# Paradise Recreation and Parks District Programmatic Plan

Final Draft

October 1, 2025



Prepared by the **Butte County Resource Conservation District**, September 2025, Final Draft

In fulfillment of deliverables from BRIC 2020 Paradise Recreation & Park District Innovative Wildfire Risk Reduction Buffers (Camp Fire) FY20 Building Resilient Infrastructure and Communities Program Grant #2020-001, Project #PJ0091, FIPS #007-91002

RESOURCE CONSERVATION DISTRICT BUTTE COUNTY

PARADISE RECREATION & PARK DISTRICT

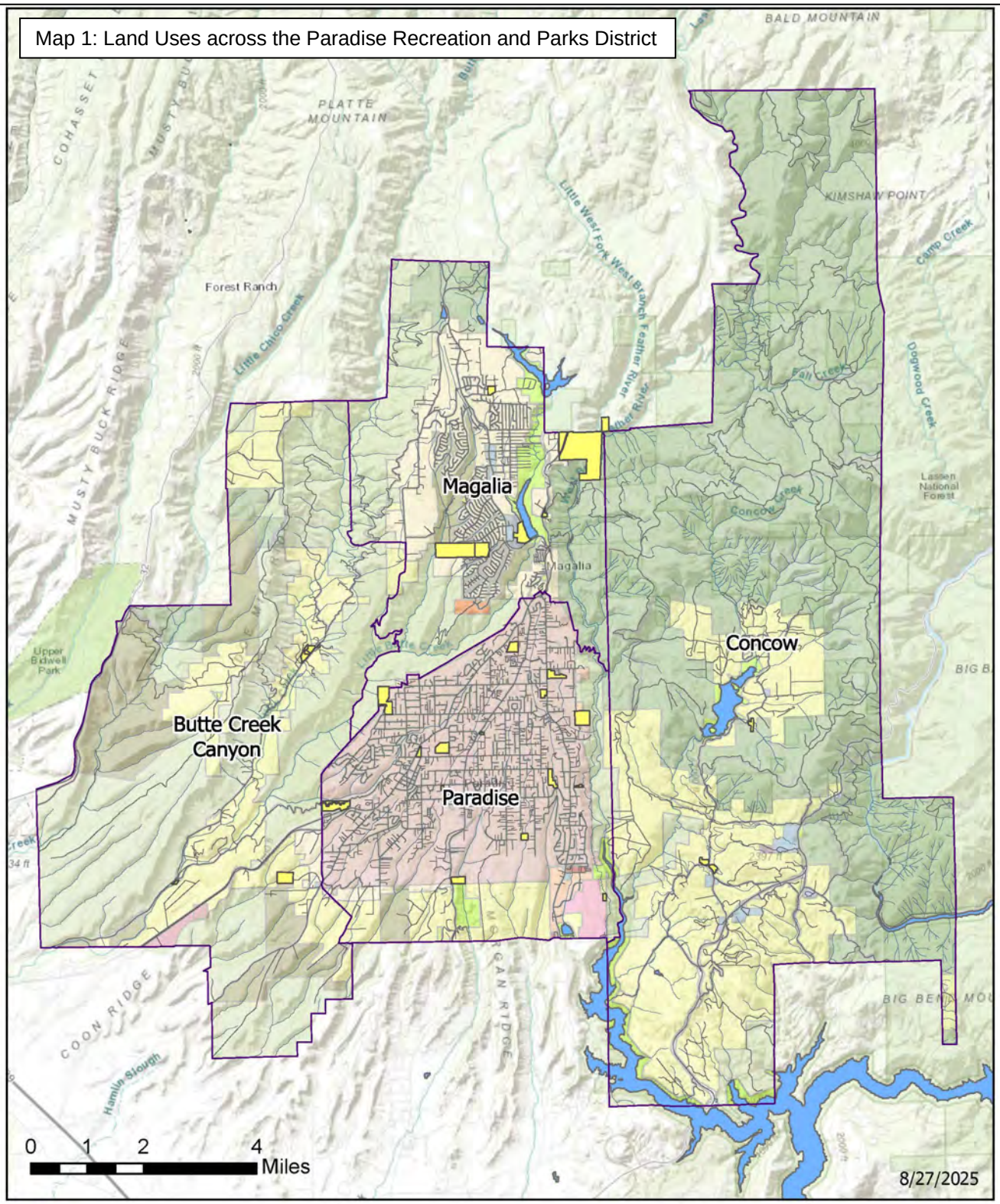
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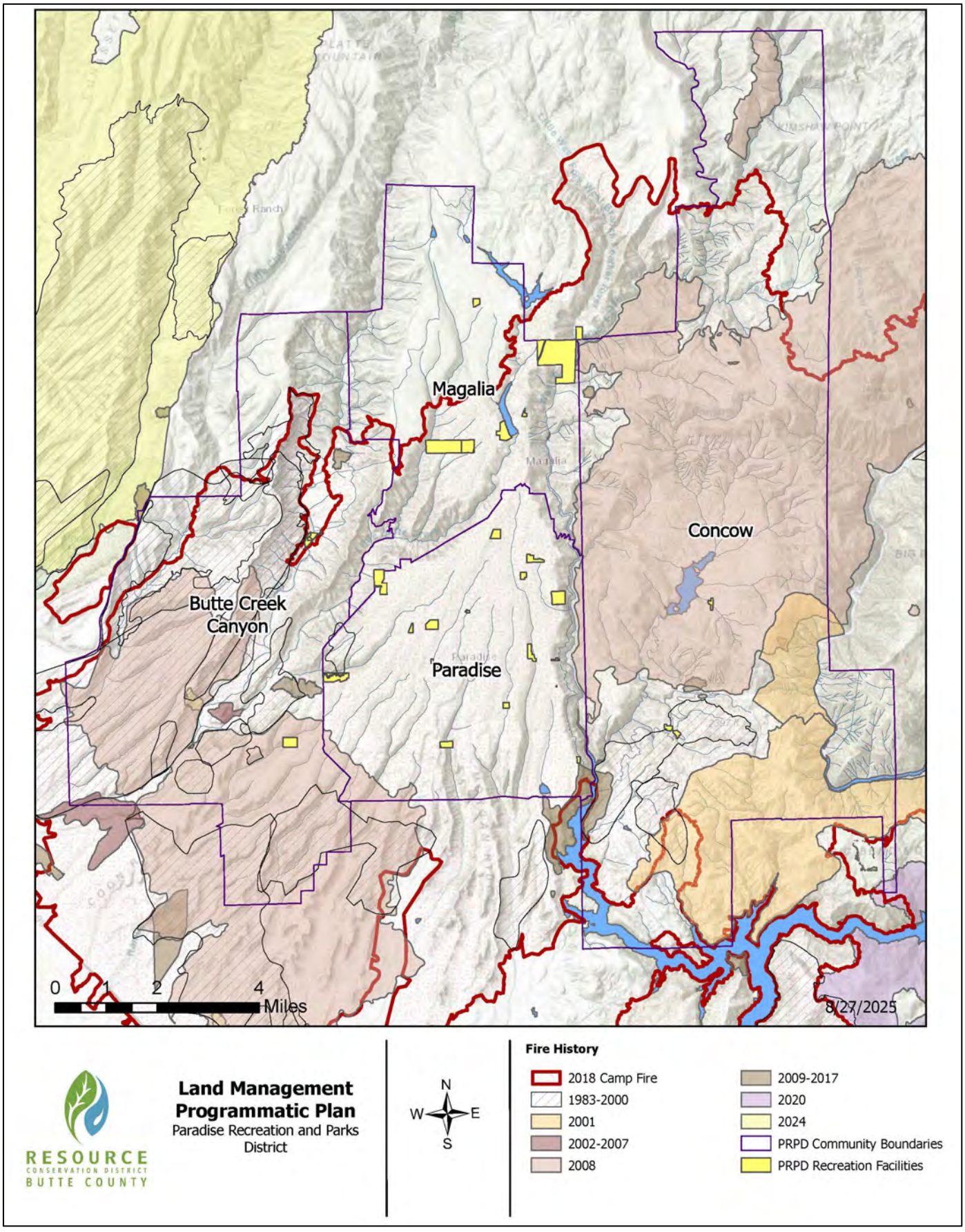

*Cover photo credit: Cait Bell.*

# Maps

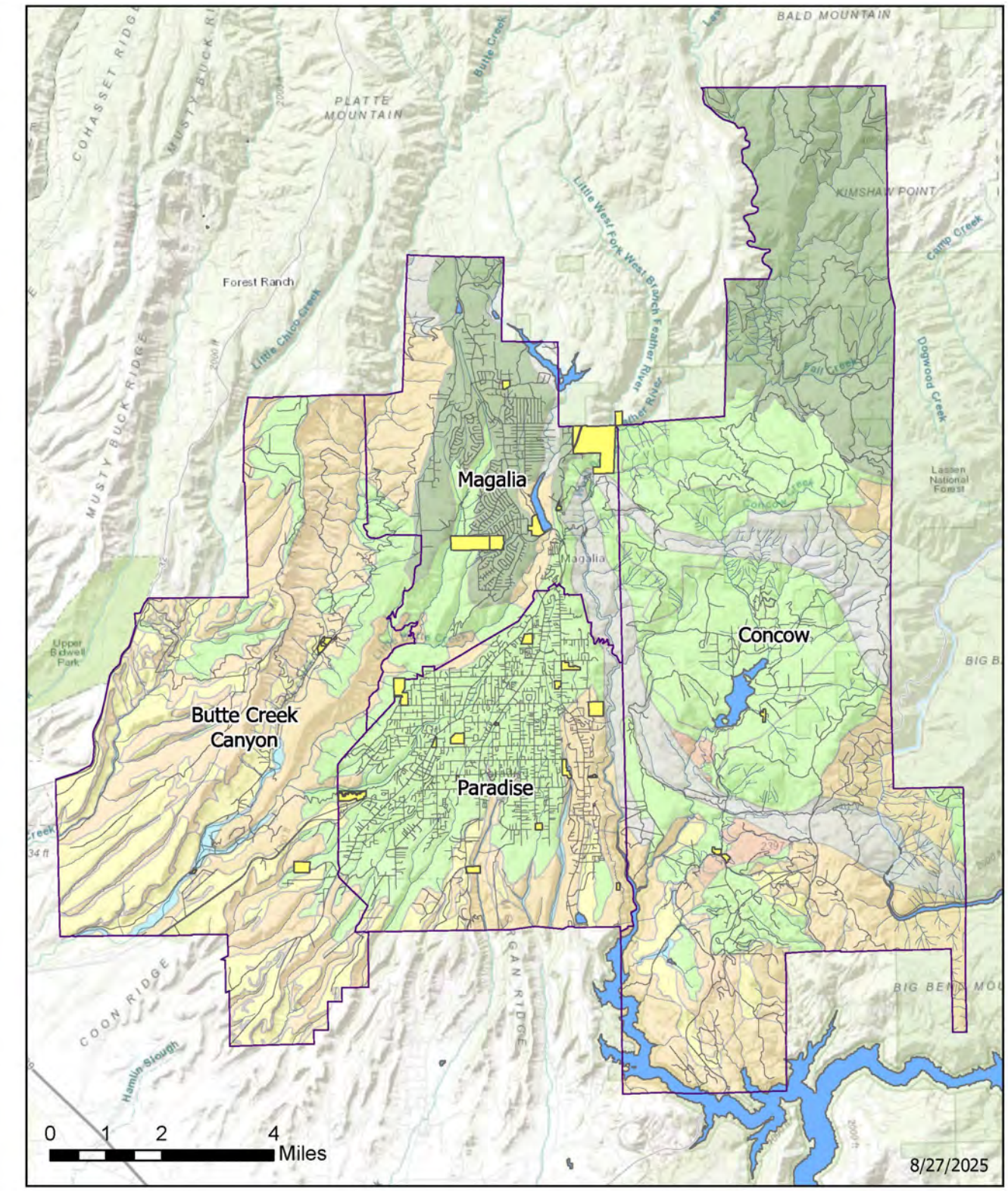
Map 1: Land Uses across the Paradise Recreation and Parks District



Map 2: Fire History across the Paradise Recreation and Parks District



Map 3: Vegetation communities across the Paradise Recreation and Parks District



# Introduction

This programmatic vegetation management plan provides PRPD with a set of best vegetation management practices applicable within the District's unique lands, spanning the fire-adapted foothills where the Sierras meet the Cascades. This plan assumes PRPD's objectives are to optimize for public safety, public access, wildfire resilience, and biodiversity. The plan is not site-specific; instead, it explores best tactics and options for each of the broad vegetation communities PRPD manages.

Thus, the plan is not just applicable to parcels PRPD already owns, but also to parcels it may acquire in the future as part of its innovative "Resiliency Parks" system. The Resiliency Parks concept would form a network of open spaces managed simultaneously as recreational resources, public refuges, and nature-based wildfire mitigation actions.

The programmatic plan that follows will allow for the application of uniform management practices for future site-specific unit plans, maximizing wildfire risk reduction across the PRPD system. It will also help PRPD explore incentives and land ownership/interest options to maximize the performance of these mitigation measures. Coordination and collaboration with public and private landowners on community-scale risk reduction will be key to the success of PRPD's mission.

**Using This Plan**

1.) ***Identification*** Land managers' first task is to determine which vegetation community they are standing in. This would seem like the easiest step but can be quite challenging, as the following pair of pictures (Figure 1) shows[1].

The landscape in the photos, as seen in 1856, was a widely spaced oak woodland, probably consisting mostly of blue oaks. One or two conifers were visible in sheltered draws. After 155 years with just 1 documented fire (in 1966), the landscape was densely stocked with ponderosa and gray pine as well as toyon, manzanita, and oak. And of course, after the 2020 North Complex fire, all trees were top-killed and the landscape appeared to be a shrubland. So, is this landscape best managed toward the desired successional outcome of a blue oak savannah, a black oak-ponderosa woodland, or an oak-chaparral mix?

These 3 vegetation communities all have their unique values to wildlife, recreation, and culture. Assuming the future may be hotter and drier than today, the blue oak savannah is the hardiest choice and appears the most time-tested. Blue oak savannah also has less energy to release when it burns, with less extreme fire behavior expected. However, converting a brushy area ("back") to a widely spaced oak woodland is an investment of time and money many land managers can't make.

[1] Thanks to Redbud Resource Group, who juxtapose these two publicly available photos of Bidwell Bar in some of the educational materials for their valuable "Going Beyond Land Acknowledgements" trainings.

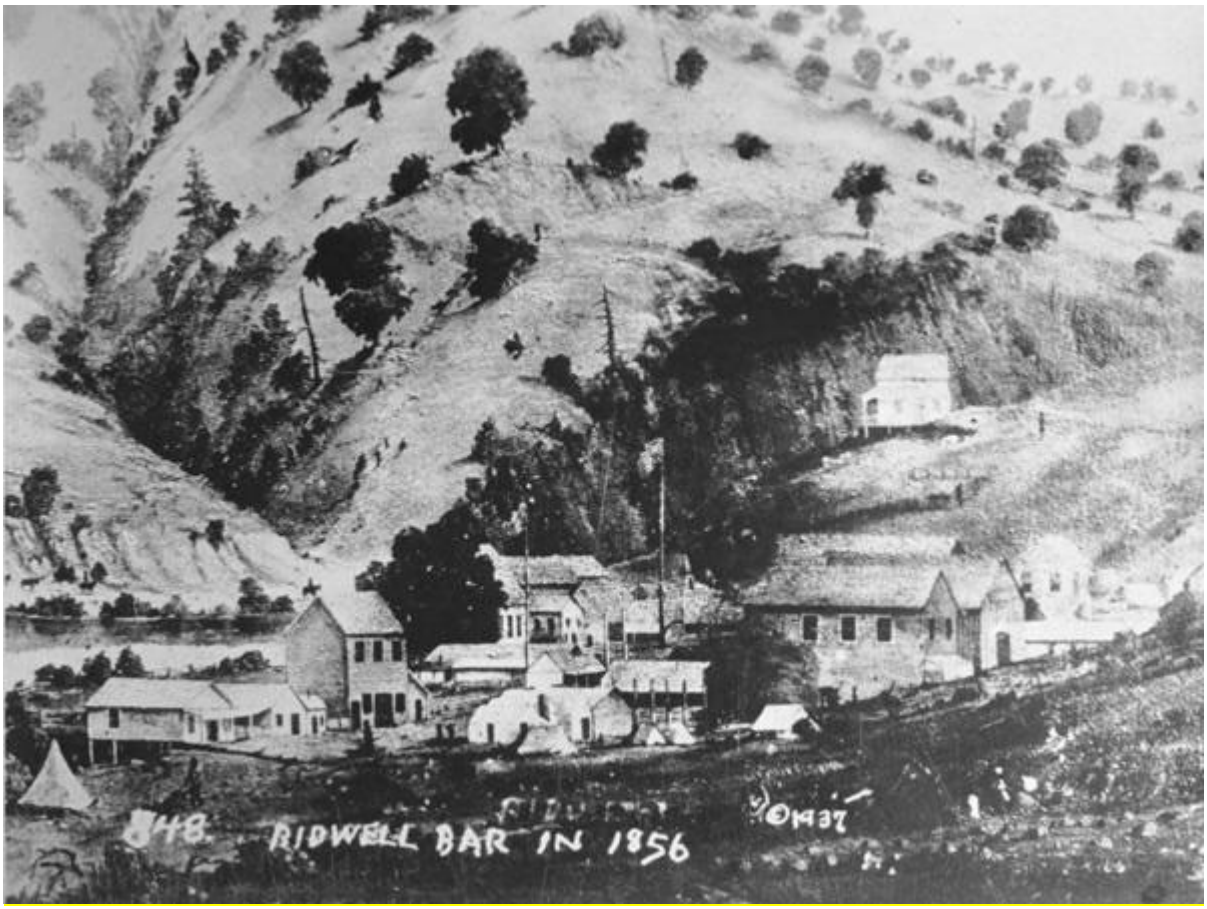





*Figure 1 -Bidwell Bar in 1856 and (lower picture) 2011. Photo credit for lower picture: Flickr user* bridgink.

Ecosystems are dynamic, and today's "shrubland" is tomorrow's forest (and vice versa). Therefore, we think it makes little sense to focus on whether a site appears to be dominated by shrubs versus trees. Instead, managers should focus on identifying the site's ***keystone tree species***. This allows managers to steer the site toward a future in which these dominant tree species, whose influence shaped the evolution of all other species on the site, can again give their unique gifts to the site. We believe this approach is the best way to maximize a site's native biodiversity and functionality. (It is also usually the approach most consistent with managing for Native cultural values.)

It is critical that managers understand that a site's keystone trees species are often present only in seedling, resprout, shrub or snag form. Sometimes, they are present only in historical record. This plan offers support to PRPD managers tasked with discerning a site's true nature when it may be hidden.

2.) ***Treatment and Maintenance*** Once a vegetation community is identified, a land manager will look at the desirable successional endpoint(s) for that community and start to sculpt the land to resemble it. Tools for this process include selective thinning (manual and mechanical), mastication/brush mowing, beneficial fire, grazing, process-based restoration, replanting, and herbicide.

