OAK WOODLAND RESTORATION POTENTIAL: PLACER COUNTY CONSERVATION PLAN

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Abstract: The Placer County Conservation Plan (PCCP) would provide for acquisition and management of oak woodland in a portion of a 24,000 acre area in the Sierra Nevada foothills. Current conditions and land relationship to existing reserves define opportunities for oak woodland restoration. This study suggests a practical restoration goal of 1000 acres, mainly for blue oak, and secondarily for black oak and valley oak. Oak restoration techniques include some level of seedling protection and may variously involve acorn or container planting and optional irrigation. Costs for oak woodland restoration are similarly variable. The reasonable range of costs to use for estimating expenditures over the life of the PCCP is between $3,000 and $30,000/acre.

INTRODUCTION

The Placer County Conservation Plan (PCCP) sets conservation goals for unincorporated western Placer County and the City of Lincoln. The Foothills Plan subarea comprises 109,000 acres and extends from roughly the 200 foot contour and the edge of the Lincoln planning area east to Highway 49. Within the Foothills subarea, there are 6,000 acres mainly in the Bear River and Coon Creek watersheds now in existing reserves (EXR) managed primarily for conservation. The PCCP designates 24,000 additional acres as Reserve Acquisition Area (RAA) to show where future conservation under the Plan may occur. The Plan conservation strategy foresees a possible additional 10,000 to 15,000 acres of reserve lands.

The importance of oak woodland as wildlife habitat is well established: future reserve acquisition in the Foothills will emphasize preservation, management, and restoration potential for oak woodland.

The oak woodland within the RAA and the Plan area varies in condition and conservation status. Some oak woodland is already within conservation reserves owned and managed by the county, Placer Land Trust and other entities. Whether within or outside an existing reserve, the condition of oak woodland may range from relatively intact to severely impacted. Condition refers to the state of the woodland in comparison to a state in which species composition, density and canopy cover are commensurate with the ecological potential of the site.

In addition to sites that currently support oak woodland, there are sites within the RAA and existing conservation reserves that could support oak woodland but have been cleared, affected by wild fire or otherwise altered by past and present management. These sites represent potential locations for oak woodland restoration.

The objective of this study is to identify general opportunities for oak woodland restoration for inclusion in the PCCP Foothills conservation strategy. As discussed below, there are three oak dominated vegetation types targeted for restoration. It is not the intent to develop actual restoration plans, but rather to show the approximate scope and location of restoration that may be undertaken during plan implementation. There is no specific plan to acquire any of the examples used in this study. The study follows these steps:

1. Quantify the extent of existing oak woodland in the Foothills RAA.
2. Determine the amount of each oak woodland type in existing reserves that are within or contiguous to the Foothills RAA delineated in the Plan.
3. Examine relationships between the oak woodland types and Natural Resources Conservation Service (NRCS) ecological site classes mapped for the Plan area.
4. Identify areas with ecological site conditions suitable for restoring oak woodland types but without oak woodland at present.
5. Apply geographic constraints to narrow the range of potential restoration sites.
6. Describe restoration reference conditions for each oak woodland type.
7. Determine restoration prescriptions for the three oak woodland types.
8. Estimate the costs of management and restoration of oak woodlands.

EXISTING OAK WOODLAND AND WOODLAND-SOIL ASSOCIATIONS

Methods

Data available for this project include:

1. The Placer County Natural Resources Report (Jones and Stokes 2004) which includes a mapping of Placer Wildlife Habitat Relationships (PWHR) habitat types for the PCCP planning area[1].
2. The Placer County Oak Management Plan[2].
3. California Department of Fish and Wildlife (formerly Department of Fish and Game; referred to hereafter as DFW) classification and mapping of the vegetation of Placer County (Klein et al. 2007)[3].
4. The Natural Resources Conservation Service Soil Survey Geographic Database (SSURGO) soil-landform mapping and descriptions for Placer County[4]
5. PCCP planning area mapping of the Foothills RAA, the potential growth area, and existing conservation reserves.

The PCCP conservation strategy identifies three main natural community targets in the Foothills: 1) Oak Woodland, which includes the PWHR classes Blue Oak Woodland, Mixed Oak Woodland, Oak-Foothill Pine Woodland, and Oak Woodland-Savanna; 2) Valley Oak Woodland; and 3) Valley Foothill Riparian Woodland. The analysis of

[1] Available from the Placer County Planning Department.
[2] http://www.placer.ca.gov/Departments/CommunityDevelopment/Planning/PCCP/BackgroundData/OakWoodlands.aspx
[3] http://www.dfg.ca.gov/biogeodata/vegcamp/veg_classification_reports_maps.asp
[4] http://soildatamart.nrcs.usda.gov

restoration potential presented here pertains to oak woodland and valley oak woodland and does not include Valley Foothill Riparian Woodland. The Placer County Natural Resources Report and Oak Management Plan provide summary statistics and general descriptions for these PWHR types. The mapping included with the Natural Resources Report was done entirely with aerial photographs and there are no accompanying stand-level statistics. The Natural Resources Report provides a broad classification of natural communities and maps the urban, suburban and altered landscape so as to be able to predict future land conversion effects.

DFW mapping was done using aerial photographs but included the collection of extensive field data to verify the mapping and provide statistical descriptions of the vegetation types. Vegetation was classified floristically and the vegetation types represent suites of species that occur together. Vegetation type is typically mapped at the alliance level, based on the vegetation classification and keys provided by DFW. The vegetation classification is based on the 2009 edition of the Manual of California Vegetation (MCV) and is in alignment with the National Vegetation Classification System (NVCS). The DFW GIS data includes classification of the floristic map units under several systems, including California Wildlife Habitats Relationships Program (CWHR). The attributes for each polygon dominated by hardwoods include the hardwood alliance type and the percent cover of hardwoods. This allows direct assessment of the main oak species which will be the primary focus of restoration. This study uses the DFW GIS field “MAPUNIT” as its primary vegetation information source.

The DFW oak alliance vegetation types can be exactly cross-walked to CWHR. The DFW vegetation types can only be roughly cross-walked to PWHR types. The blue oak vegetation alliance occurring in the Plan area contributes to four PWHR types (Blue Oak Woodland, Mixed Oak Woodland, Oak-Foothill Pine Woodland, and Oak Woodland-Savanna). There are two PWHR types “oak woodland savanna” and “rural residential forest” that are classified mainly as grassland by DFW. This is because the tree cover there does not reach the approximately 10 percent density threshold under the DFW system to qualify as woodland. Grassland with scattered trees generally represents areas where oak woodland may have formerly existed but where clearance has occurred to increase range production or for other reasons.

