their slash, as beetles tend to be dormant during this period. *See <u>www.fire.ca.gov/rsrc-mgt_pestmanagement_socalbeetle.php</u> for more information on beetle infestations in California.*
- In areas with no overstory, small conifer saplings and poles will be thinned to fifteen by fifteen feet between live trees. In more open, arid, savannah-type locations, pine and oak should be favored. In some openings, shrub species may be favored or complete vegetation removal may occur to create variable density.

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[19] Brown, Richard T., James K. Agee, and Jerry Franklin. 2004. "Forest Restoration and Fire: Principles in the Context of Place." *Conservation Biology.* 18(4): Pp. 903–912.

[20] Stephens, S.L. and P.Z. Fule. 2005. "Western Pine Forests with Continuing Frequent Fire Regimes: Possible Reference Sites for Management." *Journal of Forestry.* 103(7): Pp. 357–362.

- Retain all age and *size classes* of all native species for *vertical and horizontal structural diversity* throughout the landscape (not within the same stand). Thin around the edges of multi-canopied, vertically structured tree groupings of varying sizes to separate them from other fuels.
- Retain seedlings and saplings of favored species to replace future tree mortality.
- Retain a wide variety of age, size, and *decay classes* including dead and dying vegetation, consistent with fire-hazard reduction goals. Retain some deformed trees (e.g. *pistol butts,* forked tops, trees with a low *live-crown percentage*, etc.) for genetic diversity and wildlife habitat.[21]
- Create or maintain light conditions (sun, shade, or *dappled light*) that are site-specific to species currently less common to the site. Prevalence of native species tends to discourage weedy exotic or native *generalist* species and favors native endangered or threatened wildlife and plants. *Sensitive species* likely require very specific habitat *niches* and are hence generally uncommon, rare, or threatened. *Conservative species* have restricted distribution on a particular site, but the site could support more individuals. Generalist species are those that are already everywhere on the site.
- Retain vegetation with evidence of wildlife use (e.g. bird or woodrat nests, burrows, cavities, and hollows, etc.). Retain *sheltered connectivity* and major game trails between selected tree and vegetation patches. Retain lichen and moss species diversity, including some mistletoe-infected trees and live trees with heart rot *(conks).* Retain large *downed woody debris* for moisture retention, *mycorrhizal* inoculation sites, and wildlife habitat. Retain or create large snags for wildlife.[22]
- Leave *green islands,* or patches of tree or shrub thickets (e.g. *doghair* conifer patches), for wildlife habitat. Retain an average of one patch per acre no greater than approximately twenty by twenty feet. Protect green islands by reducing fuels around it.
- Retain as much canopy closure as possible in ephemeral and perennial stream corridors.
- Enhance productive understory shrub and herbaceous vegetation by thinning conifers to allow dappled sunlight. Retain ten to thirty percent of understory shrub cover as scattered and isolated patches.
- When thinning in scattered stands of oak and Pacific madrone clumps, thin clumps to leave dominant stems. Cut stems will create fresh, nutritious shoots for wildlife browse.
- Thin and/or remove *codominant* species in order to release dominant pines or oaks (possibly for *merchantable* materials). If these trees cannot be economically utilized, leave on site to serve as downed wood for wildlife habitat. Remove all material less than three inches.

Slash Treatment

- *See Appendix F: California Forest Practice Rules, Board of Forestry Technical Rule Addendum NO 3. Brood Material for an explanation of pine slash disposal.*
- For pine, cut stems and branches into less than three-foot sections to increase the drying of the cut material. This will help reduce beetle populations.
- Ensure surface fuels are less plentiful and more compact than before treatment. Do this by lopping into small pieces, weighing them down with larger pieces, and ensuring that all slash is in direct contact with the ground to facilitate quick decomposition. Cutting material from the mid-story and crown and placing it on the surface will increase short-term fire hazard, but reduce long-term hazards.
- Chipping of cut material can also be used as a tool for slash treatment where feasible. *See Chipping in chaparral section 4.2.5 above.*

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[21] Stephens, S.L., and D.L. Fry, E. Franco-Vizcaino, M.M. Collins, and J.J. Moghaddas. 2007. "Coarse Woody Debris and Canopy Cover in an Old-Growth Jeffrey Pine–Mixed Conifer Forest from the Sierra San Pedro Martir, Mexico." *Forest Ecology and Management.* 240: Pp. 87–95.