As desired successional outcomes are approached, management will transition from a sequence of treatments to a rhythm of maintenance. The most cost-effective and ecologically beneficial maintenance tool is fire. Beneficial fire recommendations and prescriptions are provided from Butte County Resource Conservation District's (BCRCD's) experience implementing many dozens of small prescribed burns around Butte County since 2020. To address the reality that fire is sometimes an unavailable management tool, alternative maintenance models are also provided.

3.) ***Risk Reduction Incentives*** The hazard reduction work of any land manager can all too easily be undermined by hazards that go unaddressed on neighboring properties. For this reason, PRPD is interested in providing incentives to adjacent or nearby property owners to undertake fuels reduction. Some proven and some innovative avenues for this are explored in section 3 (p. 76).

Table 1: Appropriate treatment types for each vegetation community

| Vegetation Type | Treatment options |
|---|---|
| Blue Oak Woodland/Savannah | Hand cut and pile, pile burn, mowing, underburning, grazing (limited), hazard tree removal, lop and scatter, underburn, herbicide (for invasives management) |
| Mixed Oak Woodland | Hand cut and pile, pile burn, mowing, underburning, grazing (limited), hazard tree removal, lop and scatter, underburn, herbicide (for invasives management); very seldom limited mastication; hardwood release and leader-training |
| Foothill Riparian | Hand cut and pile (pile in riparian zone for wildlife habitat or outside for burning), pile burn outside riparian area, underburning (backing or cultural fire), limited hazard tree removal, lop and scatter, hand pulling or flaming invasives, herbicide (spot treatment for invasives), process based restoration. Mechanized treatment not recommended. |
| Upland Mix: True Oak-Chaparral Mixture | Hand cut and pile, “pluck and pile” a.k.a. grapple pile; pile burning; herbicide (esp. cut and paint); hardwood release and leader-training; grazing (limited; rotate species); mastication (limited) lop and scatter, underburn; hardwood release and leader-training |
| Black Oak Ponderosa Pine | Timber harvest (make sure to remove slash/tops either by hauling or piling and burning); hand cut and pile, pile burning, chipping and hauling, planting, mastication (limited), lop and scatter, underburning, herbicide (for invasives or site preparation for tree regeneration). Hardwood release and leader-training. |
| Serpentine | Hand pulling invasive species, plus herbicide (spot treatments and/or cut-and-paint) are the only treatments advised on serpentine in 90% of cases. In rare instances, encroaching brush or post-fire fuel loads may be cut and hauled off. Mechanized treatments not recommended. |
| Mixed Sierran Hardwood-Conifer | Timber harvest (make sure to remove slash/tops either by hauling or piling and burning); hand cut and pile, pile burning, chipping and hauling, planting, mastication (limited), lop and scatter, underburning, herbicide (for invasives or site preparation for tree regeneration). Hardwood release and leader-training. |

# Abbreviations and Key Terms

**1-, 10-, 100-, and 1000-hour fuels** are ways of classifying dead fuels by diameter. While a clump of dry grass will be very wet after 1 hour of rain or fog, it also may become completely dry after 1 hour of sun. Larger fuels take longer to absorb or lose moisture. Dead fuels are divided into four size classes: 1 hour (flashy fuels like dry grass or pine needles), 10 hour (1⁄2-inch diameter, like many fallen twigs), and 100 hour (3-inch diameter like decent-sized manzanita branches). 1,000 hour fuels (8-inch diameter or bigger, e.g. logs) are often still receptive to fire in fall long after the smaller fuels around them are soaked (which is why fall pile burning can be safe), yet may remain unavailable to fire late into summer when smaller fuels around them will readily ignite.

**Backing fire** is fire that is moving upwind, downslope, or both. Fire forced to "back" has lower flame lengths, lower rate of spread, and generally easier control and manageability, than fire that is advancing downwind, upslope, or both. However, backing fire also can have higher residency time (i.e. the same square inch of ground is subjected to fire for longer). This higher residency time can (under certain circumstances) be more effective at killing certain seeds and propagules.

**Beneficial fire** is a broad term to describe any intentional, or acceptable, introduction of fire that meets land managers' objectives and approval. It is used when there is no need to differentiate among the terms cultural fire, broadcast burning, prescribed fire, "controlled burns," "underburns," and managed wildfire.

**Broadcast burning** is a form of beneficial fire in which the fire is allowed or compelled to cover the entire area of a burn unit (as opposed to just burning piles or deliberately applying fire to target species one clump at a time). Broadcast burning can still leave unburned islands in the interior of a unit or not.

**Chip and haul** means cutting woody material, reducing it to chips by feeding it into a chipper, and then collecting the chips (usually in a chip van) and removing them from the site. Usually, the chips are trucked to a biomass facility, composting facility, or a landscaping destination where they can safely be spread as a landscaping amendment without elevating the destination's fire hazard. Chipping and hauling is more expensive than leaving chips on site but it is far more effective in reducing fire hazard.

**Cultural fire** means the intentional application of fire to land by a California Native American tribe, a tribal organization, or a cultural fire practitioner to achieve cultural goals or objectives, including for sustenance, ceremonial activities, biodiversity, or other benefits. A "Cultural fire practitioner" means a person recognized by a California Native American tribe or tribal organization with substantial experience in burning to meet cultural goals or objectives, including for sustenance, ceremonial activities, biodiversity, or other benefits. (Source: SB 310, which became law on Sept. 27, 2024.) Although it is legally possible for a non-Native person to be recognized by a tribe as a cultural fire practitioner, this situation (if it even exists) would be extremely rare. In general, while a non-Native person can certainly plan and light a prescribed fire *with cultural objectives*, individuals recognized as *cultural fire practitioners* will have California Native American heritage. There are hundreds of possible cultural objectives, and any two cultural fires may be extremely different from each other in seasonality, firing pattern and behavior. Cultural fire can be much smaller in scale than most prescribed fires, but there is no limit to how large in size or high in intensity a cultural fire can or "should" be.

**Cut and paint** is a method of herbicide application in which the chemical is painted on a stem immediately after it has been cut. It is a valuable (and sometimes the only) method of controlling perennial woody invasive species, such as Spanish broom, ailanthus, or privet. In most cases, it is most effective in the fall months.

**DBH** means diameter at breast height, i.e. the diameter of a tree measured 4.5 feet above the ground

on its uphill side.

**Flaming** means passing a flame torch (usually, a propane torch) over live, green vegetation (usually tiny seedlings) in order to kill them. Rather than ignite, the seedlings are steamed in place or wilt permanently. This is a highly effective way of eliminating a spring flush of seedling regeneration (e.g. of French broom) because it leaves the soil undisturbed. (By contrast, a seedling control method that disturbed the soil would most likely stimulate a new crop of seeds to germinate after the very next rain.)

**Grapple piling** means using a grapple or claw to pull woody vegetation out of the ground whole, then pile it for burning. It causes intense ground disturbance but can be a desirable option on some sites when the objective is to reduce some species that are almost impossible to kill with fire, grazing or mastication (for example, live oak) ***and*** herbicide is unacceptable.

**Grazing** means allowing domestic animals to consume vegetation. Usually, the animals are confined to a fixed unit or paddock at a time. Decisions to move animals from paddock to paddock are made by balancing the desire for animals to put on weight with the desire for the vegetation to look/grow a certain way. When the primary land management objective is fuels reduction, these two desires can be contradictory. Grazing animals often still leave unacceptable fuel loading or species composition behind them, if they are allowed to eat their preferred and most nutritious feeds. In short, many hazardous fuels are unpalatable most of the year. This is why grazing for fuels reduction often costs money, rather than turning a profit. Some considerations when planning grazing are the need to fence animals out of sensitive (riparian/wetland/other?) areas; whether the target species are palatable to livestock or not, and some animals' (especially goats') tendency to girdle some species (leaving standing dead fuels in place of green live vegetation) rather than browsing the vegetation to a shorter height as managers might have hoped.

**Hand cut and pile (HCP)** is one of the most common fuels reduction tactics. It involves cutting live or dead woody vegetation (usually at the base) and piling the cut material in such a way that the pile can easily later be ignited under good conditions. HCP leaves the ground surface undisturbed, and (once the piles are burned) it provides a greater and more long-lasting reduction in fire hazard than mastication or sometimes even underburning. Most species will re-sprout after HCP (as after other treatments) but if resprouting is unacceptable, a follow-up herbicide treatment can be used. The most effective method of pairing HCP and herbicide is probably to have someone paint stumps with herbicide the same day they are cut, ideally in fall. HCP is easier to combine with herbicide application than most other treatment types.

**Hand pulling** means pulling a weed out of the ground with one's hands (but can also include the use of a manual tool like a weed wrench). It is the most effective way to handle small infestations, especially when utilizing volunteers.

**Hardwood release** means cutting and removing less-desired species that are encroaching on, or limiting the full expression of, hardwoods such as black oak. Multiple tactics can be used to accomplish this but HCP is the most common. The species *most* often removed during hardwood release are probably deerbrush (Ceanothus integerrimus) and broom, but any species can be the target, even an (overabundant) hardwood (like live oak). Hardwood release is often a very important step in restoring a resilient stand structure after a high-severity wildfire, especially in black oak-ponderosa pine, mixed Sierran hardwood-conifer, and upland mix vegetation types. Often combined with leader-training at the same time.

**Hazard tree removal** means the removal of a tree (usually dead or dying) that appears likely to fall on a structure or vehicle, across a road or trail, or on a person. The decision to pursue a hazard tree removal project requires the adoption of a framework for deciding which trees are hazards. In many cases, the hazard situation can be removed by pruning the tree rather than totally removing it. If you

are removing a tree that is not within striking distance of an asset or trail/road, then you are not engaged in hazard tree removal; you are just cutting a tree.

**Herbicide** is a chemical mixture registered (by the California Department of Pesticide Regulation, or DPR) for application to plants for the purpose of killing them. It is illegal to use an herbicide in a manner inconsistent with its label. In other words, herbicide labels are the law (and indeed, the DPR program responsible for creating those labels is recognized by the State of California as "functionally equivalent to" the CEQA process.) While some herbicides can only be used by licensed registered professionals, others are widely available for public use.

**ICO** is a key term describing a spatially heterogeneous forest structure that was once the norm but is now rare. It describes a forest that is composed of **I**ndividuals (an Individual is a solitary tree whose canopy isn't touching any other canopy), **C**lumps (a clump is a group of 2 or more trees whose canopies touch) and **O**penings (an opening is a gap in the canopy of at least 0.10 acre). By contrast, most modern forests consist largely of a single closed canopy.

**Jackpot burn** is a broadcast burn lit with the knowledge that the interior of the unit contains some piles of receptive larger fuel (some "jackpots") and the hope/intention that the fire will consume these piles.

**Leader-training** means removing most stems of a multi-stemmed bush/resprouting tree, thus selecting the 1-5 strongest to become the "leaders". This can be a powerful step toward reasserting a fire-resilient stand structure. The optimal time to do this is 3-5 years after the fire that top-killed the trees/bushes you are leader-training. (Leader-training sooner than 3 years is seldom effective because at that stage, trees will immediately put their energy into producing many more new sprouts.) Leader-trained trees grow taller and thicker trunks and thus become resistant to top-kill in the next fire, substantially faster than those left alone.

**Lop and scatter** means hand-cutting material and, instead of piling it, scattering the cut vegetation around the unit. Managers can specify an upper acceptable limit for surface fuel loading (generally, less than 7 tons/ac for *all* downed fuels, 1-1000 hour fuels combined), and may only require fuels to be piled after this level of fuel loading is reached.

**Mastication** is a mechanical treatment that shreds midstory trees and shrubs into a compacted woody fuel layer with the intention of abating fire hazards in fire-prone ecosystems. Mastication doesn't *remove* fuel, however; it just *rearranges* it from the understory or mid-story layers to the surface layer. Increased surface fuel loading from mastication may lead to undesirable fire intensity, long-duration flaming or smoldering, and undesirable residual tree mortality. (Reed et al 2020)

**Mowing** is the mechanical cutting of grass or brush to within about four inches (or less) of the soil surface. After it cures in the sun (becoming much lighter in the process), mowed vegetation may be removed, burned, or left in place.

**Pile burning** means applying fire to piled dry vegetation with the intention of burning the pile but nothing else around the pile. Pile burning is perceived by the public to be safer than broadcast burning; however, this perception is poorly supported by data (many, perhaps most, of the most destructive escaped controlled fires have been pile burns, *not* broadcast burns). A burn plan that allows for fire to "creep" outside of the pile, consuming adjacent surface fuels, is often called a "creepy pile burn" or a "type 2 pile burn". [In the latter usage, type 3 would mean strictly piles.] A broadcast burn with the intention of consuming a few piles that are inside the unit boundaries is often called a ***jackpot burn.***

**Planting** can mean planting either seeds, rhizomes, cuttings or young whole plants of any species, but in this guide it usually means planting perennial woody vegetation from seedlings/saplings, generally

after high-severity fire. The most commonly replanted species are pines, cedar, Douglas-fir and true firs. Virtually every hardwood species (as well as the sequoias and California nutmeg) will naturally re-sprout after fire and seldom need to be replanted, although they may benefit from release and leader-training. However, degraded oak woodlands (especially those recovering from development or overgrazing) may benefit from the planting of oak seedlings. Unlike with conifer seedlings, oak seedlings should ***always*** be planted in fall and should be protected from browsing (with cages etc.) for the first 3-10 years of growth.

**"Pluck and pile"** See grapple piling.

**Prescribed fire** means the intentional introduction of fire under specified conditions (i.e., a *prescription*) chosen to achieve specified *objectives*, such as restoring habitat, reducing hazardous fuels, and promoting certain species or land uses. Prescribed fire is usually the most cost-effective means of fuels reduction, given its lasting beneficial effects. However, it is also the most difficult to ascribe a cost per acre to, since its cost is so site-dependent. A small crew of PRPD workers working with a water truck, and perhaps a couple of volunteers, could probably maintenance-burn 10 acres of black oak-ponderosa pine for a total cost to PRPD of $250/acre. On the other hand, a complex, steep MSHC unit might be burned for $1200/acre if a professional crew and engine from Firestorm is engaged.

**Process-based restoration (PBR)** means an ecological restoration approach that prioritizes the recovery of dynamic ecosystem functions and processes over static structural attributes. PBR is different from "form-based" restoration (which seeks to reshape a landscape into a desired form), in that PBR typically harnesses natural processes like runoff, coupled with relatively low-tech structures usually built from natural materials that are meant to eventually become part of dynamic ecosystems.

**Reforestation** means the re-establishment of forest. Although in the 20th century it has traditionally been a term reserved to mean mostly the replanting of conifer seedlings, in an era of climate change and resurgent regular fire "reforestation" can and should also be thought of as the re-establishment of oak (and mixed) woodlands. Re-establishing a fire-resilient oak woodland after high-severity fire may be achievable without replanting anything at all, if land managers invest in hardwood release, leader-training, and invasives control.

**Release** means removing less-desired species to a level that allows a desired species to accelerate its growth and become codominant or dominant in a stand or stand layer. An example would be removing 90% of the deerbrush in a stand, such that the formerly ***suppressed*** black oak and redbud in the stand are able to double in biomass over the next growing season.

**rSDI** means "relative Stand Density Index," a measure of how densely stocked a stand is with trees, *relative* to its carrying capacity for that species or species mixture.

**Site preparation** means preparing a site for the planting of seedlings.

**Slash** is whatever dead or dying material is left over after a timber or biomass removal. This includes unmarketable tops of trees. Slash is a major driver of wildfire intensity. It is imperative that timber and biomass removal contract specify how and how soon the slash must be removed (by either hauling or burning).

**Spot treatments** are applications of herbicide designed to minimize any drift onto non-target vegetation. In contrast to ***broadcast treatments***, they are administered usually by hand and up close, directing the chemical directly onto target species tissues.

**Timber harvest** means the cutting and removal of live (or recently dead) trees from a site. The term timber harvest implies that the trees have commercial value and their removal will produce a profit or at least break even.

**Underburning** means broadcast burning, specifically under a tree overstory when the managers' intention is to kill less than 100% of that overstory.

# 1.) Identifying The Vegetation Communities of the Paradise Recreation and Parks District

This plan divides the lands of the Paradise Recreation and Parks District into 7 vegetation communities. There is extraordinary variability within some of these communities (for example, probably no two acres of Mixed Sierran Hardwood-Conifer are exactly alike!) and, if desired, vegetation keys such as the Manual of California Vegetation exist to pare them into exquisite subdivision. However, this plan focuses on the common principles and ecological needs that drive the dynamics of each large community. Knowing PRPD land managers will necessarily be responding to unique on-the-ground conditions at each park site, the most meaningful benefit is provided by emphasizing how each broad vegetation type functions and what it responds to.

1. Site noticeably barren of vegetation compared to adjacent lands, often with a very visually striking demarcation where a wall of vegetation begins and the relatively barren site ends. At least ½ of the ground surface will be rocky exposed soil. Soil may be reddish (with a "Martian" appearance), or almost white with shiny outcroppings of greenish-white rock that sustains little life, but is not a traditional black or "brown dirt" color. If conifers are present, they are probably gray pines (sometimes Jeffrey pines and/or uncommon, juniper-like closed-cone conifers).

    1a. Yes: go to **Serpentine.** Because serpentine may contain riparian areas, check for the riparian indicators on p 30.
    1b. Not as above: go to 2

2. Oaks present?

    2a. Yes, go to 3

    2b. No, go to 8

3. Blue oaks present?

    3a. Blue oaks, go to 4

    3b. No blue oaks, go to 6

4. Live oaks present along with blue oaks?

    4a. Yes, live oaks, go to 5

    4b. No live oaks: Go to **Blue oak woodland/savannah.** Because blue oak communities may contain riparian areas, check for the riparian indicators on p 30.

5. Mixed oak woodland or oak- chapparal mixture?

    5a. Elevation is generally below 1000'; shrubs may be present but are separated by moderate to large openings dominated by grasses, sometimes with annual forbs; some areas of deep soil supporting tall grasses (knee to waist height in places); at least some oaks have grown into large trees (these may be dead/burned and if so will need to be identified by their re-sprouts): **Mixed Oak Woodland.** Because mixed oak communities may contain riparian areas, check for the riparian indicators on p 30.

5b. Elevation generally 1000-3000'; most oaks present are evergreen, waxy-cuticled oaks, predominantly in shrub form whether the area burned recently or not. Non-oak shrubs (or their skeletons) form a more or less continuous cover with few openings, and openings are as likely to be bare ground or shrub litter as they are to be grasses or forbs. If area was recently heavily burned, identify shrubs by their resprouts. Few large trees exist, although isolated clumps of larger trees may be scattered across the landscape, especially around springs or in draws: **Upland Mix (true oak-chaparral mixture).** Because mixed oak-chaparral communities may contain riparian areas, check for the riparian indicators on p 30.

6. Black oaks present?

   6a. Black oaks, go to 7

   6b. No black oaks, go to 8

7. Is the site:

   7a. about 1,500-3,000 feet in elevation? **Black Oak-Ponderosa Woodland.** Because mixed oak-chaparral communities may contain riparian areas, check for the riparian indicators on p 30.

   7b. higher than 3,000 feet in elevation? **Mixed Sierran Hardwood-Conifer.** Because mixed oak-chaparral communities may contain riparian areas, check for the riparian indicators on p 30.