SSURGO mapped data were also obtained through aerial photograph analysis with limited field verification. Mapped soils are described on the basis of “typical pedons” located at documented sites. The mapping units are classified into soil-landform (slope class) units e.g., Auburn silt loam, 2-30 percent slope. Soil descriptions are available at http://soils.usda.gov/technical/classification/osd/index.html.

Placer County Community Development/Resource Agency Planning Division staff performed the following analysis:

1. DFW mapping was used to determine the extent of oak woodland within existing conservation reserves or the RAA:
    a. Blue oak (*Quercus douglasii*) alliance (Blue Oak CWHR)
    b. Black oak (*Quercus kelloggii*) alliance (Montane Hardwood CWHR)
    c. Valley oak (*Quercus lobata*) alliance (Valley Oak Woodland CWHR)

2. DFW vegetation mapping was overlain with SSURGO soil-landform mapping to enable evaluation of associations between soil-landform units and vegetation types.

Results

Within the Foothills RAA DFW mapped 8446 acres of blue oak communities, 99 acres of black oak communities and 1118 acres of valley oak communities. Within the PCCP Foothills as a whole including some land below 200 feet in elevation DFW mapped 22,449 acres of blue oak, 1102 acres of black oak and 3765 acres of valley oak communities.

There are 14 conservation reserves presently within or contiguous to the delineated boundaries of the Foothills RAA. Within these, DFW mapped 3292 acres of blue oak, 41 acres of black oak and 101 acres of valley oak.

When the DFW mapping was overlain with SSURGO mapping some patterns emerged. These patterns must be interpreted with some caution since they are not statistically determined.

Nearly 68 percent of blue oak communities within the Foothills RAA are found on the following three soil-landform units:

- Auburn silt loam, 2-15 percent slopes (1125 acres; 13 percent of all blue oak)
- Auburn-rock outcrop complex, 2-30 percent slopes (2824 acres; 33 percent of all blue oak)
- Auburn-Sobrante-rock outcrop complex, 2-30 percent slopes (1762 acres; 21 percent of all blue oak)

Of all the other mapped soil-landforms, only two had more than eight percent of the total area of blue oak woodland. Both of these were in the Auburn-Sobrante series on slopes ranging from 15-50 percent.

There is a small area of black oak vegetation types within the Foothills RAA. Over 63 percent of this area was associated with Boomer-rock outcrop complex on slopes of 5-50 percent. Boomer soils are distributed extensively throughout the Sierra Nevada and are frequently vegetated with ponderosa pine, black oak and manzanita. Another 14 percent of the black oak types was found on Auburn-Sobrante silt loam, 15-30 percent slopes.

Valley oak woodland is found on frequently flooded xerofluvents (21 percent of the valley oak in the RAA) and xerorthents, placer tailings (35 percent of the valley oak in the RAA). These soil-landforms generally conform to floodplains along major streams and tributaries although placer tailings may be located at some distance from a stream. The only other soil-landform that had a significant amount of valley oak within the RAA was the Andregg coarse sandy loam, 2 to 9 percent slope. Nine percent of the valley oak in the RAA was found on this soil.

POTENTIAL AREAS FOR RESTORATION

Process and Selection Criteria

After evaluation of the co-occurrences of oak woodland types with the various soil-landform units, another analysis was performed to determine what other DFW land covers were found on the soil-landform units within the Foothills RAA. If the soil-landforms were suitable for oak woodland, but other land covers were present because of past land uses, it was surmised that these sites were potentially restorable to oak woodland. Table 1 below summarizes the results. Only those land covers considered potentially restorable are listed. Potentially restorable land within existing reserves is not included in the table. Appendix A, Figure 1 shows the distribution of potentially restorable land.

Table 1: Soil and Land Cover Co-occurrences Potentially Suitable for Restoration Within the Foothills RAA. Existing Reserves Not Included.

For Restoration as Blue Oak Woodland		
Soil-Landform	**Land Cover(s)**	**Acres**
Auburn silt loam, 2-15 percent slopes	California annual/perennial grassland Irrigated pasture	2428 578
Auburn-rock outcrop complex, 2-30 percent slopes	California annual/perennial grassland	811
Auburn-Sobrante-rock outcrop complex, 2-30 percent slopes	California annual/perennial grassland Irrigated pasture	535 92
For Restoration as Black Oak Woodland		
Auburn-Sobrante silt loam, 15-30 percent slopes*	California annual/perennial grassland Irrigated pasture	967 134
For Restoration as Valley Oak Woodland		
Xerofluvents, frequently flooded	California annual/perennial grassland Irrigated pasture	65 65
Xerothents, placer areas	California annual/perennial grassland Irrigated pasture	40 35

***There was a negligible (<five acres) of potentially restorable land covers on Boomer soils.

Since existing reserves may offer opportunities for restoration, the area of soil-landforms suitable for restoration within reserves was estimated. Table 2 shows the amount of land with suitable soils and grassland land cover within existing reserves and the RAA. Irrigated pasture was not included as restorable land. Irrigated pasture in the Foothills is in limited supply and has high value for livestock production. Xerothents in placer areas were not included as potentially restorable to valley oak woodland because of the difficulties in restoring such sites.

It should be noted that the DFW grassland land cover classes encompass some land classified as oak woodland savanna or rural residential forested by PWHR. As previously stated, this is because tree canopy cover thresholds differ in the DFW mapping. The presence of scattered residual trees in grassland does not adversely affect the restoration potential of the land cover; if there are some trees present, restoration potential could be enhanced.