[22] Stephens, et. al. 2007. And: Stephens, S.L. and J.J. Moghaddas. 2005b. "Fuel Treatment Effects on Snags and Coarse Woody Debris in a Sierra Nevada Mixed Conifer Forest." *Forest Ecology and Management.* 214: Pp. 53–64.

Burning

- Allow cut vegetation to properly dry prior to initiating any burning (this can take several weeks or more).
- Burn pine slash prior to spring if possible. This will help minimize the possibility of beetle infestations.
- When cutting pine between October and May, treat fuels immediately by burning.
- Always use caution when burning in pine stands with thick duff depth (greater than 4 inches). When broadcast burning, pull duff back from the base of trees approximately ten feet to prevent steaming of the roots that grow into the duff.
- Follow general chaparral and foothill woodland burning prescriptions as described above for treatment of slash in ponderosa pine/mixed conifer forests.

For more detailed information on burning, see Appendix D.

Mastication

See Mastication in chaparral section 4.2.5 above for a brief introduction to this management tool. Follow the same thinning principles identified for this vegetation type when using a masticator. The masticator may take the place of hand crews where feasible, generally on slopes below 30% and away from watercourses. It is important to select a unit that is capable for the work needed. Typically an equipment operator is needed, not hand crews. However, due to limitations of masticators, such as slope and tree size, hand crews may need to work in conjunction with them, in order to create the desired fuel-reduction objective.

4.5. Closed-Cone Pine/Cypress[23]

Closed-cone pine/cypress forest types contain a variety of species, although principally dominated by knobcone pine (*Pinus attenuata).* McNab cypress (*Cupressus macnabiana*) can be found within the county although it is limited in its distribution. These two species generally do not occur together. Instead, they are usually associated with chaparral species, grasses and forbs, and gray pine and scrub oak. This type can form pure, even-aged stands surrounded by chaparral and/or mixed-conifer stands.

4.5.1. Closed-Cone Pine/Cypress Role of Fire

Periodic, often stand-replacing fire is essential for the survival of this vegetation type. These vegetation types are fire dependent and considered *climax.* Pine and cypress species are generally shade intolerant and grow best with full sun exposure. Fires that create gaps or openings in the vegetation can support their germination and growth. This vegetation type generally forms nearly pure stands due to its stand-replacing fire characteristic. The trees are generally short lived (less than100 years) with natural fire-return intervals between 35–50 years, although fire can occur during any time during stand development. Following a stand-replacing fire, the burned area is generally re-occupied by nearly pure stands of pine or cypress.

4.5.2. Closed-Cone Pine/Cypress Fire Regime

Regardless of the dominant species (i.e. pine or cypress), mature stands generally produce high-intensity fires similar to those found in chaparral ecosystems. Wildfires in this type are generally stand-replacing events; fires burn sufficiently hot to consume all of the above-ground plant material. If fire is too frequent within a stand, usually within two to ten years following a stand replacing event, the dominant knobcone pine or cypress trees may be eliminated from the site. This is due to a lack of viable seed. These vegetation types will often burn in association with surrounding vegetation types, most of which is chaparral.

4.5.3. Closed-Cone Pine/Cypress Plant Adaptations to Fire

Closed-cone pine/cypress tree communities have developed important adaptations for fire survival and re-growth. The major adaptation is the presence of *serotinous* cones that can persist on the branches for the duration of the life of the tree. These cones contain large amounts of seeds, which are released when the cone opens up due

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[23] Much of the information found in this section was taken from: Jensen, B.D. “Closed-Cone Pine-Cypress” In: Mayer, K.E., W.F. Laudenslayer Jr., ed. 1998. *A Guide to Wildlife Habitats of California.* p. 166.

to the extreme heat of a wildfire. Another major adaptation associated with the dominant tree species is the early creation of cones during the life cycle of the tree. Cones are generally produced within two to ten years for knobcone and cypress. This allows the trees to secure a seed crop within a site early, which will allow them to gain a foothold on the site, should a fire come through within those first two to ten years.