8. Is the site:

   8a. rangeland/former or current agriculture land/a cleared/formerly developed lot? Go to 9

   8b. densely forested: go to 10

9. Classify the site based on its elevation. Sites under 1,500' that supported agriculture or rangeland were most likely previously blue oak woodland or mixed oak woodland; sites from about 1,500-3,000 were most likely previously black oak-ponderosa pine; sites over 3,000 feet were most likely previous Sierran mixed hardwood-conifer. Alternatively, classify the site the same way as the nearest undeveloped site that has similar soils, elevation and slope. Finally, identify riparian zones by checking for the riparian indicators on p 30.

10. Is the site a plantation where herbicides or other means have been used in the past, or you suspect they may have been used in the past, to artificially eliminate oaks? (some tanoak may be present)

    10a. Yes, site appears like a plantation and is between 2000 and 3500 feet: **Black Oak-Ponderosa Pine**

    10b. No, site is higher in elevation or is a wild-looking mix of many species, mostly conifers, quite dark and dense, usually above 3000 feet: **Mixed Sierran Hardwood Conifer**

# 2.) Vegetation Communities And Their Treatments

## Blue Oak Woodland/Savannah

**How To Know It** - Blue oak woodlands and savannahs are sites where blue oak (and gray pine) are the only large trees. They develop on unique foothill soils that are unlikely to support any other vegetation type. “Savannah” has about 10% tree cover. “Woodland” simply has more tree cover than that. Either may have some shrub component, but this should cover 30% or less of ground area. Gray pines or California junipers may or may not be present. Redbuds and buckeyes may be present. If live, black, or valley oaks are present, this indicates soil conditions able to support other vegetation types. Such sites would be classed as Mixed Oak Woodland and would be treated differently. As always, if the site was recently burned, it should be checked for oak resprouts. These will appear like bushes but if the resprouts are blue oak, the site is a blue oak site.

Blue oaks are endemic to the California floristic province and are a uniquely drought-adapted tree, able to lose 30% of their leaf moisture without wilting. Blue oak woodlands support as many as 5,000 associated species, many of them also endemic to California. An important feature helping them do this is their ability to store water year-round in cavities accessible by wildlife and invertebrates. They are living cisterns and oases, which is one reason oak cavities should never be filled and every effort should be made to prolong the existence of blue oaks (even dead ones) that have cavities.

Blue oaks are threatened by development, by unnatural changes in their fire regime caused by the introduction of non-native grasses in the 20th century, by yellow star thistle invasion, and by grazing. (Grazing doesn’t harm mature oaks but tends to prevent young oaks from ever growing to reproductive size).

**Desirable Successional Endpoints** (species presence, fire regime, spacing)

At the desirable successional endpoint of blue oak woodland growth, a mix of blue oak age classes are ideally present. This includes very young seedlings, “pole-sized” adolescents of 2-4” DBH, mature trees, and very mature trees. Very mature trees are those that have developed the “mushroom shape” in which the branches sweep all the way down to trail on the ground. (These are the most productive trees in a stand and should never be “limbed up”.) Cavities are abundant and should never be artificially filled.

***Species presence***: Ideally, gray pines are present (this may or may not be acceptable immediately adjacent to structures, on small parcels, or where urban fire safety objectives preclude them). Shrub cover (e.g. *Rhus* spp., *Ceanothus cuneatus,* etc.) is around 5%-10%, sometimes as high as 20% in localized areas. The grass understory is a patchy matrix of native bunchgrasses, perennial forbs, and some annuals, all interspersed with “bare” ground (in practice, “bare” ground may be seasonally covered with crustose lichen/algae/liverworts/mosses (winter), geophytic flowers (spring), and/or decomposing leaves (fall)). On healthy blue oak sites, grass understory is *not* a continuous unbroken stand of annual grasses.

***Fire regime**:* Blue oak woodland/savannah is one of the most flexible ecotypes when it comes to fire frequency. When fire is excluded from it, it suffers less than most California vegetation communities, because it already occupies sites so dry and marginal that few other species can encroach. (Thus, the problem resulting from fire exclusion in blue oak is less type conversion than poor nutrient cycling). On the other hand, blue oak woodland can tolerate almost annual fire if the fire is applied in the fall under a cool prescription. (The ideal time for this is just before, or within 2 weeks after, the first soaking rains.)

The key to fire resilience in blue oak is to 1) protect trees from fire when conditions are very hot/windy (e.g. Park Fire conditions), and 2) cultivate a native California prairie understory (i.e., dominated by perennial bunchgrasses and consistent patches of bare ground) beneath the trees. Ground fires in this patchy, native-dominated understory will themselves be patchy and self-limiting, and they will be less likely to produce enough heat to kill the cambium of blue oaks.

***Threats to blue oak from fire*** When blue oaks die in fires, it is usually not from being ignited by ladder fuels. Rather, blue oaks die in fires one of two ways. The first way is when a windborne ember, sooner or later, gets into a cavity in a mature blue oak. There is very little a manager can do about this (except perhaps mow around the base of a mature tree that has a basal cavity) because this type of mortality is unaffected by ladder fuels or tree spacing. To put it bluntly, every tree has an expiration date, and this is how a blue oak wants to go. This is the way blue oaks sometimes die during prescribed fires (and low-intensity wildfires).

The second way a blue oak can die in a fire is by being cooked in place by a very hot fire front moving through, during an extreme wildfire event. Such trees remain standing, appear whole, and often even still have uncharred bark. This is how most blue oaks died in the Park Fire. This less natural source of blue oak mortality can be substantially reduced by management actions, such as:

- Adjusting the mix of grass in the woodland/savannah (patchy, bunchgrass-based native prairie carries fire much differently and at a cooler rate than continuous, annual-based non-native grassland)
- Carefully choosing the seasonality of Rx fire to promote the above. (Early fall burns are best for native grassland restoration, although early summer burns are best for star thistle elimination and can be conducted safely on several days each June.)
- Limiting unwanted human-caused ignitions
- Encouraging neighboring land users to install landscaping that will release less energy when it burns. (For example, replacing eucalyptus, ornamental cypress/juniper, oleander, and wooden decks/pathways, with e.g. willow, redbud, buckeye, and stone.)

***Spacing:*** For California native plants, blue oaks are relatively resistant to torching and throw far fewer embers than most other trees their size. For this reason, there is usually no ecological or public safety advantage to thinning out clumps of blue oaks; the site can hold as many as it will. Blue oaks can tolerate a wide diversity of spatial arrangements, from solitude to rather dense clumps. Extensive grazing has artificially depressed blue oak survival and caused generations of Californians to grow up thinking blue oak stands are naturally very widely spaced.

**Recommended treatments:**
In many ways, blue oak woodland is one of the less challenging ecosystems to manage. Management centers on reducing hazards to the public (mowing/grazing/burning appropriately, and judiciously managing hazard trees/limbs), improving fire and hydrological outcomes restoring grassland toward a native-dominated palette, and facilitating young oak recruitment. The following are recommended treatments on blue oak sites.

- **Remove invasives.** Particular ones to watch are
  - yellow star thistle, which can alter the groundwater regime in a blue oak woodland (control with herbicide, e.g. aminopyralid, and/or 3 early summer burns in a row, if trees are mature and widely spaced enough to be unharmed by the fire)
  - medusahead and other annual invasive grasses (control with fall burns 1-2 weeks after first soaking rain)
  - Ailanthus trees (control with cutting and painting stump w/ herbicide)
  - Oak pests such as the golden oak borer (control by following UCANR and/or Agricultural Commissioner's guidelines).

- **Large downed debris.** Every 5-10 years or after severe blowdown/snowdown events, crews may treat downed 10-1000 hour fuels. Either pile and burn, or (in lower fire-risk areas or in the interior of future burn units at least 15' from keeper trees) buck so all pieces are in ground contact and leave them to slowly decompose. Sites that receive less public use should receive less surface fuels reduction.

  Dead and decadent blue oaks are some of the most important habitat in the PRPD area. Regardless of their cavities or structural integrity, they should be retained unless they pose an imminent danger they will fall on structures or trails.

- **Underburning** should focus on improving the grass/forb composition of the understory and should have a goal of 0% oak mortality among oaks greater than 2" dbh. In a perfect world, blue oak sites would be burned about every 1 year in 3, grazed one or two years in three, and left alone one year in three. To protect mature oaks from fire, you can mow or weed-whack around their base (if high grass is close to the trunk). **Never limb up blue oaks whose branches are trailing on the ground.**

- **Thinning:** Don't cut blue oaks. Blue oak mortality should only be an incidental consequence of fire. Blue oak burn plans generally should have an objective of 0-5% mortality among blue oaks 2" dbh and bigger.

- **Grazing:** If blue oak woodlands are grazed, **oaks less than 2" dbh must be caged** to protect them from grazing. Thanks to a century of extensive grazing, most Butte County oak woodlands have good numbers of large, mature-to- decadent oaks, but have few or no seedlings coming up in the younger generation. If not remedied, this situation portends an oak population crash in the

next 20-50 years in Butte County. Goats and cows are both extremely detrimental to oak seedling recruitment. Sheep are thought to be less so, but given the importance of oak seedlings to Butte County's ecology and recreational economy, seedlings should probably be caged even if the only grazers will be sheep.

Contrary to popular belief, winter grazing isn't inherently beneficial to oak woodlands, but it is possible for it to be neutral in its effects. Short-duration, high-occupancy grazing is best, at a time when soils are not saturated. Ecological benefits from timed grazing are high when short-term grazing occurs in mid fall or early spring, as long as soils are not too wet. Fuels reduction benefits are highest when the timed grazing occurs from late May into late June. Unfortunately, this latter timing is challenging because as the grass dries out, animals start to lose weight grazing it. Letting animals graze blue oak woodland until early May, and them moving them to higher-elevation pastures, is the traditional method and is best for the animals, but it provides minimal fire danger reduction. The tradeoff between animal health and site health must be considered on a year-by-year basis.

Even in blue oak stands that are regularly grazed, continue to underburn the oaks at least 1 year in 3 in fall until grassland species mix objectives are met. If star thistle is a serious problem, annual late spring burning may be needed instead.

- **Seedling recruitment** can be promoted by 1) accepting some shrub cover (even 5% is likely enough to provide all the nurse shrub services a blue oak woodland needs); 2) placing rocks or downed limbs on the south side of seedlings, which is often enough to provide the small amount of shade/cooling seedlings need to survive; and 3) reducing thatch through fire. (Blue oak seedlings can surprisingly survive cool-season fires if a few inches' fuelbreak is scuffed around them, e.g. with the heel of a boot.

**Indicators Of Success -** Cavity-nesting species will be abundant on the site. Examples are Western screech owls (*Megascops kennecottii*), Western bluebirds (*Sialia mexicana*), abundant bumblebees (*Bombus* spp.), abundant bats, tree frogs (Pacific chorus frog, *Pseudacris regilla*), and Western velvety tree ants (*Liometopum occidentale*). As understory diversity improves, more ground-nesting birds will be seen, such as quail, roadrunners, turkeys and meadowlarks.

Bunchgrasses will dominate the understory. Examples are purple needlegrass (*Stipa pulchra*), squirrel tail (*Elymus elymoides*), California melicgrass (*Melica californica*; *Melica torreyana*); (around springs/seeps) deergrass (*Muhlenbergia rigens*) and/or bushy bluestem (*Andropogon glomeratus*); and (on granitic soils) Diego bentgrass (*Agrostis pallens*). (Not all sites will or should have all spp.)

Other desired perennial understory plants include soaproot (*Chlorogallum* sp.), woolly-fruited lomatium (*Lomatium dasycarpum)* and hog parsley (*Lomatium utriculatum*, *vaginatum*, etc); Butte County checkerbloom (*Sidalcea robusta*); geophytes in the family Themidaceae, mariposa lilies (*Calochortus* spp.), *Clarkia* spp., narrow-leaved onion (*Allium amplectens*), doveweed (*Croton setiger*) etc. (Not all sites will or should have all spp.)

Bare ground will be extensively distributed across the site and easily visible to the naked eye. Bare ground should comprise 10-20% of most sites. This is a natural emergent property of a site dominated by California native (perennial) bunchgrasses and managers shouldn't try to achieve this metric just by actively disturbing vegetation (e.g. with blades, herbicide, etc); rather, it. As of this writing in 2025, virtually all California grasslands and savannahs are now dominated by invasive annual grasses with little to no bare ground visible. Transformation from annual-dominated to perennial-dominated grassland/savannah is a gradual process best mediated by regular fire.

*Acorn productivity* Blue oak acorns are an extremely important food resource for wildlife and humans. Most blue oak trees produce few or no acorns most years. Rather, the majority of acorns in a stand are produced by a minority of trees, usually (but not always) the largest and oldest. These trees should be prioritized for special care and respect. Trees whose branches trail on the ground are displaying a fire adaptation associated with extreme longevity and productivity and ***should never be pruned or limbed up.***



Older "mushroom-shaped blue oaks should never be "limbed up" to raise their canopies off the ground. That is because the "mushroom-shaped" canopies of these trees, when left alone, create a zone of special conditions beneath the tree's dripline. It's a zone of higher humidity, no wind, and suppressed grass growth. This zone of naturally fire-safe conditions is the tree's own "defensible space" around its trunk.

A blue oak's trunk is the part of its body that is most vulnerable to severe fire. If people raise the height of the tree's canopy, the tree's defensible space zone gets suddenly exposed to sun, wind and invasion by grasses which can then carry fire right up to the blue oak's trunk.

Blue oak twigs and leaves are actually pretty hard to light on fire, so their lower limbs should not be considered ladder fuels as a cedar's or live oak's low limbs would be.

In a high-severity fire (e.g., 2024 Park Fire conditions), blue oaks are about equally vulnerable to fire whether their limbs are touching the ground or not. But under low-severity conditions (like a prescribed fire or shoulder-season wildfire), ***blue oaks are much more vulnerable to death by fire if their limbs are high off the ground.***

*Shrub presence* The occupation of 5-30% of a site by native shrubs (e.g. manzanita, buckbrush (*Ceanothus cuneatus)*, sumac/redberry (*Rhus* spp.), etc.) is a positive sign and usually should not be interpreted as "shrub encroachment" in need of fixing. Blue oaks actually need "nurse shrubs" to germinate properly and survive their first several years of life.

**Maintenance** (scheduling; cost estimates; long-term financial analysis)

***For example budgets, see Appendix, Table A-2.***

Hand-cut-and-piling would only be done in the most heavily stocked blue oak sites and would cost $1600-2500/ac[2]. Where the fuel load is heavy enough to need removal, but a bit too light to require piling before burning, it can be lopped-and-scattered. This threshold is usually around 6T/ac. Lop and Scatter costs $650-1500/acre.

Herbicide costs $200-$400/acre, but will be more per acre for smaller, linear projects such as along streams.

Prescribed grazing can cost $400-$600 per acre, but in low-elevation oak woodlands is sometimes free or can even pay $20 per acre or so, depending on forage quality and site accessibility during the winter. If livestock cannot be securely fenced out of a riparian area, don't graze the property.

Prescribed fire goes fast in grassland and would cost around $100-$500/ac.

**Recreational and Infrastructural Considerations** Blue oak soils tend to be relatively resistant to erosion or rutting, and they revegetate quickly (albeit often with invasive plants). Therefore, trailbuilding is relatively easy here. The flipside of this is that unauthorized trails quickly proliferate. Trails and heavy recreational use (as well as, in some cases, grazing) can quickly compact blue oak woodland soils, compromising blue oaks' optimal growth and health.

Domestic predators are a major threat to native birds. Consider requiring dogs stay on-leash during turkey or quail nesting season (March-June). Cats (feral as well as those supposedly domesticated) kill 4-10 songbirds each year per human resident (Loss et al 2013). **Butte County Animal Control (530-552-3888)** can assist with the capture and spay/neuter of cats. Lethal control is also an option.

[2] All treatment costs are 2025 estimates.



*Figure 2- Two views of blue oak woodland in a developed neighborhood context. Photo credits Cait Bell.*



*Figure 3 - Two views of blue oak woodland where managers should focus on 1) underburning to restore native grassland structure and 2) protecting young seedlings from grazing/mortality. Photo credits Cait Bell.*





*Figure 4 - Two views of pole-sized blue oaks growing close together. Because blue oaks resist torching fairly well, this stand density is not a fire hazard. It is within the natural range of variation for blue oak. Photo credits Wolfy Rougle.*



*Figure 5 - Typical of most blue oak woodland stands around the District, this stand's hazardous fuels problem isn't in the tree or shrub layer, but rather in the grass fuels layer. Restoring this grassland to a Californnia native bunchgrass prairie would reduce hazard. Photo credit Cait Bell.*

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*Figure 6 -The denser end of blue oak woodland. Adjacent stands that are still annually grazed have no trees under 6 inches dbh. This stand could be thinned and pile-burned and still have a healthy range of age classes. Photo credit Wolfy Rougle.*

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*Figure 7 - "Mushroom shaped" oaks are the oldest and usually most acorn-productive individuals. Blue oak foliage is relatively fire-resistant; blue oaks should never be "limbed up." Doing so actually increases the chances a fire will kill them. Photo credit Wolfy Rougle.*

# Mixed Oak woodland

How To Know It – Mixed Oak Woodland is similar to blue oak woodland in that

- Tree cover is more than 10%;
- Gray pines, redbud and/or buckeye may be present;
- Shrub cover is ideally 5-10% (but can (problematically) reach much higher than is usually reached on blue oak sites);
- The understory is grass-dominated
- The elevation is generally under 2,000 feet and in fact usually well below 1,000 feet

The difference is that mixed oak woodland will also have live and/or valley (sometimes, black) oaks. The presence of these faster-growing oaks indicates more water and deeper soils on these sites, which means they also grow more shrub and grass fuels and (since live oak burns much hotter than blue oak and throws more embers) pose greater fire spread risks to adjacent properties.

Examples of this vegetation type can be found along Hwy 70 between 191 and Lake Oroville, as well as along lower Pentz west of Durham-Pentz Rd.

**Desirable Successional Endpoints** (species presence, fire regime, spacing)

***Species presence***: A mix of oak age classes are ideally present, including very young seedlings (or resprouts), adolescents of 2-4" DBH, mature trees, and very mature trees. Very mature live or valley oak trees are those that have developed the "mushroom shape" in which the branches sweep all the way down to trail on the ground. Valley oaks, like blue oaks, should never be limbed up. However, since live oak is considerably more flammable and volatile, it may make sense to limb up live oaks, in order to moderate fire behavior and reduce torching. Shrub cover (e.g. *Rhus* spp., *Toxicodendron*, etc.) is ideally around 5-10%.

Cavities are abundant and should never be artificially filled. Ideally, gray pines are present (this may or may not be acceptable immediately adjacent to structures, on small parcels, or where urban fire safety objectives preclude them). The grass understory is a patchy matrix of native bunchgrasses, perennial forbs, and some annuals, all interspersed with "bare" ground (in practice, "bare" ground may be seasonally covered with crustose lichen/algae/liverworts/mosses (winter), geophytic flowers (spring), and/or decomposing leaves (fall)). On healthy mixed oak sites, the grass understory is *not* a continuous unbroken stand of annual grasses.