Table 2: Potential Restoration Areas within the RAA and Existing Reserves

Oak Woodland Type	Location	Total Acres
Blue Oak	Existing Reserves	343
	RAA	3774
Total Blue Oak		4117
Black Oak	Existing Reserves	128
	RAA	970
Total Black Oak		1098
Valley Oak	Existing Reserves	10
	RAA	65
Total Valley Oak		75
Grand Total		5290

Application of Geographic Constraints

The area of land with restoration potential was narrowed by application of geographic constraints. Restoration areas were mapped using the following criteria:

1. The area has the soil-landform type associated with one of the woodlands
2. It has a land cover potentially restorable to oak woodland
3. The area is within 50 feet of or within an existing conservation reserve that is contained within or contiguous to the Foothills RAA
4. It is within 200 feet of an existing road
5. The restored area would contribute to conservation objectives by either increasing the size of a habitat patch, increasing connectivity between habitats or increasing habitat diversity.
6. The area is not considered prime agricultural soils or soils of statewide significance.
7. The area is not within the designated future growth area

It should be noted that no field confirmation of restoration potential was performed for this study. Further evaluation would be required prior to developing restoration plans. The intent of this study was to create a suite of potential restoration opportunities for future consideration. The rationale for using these screening criteria is explained below.

It was assumed that some land covers would be difficult and/or relatively expensive to restore. These include sites that are developed, currently used for agricultural production or otherwise highly disturbed. Irrigated pasture is indicated as a potentially restorable land cover in Table 1. In practice, this land cover may have a lower feasibility

for restoration than open grassland. Therefore, it was not included as a restorable land cover in the results that follow.

Landowner willingness to undertake restoration on lands not subject to acquisition could be a significant impediment to restoration. In the results that follow, no assumptions about landowner preferences were made.

Enlarging oak woodland within or adjacent to an existing conservation reserve was used as a criterion because it would increase the reserves' habitat value. Enlarging existing reserves through acquisition could complement restoration efforts or might be necessary to facilitate restoration.

Accessibility by an existing road was used as a criterion to both facilitate management and perhaps reduce restoration costs. Since much of the PCCP Foothills in the vicinity of existing reserves is accessible by county roads, this is not a significant constraint.

Restoration can increase the size of a habitat patch, increase connectivity between habitats or contribute to habitat diversity. In considering the restoration of a specific site, objectives need to be established. For example, in some cases, retaining grassland within a matrix of blue oak might have a higher priority than closing the gaps by blue oak restoration. By presenting candidate areas for restoration it is not presupposed that all or even most locations would be treated in the same way.

There are very limited occurrences of soils considered prime for agriculture or of statewide significance in the PCCP uplands. It is unlikely that there will be sites considered for restoration that would fall in either category. None of the soils-landform types supporting oak woodlands in the Foothills are designated prime soils.

Table 3 shows the amount of potentially restorable land meeting the location criteria.

Table 3: Potentially Restorable Land Meeting Location Criteria

Oak Woodland Type	Location	Total Acres
Blue Oak	Existing Reserves	174
	RAA	568
Total Blue Oak		742
Black Oak	Existing Reserves	86
Black Oak Total		86
Grand Total		828

There was no area suitable for valley oak woodland restoration meeting these criteria.

Only 16 percent of the potentially restorable land shown in Appendix A, Figure 1 and Tables 1 and 2 met the selection criteria.

Restoration Potential for Existing Reserves

An evaluation of all existing reserves within the Foothills RAA was performed to identify those that had the largest amounts of potentially restorable land. There are nine reserves that have at least some land meeting the location criteria. Of these, five have the greatest amounts of restorable land either within their boundaries or in adjacent RAA (Table 4).

Table 4: Existing Reserves with the Largest Amounts of Potentially Restorable Land

Reserve	Oak Woodland Type	Location	Total Acres
Hanley Ranch	Blue Oak	Within Reserve	22
	Blue Oak	RAA	156
Total			178
Blue Oak Ranch	Black Oak	Within Reserve	66
	Blue Oak	Within Reserve	89
Total			155
Hidden Falls Park	Black Oak	Within Reserve	20
	Blue Oak	Within Reserve	5
	Blue Oak	RAA	51
Total			76
Taylor Ranch	Blue Oak	Within Reserve	42
	Blue Oak	RAA	32
Total			74
Kirk Ranch	Blue Oak	RAA	308
Doty Ravine*	Valley Oak	Stream System	15
Grand Total	All	All	806

*There are no lands potentially restorable to valley oak woodland meeting the location criteria. Consequently, the location criteria were suspended to determine if there were any areas that could be restored to valley oak woodland in the general vicinity of a conservation reserve. One such site was located in the upper reaches of Doty Ravine near its confluence with Sailor's Ravine and the Nature Trading Company reserve with a potential area for restoration of about 15 acres. The restoration potential of that site is discussed in a following section.

There are about 36 acres of potentially restorable land associated with the other nine existing reserves located within or contiguous to the RAA.

Viewed in the context of a possible additional 10,000 to 15,000 acres of reserve lands, this study suggests a practical restoration goal of 1000 acres, mainly for blue oak, and secondarily for black oak and valley oak.

Restoration Examples at or Adjacent to Existing Reserves

Hanley Ranch

Hanley Ranch is a property owned by Caltrans and acquired to compensate in part for state highway construction impacts. It will be maintained in perpetuity as habitat. No public recreation or other uses are proposed. Existing vegetation consists of blue oak woodland, valley oak woodland and grassland. There is a relatively large area within and contiguous to its boundaries that is potentially restorable to blue oak woodland (Appendix A, Figure 2). In conjunction with surrounding blue oak woodland, restoration would increase the size and connectivity of habitat.

Hidden Falls Park and Blue Oak Ranch

Hidden Falls Regional Park consists of almost 1200 acres owned and managed by Placer County. It is partly developed for recreational uses but nearly 1100 acres will remain undeveloped. The predominant vegetation types are blue oak woodland, valley oak woodland and grassland. A grazing lease applies to a portion of the property. Hidden Falls Park has very limited land potentially restorable to blue oak woodland or black oak woodland (Appendix A, Figure 3). Previous investigations at the property indicated some potential for increasing connectivity of the riparian woodland corridor along Coon Creek.

Blue Oak Ranch is adjacent to Hidden Falls Park and bordered on the south by an area designated for future growth. It has a significant area of potentially restorable land within its boundaries overlapping with the adjacent Hidden Falls Park (Appendix A, Figure 3). Restoration would increase the size of a blue oak patch and increase diversity by restoring black oak woodland. Blue Oak Ranch has a conservation easement that restricts the amount and location of future residential development.

Taylor Ranch

Taylor Ranch is owned by Placer Land Trust and managed for cattle grazing. It is 321 acres of mainly blue oak woodland and grassland that is contiguous to four other reserves. A public access trail easement traverses a portion of the property.

Restoration within and adjacent to the reserve would increase the size of an existing blue oak patch. When habitat on adjoining reserves is taken into account, the resultant patch would be substantial in size (Appendix A, Figure 4).