Fire adaptations for associated chaparral plants can be found in section 4.2.3 above.

4.5.4. Closed-Cone Pine/Cypress Conservation and Fuel Modification Objectives

Closed-cone pine/cypress communities in Lake County comprise an extremely important niche of regional biodiversity, providing habitat for a variety of wildlife species.

Prior to the implementation of fire-suppression policies, these vegetation types experienced periodic stand-replacing fire, which was the historic natural fire regime. Because of high-intensity fire intervals of 35–50 years, and its common presence within WUI communities, it is important that fuel mitigation strategies are combined with the conservation and protection of this important vegetation community. Fuel-reduction objectives should focus on increasing community wildfire protection as well as maintaining these significant vegetation types into the future. In addition to meeting fuel-reduction objectives, both the retention and reduction of knobcone pine/cypress patches should focus on maintaining and enhancing wildlife habitat. Reinvigorating and maintaining these vegetation types will be advantageous to species dependent upon it.

Objectives for fuel treatments are to maintain the vegetation types while reducing excessive understory shrubs. Live and dead biomass of pine and cypress can also be carefully reduced by thinning the lower branches, helping to reduce the fuel ladder. Fuel treatments should focus on areas immediately adjacent to roads and/or communities. When these vegetation types occur far away from roads and/or communities (not a direct threat to life or property) they should be left in their natural state and allowed to regenerate through stand-replacing fires.

4.5.5. Closed-Cone Pine/Cypress Fuel Modification Treatment Prescription

Thinning

- Thinning treatments should focus on surface fuels and ladder fuels, such as the lower branches and chaparral shrub component associated with this type. Implement mosaic thinning of understory species to create a diverse, beneficial wildlife habitat.
- Select patches of shrubs and trees within fuelbreaks to be retained in order to maintain wildlife habitat.
- When creating shaded fuelbreaks along roads or directly adjacent to communities, as with ponderosa pine, selective thin knobcone pine to help reduce fire threat. Thin to favor the largest and most structurally sound trees. Focus removal on suppressed or unhealthy trees. Separate canopies of individual trees within fuelbreaks. Prune lower limbs of pine and cypress to a height of approximately eight feet, to help eliminate ladder fuels. Avoid removal of McNabb Cypress unless it poses an immediate threat to life or property.

Burning

Because fire is a requirement for seed dispersal, it is important to use fire as a vegetation management tool where local conditions permit. Focus burning within these vegetation types on the replenishment of native trees. To reduce the intensity of fire and risk of escape, fall trees, then lop and scatter in order to reduce the height of the vegetation within the burn unit. Always use the Precautionary Principle. Be sure that cut material is properly dry before burning. Broadcast burning can be used in late fall to reduce the intensity of fire while still allowing cones to open and release the next seed crop.

Slash Treatment

- Chipping can be used to treat slash within fuelbreaks (i.e. shaded fuelbreaks and roadside clearing). Chips can either be removed for biomass utilization or blown back onto the site to a depth of no more than four to six inches. *See Chipping in chaparral section 4.2.5 above.*
- Swamper-burn pine slash prior to spring when possible, to prevent beetle infestations.
- Follow general chaparral and foothill woodland burning prescriptions as described above for treatment of slash in these vegetation types.

- Mastication can be used to treat stands that are significant threats to communities and/or community assets. *See mastication description in chaparral section 4.2.5 above.*

4.6. Montane Hardwood/Conifer[24]

Montane hardwood/conifer forests form dense canopies of intermixed hardwood and conifer species. Stands are made up of at least one-third conifer and one-third broadleaf species. Dominant species associated with this vegetation type are ponderosa pine, Douglas fir, Pacific madrone, California black oak, and canyon live oak. This habitat type forms mosaic-like forests with small pure stands of conifer interspersed with small pure stands of broad-leafed trees. Conifers are the typical overstory vegetation while broad-leafed trees make up the lower canopy. There is very little understory due to the dense bi-layered canopy.