***Fire regime****:* The presence of large live oaks, in itself, is an indicator that fire has been excluded from an area for a long time, because live oaks have very thin bark and are easily top-killed by even moderate-intensity fire. Fire may have been excluded by human decisions or by the site itself, or a combination of the two. (As examples of a site that naturally excludes fire, large live oaks are often found either among large boulders or in mesic or streamside area that are refugia from fire). If large live oaks are growing on a dry, productive site surrounded by tall grass, this may be an unnatural

artifact of long-term fire suppression, and such live oaks are fairly likely to be top-killed by the next fire. To keep shrubs, grasses and natural tree regeneration in  in a healthy balance, mixed oak woodland should burn every 5 years or so, give or take two.

Maintenance underburns in mixed oak woodlands are the same as in blue oak woodlands, except with more emphasis on managing ladder fuels. Early fall burns will be best for native grassland restoration, although early summer burns are best for star thistle elimination if they can be conducted safely (consider mowing around live oaks before broadcasting).

The key to fire resilience in mixed oak woodland is to 1) control shrub fuels by hand-cutting and piling, or carefully underburning, every 3 to 5 years; 2) protect trees from ignitions when conditions are very hot/windy (e.g. Park Fire conditions), and 3) cultivate a native California prairie understory (i.e., dominated by perennial bunchgrasses and consistent patches of bare ground) beneath the trees. Ground fires in this patchy, native-dominated understory will themselves be patchy and self-limiting, and they will be less likely to produce enough heat to kill the cambium of live oaks. However, because mixed-oak woodland soils are relatively productive and invasive annual grasses are more competitive on productive sites, converting grasslands back to native dominance will be harder to achieve here than on blue oak sites.

Limiting unwanted human-caused ignitions is key in this much-used vegetation type, as is encouraging neighboring land users to install landscaping that will release less energy when it burns. (For example, replacing eucalyptus, ornamental cypress/juniper, oleander, and wooden decks/pathways, with e.g. willow, redbud, buckeye, and stone.)

***Spacing:*** It is acceptable for live oak canopies to touch, especially if this provides enough shade to suppress grass around the trunks. In heavily used sites where accidental ignitions are a concern, where grass is dense consider having crews weed-whack/mow around the base of each live oak (at least 4  feet radius out from bark) as a firebreak. Without the presence of dry grass, live oak leaf litter burns hot on hot dry windy days, but otherwise is hard to ignite.  To reduce the odds of torching and ember cast, live oaks can be limbed up to 6-10 feet.

**Recommended treatments:**

- **Grazing:** If mixed oak woodlands are grazed, **oaks less than 2" dbh must be caged** to protect them from grazing. (This is especially critical for blue oak seedlings, but also all other species.) Thanks to a century of extensive grazing, most Butte County oak woodlands have good numbers of large, mature-to- decadent oaks, but have few or no seedlings coming up in the younger generation. If not remedied, this situation portends an oak population crash in the next 20-50 years in Butte County.  Goats and cows are both extremely detrimental to oak seedling recruitment. Sheep are thought to be less so, but given the importance of oak seedlings to Butte County's ecology and recreational economy, seedlings should probably be caged even if only sheep will be grazing.  A good rule of thumb is that cages should be twice as big in all dimensions, and ten times as expensive, as you think will be adequate.

  Contrary to popular belief, winter grazing isn't inherently beneficial to oak woodlands, but it is possible for it to be neutral in its effects. Short-duration, high-occupancy grazing is best, at a time

when soils are not saturated. Ecological benefits from timed grazing are high when short-term grazing occurs in mid fall or early spring, as long as soils are not too wet. Fuels reduction benefits are highest when the timed grazing occurs from late May into late June. Unfortunately, this latter timing is challenging because as the grass dries out, animals start to lose weight grazing it. Letting animals graze low-elevation oak woodland until early May, and them moving them to higher-elevation pastures, is the traditional method and is best for the animals, but it provides minimal fire danger reduction. The tradeoff between animal health and site health must be considered on a year-by-year basis.

Even in mixed oak stands that are regularly grazed, continue to underburn the oaks at least 1 year in 3 in fall until grassland species mix objectives are met. If star thistle is a serious problem, annual late spring burning may be needed instead.

- **Fuels reduction:** Where fuel loading is too heavy for the area to burn safely, managers should start with a hand-cut-and-pile treatment, burn the piles as soon as possible (except those that will be left for wildlife), then switch to annual grazing and/or burning. A mix of the two latter treatments is usually best.

- **Herbicide:** Spot-treating invasives with herbicide can be the most cost-effective option if infestations are small. See the Blue Oak section for more details on treating sites that include blue oaks. See Foothill Riparian for considerations for the draws and drainages that usually crisscross mixed oak woodlands.

- **Underburning:** See the Blue Oak section but be aware that mixed oak woodlands are often more topographically diverse and (due to more productive soils) have taller grass which means higher flame lengths. For these reasons, average burn complexity can be higher in mixed oak tan in blue oak.

**Indicators Of Success:** Soaproot, redbud, and *Rhus* spp. will be common. Bats and pollinator diversity will be high. Deer will use the area heavily because shrubs are being kept in a state of perpetual young growth.

**Maintenance** (scheduling; cost estimates): For example budgets, see Appendix, table A-3.

Hand cut and piling costs $1500 - $3,000/acre. Where the fuel load is heavy enough to be removed but light enough to not require piling before burning, then it can be lopped-and-scattered. This threshold is usually around 6T/ac. Lop and Scatter costs $650- 1500/acre.

Herbicide costs $200-$400/acre, but will be more per acre for smaller, linear projects such as along streams.

Prescribed grazing can cost $400-$600 per acre, but in low-elevation oak woodlands is sometimes free or can even pay $20 per acre or so, depending on forage quality and site accessibility during the winter. If livestock can't be securely fenced out of a riparian area, don't graze the property.

Mixed oak sites often have more topographic and fuels variation than blue oak sites, making them slightly more complex on average. Prescribed fire might cost around $100-$800/ac.

**Recreational and Infrastructural Considerations:**

Domestic predators are a major threat to native birds. Consider requiring dogs stay on-leash during turkey or quail nesting season (March-June). Cats (feral as well as those supposedly domesticated) kill 4-10 songbirds each year per human resident (Loss et al 2013). **Butte County Animal Control (530-552-3888)** can assist with the capture and spay/neuter of cats. Lethal control of cats is also a wildlife-friendly option.

Because of their relatively productive soils and high levels of sun, mixed oak woodland sites are great nurseries for invasive plants. They are also inviting places to build trails. Trail systems in mixed oak woodland sites should be priority targets for the District's integrated weed management program.



*Figure 8 - The mixed oak woodland above has been fireless for at least 15-20 years, so it is getting overgrown. Managers could limb up all live oak trees, reduce the number of gray pine trees by about 50%, and alternate grazing with fire to keep grass & shrub biomass in check. Photo credit Cait Bell.*

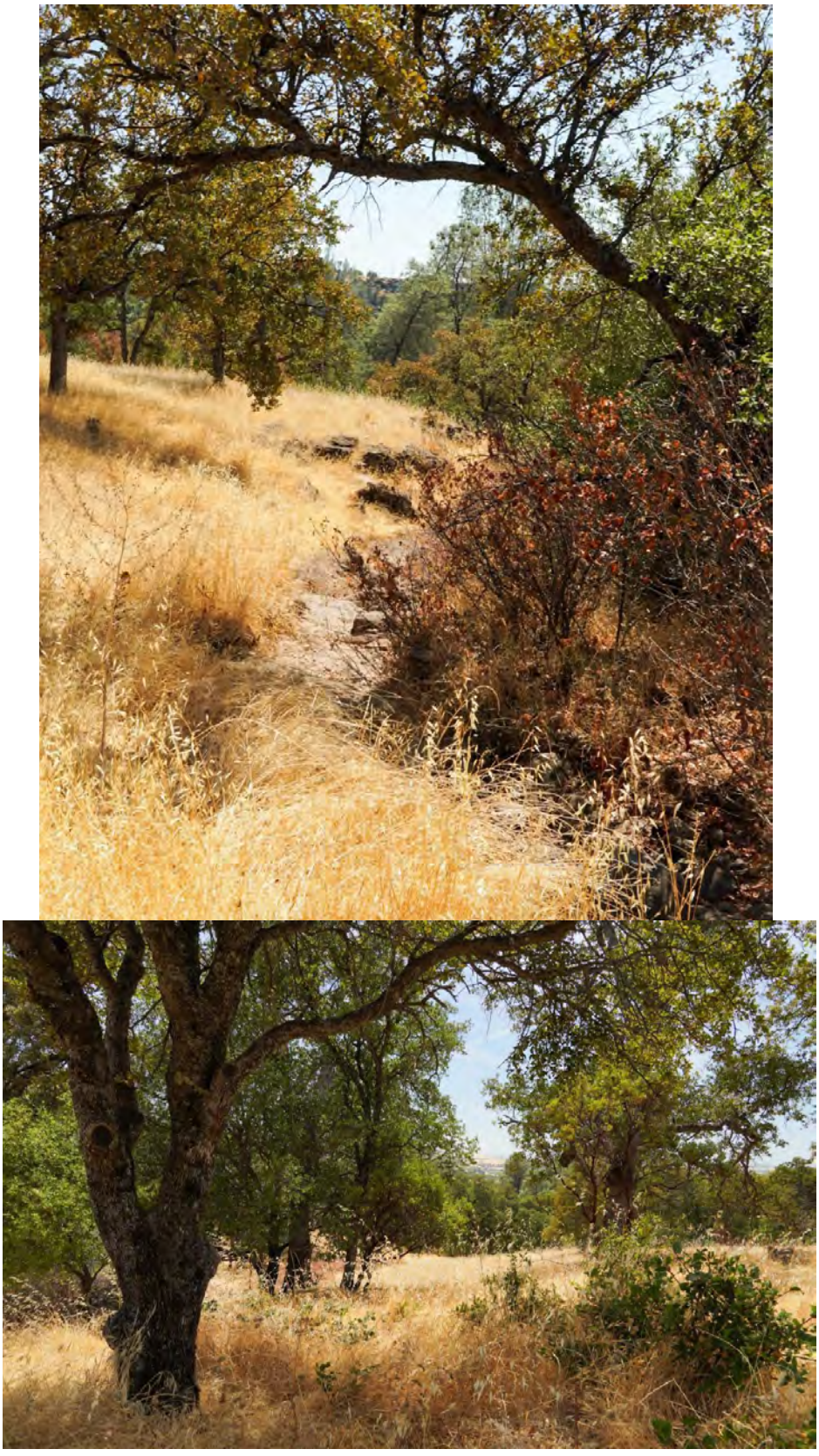


*Figure 9 - 2 photos showing a mixed oak woodland where overall tree stocking is acceptable but the main fire hazard is coming from the fine flashy fuel layer (grass). More regular fire, mowing, grazing, or a combination of these would reduce fire hazard. Photo credits Cait Bell.*



*Figure 10 - A mixed oak woodland 1 year after high-severity fire. This is an excellent example of a site where managers can pay close attention to the resprouts to discern what the site "is trying" to be. Photo credit Cait Bell.*

## Foothill Riparian

**How To Know It** - Foothill riparian communities are found along creeks, drainages and draws throughout PRPD's jurisdiction. Ideally, these areas are characterized by a higher groundwater table than surrounding uplands and host some of the most important habitats for an abundance of plant and wildlife species. However, after high-severity fire, development, intensive grazing or other major disturbances, sometimes riparian areas are hard to recognize. Three photos on the next pages show riparian areas hiding in plain sight, waiting for land managers to restore them to better function.

### Clues to help spot riparian areas "in exile":

- Topographic depressions/drainages (may have water or not)
- Evidence of scour (scour means the ground detritus, such as pine needles etc., has been swept away annually, leaving bare mineral soil at least in spring)
- Old watercourse flagging from previous projects. (This is often blue-and-white striped and will be found in a line parallel to a linear depression, usually 25', 50' or 100' from the "streambank")
- Remnant riparian vegetation. May be stranded in a sea of deerbrush, broom or dry grass. Remnant riparian vegetation includes lone willows, alder, cottonwood (*Populus* genus), Western azalea, giant checkerbloom (Sidalcea gigantea), mulefat (*Baccharis salicifolia*), isolated clumps of rushes or sedges, and, if you are below about 3000 feet, bigleaf maple.
- Linear populations of broom that's a few years taller/older than the surrounding sea of broom. This indicates that at one point, someone tried to eradicate the broom by spraying or masticating it, but skipped treating the riparian corridor that was visible at that time.



*Figure 11 - 2 views of a heavily burned seasonal drainage at Paradise Lake that has been completely converted to a deerbrush patch. Re-establishing riparian vegetation, forest cover, and hydrologic function at this site would likely benefit amphibians and most invertebrates – as well as improve public access and enjoyment.* Photo credits Cait Bell.





*Figure 12 - This riparian area has been scoured (incised) by repeated high-flow runoff events following high-severity fire. Meanwhile, it has been invaded by Scotch broom (Spartium juncaeum), preventing native riparian vegetation from re-establishing. This Coutelenc area drainage is unusual because it is on serpentine, so managers wouldn't choose to plant typical riparian vegetation such as willow and Baltic rush, nor would it be appropriate to load the drainage with coarse woody debris. However, this site still likely could sustain wet conditions for longer, and support better biodiversity, if invasives were removed and a few rocks were strategically rolled into the drainage to detain sediment. Photo credit Cait Bell.*

Most people would say that ideally, foothill riparian zones should be a more or less continuous corridor along watercourses, providing an unbroken network for wildlife and plant life buffered from any upland land uses (e.g. grazing). These zones should be lush with abundant native plant species providing bank stabilization and vegetation that provides a canopy to shade the drainage. In particular, willow should be prioritized because of its outsize benefits to wildlife.

However, a thriving foothill riparian zone can still exist without perennial surface water. Streams that are connected to groundwater sources but still go dry in the dry season are called intermittent, while those that only run immediately after a precipitation event are called flashy or ephemeral.

**Desirable Successional Endpoints** (fire regime, spacing, species presence):

***Species Presence***: Species indicators of this ecosystem include willow (*Salix* spp.), elderberry (*Sambucus*), cottonwood (*Populus* spp.), alder (*Alnus* spp.), spicebush (*Calycanthus*), ash (*Fraxinus latifolia*), wild rose (*Rosa californica*), mulefat (*Baccharis salicifolia*), wild grape (*Vitis* spp.), mugwort (*Artemisia douglasiana*), monkeyflower (*Erythranthe* spp.), and deergrass (*Muhlenbergia rigens*). Below about 3000', big leaf maple (*Acer macrophyllum*) is also a riparian indicator. If even one of these species is present, you are probably in a riparian area. (Due to the departed/degraded conditions of many lands that may come into PRPD's management, many riparian areas may have less diverse or less abundant riparian plants than they could support with some management and care.)

Riparian communities are also host to many invasive species such as Himalayan and cutleaf blackberry (*Rubus armeniacus* and *R. laciniata*), tree of heaven, arundo, and various broom species.

***Spacing***: It is natural for California streams to be flashy, usually running either above or far below their banks. Seldom do you see them at bankfull. To avoid downcutting and incision, a stream should be allowed to connect to its surrounding floodplains/wetlands each year when it floods, allowing it to safely dissipate excessive flows. If an area is to be grazed, livestock fencing should protect the entire area where water is likely to stand for even a couple of days. Providing off-stream water sources is key to helping livestock and streams co-exist.

***Fire Regime***: In a healthy riparian zone, fire does enter, but it seldom carries far, perhaps consuming a single snag or patch of willow at a time. Fire in riparian areas is usually either backing or flanking fire from adjacent drier areas *or* is deliberately applied to one riparian plant at a time to achieve cultural objectives (cultural fire). Accelerants should be excluded from riparian areas.

**Recommended treatments:**

The following types of treatment are listed in the order managers should address them. It is possible to address many of these topics at the same time; however, in case resources are limited, the action items that are usually most urgent are listed first. As one intervention is completed or deemed unnecessary, managers can move to the next.

- **Don't graze riparian areas.** Grazing can help managers meet objectives in many ecosystems, but riparian systems are not among them. Livestock should be fenced out of riparian zones to limit the compaction and degradation of soils, water pollution, and overgrazing of native riparian species. To facilitate the application of beneficial fire, consider making fences of material that won't burn or injure firelighters (i.e., high tension non-barbed wire fence). If the site is ungrazed, fencing is unnecessary.

- **Remove invasive species.** Native species growth should be encouraged by the removal of invasive species. The best techniques for this in riparian areas are:
  - Hand-pulling or weed-wrenching up to the saturated soil line (if the plants have seed on them, dispose of the pulled plants by landfilling, burning very hot, or at a minimum piling on a tarp or the least hospitable substrate).
  - flaming of young seedlings (with a propane torch when the surrounding ground is saturated). This tactic can be very effective because it does leaves the ground undisturbed. Flaming doesn't produce smoke (it produces steam), so air quality permits shouldn't be needed, but PRPD should prepare a Hazard Assessment with respect to site fuel conditions and have a go/no go condition with respect to weather.
  - pile-burning on top of infestations where feasible
  - (Annual weeds) weed-whacking at the perfect moment in the life cycle can sometimes eliminate an infestation, if weather cooperates
  - For perennial weeds, cutting with a metal blade and dabbing herbicide on the cut face.

    Some herbicides approved for aquatic use include Aquaneat (glyphosate) and Habitat (imazapyr). Both are "Caution" label herbicides and the public can safely re-enter the area as soon as the spray has dried.
  - Some invasive weeds have biocontrol options but these don't offer elimination, just (at best) reduction to a "naturalized" state.
  - The key to success in reducing invasive infestations is repetition, year upon year. During weed removal, 100% of native riparian adapted species (e.g. bigleaf maple, dogwood, elder, all willow, cottonwood, mugwort, native rose) should be left. Native non-riparian adapted plants (e.g. manzanita) can be pruned, lopping-and-scattering them. Most or all deerbrush (*Ceanothus integerrimus*) and all broom (*Genista, Cytisus*) should be removed in riparian buffers.
  - Spanish broom can be treated annually at start of bloom (March-June) by cutting any stem larger than a pencil and dabbing the cut stem with triclopyr ester. Cut material in flower should be pulled away from the herbicide application site so pollinators don't visit it.
  - Invasive trees (e.g. privet, ailanthus) can be cut and the stumps painted with herbicide. If the desire is to leave them as snag habitat, then a fall hack-and-squirt treatment using aquatic-labeled glyphosate or imazapyr can be conducted, following label rules[3].

- **Monitor the progress of invasives removal.** GPS-ing all infestations and returning to them annually is essential.

- **Process-based restoration** Streams support the most wildlife and provide the best wildfire mitigation when they release water slowly throughout the season. Streams that are straight, are downcutting/incised (i.e., they never overflow their banks anymore), and/or are free of barriers to water flow, are unhealthy. These streams are good candidates for process-based restoration.

[3] Thanks to Jim Dempsey of Dempsey Vegetation Management for much of the riparian invasive weed control advice in this section.

Process-based restoration uses a *process* (in this case the process of sediment deposition natural to any stream channel) to restore desired conditions. In practice, what this means is that woody debris, live woven plants, or stones and soil are strategically placed into a stream where the material will slow down water and force it to drop its sediment load. When the sediment drops, it settles to the bottom and, bit by bit, the channel is aggraded. The stacked, woven, or submerged "structures" used in PBR (which may be as sophisticated as a carefully woven beaver dam analogue or BDA, or as simple as a tree root ball) are often collectively called "PBRs". Proper placement of these materials is critical and may not require a Ph.D., but does require a sophisticated understanding of how streams function.