Kirk Ranch

Kirk Ranch is a 281-acre working ranch used for cattle grazing. It is protected through purchase of a conservation easement pursuant to the Placer Legacy program. The easement prohibits new permanent structures, cultivation or the development of permanent crops such as vineyards or orchards. The property is predominately blue oak woodland and grassland.

A large potential area for restoration barely meets the criteria for location within 50 feet of an existing reserve (Appendix A, Figure 5). Restoration of this area would increase the size and connectivity of existing blue oak woodland. Since the area for restoration is located completely off the reserve, the owners and operators of Kirk Ranch would not have responsibility for undertaking the restoration or managing it.

Doty Ravine

An area along Doty Ravine downstream from its confluence with Sailors Ravine is included to provide some opportunity to restore valley oak woodland in the uplands. Restoration would increase habitat connectivity along Doty Ravine. Additional restoration could be explored to increase connectivity between valley oak patches on Sailors Ravine and Doty Ravine. The total potential area for restoration is about 15 acres (Appendix A, Figure 6).

This area is near a 40-acre privately owned organic farm that has an open space and conservation easement referred to as the Natural Trading Company.

Prioritizing Restoration

A process for prioritizing restoration has not yet been developed. Some potential criteria for prioritization would include:

- Landowner willingness: in cases where the landowner is a public agency or Placer Land Trust (Hidden Falls, Taylor Ranch, Hanley Ranch) restoration at least within a reserve might be more likely. For lands outside reserves or with private owners (Kirk Ranch, Doty Ravine, Blue Oak Ranch) incentives to undertake restoration would be needed or properties would need to be acquired with restoration in mind.
- Restoration feasibility: feasibility can only be evaluated on a site-specific basis by a qualified restoration practitioner. Issues such as existing soil and vegetation conditions, existing uses, presence of animals and insects potentially affecting plantings, site-specific accessibility and availability of water would all have a bearing on feasibility.
- Restoration benefits: benefits may include enhancement of wildlife habitat, stabilizing soils and increased wildlife populations.
- Costs and availability of funding: restoration costs are discussed in the last section of this report. Costs can vary by an order of magnitude. The source(s) of funding to undertake restoration have not been identified.

The candidate areas can be screened using the criteria above plus other relevant factors to identify which, if any would be treated first. It is possible that some other potentially restorable areas shown on Appendix A, Figure 1 might take precedence over the existing conservation reserves. This may depend on what properties are acquired pursuant to implementation of the PCCP conservation strategy.

RESTORATION PROCEDURES

Introduction

Virtually all oak woodland in Placer County has been affected by past management and land uses. Clearing, fuel wood harvesting, grazing, invasion by exotic plant and animal species and environmental changes have caused changes to oak woodland. Consequently, there may be no examples that represent what pre-settlement oak woodland may have been to guide restoration efforts. In the absence of these reference conditions, restoration may be based on historical analysis or accounts, modeling or simply, professional judgment (Harris 1999). Fortunately, there is both general and more detailed information on the present composition and structure of Placer County's oak woodlands (Jones and Stokes Associates 2004; Klein et al. 2007). There is also the experience of practitioners involved in oak woodland restoration. These sources were used to provide guidance for future restoration planning.

It should be noted that oak woodland restoration is a long process and it will require many decades before a restored site will resemble mature, functioning woodland. California oaks are slow growing. All the species recommended for restoration (blue oak, valley oak and black oak) can live for hundreds of years and attain large sizes. Over the course of maturation, a restored site will attain characteristics associated with mature woodland such as a complement of associated plant and wildlife species. Before embarking on an ambitious restoration program the lack of immediate results should be appreciated. The time frame of restoration for oak woodland is considerably longer than it is for other communities such as wetlands.

Species Composition and Structure of Existing Vegetation Types

Blue Oak Woodland

Jones and Stokes (2004) identify several PWHR types that include blue oak as a dominant or co-dominant species. The Placer County Oak Management Plan describes the Blue Oak Woodland CWHR type as follows:

> "Blue Oak Woodland is highly variable. Typically blue oak comprises 80-100 percent of the trees present (>50 percent of the canopy cover). Foothill pine, California buckeye, valley oak, interior live oak, canyon live oak and California black oak are common associates of blue oak. Non-native annual grasses form most of the under-story in open woodlands. Characteristic shrub species in this community include poison oak, California coffeeberry, and several species of ceanothus and manzanita."

Klein et al. (2007) identify several Blue Oak sub-alliances and associations. Of these, the Blue Oak/Annual Grass/Forb sub-alliance is the most common in Placer County. The Blue Oak sub-alliances in general are described as follows (with minor editing):

> "Blue oak is usually dominant or sometimes co-dominant in the tree canopy with foothill pine and other oak species. The canopy is continuous, intermittent, or

> savanna-like. The shrub layer is sparse to intermittent and ceanothus or manzanita may occur. The herbaceous layer is sparse or grassy, and forbs are present seasonally."

The Blue Oak/Annual Grass/Forb sub-alliance is further described as follows:

- Total Vegetation Cover: 73 percent average, range 34-100 percent
- Hardwood Tree Cover: 26 percent average, range 3-75 percent
- Shrub Cover: 2 percent average, range 0-30 percent
- Grass/Forb Cover: 61 percent average, range 21-95 percent

Conifer tree cover is generally absent but if present, may range up to 35 percent.

The species with the highest cover and constancy in the sub-alliance are blue oak in the tree layer, poison oak (minor) in the shrub layer and introduced annual grasses. There were no "ecologically significant native annual plants that would represent good differential species for defining plant associations" (Klein et al. 2007).

Black Oak Woodland

Black Oak Woodland is included in the broad Mixed Oak Woodland PWHR type cited in the Placer County Natural Resources Report. Black oak dominated woodlands were classified by DFG as the Montane Hardwood CWHR type (Klein et al. 2007). The Montane Hardwood type is described as follows in the Placer County Oak Management Plan:

> "This vegetation type is (characterized) by a variety of hardwood species with black oak and canyon live oak being the dominant oak species."
>
> "Black oak tends to dominate on gentle topography at higher elevations. It grows to heights of 70 to 80 feet at maturity, with long, straight trunks in closed canopy situations. In open forests, black oak has larger, spreading crowns."
>
> "Associates of Montane Hardwood at lower elevations and on steep slopes with poor soils include foothill pine, knobcone pine, tan oak and Pacific madrone. Under-story shrub species include poison oak, ceanothus, manzanita, mountain mahogany, coffeeberry, wild currant and mountain misery. Forbs and grasses are not as prevalent as in (other) lower elevation hardwood types. Montane Hardwood forests have poorly developed shrub and herbaceous layers."