4.6.1. Montane Hardwood/Conifer Role of Fire

Periodic fire in montane hardwood/conifer forests can reduce the competition for water and nutrients by reducing the understory tree and shrub component. It can also reduce the amount of shade-tolerant conifer species that can dominate a site when fire is lacking. Finally, it also causes small patches and openings where shrubs and trees can both regenerate. These patches and openings are critical for wildlife diversity.

4.6.2. Montane Hardwood/Conifer Fire Regime

Historically, fires were generally frequent in this vegetation type. Fire intensity and frequency varies throughout this type because of variations in moisture content and structural diversity. Dryer areas with longer fire seasons tend to have more frequent and higher intensity fires. The natural fire regime favored broad-leafed vegetation by killing fast growing conifers. Today, with less fires burning through this type, conifers are becoming more dominant in many areas.

4.6.3. Montane Hardwood/Conifer Adaptations to Fire

Tree responses to fire in montane hardwood/conifer systems are varied. Bark thickness, tree structure, and sprouting response each affect the ability of a given species to resist or recover from fire. Species such as canyon live oak have thin bark, and their tops are sensitive to the heat of a fire. In order to survive frequent fire, these species are able to vigorously re-sprout from burned stumps. Ponderosa pine and Douglas fir have thick bark that protects them during wildfire events. Shrubs and grasses in the understory have similar adaptations to those discussed in the chaparral and grassland sections above.

4.6.4. Montane Hardwood/Conifer Conservation and Fuel Modification Objectives

With its structural diversity and landscape heterogeneity, montane hardwood/conifer forests provide essential habitat for a variety of wildlife species. Oak tree patches provide cavities and nesting habitat for migrating birds, and den sites for mammals. Conifers, like the broad-leaved species associated within this vegetation type, provide essential nesting, foraging, and perching habitat for many wildlife species.

Objectives for fuel modification treatments within this type are to reduce the conifer component. In some cases, objectives will include carefully and selectively thinning broad-leafed trees. Fuel-reduction activities within montane hardwood/conifer forests can be a significant proactive step to both reduce fire hazard and increase community wildfire safety, as well as aiding in the process of ecological recovery.

4.6.5. Montane Hardwood/Conifer Fuel Modification Treatment Prescription

Understory Thinning

- Remove understory shrubs and small trees under drip lines. Where canopy is dense and closed, prune lower branches of trees to a height of approximately eight feet.

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[24] Much of the information found in this section was taken from: Anderson, R. "Montane Hardwood-Conifer" In: Mayer, K.E., W.F. Laudenslayer Jr., ed. 1998. *A Guide to Wildlife Habitats of California.* p. 166.

- In some closed-canopy habitats, select productive shrub habitat and understory vegetation as isolated retention patches under multi-stemmed oaks and conifers. Diversify this mosaic thinning treatment by reducing shrubs and thinning from below other closed-canopy areas.
- Incorporate a variety of treatments based on strategic fuel modification locations. For example, if working near a road or trail that can serve as an area where firefighters can suppress fire or set a backfire*,* thin the understory more thoroughly. If on a mid slope or more distant from roads, consider retaining more patches of multi-stemmed oaks and brush in large clumps for wildlife habitat.

Thinning

See thinning prescriptions described for Foothill Woodland in Section 4.3.5 above.

Slash Treatment

Burning

- Follow initial entry into montane hardwood/conifer forests with a combination of swamper burning or hand pile burning *(see Burning in Chaparral section 4.2.5 above, or Appendix D, for more information)*. Following initial treatment, maintenance can be done with a variety of methods, including broadcast burning. Under shaded fuel breaks, grazing is also a maintenance option.
- In combination with burning, the practice of lopping and scattering slash at different locations (away from the burning) throughout the treatment area can facilitate the construction of wildlife brush piles. Be sure to follow the guidelines for the treatment of pine slash mentioned in section 4.3.5 Slash Treatment above.

Chipping and Mastication can also be used to treat slash. These treatments should be located where access permits it, such as close to roads or on gentle slopes. *See Chipping and Mastication in chaparral section 4.2.5 above.*

Map 4-1. Lake County Vegetation Types