BDAs/PBRs are not suitable in large rivers and/or channels with a steep gradient over 3%. It's important to consider the channel complexity, floodplain width, and previous occupancy of beavers (or lack thereof), so hiring an expert to site (or at least training crews in siting) structures is essential. PBR structures are best used in lower order (ephemeral or intermittent or very small perennial) streams and especially flat, meadow headwaters. In larger perennial streams, they may have a place in off-channel habitat or secondary channels (sloughs). Bank erosion issues in a larger perennial stream may be best addressed with rock cross vanes (which direct flow to the center of the channel) or J-hooks (which focus hydraulic force away from one bank), etc.

Inherently, PBR increases the risk of a stream overflowing its banks – indeed, reconnecting a stream to its floodplain is the point. Depending on the size of the stream and the watershed it drains, this flooding can be significant or almost unnoticeable. Managers should carefully consider whether occasional upstream flooding is acceptable before starting a PBR project.

- **Woody debris is a friend** Large woody debris, where it exists, should be retained inside streams/draws/drainages to provide fish and aquatic habitat; or, in ephemeral streams, to at least slow flashy flows. (When snags must be cut to meet public safety objectives, they may be perfect for adding to streams, but see below about environmental compliance.) Straightening and channelizing streams should be avoided. Woody debris retention and addition is a form of PBR and does increase the odds of a stream overflowing its banks. (This is, again, a good thing from an ecological perspective, but parks managers should check to make sure it is acceptable from the perspective of risk to infrastructure or to the public's safety or convenience.)

**Special environmental compliance considerations for process-based restoration**
All waterways, even most ephemeral ones, are considered Waters of the United States by the Army Corps of Engineers and thus a 404 permit is required before adding material to them. A potential permitting pathway is Regional General Permit (RGP) 16. Allow 1 year for ACOE permitting. 401 compliance is probably best addressed through the Water Boards' Statewide Restoration General Order (SRGO). A finished CEQA document is a prerequisite for enrollment under SRGO. A helpful CEQA option for process-based restoration projects in particular may be CDFW's Statutory Exemption for Restoration Projects (SERP). The newer Restoration Management Permit process, available since January 2025, combines 5 different CDFW permits (an array of "take" permits, and the Lake and Streambed Alteration permit) into one, but CEQA compliance must be pursued separately.

- **Monitor and Reduce Erosion** Measures should be taken to avoid erosion in order to protect aquatic life within riparian zones. This includes limiting activities that may cause erosion and soil compaction within watercourse corridors. Operating heavy machinery in riparian zones should be restricted.

- **Beneficial Fire** Fire can be healthy for riparian zones. It need not exclusively be low-intensity, but it should always be patchy. Any fuel mixture used for fire ignitions (accelerant) should be kept out of riparian zones, to prevent chemical contamination. Cultural burning practices can be utilized to manage invasive species along riparian corridors.

- **Pile Burning** Material from thinning activities should be pulled out of the riparian corridor before being piled for burning. (This reduces the fine silt runoff into watercourses after burning, and also reduces the chances that wildlife will nest in the pile between the time it is built and the time it is burned). If material is piled inside riparian corridors (i.e. within 25 feet of an ephemeral stream or in the floodplain of a larger stream), consider leaving the piles unburned to serve as wildlife habitat. If more material is cut within a wetland/riparian zone than can safely be piled and left for habitat, then the extra material would be pulled out of the riparian zone to be pile-burned, chipped and hauled, or scattered on the ground prior to broadcast burning. An exception to the above is if a pile can be built on top of an invasive plant infestation. In that case, the opportunity to sterilize a large amount of invasive seed may outweigh the temporary impacts from burning a pile in a riparian area. This tradeoff should be evaluated on a case-by-case basis.

- **Planting** Most riparian areas can recover on their own but in areas where native riparian plant cover has been lost or degraded, replanting native species may be beneficial. Willow, cottonwood and sometimes alder, rose and grape can be planted as cuttings. Burn piles can be oversown with a locally collected mix such as blue wild rye (*Elymus glaucus*), mugwort (*Artemisia douglasiana*), native clover (e.g. *Trifolium wormskioldii, T. willdenovii*, etc.) and bentgrass (*Agrostis pallens*).

- **Mechanical operations**

  Foothill ecosystems often see heavy brush regrowth following high intensity wildfires. This brush overgrowth persists years after the initial fire event. Without intervention within the watercourse, this heavy woody debris could form logjams that could increase the risk of winter flooding, as well as additional fuel for the next fire. Many landscapes within the PRPD boundary have been converted from forest to brush, as well as become dense with several invasive species. Utilizing machinery offers an additional tool for managing these areas, however, caution should be exercised with regards to sensitive riparian habitats. A small tracked chipper would be preferred; it can be stationed outside the riparian zone and fed by people cutting vegetation by hand within the riparian zone.

  Heavy equipment should be kept off slopes steeper than 50% or on saturated soil. The following guidelines are recommended from experience[4] *but site-specific CEQA documents and permits*

[4] These guidelines were used in BCRCD's Small Forest Landowner Assistance Program, where the objective was to reduce future fire hazard by assisting residents who were rebuilding with cleanup and removal of standing dead brush and trees.

*may require larger buffers*. Timber harvest documents would require larger buffers. The stipulations of a site-specific permit always take precedence. The soil type, and its erodibility, should also be taken into consideration when designing buffer widths.

***Ephemeral streams (or wetlands)** should be buffered a minimum of 25' from the streambank (or, for a wetland, from the outer edge of wetland obligate vegetation). Many environmental documents will require 50'. Within the buffer, no heavy equipment may enter, but may reach into the buffer as long as the boom arm reaches. If a dense infestation of invasive plants exists within the buffered area, chipping of invasives is acceptable provided chips are broadcast outside the buffered area. Equipment may establish a single perpendicular crossing (if none exists) for each ephemeral stream, and continue to use it for the life of the project.*

***Perennial streams (or wetlands)** should be buffered from the streambank the following distances, at a minimum: 40' if under 30% slope, 50' if 30-50%, 60' if over 50%. Many environmental documents will require 100'. Perennial wetlands should be buffered the same distance from the outer edge of wetland obligate vegetation. Within the buffer, no heavy equipment may enter, but may reach into the buffer as long as the boom arm reaches.*
*Machines and vehicles may cross the stream buffer using existing roads/driveways, landings, and crossings, but may not create new ones.*

*Equipment should cease operations after any rainfall over ¼", and should not resume until a drying period of at least 24 hrs has passed, or as much additional time as it takes after 24 hours for the soil to no longer be saturated. Hand crew operations are still appropriate with saturated soils as long as conditions are safe for them. Nothing should be skidded out of watercourse buffer areas, but material may be chucked or hand-carried out to meet fuel loading objectives. Light brush may be pulled out with ropes and winches.*

**Indicators Of Success:**
Willows and cottonwoods will increase in number and size. Porcupines are an excellent indicator of a healthy foothill or Valley riparian woodland. In a perennial stream, abundant species diversity such as birds, amphibians, fish, mammals, willows and other plant life, and aquatic vertebrates will be present. The ultimate indicator of success for most stream managers might be for beavers to take up residence again! (If coexistence with beavers poses a challenge to PRPD or neighboring land users, resources are provided at the end of this document.)

Ephemeral streams won't have all of the success indicators perennial streams do. However, as water is slowed and spread and invasive encroachment is reduced, the green zone around ephemeral streams will get wider in space and will persist longer in time. Even if these gains are modest, they can have substantial positive impacts on (for example) the pollinator community, as well as the public experience.

**Maintenance** (scheduling; cost estimates)
***For example budgets, see Appendix, Table A-4.***

Hand cut and chipping costs $1500 - $3,000/acre.

Herbicide may cost around $500-900/acre for smaller, linear projects that incorporate cut-and-paint prescriptions, such as those common along riparian areas.

Small “leaky weir” style PBR structures can be built out of native materials for $200 each (and up).

**Recreational and Infrastructural Considerations:** Riparian zones are under the jurisdiction of the California Department of Fish and Wildlife (CDFW) and are highly regulated and protected. Extensive permitting processes await any manager who undertakes to alter the bed, channel, or bank of any watercourse. Plans for development should minimize disturbance and retain riparian vegetation. Recreational access to riparian areas should emphasize existing roads and trails and minimize informal trails. Bridges can be beautiful and meaningful landscape features that focus traffic and protect the rest of a stream’s bank from trampling.

Domestic predators are a major threat to native birds. Consider requiring dogs stay on-leash during turkey or quail nesting season (March-June). Cats (feral as well as those supposedly domesticated) kill 4-10 songbirds each year per human resident (Loss et al 2013). **Butte County Animal Control (530-552-3888)** can assist with the capture and spay/neuter of cats. Lethal control of cats is also a wildlife-friendly option.



*Figure 13 - A healthy foothill riparian zone. Cattails indicate water is perennial and flowing (even if slowly). Photo credit Cait Bell.*



*Figure 14 - A downcut riparian zone. Invasive blackberry encroachment is heavy and willows are no longer common. Process-based restoration here, such as chopping and dropping dead trees into the creek, could aggrade the channel, reconnect the stream to its floodplain and improve riparian habitat connectivity. Both pictures 10 and 11 were taken 7 years post-high severity fire. Photo credit Cait Bell.*

# Upland Mix: True Oak-Chaparral Mixture

**How To Know It:** True "upland mix" contains oaks, but they are not its most noticeable feature, and they rarely exist in their tree form. Rather, this vegetation community looks like shrubland or chaparral, sometimes punctuated by isolated stands of oak. It is dominated by evergreen, waxy-leaved spp. like manzanita (e.g. *Arctostaphylos viscida*), toyon (*Heteromeles*), *Garrya* (silktassel), *Adenostoma* (chamise), *Lepechinia* (pitcher sage), ceanothus (*C. cuneatus, C. cordulatus*), yerba santa (*Eriodictyon californica*), scrub live oaks (e.g. *Q. berberidifolia* or very stunted *Q. wislizeni*) and sometimes buckeye and/or redbud.

There may be an oak component (usually a waxy-cuticle, evergreen scrub oak) in upland mix, but its thin soils leave it without the capacity to support many large tree oaks. If present, tree oaks are usually restricted to pockets of better soil, on north-facing slopes and in draws or around springs. Upland Mix is distinguishable from degraded, encroached or severely burned blue oak or black oak woodland because of its unique elevation band and soil type.

Sites that appear to be shrublands and are composed mostly of dense stands of deerbrush (*Ceanothus integerrimus*) or French broom (*Genista monspessulana*) are more likely to be recently burned black oak-ponderosa woodland.

**Desirable Successional Endpoints:** (fire regime, spacing, species presence)

The species comprising upland mix are virtually all adapted to a stand-replacement fire regime, which means they inherently burn at high severity. Paradoxically, they can be almost impossible to ignite in certain seasons (e.g. early spring) when their moisture content is high. Also, certain species (for example buckbrush, *C. cuneatus*) are incredibly fire-resistant even under severe conditions. (Bands of unburned *C. cuneatus* can be seen standing within ten feet of bands of completely incinerated live oak, throughout the Park Fire footprint.)

Left to its own devices, this vegetation type will grow denser and denser until it ignites and burns as one even- aged stand on one particularly hot and windy day. In the PRPD area, without human aid, this happens naturally every 20 years or so.

Indigenous land managers set smaller, intentional fires more frequently. This created a mosaic of different ages and improved hunting by increasing the amount of forage available for deer. (Deer prefer shrubs burned in the last 1-3 years.) This frequent burning would have meant that old-growth chaparral would only exist on the most mesic (i.e., north-facing or wet) sites. Over time, frequent burning can slowly create openings, which facilitates some wildlife habitat and human gathering. Indigenous managers also selected for the more productive manzanitas and treated them like orchard trees, ringing them with enough open space to be accessible and easy to harvest[5].

The desired outcome for shrub-based communities is an uneven-aged mosaic with plenty of openings.

[5] Magan Herrera pers. comm.

**Recommended treatments:**

- **Fire** Fire in shrublands is essential yet unpredictable; it may burn one area hot and leave the next untouched in a way that seems mysterious. This patchiness met Indigenous land managers' objectives. Since modern land managers tend to emphasize fuels management over wildlife habitat and prefer total consumption, they manipulate shrub vegetation by crushing or chaining sections of it and then allowing these to dry for a few weeks prior to igniting them in cool spring or fall weather. The dry sections provide enough heat to ignite (or at least top-kill) the live sections. Shrub fires throw a lot of embers, which (combined with their tendency to be on steep terrain) makes them hard to control.

  Areas that have been fireless for 20-30 years or more (if you can find them) are the highest priority for treatment. Prescribed fire in shrublands is moderate-to high-complexity and is most cost-effective when done at scale of hundreds of acres. However, if the right holding features are in place, controlled fires of 20-50 acres are doable, for example in late fall or midwinter in units defined by south- and west-facing aspects, when north-facing aspects are too wet to burn[6]. If fire is infeasible, managers can pile and burn shrubs periodically.

- **Mastication** Just masticating shrubs doesn't reduce their fire hazard acceptably; in fact, it can even worsen wildfire outcomes. This is because the masticated fuel stays on the ground and takes so long to decay that subsequent years' resprouts grow through it and even senesce while it is still there. Not recommended.

- **Pluck and pile/ grapple pile/hand cut and pile** Some managers have had success with a method called "pluck and pile," or grapple pile, where a small excavator or Bobcat equipped with a grapple pulls whole bushes out of the ground and piles them for burning. This is a highly ground-disturbing treatment and a bad fit for steep slopes, but when done in a patchy, mosaic arrangement on relatively level ground, this treatment can avoid unacceptable erosion outcomes. Burned piles, and bare ground, can be overseeded with a mix that will conduct fire in a desirable way (such as a low-growing forbs mix, or possibly a prostrate ceanothus).

[6] "Prescribed Burning Plan for Lands Managed by the City of Chico." Prepared by Zeke Lunder. Deer Creek Resources: Spring 2021.

- **Selecting for underrepresented or more fire-resilient shrub species**

  Past management actions (including repeated grazing with the same species and seasonality) can result in a shrubland that is less diverse than the site could support. When a more open or more diverse shrub profile is desired, shrubs can be machine-plucked or cut-and-painted (with herbicide), until a desired spacing and diversity is achieved. A prescription might look like this[7]:

  1.) *Leave all black oak, blue oak, valley oak, bigleaf maple, elderberry, redbud, Rupertia.*

  2.) *Thin other species to 25 ft spacing. Below is the preferred species in order of priority to retain [**adapt this list depending on location and objectives**]: Conifers of any species; two-petalled ash (Fraxinus dipetala); hop tree (Ptelea); California buckeye; Brewer's oak (Quercus garryana); interior live oak (Q. wislizeni); toyon (Heteromeles arbutifolia); mountain mahogany (Cercocarpus); silktassels (Garrya); coffeberry (Frangula); deerbrush (Ceanothus integerrimus).*

  3.) *All vegetative debris that will not be burned shall make contact with the soil. Debris shall be no greater than 4 ft in length. However, leave logs that are greater than 10 ft in length and 10 inches in diameter intact for wildlife habitat. No debris may be left within 5ft of "Keep" individuals.*

  4.) *Stumps shall be cut flush to the ground when possible. Otherwise stumps should be cut to a maximum height of 6 inches above the average ground level as measured on the uphill side or 6 inches above natural obstacles (i.e., logs, rocks).*

  5.) *No damage to living trees over 6" in DBH will result from contract operations.*

  6.) *No slash buildup to be left on lava caps.*

  7.) *Spacing of brush and trees will vary as the vegetation types and sizes vary however the goal of 25' spacing should be standard. In areas dominated by brush, brush species may be selected to maintain the 25' of spacing and to provide shade and prevent further brush regrowth.*

- **Grazing** Shrublands evolved with grazing and are remarkably resilient to it. Managers should consider that over time, repeated grazing in the same season with the same type of animal will select for certain species (e.g., yerba santa) at the expense of others (*C. cuneatus* is a favorite of goats; manzanita is often girdled but left standing, resulting in a transition from live fuels to dead). Consider alternating between goats and cows, where resources permit (i.e. there are no fragile riparian or cultural gathering areas to protect from cows, and/or fencing is adequate).

- **Herbicide** Herbicide can be a valuable tool for creating and maintaining openings in

[7] Thanks to Big Chico Ecological Reserve (Rhianna Dutra, RPF, and Mitch Bamford, Fire and Flora Coordinator) for permitting this prescription to be adapted for this plan. They originally developed it for a large project on Musty Buck Ridge.

shrubland. To protect pollinators, herbicides should be withheld when shrub species are in bloom. The fastest and most lasting fuels reduction is accomplished by cutting shrubs as close to ground level as possible, painting the cut stumps with a dyed herbicide, and removing the cut biomass (either by piling and burning, or by trucking it to a biomass facility such as the Butte Soil Factory.

A shrubland herbicide prescription might look like this example[8]:

*Do not treat the following species:*

- *Black Oak*
- *Valley Oak*
- *Blue Oak*
- *Big leaf maple*
- *Elderberry*
- *Conifers of any species*
- *Two petalled ash*
- *Hop Tree*
- *Buckeye*
- *Western Redbud*

*Treat approximately 50% of the following species:*

- *Brewers Oak*
- *Toyon*
- *Silk Tassels*
- *Coffee Berry*
- *Deer Brush*
- *Mountain Mahogany*
- *Interior Live Oak*

*Treat approximately 90%* of the following species:*

- *California Bay Laurel***
- *Scrub Oak*
- *Buck Brush*

**Treatment percentages are not expected to be hit perfectly, but instead just a general guideline for the future stand composition. PRPD managers can and should adapt this prescription for each specific site and set of objectives.*

*Individuals left untreated should be spaced out as evenly as possible*

*Individuals left untreated should be the largest individuals of those species in the area*

*** These are just examples, and BCRCD recommends managers experiment with innovative alternatives such as limbing-up certain species, like toyon and the particularly*

[8] Thanks to Big Chico Ecological Reserve (Rhianna Dutra, RPF, and Mitch Bamford, Fire and Flora Coordinator) for permitting this prescription to be adapted for this plan. They originally developed it for a large project on Musty Buck Ridge.

*culturally important bay laurel, rather than removing them outright.*

**Indicators Of Success:** Deer will be abundant. A wide diversity of nesting songbirds will be seen. In isolated areas, especially in shadier draws or north-facing slopes, soil crusts will be developing on exposed soils.

**Maintenance** (scheduling; cost estimates): ***For example budgets, see Appendix, Table A-5***. Hand cut and piling costs $2000 - $3,000/acre in upland mix, often on the higher end in areas that burned 4-10 years ago. Lighter fuel loads can be lopped-and-scattered, if they will result in a surface fuels load of less than about 6T/ac (adjust for the site). Lop and Scatter costs $650- 1500/acre and (similar to mastication) only rearranges fuels; however, it will carry beneficial fire sooner than mastication. Lop-and-scatter in shrublands should only be done when there is a plan and ability in place to follow it up with fire.

Grapple piling may cost $725-$1000 per acre.

Mastication costs $1500-2500/acre.

Herbicide costs $200-$300/acre most places, but on steep brushy shrubland sites, it can be as high as $1,000 acre.

Prescribed grazing can cost $400-$600 per acre.