Klein et al. (2007) indicated three Black Oak associations in Placer County but only 99 acres of black oak dominated vegetation were mapped within the Foothills RAA. Within the entire PCCP Foothills, only 1102 acres were mapped. Black oak-dominated stands are described as follows (with minor editing):

> "Black oak is dominant in the tree canopy with numerous associated conifer and hardwood tree species. Foothill stands tend to be open to continuous and may contain toyon, coffeeberry and poison oak in the shrub layer."

Two of the Black Oak associations described by Klein et al. (2007) have whiteleaf manzanita as indicator species.

For the Black Oak associations in Placer County, the vegetation cover is reported as follows:

- Total Vegetation Cover: 58 percent average, range 35-98 percent
- Hardwood Tree Cover: 29 percent average, range 1-60 percent
- Shrub Cover: 28 percent average, range 1-64 percent
- Herb Cover: 10 percent average, range 0-60 percent
- Conifer tree cover may range up to 10 percent.

The dominant species are black oak in the tree layer, poison oak and manzanita in the shrub layer and introduced annual grasses. Black oak occurs rarely in association with ponderosa pine in the predominately lower elevation PCCP Foothills.

It should be noted that black oak increases in abundance with increased elevation in Placer County. Most of the PCCP Foothills are below its optimal range.

Valley Oak Woodland

Jones and Stokes (2004) indicate a very limited area dominated by Valley Oak Woodland in the Foothills. The Placer County Oak Management Plan describes Valley Oak Woodland as follows:

> **"**This vegetation type is dominated by valley oak and varies from savannah-like to forest-like stands with partially closed canopies."
>
> "Associated tree species include California sycamore, California black walnut, California boxelder, Oregon ash, interior live oak, California buckeye and blue oak. At low elevations close to water, valley oak is associated with Fremont cottonwood and willow. Denser stands occur along natural drainages with deep soils. Tree density tends to decrease from lowlands to uplands. The under-story shrub layer can be dense along drainages and very sparse in uplands. It may consist of poison oak, California wild grape, toyon, California coffeeberry and Himalayan blackberry. Under-story grasses and forbs are mostly introduced annuals such as Italian ryegrass, ripgut brome, Mediterranean barley, yellow star thistle, wild oats and tarweed."

Klein et al. (2007) identify three Valley Oak associations, one of which is predominant in Placer County: the Valley Oak/Himalayan Blackberry association. As with the Placer County Natural Resources Report mapping, Klein et al. (2007) also classify a number of riparian and semi-riparian communities that include valley oak as an important component. For the purposes of this evaluation, riparian woodlands are not considered a target for restoration. The Placer CARP will secure the protection of riparian woodlands and some restoration projects may be proposed within the CARP.
Klein et al. (2007) describe the Valley Oak associations as follows;

> "In the Foothills study area, valley oak forms woodland and (rarely) forest along floodplains and terraces in seasonally saturated soils. Interior live oak is the most frequent overstory species found with valley oak, while foothill pine, willows, California sycamore and other oak species are found occasionally. Common understory trees are buckeye, interior live oak and willows."

The Valley Oak/Himalayan Blackberry association is further described as follows:

> "The overstory tree canopy was typically open to continuous and dominated by valley oak at 8-60 percent cover. Interior live oak was characteristically present as a tree and/or shrub. The shrub layer was open to continuous with Himalayan blackberry dominant and with poison oak and wild grape often present. The herbaceous layer was open to intermittent with wild rye and mugwort occasionally present."

Klein et al. (2007) note that there is a close ecological relationship between California woods rose and Himalayan blackberry suggesting that the blackberry may have displaced the native rose from foothill sites. A similar relationship has been observed on the California coast in oak-bay woodlands where German ivy has apparently displaced poison oak in the shrub and vine layers (R. Harris and P. J. Zinke, personal observations).

Vegetation cover in the Valley Oak/Himalayan Blackberry association is described as follows:

- Total Vegetation Cover: 79 percent average, range 55-95 percent
- Hardwood Tree Cover: 33 percent average, range 15-75 percent
- Shrub Cover: 52 percent, range 20-80 percent
- Grass/Forb Cover: 9 percent, range 0-35 percent

Non-native species constitute nearly half of the average vegetation cover.

There are several tree species occurring in association with the dominant valley oak, as previously noted and as indicated in Jones and Stokes (2004). There are also instances where valley oak occurs alone in groves and galleries. Blackberry is ubiquitous but wild grape and poison oak are found with relatively high constancy. The herb layer is sparse due to the effects of the dense blackberry canopy.

Restoration Reference Conditions

The vegetation descriptions presented above provide clues regarding restoration targets. The information is incomplete however, and was supplemented with professional judgment based on field observations in Placer County and consultation with knowledgeable ecologists and restoration practitioners. The criteria listed below are a blend of these sources.

Any restoration plan will emphasize the oak species. In some cases, managers may

propose native shrub and/or herb/forb propagation, control of exotics to favor native species or other measures. The primary restoration target would be the desired oak canopy cover and/or tree density at community maturity.

Blue Oak Woodland

Under “natural” conditions tree cover in blue oak woodland is not complete. The mature blue oak/grassland community would likely occur as patches of mature trees in a matrix of grassland. DFW data indicate that shrub cover is low or absent and ground cover (grasses and forbs) is relatively high in a mature community. Historical suppression of wildfire is reflected where cover of shrubs is presently high, or there is a relatively dense understory. A restoration target for blue oak canopy cover at community maturity would be in the range of 30-40 percent, locally higher within separated groves. Patches of native shrubs might be introduced or retained if present. In the pre-settlement era, the grass and forb layer would have consisted of native annual and perennial species. An aggressive restoration program would attempt to re-introduce those species.

Black Oak Woodland

Uniform stands of black oak rarely occur naturally. The species is generally found as a dominant or co-dominant species in mixed montane hardwood stands. Goals for minimum cover of black oak have been proposed for the Sierra Nevada because of its acknowledged value as wildlife habitat. On appropriate soils, it may be considered as part of a multi-species restoration plan. As an associated or co-dominant species its canopy cover at maturity would be in the range of 10-20 percent.