Prescribed fire costs are effectively paid by the day and are much cheaper per acre for larger burns. A moderately complex to complex 20-acre shrubland burn in Butte Creek Canyon might cost $500-$900/acre. Again, all costs are 2025 estimates and will be hugely affected by the size and complexity of the unit and the extent to which the burn can be conducted in-house/with experienced volunteers, or if PRP will hire contractors.

**Recreational and Infrastructural Considerations:** Because of shrublands' sun exposure and hazards like rattlesnakes and ticks, combined with their accessibility to the WUI, people can experience heatstroke and other medical emergencies when recreating in shrublands more often than in many other vegetation types. Signage and (where possible) water access are especially helpful here.



*Figure 15 - An arid shrub dominated hillside in Concow, post Camp Fire. This site has naturally regrown with decent spacing between the black oak and ponderosa pine resprouts.*

*Photo credit Cait Bell.*



*Figure 16 – Above and below, 2 views of a shrubland ecosystem in Concow 7 years after high severity fire Resprouting trees are bay laurel and bigleaf maple, proof chaparral systems aren't limited to arid sites. Reducing shrub/tree density here likely depends on the use of herbicide. Photo credits Cait Bell.*





*Figure 17 -It is normal for shrublands to burn at high intensity and then appear "slicked-off," such as this shrub ecosystem on basalt-derived soils at about 3000' in the Deer Creek drainage, 10 months after the 2024 Park Fire.*

*Photo credit Cait Bell.*



*Figure 18 - The alternating bands of tan and green on these hillsides are lower-productivity soils alternating with higher-productivity soils. The higher-productivity soils supported live oak stands; these burned at extremely high intensity (100% top-kill) in the 2024 Park Fire and were green with resprouting foliage the following spring. The lower-productivity soils supported buckbrush stands; these burned lightly or not at all in the Park Fire, despite being decadent and mere feet away from torching live oak. Under the still-standing buckbrush, the grass had already cured by early May 2025. Photo credit Wolfy Rougle.*

## Black Oak-Ponderosa Pine

**How To Know It:** More than any other, this vegetation community represents the ecological essence of the Paradise Ridge. Black oak-ponderosa pine is the vegetation type most emblematic of the fertile Southern Cascades volcanic plateaux, including places like Paradise, Forest Ranch, Cohasset, and the pineries of the Ishi Wilderness[9]. However, by 2025, many acres that would have been black oak-ponderosa pine woodland in 1849 are now converted to other ecological communities, making black oak-ponderosa seem rarer than it really "is". This conversion happens in any of the following ways:

- when land managers cut and remove all the ponderosa trees on a property, either for revenue or in the belief that this will make the property more fire-safe
- when long-term fire suppression allows shade-tolerant species, such as incense-cedar or even white fir, to encroach into ponderosa stands and make them seem like mixed conifer stands;
- when the black oak-ponderosa woodland burns at high severity and is succeeded by a wave of shrub regrowth (usually mostly deerbrush and broom).

In other words, black oak-ponderosa woodland is one of the most fragile and easily lost ecosystems. This is paradoxical, because it is also one of the easiest to sustain forever in a highly stable state maintained by low-intensity fire.

***Other conifer encroachment*** It is normal for black oak-ponderosa woodlands to contain isolated single representatives of another species here or there (particularly, incense cedar or Douglas-fir). However, after even one missed fire return (i.e., 10 years without fire), an acre of black oak-ponderosa pine woodland that started out with even a single incense-cedar in it will be carpeted with incense cedar seedlings, making it appear as if incense cedar makes up 20 or 50% of the stocking. This is an artifact of unnatural fire suppression. It should not be interpreted as the site "really being" a mixed Sierran hardwood-conifer forest.

**Desirable Successional Endpoints** (species presence, fire regime, spacing):

***Fire regime:*** Black oak-ponderosa pine is simultaneously the ecosystem that needs fire the most regularly, and the one that offers the best opportunities to maintain a safe, low-intensity fire regime. Communities such as chaparral or grassland simply cannot be maintained in a steady state with low-complexity fire, but black oak-ponderosa can. This is a natural fire resiliency advantage that blesses Paradise and Cohasset, compared to places like Los Angeles and Malibu.

Ideally, black oak-ponderosa is underburned every 2-5 years (plan on 3 years). It can, indeed, be underburned every single fall, or as soon as there is enough needlecast to carry fire, without damage to the ecosystem. As long as the fire burns before about February 1, annual fire will only benefit this

[9] The Beaver Creek Pinery was the best of these. Never logged nor grazed, and allowed to burn *relatively* frequently because of its wilderness identity, it was the last intact old-growth black oak-ponderosa stand at the 2500-3500' elevation. As such, it served as a reference site for what Paradise Ridge would have looked like in 1840, and how Paradise Ridge's fire ecology would have functioned. Many of the pictures in this section are taken from it. Unfortunately, even Beaver Creek Pinery was forced by fire suppression to miss about six fire returns between 1994 and 2024. It died of fire exclusion in 2024.

ecosystem, while at the same time making it extremely fire-safe to live in and offering opportunities to build community-based fire skills in a low-complexity training situation.

- ***Spacing:*** Spatial heterogeneity is of the essence for black oak-ponderosa pine woodland. Unless the site is a designated fuelbreak *that will be staffed and defended in the event of a wildfire*, it should be managed toward an "ICO" structure (see Abbreviations and Key Terms). This spatially heterogeneous ICO structure slows fire spread better than a spatially homogenous stand, even a beautifully maintained (but regularly spaced) shaded fuelbreak stand. In other words, a stand with clumps and openings is more resilient than a stand of perfectly evenly spaced trees. Prioritize rocky areas for openings, and use a starter spacing of 25' - 35' between trees (but tolerate and encourage variability, and retain the largest trees, even if they are close together, since they are the most fire-resilient individuals).

***Practicing fuelbed forestry*** For some managers, it is tempting to remove ponderosa pine from the system entirely. Everyone can remember ponderosas torching during the Camp Fire, and black oaks are harder for wildfire to ignite. However, ponderosa provides an essential service *to black oak* by contributing its own springy, fast-drying, resinous needles to the fuelbed. After being flattened by rain or snow, ponderosa's longleaf needles dry out and bend in just a few hours of sun, making the fuelbed fluffy and available to burn at comfortable intensities. Alone, black oak leaves will stay soggy and compressed for a week after a snow. Therefore, with no ponderosa in the mix, an acre of black oak woodland may only be safely burnable at low intensities five to ten days a winter. With ponderosa in the mix, that number is more like 30 or 60. Low-intensity fire is essential for optimal black oak woodland health – it's the best way to reduce pests, encroachment, and wildfire hazard --, yet black oak alone cannot provide enough fire to meet its own and its allies' needs. Even five to eight mature ponderosa pines per acre can be enough.

***Species presence****:* Common associate species of black oak-ponderosa, which may persist as indicators of this woodland type long after the actual woodland is gone, include: *Pedicularis densiflora* (warriors' plume), *Carex multicaulis*, *Iris hartwegii*, *Ceanothus lemmonii*, *Calochortus monophyllus*, and milkwort (*Rhinotropis cornuta*).

**Recommended treatments:**

- **<u>Recovery from high-severity fire</u>** If possible, managers should log and remove the dead ponderosa trees in year 1, while they still have value to a mill. Obviously, this is easier said than done. As salvage progresses, pile tops and slash for later burning. If snags cannot be removed and sold to a mill in the first year, they probably need to be piled and burned whole. However, it may be feasible to truck them, chipped or whole, to a biomass facility such as the soil factory in Butte Valley.

  Once snags are removed, if lots of woody debris is left on site, then chipping it and spreading the

chips to a MAXIMUM height of 3" is very effective at reducing brush competition and helping with moisture retention for natural regeneration or eventual planted seedlings. A chips depth of 4-6" will be impossible to plant into. Excess chips should be trucked off-site.

***Replanting – Waiting is best*** Two springs post-fire, natural conifer regeneration will be evident. This is the time managers can decide how many supplemental ponderosa seedlings would be helpful. Plant ponderosa seedlings in year 3 (see "herbicide" below for site preparation considerations). It is okay to plant a few incense cedars among the ponderosa pines, but other conifer species will usually be inappropriate. Usually, replanting oaks or hardwoods will be unnecessary.

In the 3-5 year window post-fire, conduct hardwood release and leader training of the resprouting oaks. This means to prune each surviving keeper oak (or other hardwood if present and desired) to its 2-5 strongest stems. At this time you can also limb up the stems to 6'. Pile and burn the prunings.

- **Recovery from fire exclusion** In today's world, if you're not recovering from fire, you're recovering from fire exclusion. Sites that have been fire-excluded for long enough become too densely stocked to safely underburn. These sites require biomass removal before beneficial fire can be reintroduced. Options for biomass removal include timber harvest, hand cutting and piling (and burning the piles), or hand cutting and chipping and removing the chips (e.g. to the Butte Soil Factory in Butte Valley, or a similar option). A common minimum prescription is to remove dead fuels 15" DBH and less (leaving 6 snags per acre where possible), and remove live fuels 10" DBH and less.

- **Mastication** Mastication is a popular treatment because it makes a stand immediately walkable, produces an instant visual reward, and can moderate wildfire *behavior* (but without actually improving tree survival[10]). However, it is not recommended. Since it leaves the material on site, it requires follow-up, while also delaying the most cost-effective *form* of follow-up (i.e., fire) for longer than other tactics would.

  Fuels can be reduced more cost-effectively through other tactics, such as cut and pile + pile-burn; cut and chip + haul; timber harvest + machine-pile biomass +pile-burn, etc. All these would allow a faster journey to reintroduction of low-intensity fire, which is the treatment that results in the best stand survival outcomes post-wildfire[11].

  Underburning in mastication units is difficult, spotty, and can be downright unadvisable, even if mastication is a temptingly quick and easy way to realign fuels. The reason it is risky to follow mastication with fire is because the fuelbed is so deep, and contains so much energy, that burning it may kill the surrounding trees by cooking their roots. This can happen when the masticated fuelbed is very dry and it can also happen when it is quite wet. (That is because even though damp fuels burn with less heat, water holds heat longer than air). We have burned in a few stands that were masticated 2 years prior with good results, but we have seen many more stands where

[10] Knapp et al 2011.
[11] Davis et al. 2024. Ryan Bauer personal communication post-Dixie Fire. Brodie et al 2024.

mastication rendered the stand un-burnable for 3, 4, 5, or even 7 years – a disastrous outcome.

If mastication is absolutely desired, then at a minimum, a mastication prescription should insist that no pieces are left larger than 2" in diameter and soil disturbance should be no deeper than 1-4". A rolling drum masticator head is more likely to produce these outcomes[12]. We have visited some recently masticated units in Forest Ranch that appeared potentially underburnable within 1 to 2 seasons, and they used these specifications.

A small "test" unit should be masticated first so managers can assess the size and depth of material left behind. Mastication outcomes are unacceptable if material looks like it won't break down to the point of carrying a low-intensity underburn in 2 wet seasons.

Include machinery buffers 50-100' around riparian areas.

- **Herbicide** Sometimes, after a fire, a black oak-ponderosa site experiences prodigious brush growth that will be in strong competition with tree seedlings. The brush is usually dominated by deerbrush (*Ceanothus integerrimus*), broom species, and blackberry (*Rubus armeniacus*). In these cases, managers can opt for *one or more of* the following:

  - Pre-emergent herbicide (soil-based) can be applied immediately after fire (but that will kill potential desired seedlings in the seedbank too).
  - Foliar applications can be sprayed on brush grown back within the first 3 years, either before planting, after planting (requires applicators to have shield for seedlings), or both. This can be followed/mixed with a pre-emergent herbicide ***if*** grass or annual forbs are anticipated to be a strong competitor.
  - Wait until seedlings are planted and then apply a targeted 7-10' circle around each seedling (7 feet minimum). This allows for brush reduction without a large blanket application of herbicide
  - Brush species can be cut, and the stumps painted with herbicide, 2-4 years post-fire. The cut brush can be piled and burned or chipped and hauled. This is labor-intensive but probably the most effective way to reduce brush. The following spring, any new baby brush seedlings can be flamed when they are tiny and the ground is wet.

- **Underburning** Underburning is the single most important treatment in black oak-ponderosa pine. Fall or early winter burning is recommended to consume shade-tolerant seedlings (e.g. incense cedar) and reduce surface fuel loading.

  When burning on the hot end of prescriptions –or in spring--, it may be necessary to ring black oaks, especially if they have catfaces or basal cavities. Spraying down the oaks with water right as the fire front reaches them can prevent the fire from climbing the dry moss on the oaks' boles.

**Indicators Of Success:** An ICO structure will be apparent, with clumps of young "regen," clumps of old growth, and areas of middle-aged trees.

[12] Thanks to Sarah Jo McDowell at the Butte County Fire Safe Council for sharing specifications used in their most recent mastication project (at time of this writing) on Doe Mill Ridge in spring 2025.

Large flocks of pigeons use the woods. Deer use the site because of heavy acorn crops. A diversity of rodents are seen. Forest carnivores such as fisher may visit. Abundant and diverse woodpeckers are seen. The floor of the woodland will be bright in spring with a mix of wildflowers and grasses (examples: *Fritillaria*, *Calochortus (esp. C. monophyllus)*, *Pedicularis densiflora, Rubus* (native spp.), *Ribes, Corylus*, Oregon grape, and *Sambucus*; *Festuca californica, Carex multicaulis,* and/or *Elymus elymoides*). Coccora mushrooms (Amanita calyptroderma), *Ligusticum* herb sp. and soaproot (*Chlorogallum*) will be common.

*Trientialis latifolia* and dogwood may be seen in shady spots, but are not very common understory plants.

**Maintenance** (scheduling; cost estimates): ***For example budgets, see Appendix, table A-6.***

Hand cut and piling costs $2000 - $3,000/acre if it is a necessary first-entry. After that, the stand should be maintained with broadcast fire.

If an initial entry is required but ladder fuel loading is on the lighter side, then it can be lopped-and-scattered. This surface fuel loading threshold is usually around 6T/ac (adjust for the site). Lop and Scatter costs $650-1500/acre and (similar to mastication) only rearranges fuels; however, it will carry beneficial fire sooner than mastication.

Mastication costs $1500-2500/acre.

Herbicide costs $200-$600/acre.

Post-fire snag removal, decking and hauling away can easily cost $4,000-6,500/acre.

Planting conifer seedlings costs $80-150/acre, exclusive of the cost of seedlings ($.80$1.50/seedling, so an additional $88-315 per acre). Hardwoods usually don't need to be replanted, but when they do, they normally cost more ($4-9/tree).

Prescribed fire costs are paid by the day and are much cheaper per acre for larger burns. A 10 acre burn in Paradise would cost $100-900/acre.

Maintenance burns would be conducted every 2-5 years and would have the following objectives[13]: 80-90% reduction in 1-hr fuels (e.g. needlecast); 40-70% reduction each in 10-hr and 100-hr downed fuels; 20-30% consumption of 1000-hr fuels; 95-100% mortality in trees 6" dbh and under; minimize scorch mortality (10% or less) to mature oaks and pines over 12" dbh, by ringing large trees that have basal cavities. Trees between 6" and 12" dbh are unlikely to be killed by fire at the prescriptions normally used in controlled fire within the District, unless it is a larger landscape-scale prescribed fire. Trees of this intermediate size, if overstocked, should be removed mechanically.

[13] These objectives were suggested by a California State Certified burn boss (CARx) who was asked to consider a maintenance burn conducted every 7 years at Paradise Lake, without any intervening thinning.

**Maintenance** (scheduling; cost estimates): If black oak-ponderosa can be maintained with fire, particularly if a trained in-house crew can be used, it is the least expensive forest type to keep in a state of wildfire resilience.

**Recreational and Infrastructural Considerations**: As the most mellow and enjoyable fuel type to burn in, black oak-ponderosa presents outstanding opportunities for community-based fire as a recreational and mental health-supportive activity.





*Figure 19 - Two views of black oak-ponderosa after high-severity fire. Photo credits Cait Bell.*



*Figure 20 - A neighborhood burn in a black oak-ponderosa system in Forest Ranch. Typical of black oak- ponderosa's easy fire regime when well-maintained, this burn is so low-complexity that one volunteer is spreading fire with a rake while everyone else eats pizza. Such burns would be an ideal way for PRPD to maintain its black oak-ponderosa sites.*

*Photo credit Wolfy Rougle.*



*Figure 21 - The same neighborhood burn unit in Forest Ranch two hours after the fire. Surface fuels are consumed by about 90%, meeting objectives. Trees under 6" dbh experienced very low mortality, however; mortality of 20-80% in that fuel class would have met objectives.*

*Photo credit Wolfy Rougle.*





*Figure 22 - 2 views of black oak-ponderosa pine in a residential setting. Photo credits C*

*Figure 23 -3 views of the black oak ponderosa pine ecosystem at the Beaver Creek Pinery in spring 2023. Although the sites pictured here may have more dead and ladder fuels than would be found in many managed parklands, they all still could have been safely underburned, without costly prep work, under cool conditions. Photo credits Wolfy Rougle.*









*Figure 24 - Pine litter, with its quick drying and flashy fuel availability, is one of the best surface fuels to carry low intensity fire through an ecosystem.*

*Photo credit Wolfy Rougle.*

## Serpentine

**How To Know It:** Serpentine is a special type of rock (or the soil derived from it) containing high concentrations of certain metals like magnesium, nickel, iron, manganese, chromium, and/or zinc. These metal concentrations are toxic to most plants, but unique communities of serpentine-adapted plants have evolved to fill the niche. Serpentine outcroppings can appear pale to vivid greenish white (as near the intersection of Coutelenc and Skyway) or rust-red (as above the community of Concow). Although they appear almost desert-like compared to adjacent forestlands, they are actually biodiversity hotspots which, happily, present few fire risk reduction challenges. Indeed, they tend to be the most fire-resistant of vegetation communities.

**Desirable Successional Outcomes:** (species presence, fire regime, spacing)

Most serpentine areas are self-maintaining and are already close to their optimal states. Generally, the land managers' task is to protect them from invasive species, development, abuse (such as piling biomass or soil on them), and catastrophic fire on their borders. After stand-replacing fire, some serpentine communities (e.g., MacNab cypress groves) will have heavy loads of dead woody debris. If this poses a hazard to adjoining communities or to the trees themselves (the entire stand can be lost permanently if it burns twice within 25 years), the dead wood can be hand-cut and removed from the stand, if this can be done without destroying the natural regeneration of the seedlings.

***Fire regime**:* Because of its naturally low fuel densities, serpentine seldom carries a ground fire. Serpentine areas' fire return interval is often 50-80 years, and fire usually takes hold only when embers blow in from adjacent areas of denser fuel. In WUI areas where ignitions are now unnaturally common (especially in the hotter months), the biggest fire threat to serpentine likely comes from adjacent fuel types. Consider underburning adjacent non-serpentine areas as a way to maintain serpentine's health.

***Spacing**:* Serpentine plants rarely require intervention to increase their spacing. Apart from a few special cases (e.g. closed-cone cypress groves in the wildland-urban interface) which should be managed under the direction of a rare plants specialist, serpentine should usually be left alone and managed to minimize invasive species.