The Montane Hardwood CWHR type (Mixed Oak woodland PWHR) is potentially the most diverse in the PCCP Foothills. It would also be the most difficult to create through restoration.

Valley Oak Woodland

Upland stands of valley oak under “natural conditions” would generally have intermittent, discontinuous tree cover. At the present time in existing valley oak stands, shrub (mainly blackberry) cover is relatively high, due to the aggressive nature of the exotic blackberry. Ground cover is relatively low. Restoration efforts would obviously not include propagation of blackberry. In fact, where the valley oak/blackberry alliance occurs, land managers commonly take steps to eliminate the blackberry. Instead, valley oak community restoration might include the introduction of native shrubs. Oak restoration efforts should attempt to achieve valley oak canopy cover at maturity in the range of 25-35 percent, generally in galleries or patches.

Restoration Prescriptions

Introduction

Oak woodland restoration practices in California commonly include planting container-

grown seedlings, use of shelters and exclosures to prevent damage from animals, suppression of competing vegetation and irrigation during the first few years. Restoration is expensive when all of these actions are required. Follow-up monitoring and maintenance costs add to these initial costs.

Achieving strategic conservation objectives must include minimizing costs for establishing and maintaining restoration sites in the PCCP Foothills. Restoration constraints should be addressed with least cost solutions. To an extent, these solutions may be based on mimicking the process by which oaks naturally regenerate. There is an implicit trade-off between assuring the success of a restoration project and costs.

Constraints on Restoration

There are several constraints on restoration that will affect future planning and implementation. Some of these, such as soil suitability and access, have already been incorporated into site selection criteria. Others listed below pertain to more specific issues.

- Soil and site conditions: restoration areas have been identified on the basis of the presence of suitable soils. The soils data used are very general and conditions at a specific site may vary. At a given site the soils may have been degraded by past uses e.g., compaction due to grazing, thatch layer, hardpan due to plowing, etc. Also, although the soils may be suitable and may have supported oak woodland in the past, the mycorrhizal fungi required by oaks may no longer be present (Bernhardt and Swiecki 2001).
- Water availability: most restoration plans that propose use of container plants require irrigation for at least the first few years. Irrigation may also be required to ensure successful survival of acorn plantings (Mc Creary 2009; Anderson 2010). Soil moisture availability will in the long term largely determine the composition and structure of the restored community.
- Interspecific competition: oaks or other plants used for restoration will confront competition from other plants. The adverse impacts of introduced annual grasses on natural regeneration and survival of oak seedlings have been documented. Adams et al. (1991) found that suppression of herbaceous competition was the most important factor affecting blue and valley oak seedling survival in plantations.
- Grazing or browsing impacts: for sites that are grazed, oaks planted or otherwise established intentionally will be subject to trampling, breakage or consumption. Livestock effects will generally persist until saplings are up to six feet tall (Mc Creary and Tecklin 2005). Wildlife such as deer, ground squirrels and other rodents will also consume young oaks. Insect depredation and disease can affect seedling survival (Ted Swiecki, personal communication).
- Climate change: future changes in temperature and precipitation are anticipated to have effects on the distribution of plant species in the Foothills and Sierra Nevada. Kueppers et al. (2005) cited in Kroeger et al. (2009) indicate that the current range of oak woodland in Placer County will persist in current locations and expand to upper elevations in the future. Choices about future restoration may not be significantly affected.

An overriding constraint is the availability of funding and personnel to maintain and monitor restoration sites. The amount of funding and labor required to conduct restoration and to do follow-up treatments are directly related to the constraints at a site and how those constraints are addressed.

Acorns Versus Container Stock

Oak restoration is usually done either with acorns or with container grown seedlings. For several reasons, use of acorns has gained favor with the restoration practitioner (Kraetsch 2002; McCreary 2009; Anderson 2010; Ted Swiecki, personal communication; Riley Swift, personal communication). Advantages of acorns include (see http://phytosphere.com/oakplanting/acorns.htm):

- California oaks develop extensive tap roots when they establish under natural conditions. When grown in containers, tap root development is curtailed. This can impact drought tolerance, growth and survival after planting.
- Growing seedlings in controlled environments requires space and incurs costs that are passed on to the purchaser. With the exception of labor for collecting acorns and storage costs, acorns are free.
- Container grown seedlings are more difficult to store than acorns. If stored too long, the seedlings may become root bound in the container.
- Acorns can be collected from areas near proposed restoration sites and will be from trees adapted to the area. Container grown seedlings may not be from local seed sources (although acorns can be provided to growers for propagation).
- Container soils may contain soil-borne pathogens or insect pests that will be introduced to the planting site.
- Container plants are grown under irrigation and will generally require irrigation after planting. They also require more effort and care in planting.

There has been limited study of the survival rates of container grown oaks versus oaks grown from acorns (but see http://slosson.ucdavis.edu/newsletters/Young_200229012.pdf where it was reported that valley oaks grown from acorns had significantly greater survivorship than oaks planted from containers in non-irrigated plots). In one case study, about 75 percent of sites planted with three acorns, protected with weed mats and tree shelters and hand watered for two summers contained at least one seedling (Kraetsch 2002). The expectation in that case was that up to one third of the sites would ultimately have saplings. Practitioners in Placer County observe that sites planted with acorns exhibit 60 percent survival while sites planted with seedlings have 40 percent survival after three years without irrigation (Riley Swift, personal communication). Acorn plantings may suffer more mortality than seedlings in the first spring due to a variety of causes whether irrigated or not (Riley Swift, personal communication). Consequently, practitioners commonly plant more than one acorn per planting site.

For the reasons stated above and to minimize costs to the extent possible, oak woodland restoration within the PCCP Foothills should emphasize use of acorns. As described below, the actual procedures at a specific site will depend on site conditions

and other factors.

Restoration Practices

Any area proposed for restoration will require a restoration plan detailing site conditions, planting and maintenance activities, costs and expected results. The guidance provided here is general in nature and would apply to most projects.

Species Composition. The principal objective of restoration will be to establish a canopy of the desired oak species. Practitioners differ in their opinions on planting associated shrub species. Some feel that the increased costs and complexity of including shrubs outweigh the potential benefits (Ted Swiecki, personal communication). Once a canopy is established, birds will commonly bring in shrub seeds from neighboring areas. Introducing shrubs can also be problematic if the restoration site is grazed. Because of the time needed to establish an oak canopy (on the order of decades) other practitioners feel that the immediate benefits to wildlife of planting shrubs outweigh the additional costs (Riley Swift, personal communication).

Although prescriptions will stress the planting of the dominant oak species (blue, valley or black) associated trees may be planted as well. For valley oak woodland, these may include California black walnut and interior live oak. For blue oak woodland, California buckeye, interior live oak and valley oak may be introduced. Black oak or montane hardwood plantings could include other oaks or even conifer species (Riley Swift, personal communication).

Planting Pattern. For blue oak and valley oak, the initial planting density should be on the order of 40 planted sites per acre, located 30-50 feet apart with three to four acorns planted at each site (McCreary 2009 cited in Anderson 2010). Planted sites may be spaced more closely to simulate the patchiness of natural stands or to take advantage of especially favorable soil conditions. Planting at this density should create an eventual density of about 40 trees/acre. Survival will depend on the protective measures applied (Tecklin et al. 1997; Kraetsch 2002). Depending on survival and spacing of survivors, follow up inter-planting may be required. Eventually, stands may require thinning to achieve the desired canopy cover and tree distribution at maturity. Some thinning will occur naturally through competition. Larger areas may be planted in phases to create multi-aged stands. Favorable locations should be chosen for planting sites e.g., avoid south-facing slopes, shallow soils or excessively wet areas. In addition to the planted sites, which may receive protection (see below) acorns may be sown in areas where soil has been exposed or tilled.

For black oak, it is assumed that restoration will occur in the context of multi-species plantings. In plantings of trees at the densities given above for blue oak and valley oak, black oak acorns should be planted at densities of 10-20 planted sites per acre.

Planting Stock. Acorns are preferred for planting although in specific cases, container stock may be utilized e.g., in situations where stock is donated or would otherwise go to waste. Detailed procedures for collecting, treating and storing acorns are described in Anderson (2010; http://ucanr.org/sites/gsobinfo/files/152320.pdf) and

Kraetsch (2002; http://www.fs.fed.us/psw/publications/documents/gtr-184/050_Kraetsch.pdf). Additional information is available at the University of California oak program website (http://ucanr.edu/sites/oak_range/). It is assumed that contractors or others undertaking restoration projects in the Foothills will have the knowledge and experience to collect and process acorns.

Site Preparation. For acorn planting, at each site the grass and thatch should be scraped away from an area three feet in diameter. Some practitioners create a basin within which acorns are planted (Riley Swift, personal communication). Others recommend that a planting hole eight inches deep should be dug within the cleared area (Anderson 2010).

Larger areas may be cleared and tilled if acorns are to sown without planting. Tilling to a depth of six inches should be adequate to break up thatch (Justin Wages, personal communication).

Planting Procedures. Specific information on planting acorns is available at the University of California oak program website (http://ucanr.org/sites/oak_range/) and in other publications cited above. Soil collected from the oak woodland or beneath the tree where acorns were collected may be used in part to backfill the hole after acorns are planted to ensure that appropriate mychorrizae are present at the site (Anderson 2010). Mychorrizal innoculum is also available commercially (Riley Swift, personal communication).

Protection. The need for protecting seedlings against herbivores or physical damage depends on site-specific conditions. If livestock graze an area, fenced exclosures and/or tree shelters may be used to provide protection until seedlings are sufficiently established. Shelters up to six feet tall may be required for grazed sites or where deer or pigs may be attracted to the plantings. Both tubes and welded wire “cages” may be used to protect against livestock. Experience with these devices varies. Some practitioners recommend use of welded wire cages (Sue Wickham, personal communication; Riley Swift, personal communication; Ted Swiecki, personal communication) but these may require time to fabricate in the field. If livestock are not present shelters two to four feet tall can protect seedlings from deer, rabbits and rodents (Anderson 2010). If rodent and/or insect predation is likely, additional protection may be required, such as the use of screen cylinders (“gopher guards”) within shelters (Kraetsch 2002). Short tree shelters (1-2 feet tall) can provide protection as well as some shade, thereby reducing moisture stress.

The photograph above shows three different tree shelters installed at a restoration site in Lynch Canyon, Solano County. Rigid tree tubes, flexible biodegradable tubes and welded wire cages with additional screen exclosures to prevent rodent damage were used. The rigid tubes resisted grazing animals best but the welded wire exclosures allowed access for maintenance (weeding) (photograph courtesy Sue Wickham, Solano Land Trust).

Competition Control. The need to control competing vegetation is site-specific. Since the land cover considered most feasible to restore is grassland, competition from introduced annual grasses and forbs could adversely affect seedling survival, particularly in the first few years. Grass and forb competition can be controlled in several ways including targeted grazing, mulching, mats, mowing, manual scalping and herbicides. Keeping grasses and forbs under control has the secondary benefit of reducing habitat for small mammals and insects that may prey on seedlings (Ted Swiecki, personal communication).

Irrigation. One reason for using acorns instead of container stock is to avoid irrigation if possible. Irrigated plants may become stressed when watering is discontinued. Irrigated plants may also have poorly developed root systems. If acorn planting occurs after the first few good rains during the winter, the need for irrigation may be eliminated altogether. If the weather is exceptionally dry, some practitioners have recommended hand watering with 1-2 gallons per planting site in July and September for first two years (Anderson 2010). The ability to water by hand depends on availability of on-site water, distance from a road (for use of a water truck) and costs.

Drip irrigation systems may be installed to water plants after germination if watering is essential to ensure a reasonable level of survival. Drip irrigation is an expensive option and some practitioners have experienced problems with superheating of above ground pipes (Justin Wages, personal communication). By using self-flushing systems and/or

installing pipes below ground these problems can be avoided (Riley Swift, personal communication).

An alternative to conventional irrigation is the use of Dri Water gel packets in planting holes (http://driwater.com/). Placer Land Trust has had success using Dri Water at its Doty Creek Reserve (Justin Wages, personal communication). Up to three gel packs per tree per year are needed. Dri Water is only applicable to container stock plantings.

Monitoring. Planted sites should be monitored from early March to early June to check for seedlings, weed inside shelters, control competition around planted areas (if necessary) and collect shelters from sites where seedlings did not successfully germinate. If acorns were sown in the open without protection, shelters may be transferred to seedlings that did establish. Monitoring will be necessary at intervals throughout the establishment phase (up to five years) and as the planting matures (up to 15 years).