**Recommended treatments:**
Serpentine needs little management. Protect from herbicide (except possibly highly targeted use to control invasives; for a breakdown of what this might look like, see Appendix, table A-7). Never graze serpentine. Never allow piles to be built and burned on serpentine. Never scatter biomass (e.g. wood chips, lopped-and-scattered material, etc.) on serpentine.

**Indicators Of Success:**
Rare plant populations are stable or increasing (consult a botanist). Where closed-cone cypress are present, multiple generations are growing together, and fire return intervals are 25 years or more.

**Maintenance (scheduling; cost estimates):** Patrol for invasive species or trash dumping; mitigate. Invasive species can be hand-pulled or can be controlled with herbicide as long as a botanical survey is conducted first and known rare plant locations are protected from spray. (Few weeds can survive on serpentine, but yellow star thistle and Spanish broom, and sometimes cheatgrass or medusahead, can manage it). Cut-and-paint is an ideal herbicide application tactic for serpentine. The best window for control of most *annual* invasive species that affect serpentine areas is mid-April through the end of June. The best window for control of broom is (if cutting-and-painting) late September through frost; (if flaming) early spring when the soil is saturated; or (if hand-pulling) mid to late spring before seed has set.

Rather, protecting serpentine may often mean conducting aggressive fuels reduction immediately adjacent to it (a serpentine area should not end at a wall of broom).

**Recreational and Infrastructural Considerations**

Many serpentine areas in Butte County contain naturally occurring asbestos (NOA). This can be released when people try to build trails and roads there. Minimize trailbuilding and encampments. Serpentine is usually so rich in protected rare plants that very little infrastructure can legally be permitted there anyway. Serpentine does, however, make a convenient natural firebreak. Rather than attempt to build fireline across serpentine, look for opportunities to burn adjacent areas up to the edge of the serpentine. The fire will usually simply go out at the geological transition, and most serpentine endemic plants will benefit as long as the fire is implemented in fall or early winter before mid-January. When reducing fuels on adjacent dense areas, it is tempting to use the conveniently “empty” serpentine to pile or scatter brush or wood chips. This is harmful to serpentine-adapted plant communities. Train crews never to pile any biomass on serpentine.



*Figure 25 - Two views of serpentine landscapes. Both sites were burned in the Camp Fire. The unproductive nature of the soils in serpentine environments creates natural spacing between species. This is likely why the grey pines pictured survived the high intensity burn. The bottom image shows the dramatic natural boundary between a serpentine site and a mixed oak woodland. Photo credits Cait Bell.*

SERPENTINE



*Figure 26 - A band of midslope serpentine sandwiched between black oak ponderosa pine (lower elevations visible on the steep downslope) and sierran mixed hardwood-conifer (upper elevations on the ridgetop). Photo credits Cait Bell.*

# Mixed Sierran Hardwood-Conifer (MSHC)

**How To Know It** - The District contains endless variations on this endlessly variable vegetation type (which is, of course, not quite limited to the Sierras from which it takes its name). MSHC can express itself in a range from almost pure stands of sugar pine to extremely diverse stands where Douglas fir, white fir, ponderosa, dogwood, black oak, madrone, tanoak and even yew all grow together. This diversity is partly due to the District being under the influence of the "Oroville Anomaly" – a disjunct climate and flora concentrated around Berry Creek (but spreading its wings as far north as Forest Ranch and as far south as Nevada City) full of species that otherwise are confined to the inland Pacific Northwest of California, i.e. the Klamath River mountains. The District's vigorous tanoak, madrone, and many otherwise coastal lichen species are prime examples of this. The Oroville Anomaly also attests to long-standing trade relationships between Konkow Maidu and Klamath Mountains peoples.

**Desirable Successional Endpoints** (fire regime, spacing, species presence):

There is no "endpoint" in a forest as diverse and dynamic as MSHC. Rather, it is always in flux, with some clumps of trees dying out and being reborn constantly. That said, some clumps of trees, especially in deep canyons and on north-facing slopes, will attain true old-growth status. Tanoaks aren't (only) shrubs; tanoak trees eighty feet tall, with spreading canopies that produce bushels of acorns in good years, are indicators that this community is living up to its potential.

The dynamic equilibrium that characterizes this vegetation type is mediated by fire. Managers can imitate fire effects with fire surrogates, such as small group selection. (Fire surrogates without any fire follow-up seldom repay the wildlife resilience dividends paid by burning.) High-severity fire (or its surrogate, complete tree removal) should be accepted as a normal phenomenon, but should only account for up to 15% of an overall fire area or a patch size of up to 100 acres.

MSHC should be managed using the concept of relative stand density index (rSDI). rSDI is a measure of a site's carrying capacity. At 55-60% of rSDI, stands become so dense that trees spontaneously die ("the zone of imminent mortality"). In our area, healthy stands are best maintained at 23-27% of rSDI. For most MSHC stands, this will mean a basal area of 60-150 $ft^2$/ac on south aspects and 80-200 $ft^2$/ac on north aspects.

Spatial heterogeneity is extremely important for fire resilience in MSHC. The community should be managed toward an "ICO" (individuals-clumps-openings) structure[14], especially on southern and western aspects. (North-facing aspects are the places to potentially manage for multiple canopy layers). Surface fuels will be at a minimum in a healthy MSHC stand, except on highly mesic north-facing sites, where a complex surface debris profile may develop, providing the complicated habitat forest carnivores require.

[14] An Individual is a solitary tree whose canopy touches no other canopy. A clump is a group of 2 or more trees whose canopies touch. An Opening is a gap in the canopy, preferably of at least 0.10 acre.
Historically, fire sculpted and maintained Sierra-Cascades forests in an ICO structure. By contrast, most modern forests consist of a homogeneously dense sheet of trees, and most thinned forests consist of a homogeneously not-so-dense sheet of trees. Variable density thinning is the art and science of reproducing a healthy ICO structure through mechanical intervention.

***Fire regime***

Fire returns for MSHC within the District range from 2-7 years (for stands with strong ponderosa influence) to 15 years at higher elevations on north-facing sites, where abundant Douglas-fir, sugar pine, and madrone will be found. Sites should be managed according to aspect and elevation (with shade-tolerant species such as Doug fir and true fir favored by less frequent burning on north-facing sites, and shade-intolerant species like pine and tanoak favored by frequent burning on south-facing sites). Sites with bedrock mortars probably have a history as mature black oak and/or tanoak stands, so these oaks should be promoted there.

Desired conditions are that needlecast is less than 3 inches deep (thicker accumulations will cause excessive fire intensity).

**Recommended treatments:**

- **Recovery from high-severity fire** - If possible, managers should log and remove the dead trees in year 1, while they still have value to a mill. Obviously, this is easier said than done. As salvage progresses, pile tops and slash for later burning. If snags cannot be removed and sold to a mill in the first year, they probably need to be piled and burned whole. However, it may be feasible to truck them, chipped or whole, to a biomass facility such as the soil factory in Butte Valley.

  Once snags are removed, if lots of woody debris is left on site, chipping it and spreading the chips to a MAXIMUM height of 3" is very effective at reducing brush competition and helping with moisture retention for natural regeneration or eventual planted seedlings. A chips depth of 4-6" will be impossible to plant into.

  Two springs post-fire, natural regeneration will be evident. This is the time managers can decide what species are actually missing, what trees are coming back on their own, and what species and numbers of supplemental tree seedling would be helpful. Plant seedlings in year 3 (see “herbicide” below for site preparation considerations). In the 3-5 year window post-fire, conduct hardwood release and leader training. This means to prune each surviving keeper oak, madrone and maple to its 2-5 strongest stems. At this time you can also limb up the stems to 6’. Pile and burn the prunings.

- **Recovery from fire exclusion*:*** Sites that are too densely stocked to safely burn require biomass removal first. Alternatives for this include timber harvest, hand cutting and piling (and burning the piles), or hand cutting and chipping and removing the chips (e.g. to the Butte Soil factory). A common minimum prescription is to remove dead fuels 15” DBH and less (leaving 6 snags per acre where possible), and remove live fuels 10” DBH and less.

- **Mastication** Mastication is a popular treatment because it makes a stand immediately walkable, produces an instant visual reward, and can moderate wildfire *behavior* (but without actually

improving tree survival[15]). However, it is not recommended. Since it leaves the material on site, it requires a follow-up entry, while usually delaying the reintroduction of fire longer than other tactics would. Fuels can be reduced more cost-effectively through other tactics, such as cut and pile + pile-burn; cut and chip + haul; timber harvest + machine-pile biomass +pile-burn, etc. All these would allow a faster journey to reintroduction of low-intensity fire, which is the treatment that results in the best stand survival outcomes post-wildfire[16].

Underburning mastication is difficult, spotty, and can be unattainable/unadvisable for many landowners. The reason it is risky to follow mastication with fire is because the fuelbed is so deep, and contains so much energy, that burning it may kill the trees in a stand by cooking their roots. This can happen when the masticated fuelbed is very dry and it can also happen when it is quite wet. (That is because even though damp fuels burn with less heat, water holds heat longer than air). We have burned in a few stands that were masticated 2 years prior with good results, but we have seen many more stands where mastication rendered the stand un-burnable for 3, 4, 5, or even 7 years – a disastrous outcome.

If mastication is absolutely desired, then at a minimum, a mastication prescription should insist that no pieces are left larger than 2" in diameter and soil disturbance should be no deeper than 1-4". A rolling drum masticator head is more likely to produce these outcomes[17]. We have visited some recently masticated units in Forest Ranch that appeared potentially underburnable within 1 to 2 seasons, and they used these specifications.

A small unit should be masticated first so managers can assess the size and depth of material left behind. Mastication outcomes are unacceptable if material looks like it won't break down to the point of carrying a low-intensity underburn in 2 (maximum) wet seasons. Use machinery buffers of 50-100' around riparian areas.

- **Herbicide** If a site experiences prodigious brush growth that will be in strong competition with tree seedlings or will exclude beneficial fire as a tool, then managers can opt for *one or more of* the following:

    - Pre-emergent herbicide (soil-based) can be applied immediately after fire (but that will kill potential desired seedlings in the seedbank too).
    - Foliar applications can be sprayed on brush grown back within the first 3 years, either before planting, after planting (requires applicators to have shield for seedlings), or both. This can be followed/mixed with a pre-emergent herbicide ***if*** grass or annual forbs are anticipated to be a strong competitor.
    - Wait until seedlings are planted and then apply a targeted 7-10' circle around each seedling (7 feet minimum). This allows for brush reduction without a large blanket application of

[15] Knapp et al 2011.
[16] Davis et al. 2024. Ryan Bauer personal communication post-Dixie Fire. Brodie et al 2024.
[17] Thanks to Sarah Jo McDowell at the Butte County Fire Safe Council for sharing specifications used in their most recent mastication project (at time of this writing) on Doe Mill Ridge in spring 2025.

herbicide.

- **Underburning:** Fall or early winter burning is recommended to consume shade-tolerant seedlings (e.g. incense cedar) and reduce surface fuel loading. Thin to create an ICO structure, with rocky areas prioritized for openings. Use a spacing of 25' - 35' between trees but tolerate and encourage variability (a stand with clumps and openings is more resilient than a stand of perfectly evenly spaced trees).

  If burning on the hot end of prescriptions, it may be necessary to ring madrones and tanoaks.

**Indicators Of Success:** Large flocks of pigeons use the woods. Tanoaks and madrones are large trees, with enough space to fulfill their canopy potential, and they regularly fruit. A diversity of rodents are seen. Forest carnivores such as marten and fisher may be in evidence. Abundant and diverse woodpeckers are seen. Abundant mushrooms are seen, particularly those associated with hardwoods (e.g., matsutake, Armillaria, and Morchella). Understory flowering plants are seen and include at least two of the following: *Ligusticum, Fritillaria*, *Asarum*, *Rubus* (native spp.), *Prunus, Ribes, Corylus*, *Sambucus,* and *Dicentra*. *Festuca californica* is common. *Trientialis latifolia* is seen in shady spots but is not usually the most common understory plant. Dogwood is present and increasing.

**Maintenance** (scheduling; cost estimates): ***For example budgets, see Appendix, Table A-8***.

Hand cut and piling costs $2000 - $3,000/acre and is usually a necessary first-entry. After that, unless the stand is maintained with broadcast fire, the hand-cut-and-pile (and pile burning) must be repeated every 5-15 years.

If ladder fuel loading is light enough (usually, under 6T/ac), then it can be lopped-and-scattered. Lop and Scatter costs $650-1500/acre and (similar to mastication) only rearranges fuels; however, it will carry beneficial fire sooner than mastication.

Mastication costs $1500-2500/acre but is less cost-effective (long-lasting) a treatment than hand cut and piling or chip-and-hauling.

Herbicide costs $200-$500/acre.

Post-fire snag removal, decking and hauling away can easily cost $4,000-6,500/acre.

Planting conifer seedlings costs $80-150/acre, exclusive of the cost of seedlings ($.80$1.50/seedling, so an additional $88-315 per acre). Hardwoods usually don't need to be replanted, but when they do, they normally cost more ($4-9/tree).

Prescribed fire costs are paid by the day and scale dramatically based on the acreage, but a 10-

acre burn in Magalia would cost $200-1000/acre.

In MSHC, to meet fire returns, maintenance burns would be conducted every 5-15 years and would have the following objectives[18]: 80-90% reduction in 1-hr fuels (e.g. needlecast); 40-70% reduction each in 10-hr and 100-hr downed fuels; 20-30% consumption of 1000-hr fuels; 95-100% mortality in trees 6" dbh and under; minimize scorch mortality (10% or less) to mature oaks and pines over 12" dbh, by ringing large trees that have basal cavities. Trees between 6" and 12" dbh are unlikely to be killed by fire at the prescriptions normally used in controlled fire within the District, unless it is a larger landscape-scale prescribed fire. Trees of this intermediate size, if overstocked, should be removed mechanically.

Duff layer: The duff layer is seldom used as a metric for Rx burn objectives because under the cool prescriptions that are normally used in prescribed fire, duff is unavailable to burn. As a rule of thumb, if the moisture content of the duff is 30% or below, then the duff will be consumed. (Prescribed fires are seldom conducted when duff is that dry.) If the moisture content of the duff is over 120%, then the duff is too wet to ignite. (But it may burn if it is under particularly heavy fuel loading, such as masticated fuels.) In between those limits, duff could burn or not, depending on adjacent fuels. Under 2" of duff is considered low risk (in terms of promoting aggressive fire behavior). 2-5" of duff requires careful consideration. If duff levels are deeper than 5", the unit is considered high risk for total consumption during a wildfire.

**Recreational and Infrastructural Considerations:**

Much of the District's MSHC is on red, clay loam soils. While these are relatively resistant to erosion (at least compared to some soils in the County such as decomposed granite soils), they present special drainage considerations for trails, parking lots and other infrastructure.

[18] These objectives were suggested by a California State Certified burn boss (CARx) who was asked to consider a maintenance burn conducted every 7 years at Paradise Lake, without any intervening thinning.



*Figure 27 - A ridgetop MSHC ecosystem, with a mixture of ponderosa pine, incense cedar, tan oak, and Douglas-fir. Photo credit Cait Bell.*




*Figure 28 - Typical of most MSHC sites, this residential area in Magalia has a very dense mix of pines, doug fir, incense cedar, and black oak interspersed with city infrastructure. Thinning this dense stand to 23-27% rSDI would improve forest health and public safety, and would change the aesthetic of the neighborhood.*

*Photo credit Cait Bell.*




*Figure 29 - On sites like the one above, broadcast burning can be introduced with little or no prep work. Ladder fuels aren't posing an excessive threat to the overstory, and a layer of leaf litter and duff would carry healthy low intensity fire. The plan would likely have an objective of consuming 80-90% of the 1-hr fuels, 40-70% reduction each in 10-hr and 100-hr downed fuels; 20-30% consumption of 1000-hr fuels, and 95-100% mortality in trees 6" dbh and under. The fire would leave some standing dead trees, which is to be expected and accepted. These would be consumed by successive Rx fires. Photo credit Wolfy Rougle.*



*Figure 30 – Above, a severely burned MSHC landscape in Concow. Hardwoods are vigorously resprouting. A good prescription for this site might be to cut most standing dead trees, remove or burn them, leader-train the oaks in year 3-5 after fire (cutting and piling shrubs at the same time) and then replant conifers if desired the following year, after burning the piles. Photo credit Cait Bell.*

*Figure 31 - On sites like the one below, mechanical thinning would be a recommended treatment before entry with fire. Treatment would focus on removing (or at least piling) the thick shrub growth to reduce the risk of ladder fuels leading to torching in the overstory. Most snags would probably be felled prior to ignition, but those in the interior of the unit may be left standing under some prescriptions. Photo credit Wolfy Rougle.*





*Figure 32 - A MSHC landscape 2 years post mastication. Overstory cover remains thicker than desired, but the treatment was unusually well designed and successfully readied understory fuels for broadcast burning. Photo credit Cait Bell.*

# 3.) Risk Reduction Incentives

To minimize the possibility that nearby land uses undermine the health of PRPD- managed lands and/or the effectiveness of Resilience Parks, the District seeks to incentivize neighbors to pursue best land management practices. Incentives could include:

***Easements:*** Neighboring landowners could receive a one-time or ongoing payment to allow trails or other public uses across their land.

Neighboring landowners could also receive a one-time payment to install firewise landscaping that goes above and beyond the code requirements in that specific location. (For example, replacing eucalyptus, ornamental cypress/juniper, oleander, and wooden decks/pathways, with e.g. willow, redbud, buckeye, and stone.)

***Beneficial fire technical assistance:***
Increasing the scale of prescribed burning will lead to more landscape level risk reduction in wildfire. When conducted at a meaningful scale, prescribed fire creates broader buffers of treated land that protects nearby communities and infrastructure. Burn planning should focus on including multiple landowners with abutting property boundaries to create these buffers.

Many landowners within the District are actually very receptive or even eager to apply beneficial fire to their lands. At the time of this writing, broadcast burning is legal in Paradise but only on units of greater than 5 acres. The units can be owned by one or multiple ownerships.

In the Town of Paradise, the District could create agreements allowing multiple adjacent landowners, each of whom may have less than 5 acres, to conduct one large burn including District lands or easements. Furthermore, the District could fund CARx/Prescribed Burn Association assistance to neighboring landowners willing to burn. Pursuant to SB 310, in most cases this funding could also be directed to technical assistance for a cultural burn boss if the landowner either a) is Indigenous or b) signs an access agreement affirmatively inviting Tribal members to return and harvest materials.

***Insurance*** Insurance availability in fire prone areas has become a significant financial barrier for landowners, with some areas being cut off completely or seeing astronomically high premiums. Insurers are increasingly recognizing wildfire risk reduction treatments as qualifying areas for lower premiums and greater availability of coverage. Indeed, a major rationale for the BRIC project is to reduce insurance premiums for all residents of Paradise. Perhaps the District could work with insurers to persuade them to offer particularly low rates to PRPD-adjacent landowners who participate in cross-boundary stewardship. Or, if the PRPD enjoys low insurance premiums as a result of its good fuels management, is there the potential to offer neighbors who adopt the same fuels management prescriptions certificates naming them as additional insureds under PRPD’s policy?

# 4.) Environmental Compliance Considerations

***CEQA*** As a California Special District, PRPD is a lead agency under the California Environmental Quality Act (CEQA), and therefore can prepare its own CEQA documentation. Several existing forest health CEQA documents are also active in PRPD's footprint. These can potentially be utilized by PRPD (or any other implementing agency with control of land inside the document footprint), assuming the treatments authorized in the document are treatments PRPD desires to carry out on a given property. For example, the Concow/Yankee Hill Fuels Reduction NOE, the Upper Ridge Fuels Reduction NOE, and the Paradise Vegetation Management MND. The geographic footprint covered by each document can be viewed on this interactive map hosted on the Butte County Collaborative Group (BCCG) hub site. For the NOEs, a checklist must be obtained and followed to ensure compliance with the project description. This checklist was unavailable on the County of Butte environmental documents page at the time of writing, so contact Taylor Nilsson, executive director of the Butte County Fire Safe Council, to obtain a copy. Utilizing these documents is cost-free. Most activities in this plan, with the exception of process-based restoration, can be achieved with no additional permitting besides CEQA. Burn projects will also require permits from Butte County Air Quality Management District and (depending on season and geography) CAL FIRE.

***Lake and streambed alteration*** Projects that place material into a lake or streambed or substantially alter riparian habitat may need a Lake and Streambed Alteration Agreement (an LSAA or sometimes known as "a 1600 permit"). These agreements are developed between an agency and CDFW. An agreement can be for a single project or can cover all the activities a District will carry out over 5 years. These agreements range in cost from several hundred dollars up to $15,000 (in 2025), payable to CDFW.

***Endangered species*** Many listed species can be spared from impact by timing fuels reduction activities (e.g., burning in the fall). For work in and around streams where rare species may be present (for example, the Foothill Yellow-Legged Frog), CDFW's Restoration Management Permit combines an LSAA permit with take authorizations of CA listed and fully protected animals and rare plants. For Federally listed species, USFWS offers a programmatic biological opinion for restoration activities. Restoration project managers can apply to have their project consultation streamlined under this biological opinion – often receiving a notice to proceed within a week or two – by working through an application in checklist format.

***Clean Water Act 404/401*** Placing material into a watercourse also triggers permitting requirements from the U.S. Army Corps of Engineers under **section 404** of the Clean Water Act. Such permits are free but take a long time and trigger new Tribal consultation requirements (i.e., government-to-government consultation originating from the U.S.A.C.E.), even for projects that have already completed Tribal consultation.

Separately, **section 401 compliance** is managed by the state Water Boards. (PRPD's is the Central Valley Regional Water Quality Control Board, or CVRWQCB). Projects that expose soil or place material in waterways likely need to apply for a Water Board permit, which comes with a cost of several hundred to several thousand dollars.

# Further Resources

***Beaver Coexistence:***

https://oaec.org/projects/california-beaver-coexistence-training-and-support-program/

Strategies and technologies to reduce beaver-human conflicts: https://oaec.org/our-work/waterinstitute/beaver-home/got-beaver-problems/

For customized or site-specific technical assistance, land managers can contact Grey Hayes, Program Manager, WATER Institute, Occidental Arts & Ecology Center.

(707) 874-1557 X133; grey@oaec.org

***Environmental compliance:***

The Accelerating Restoration website is the best source for keeping up-to-date on permitting pathways and environmental compliance streamlining in California.

***Rx fire:***

The best resource is the rich local knowledge of Butte County's experienced fire practitioners.

Butte County has the most state-certified burn bosses (CARx) per capita of any county in the state. The Butte PBA has been teaching and assisting ordinary people to burn on one anothers' land since 2019 (and maintains a library of burn plans that, by now, is rich enough to be adapted for almost any property in the county). The Big Chico Creek Ecological Reserve has trained scores of Wildland Management masters' students, all of whom graduate with prescribed fire experience. Five Butte Cal-TREXes from 2020-25 have trained hundreds of local residents in fire science, practice, and culture, and more Cal-TREXes are planned. The Butte County Fire Safe Council is one of the most active in the state and conducts thousands of acres of treatment a year, primarily mastication and grazing, providing managers the ability to draw conclusions over time about the longevity and effectiveness of these tactics. And of course, the landscapes of "the Paradise Recreation and Parks District" have been managed with fire by Maidu people since time immemorial. PRPD has a history of actively collaborating with local Tribes on (for example) education and art, a collaboration which is only expected to strengthen over time.

Beneficial fire knowledge is best found in unwritten form! However, if a document citation is needed, the Placer PBA's Rx Fire Field Guide is a serviceable land manager education tool that provides a framework to guide discussions on prescribed burning between natural resource management agencies and private landowners. In particular, it assists landowners to classify prescribed burn units as Low, Moderate, or High Complexity and offers methods for minimizing risks and hazard abatement.

# References and Acknowledgements

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**Butte County Resource Conservation District Staff**

Wolfy Rougle (Planning and Watershed Program Manager) provided the primary source of information surrounding vegetation management across various landscapes and geographies within this plan.

Cait Bell (Forestry Technician) led the GIS and photography initiatives, as well as draft design and plan writing support.

Dallas Koller (Fire Program Manager, California State-Certified Burn Boss (CARx)) provided insights on prescriptions & objectives for prescribed fire, as well as recommended treatments for vegetation management for safe and effective burning practices.

Julia Sidman (Forestry Program Manager) provided document review and recommendations on effective treatments across various vegetation types to meet fuels density needs, cost estimations, and maintenance requirements.

Thad Walker (District Manager) provided administrative support and document review.

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Table A-1: Approximate treatment costs per vegetation type in 2025. Treatments **vary widely** in the magnitude or duration of their fuels reduction effect. (For instance, grazing's or mastication's effect may last 1 year, while the effect of a chip & haul treatment can last 3-7.

| | Blue Oak woodland | Mixed Oak Woodland | Foothill Riparian | Upland Mix: True Oak-Chaparral Mixture | Black Oak-Ponderosa Pine | Serpentine | Mixed Sierran Hardwood Conifer |
|---|---|---|---|---|---|---|---|
| **Chipping and hauling** | **N/A** | **N/A** | **N/A** | $1650-$2000/ac | $1650-$2000/ac | **N/A** | $1650-$2000/ac |
| **Grazing** | $-20 - $400 per acre | $-20 -$600 per acre | **N/A** | $400-$600 per acre | **N/A** | **N/A** | **N/A** |
| **Hand cut and pile** | $1,600-$2,500/ acre | $2,000-$3,000/ acre | $2,000-$3,000/ acre | $2,000-$3,000 per acre | $900-$3,000 per acre | **N/A** | $900-$3,000 per acre |
| **Hardwood release/ leader training** | $400-$500/ac (assumes no shrub removal) | $400-$500/ac (assumes no shrub removal) | $400-$500/ac (assumes no shrub removal) | $400-$500/ac (assumes no shrub removal) | $400-$500/ac (assumes no shrub removal) | **N/A** | $400-$500/ac (assumes no shrub removal) |
| **Herbicide** | $200-$400 per acre | $200-$400 per acre | $200-$400 per acre | $200-$300, up to $1000 per acre | $200-$300 per acre, up to $1000 per acre for reforestation prep | **N/A** | $200-$300 per acre, up to $1000 per acre for reforestation prep |
| **Lop and Scatter** | $650-$1,500 per acre | $650-$1,500 per acre | $650-$1,500 per acre | $650-$1,500 per acre | $650-$1,500 per acre | **N/A** | $650-$1,500 per acre |
| **Mastication** | **N/A** | **N/A** | **N/A** | $1500-$2500 /ac | $1,500-$2,500 /ac | **N/A** | $1,500-$2,500 / ac |
| **Planting (*excludes cost of site prep/ release*)** | $80-$150 per acre, plus $4-$6 per seedling | $80-$150 per acre, plus $4-$6 per seedling | $80-$150 per acre, plus $4-$10 per seedling | **N/A** | $80-$150 per acre, $.80-$1.50 per seedling | **N/A** | $80-$150 per acre, $.80-$1.50 per seedling |
| **Post-Fire Dead Tree Removal** | [when needed due to hazard, cost is per tree] | [when needed due to hazard, cost is per tree] | [when needed due to hazard, cost is per tree] | [when needed due to hazard, cost is per tree] | $4,000-$6,500 per acre | **N/A** | $4000-$6,500 per acre |
| **Timber Harvest** | **N/A** | **N/A** | **N/A** | **N/A** | ~$0-$800 profit per acre | **N/A** | ~$0-$800 profit per acre |
| **Process-based restoration** | $200-$1000 per structure | $200-$1000 per structure | $200-$1000 /structure | $200-$1000 per structure | $200-$1000 per structure | **N/A** | $200-$1000 per structure |
| **Prescribed fire** | $100-$500 per acre | $100-$500 per acre | incidental | $500-$900 per acre | $100-$900 per acre | **N/A** | $500-$900 per acre |

Table A-2: Blue Oak Woodland/Savannah treatment cost examples for first 15 years

| | Treatment (Year) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heavy Fuel Loading** *Total over 15 years = $4,100/ac* | Lop and Scatter | 1500 | | | | | | | | | | | | | | |
| | Graze | | 200 | | | 200 | | | 200 | | | 200 | | | 200 | |
| | Underburn | 400 | | | 300 | | | 300 | | | 300 | | | 300 | | |
| **Moderate Fuel Loading** *Total over 15 years = $3,000/ac* | Graze | 300 | | | 200 | | | 200 | | | 200 | | | 200 | | |
| | Underburn | | 400 | 300 | | | 300 | | | 300 | | | 300 | | | 300 |
| **Light Fuel Loading** Includes all savannah sites *Total over 15 years = $3,000/ac* | Graze | 300 | | | 200 | | | 200 | | | 200 | | | 200 | | |
| | Underburn | | 400 | 300 | | | 300 | | | 300 | | | 300 | | | 300 |
| **Post High Severity Fire** *Total over 15 years= $4,300* | Hazard Tree Removal | 1000 | | | | | | | | | | | | | | |
| | Hardwood Release/Leader Training | | | | 2000 | | | | | | | | | | | |
| *It may be possible to resume grazing in year 16 to 20, or year 5 if blue oak resprouts are well caged. | Underburn* | | | | | | 400 | | | 300 | | | 300 | | | 300 |

Table A-3: Mixed Oak Woodland treatment cost examples for first 15 years

| | Treatment (Year) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heavy Fuel Loading** *Total over 15 years = $4,600/ac (Assumes piles can be built such that first year's underburn will also burn the piles.)* | Hand Cut and Pile | 2000 | | | | | | | | | | | | | | |
| | Lop and Scatter | | | | | | | | | | | | | | | |
| | Graze | | 200 | | | 200 | | | 200 | | | 200 | | | 200 | |
| | Underburn | 400 | | | 300 | | | 300 | | | 300 | | | 300 | | |
| **Moderate Fuel Loading** *Total over 15 years = $4,100/ac* | Lop and Scatter | 1500 | | | | | | | | | | | | | | |
| | Graze | | 200 | | | 200 | | | 200 | | | 200 | | | 200 | |
| | Underburn | 400 | | | 300 | | | 300 | | | 300 | | | 300 | | |
| **Light Fuel Loading** *Total over 15 years = $3,000/ac* | Graze | 300 | | | 200 | | | 200 | | | 200 | | | 200 | | |
| | Underburn | | 400 | 300 | | | 300 | | | 300 | | | 300 | | | 300 |
| **Post High Severity Fire** *Total over 15 years= $4,300* | Hazard Tree Removal | 1000 | | | | | | | | | | | | | | |
| | Hardwood Release/Leader Training | | | | 2000 | | | | | | | | | | | |
| *It may be possible to resume grazing in year 16 to 20, or year 5 if blue oak resprouts are well caged. | Underburn* | | | | | | 400 | | | 300 | | | 300 | | | 300 |

Table A-4: Foothill Riparian treatment cost examples for first 15 years

| | Treatment (Year) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heavy Fuel Loading** *Total over 15 years = $6,000/ac* | Hand Cut, Pull out of Riparian area, Pile and Burn | 3400 | | | | | | | | | | | | | | |
| | Herbicide (cut-and-paint with aquatic labeled chemical) | | 900 | | | | | | | | 900 | | | | | |
| | Hand-pulling | | | 400 | | | | | | | | | | | | |
| | Underburn | | | | | 200 | | | | | 200 | | | | | |
| **Moderate Fuel Loading** *Total over 15 years = $2,000/ac* | Herbicide (cut-and-paint with aquatic labeled chemical) | 900 | | | | | | | | | | | | | | |
| | Hand-pulling | | 300 | | | | | | | | | | | | | |
| | Underburn | 200 | | | | | | | | | 300 | | | | | 300 |
| **Light Fuel loading** *Total over 15 years = $1,700/ac* | Herbicide (cut-and-paint with aquatic labeled chemical) | 800 | | | | | | | | | | | | | | |
| | Hand-pulling | | 200 | | | | | | | | | | | | | |
| | Underburn | 200 | | | | | | | | | 300 | | | | | 200 |
| **Post High Severity Fire** *Total over 15 years= $4,600* | Snag Removal (only if threatening trail or infrastructure) | 1500 | | | | | | | | | | | | | | |
| | Herbicide (cut-and-paint with aquatic labeled chemical) | 900 | 600 | | | | | | | | | | | | | |
| | Hand-pulling | | 300 | 300 | | | | | | | | | | | | |
| | Underburn | | 400 | 200 | | | | | 200 | | | | | | | 200 |

Table A-5: Upland Mix (True Oak-Chaparral Mixture) treatment cost examples for first 15 years

| | Treatment (Year) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heavy Fuel Loading** *Total over 15 years = $6,200/ac* | Hand Cut and Pile | | | | | | 2000 | | | | | 2000 | | | | |
| | Pile Burn | | 400 | | | | | 400 | | | | | 400 | | | |
| | Lop and Scatter | | | | | | | | | | | | | | | |
| | Grapple-Pile | 1000 | | | | | | | | | | | | | | |
| | Underburn | | | | | | | | | | | | | | | |
| **Moderate Fuel Loading** *Total over 15 years = $6,900/ac* | Lop and scatter | 1500 | | | | 1200 | | | | 1200 | | | | 1000 | | |
| | Underburn | 600 | | | | 500 | | | | 500 | | | | 400 | | |
| **Light Fuel loading** *Total over 15 years = $5,200/ac* | Lop and scatter | 1400 | | | | | | 1200 | | | | | | 1200 | | |
| | Underburn | 500 | | | | | | 500 | | | | | | 400 | | |
| **Post High Severity Fire** *Total over 15 years= $4,300* | Hand Cut and Pile w Pile Burn | | | | | | | | | | 2400 | | | | | |
| | Herbicide | | 900 | | | | | | | | | | | | | |
| | Hardwood Release/Leader Training | | | | 1000 | | | | | | | | | | | |

Table A-6: Black Oak-Ponderosa Pine treatment cost examples for first 15 years

| | Treatment (Year) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heavy Fuel Loading** *Total over 15 years = $5,600/ac* | Hand Cut and Pile | 3000 | | | | | | | | | | | | | | |
| | Pile Burn | 400 | | | | | | | | | | | | | | |
| | Lop and Scatter | | | | 1200 | | | | | | | | | | | |
| | Masticate | | | | | | | | | | | | | | | |
| | Underburn | | | | | 400 | | | 200 | | | 200 | | | 200 | |
| **Moderate Fuel Loading** *Total over 15 years = $2,700/ac* | Lop and scatter | 1500 | | | | | | | | | | | | | | |
| | Underburn | 400 | | | 200 | | | 200 | | | 200 | | | 200 | | |
| **Light Fuel loading** *Total over 15 years = $1,000/ac* | Underburn | 200 | | | 200 | | | 200 | | | 200 | | | 200 | | |
| **Post High Severity Fire** *Total over 15 years= $9,900* | Snag Removal | 4000 | | | | | | | | | | | | | | |
| | Hardwood Release/Leader Training w/ pile burn | | | | 2600 | | | | | | | | | | | |
| | Replanting | | | | | 400 | | | | | | | | | | |
| | Maintenance hand-cut-and-pile burn | | | | | | | | | 2600 | | | | | | |
| *Regular underburning can resume underburning in year 10 post-fire and follow up every 3rd year thereafter. | Underburning | | | | | | | | | | | | | | | 300 |

Table A-7: Serpentine treatment cost examples for first 15 years:

| | Treatment (Year) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heavy Fuel Loading** *(These situations are rare and usually caused by Scotch broom.)* *Total to resolve a heavy fuel loading situation on serpentine: $5,100/ac* | Hand Cut and Pile (pile outside serpentine) | 3000 | | | | | | | | | | | | | | |
| | Pile Burn | 400 | | | | | | | | | | | | | | |
| | Herbicide (only if invasives are present) | 400 | 900 | | | | | | | | | | | | | |
| | Flaming (of invasives seedlings if applicable) | | 200 | 200 | | | | | | | | | | | | |
| **Moderate Fuel Loading** *Total = $2,200/ac* | Herbicide (only if invasives are present; assumes lop&scatter&cut&paint) | 900 | 900 | | | | | | | | | | | | | |
| | Flaming (of invasives seedlings if applicable) | | 200 | 200 | | | | | | | | | | | | |
| **Light Fuel loading** *Total over 15 years = $0/ac* | Monitor, and do nothing unless invasives encroach i.e. fuel loading becomes “moderate”. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **Post High Severity Fire** *(These situations are rare. Don’t assume a serpentine site even needs treatment post-high severity fire, unless it becomes heavily encroached by broom or brush. Consult a botanist.)* *Total over 15 years= $0 - $5,300* | Hand Cut and Pile (pile outside serpentine) | | | 3000 | | | | | | | | | | | | |
| | Pile Burn | | | 400 | | | | | | | | | | | | |
| | Herbicide (only if invasives are present) | | | 400 | 900 | | | | | | | | | | | |
| | Flaming (of invasives seedlings if applicable) | | 200 | | 200 | 200 | | | | | | | | | | |

Table A-8: Mixed Sierran Hardwood-Conifer treatment cost examples for first 15 years

| | Treatment (Year) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heavy Fuel Loading** *Total over 15 years = $2,800/ac* | Hand Cut and Pile | 3000 | | | | | | | | | | | | | | |
| | Pile Burn | 400 | | | | | | | | | | | | | | |
| | Lop and Scatter | | | | | | | | | | | | | | | |
| | Masticate | | | | | | | | | | | | | | | |
| | Underburn | | | | | 600 | | | | | 600 | | | | | 600 |
| **Moderate Fuel Loading** *Total over 15 years = $2,800/ac* | Lop and scatter | 1500 | | | | | | | | | | | | | | |
| | Underburn | 600 | | | | 600 | | | | | 600 | | | | | 600 |
| **Light Fuel loading** *Total over 15 years = $2,800/ac* | Underburn | 1000 | | | | | 600 | | | | 600 | | | | | 600 |
| **Post High Severity Fire** *Total over 15 years= $13,100* *It may be possible to resume underburning in year 16 to 20. | Snag Removal | 6500 | | | | | | | | | | | | | | |
| | Herbicide | | | 400 | | | | | | | | | | | | |
| | Hardwood Release/Leader Training | | | | 2000 | | | | | | | | | | | |
| | Conifer Replanting | | | | 400 | | | | | | | | | | | |
| | Herbicide Release | | | | | 400 | | | | | | | | | | |
| | Maintenance hand-cut-and-pile burn | | | | | | | | | | 3400 | | | | | |