COSTS

The costs for oak woodland restoration vary depending on several important factors:

- Land or easement acquisition costs
- Labor costs
- Materials costs
- Whether or not the site has installed irrigation
- Monitoring and reporting requirements
- Short and long-term maintenance and management costs

It is assumed that the following prescription will be applied to the majority of restoration projects in the PCCP Foothills:

- Oaks planted by direct seeding with acorns
- If included in a prescription, all associated plants are installed as seedlings
- Trees protected from animal and insect damage with cages or tubes
- Competing vegetation controlled for up to three years
- Limited monitoring and reporting during the establishment phase

It is further assumed that the costs for administering and designing the restoration project and land or easement acquisition costs are either included in the estimates presented below or otherwise negligible.

Anderson (2010) provides cost data for implementing the prescription listed above without including associated plants. She estimates materials costs at up to $500/acre assuming 50 planting sites. Labor costs per site (size not specified) are estimated at 30-40 person-days to collect and process acorns, conduct the planting, monitor the site, control competing vegetation and hand water during the first two years. Assuming a wage rate of $15 hour, this would equate to $4800 per site. For a 10-acre restoration site, the costs would therefore be about $10,000. This compares favorably to

information provided by Kroeger et al. (2009). They estimate the costs for plantings to vary from $2500-20,000/acre, depending on the density of planting. For medium density of 50 planting sites/acre, they estimate costs at $10-20,000.

Labor costs constitute the bulk of costs for restoration. Some practitioners rely on volunteers or subsidized labor to do plantings and maintenance (Sue Wickham, personal communication; Justin Wages, personal communication; Kraetsch 2002). Volunteer and subsidized labor have their advantages in terms of costs but can present other problems, including low productivity and motivation or lack of relevant skills.

Placer Land Trust has been implementing restoration at some of its reserves. In one proposal for grant funding, it estimated the costs for expanding existing oak woodland at its Havego Reserve at about $2900/acre or roughly $260,000 for nearly 90 acres (Justin Wages, personal communication). Those costs included planting oak container stock, weed mats, fertilizer, protection cages and use of Dri Water for irrigation. The planting density was 80 trees/acre to achieve an ultimate density of 40 trees/acre or 40 percent canopy cover. A private contractor would perform the work. An endowment of $25,000 was included in the proposal to conduct follow up monitoring.

In another project where volunteer labor was employed, a crew of 50 (of which about 20 were productive) planted 750 sites over about 20-30 acres in half a day. Sites were planted with acorns and mulched with no protection or irrigation (Ted Swiecki, personal communication). The success of that planting is unknown.

Practitioners report much higher costs for projects that are done utilizing contract or employee labor at prevailing wage rates. One project of note involved planting over 6000 seedlings and larger stock over 37 acres. Protection, weed control and irrigation were provided for up to five years. The costs for that project were $1.3 million or over $35,000/acre (Ted Swiecki, personal communication).

In Placer County, Restoration Resources, Inc. estimated the costs for oak woodland restoration according to the prescription given above plus associated shrub and tree species as follows:

At federal prevailing wage rates:

Non-irrigated: $33,000/acre
Irrigated: $45,000/acre

At “standard” wage rates:

Non-irrigated: $30,000/acre
Irrigated: $39,000/acre

These estimates include all administrative, design and implementation costs plus five years of monitoring and maintenance. Additional costs for monitoring in years 7, 10, 13 and 15 are approximately $34,000/acre (Riley Swift, personal communication).

In summary, the costs for oak woodland restoration in the PCCP Foothills can vary by an order of magnitude depending primarily on the source of labor and how the project is administered, by contract or otherwise. The reasonable range of costs to use for estimating expenditures over the life of the PCCP is between $3,000 and $30,000/acre in current dollars.

LITERATURE CITED

Adams Jr., T.E., P.B. Sands, W.H. Weitkamp and N.K. McDougald. 1991. Blue and valley oak seedling establishment on California's hardwood rangelands. USDA Forest Service Gen. Tech. Rep. PSW-126. Pp. 41-47.

Anderson, M. 2010. Procedures for planting fully sheltered acorns. Access at http://ucanr.org/sites/gsobinfo/files/152320.pdf.

Bernhardt, E. and T. Swiecki. 2001. Restoring oak woodlands in California: theory and practice. Access at http://phytosphere.com/restoringoakwoodlands/oakrestoration.htm

Harris, R.R. 1999. Defining reference conditions for restoration of riparian plant communities: examples from California, USA. Environmental Management 24:55-63.

Jones and Stokes Associates. 2004. Placer County Natural Resources Report. A Scientific Assessment of Watersheds, Ecosystems, and Species of the Phase I Planning Area. Placer County Planning Department. Auburn, CA.

Klein, A., Crawford, J., Evens, J., Keeler-Wolf, T. and D. Hickson. 2007. Classification of the vegetation alliances and associations of the northern Sierra Nevada foothills, California. Report prepared for California Department of Fish and Game. California Native Plant Society, Sacramento, CA.

Kraetsch, R. 2002. Ten years of oak restoration in the City of Walnut Creek open spaces. USDA Forest Service, Gen. Tech. Rep. PSW-GTR-184. P. 581-590.

Kroeger, T., F. Casey, P. Alvarez, M. Cheatum and L. Tavassoli. 2009. An economic analysis of the benefits of habitat conservation on California rangelands. Conservation Economics White Paper. Conservation Economics Program. Washington, DC: Defenders of Wildlife. 91 pp.

Kueppers, L.M., M.A. Snyder, L.C. Sloan, E.S. Zavaleta and B. Fulfrost. 2005. Modeled regional climate change and California endemic oak ranges. Proceedings of the National Academy of Sciences 102(45):16281-16286.

McCreary, D. 2009. Regenerating rangeland oaks in California. University of California, Division of Agriculture and Natural Resources Publication 2160.

Mc Creary, D. and J. Tecklin. 2005. Restoring native California oaks on grazed rangelands. USDA Forest Service Gen. Tech. Rep. RMRS-P-35. Pp. 109-112.

Tecklin, J., M. Conner and D. McCreary. 1997. Rehabilitation of a blue oak restoration project. USDA Forest Service Gen. Tech. Rep. PSW-GTR-160. Pp. 267-274.

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