Shawna Purvines <shawna.purvines@edcgov.us>

Comments on Bio Resources/ORMP dEIR

1 message

Cheryl <Cheryl.FMR@comcast.net> Mon, Aug 15, 2016 at 3:47 PM
To: Shawna Purvines <shawna.purvines@edcgov.us>

Hi Shawna--

I've attached my comments on the Bio Resources/ORMP draft EIR.

I will also drop a hard copy by the County this afternoon. The envelope will include the comments plus a disk (and a copy disk) that contain references for the comment document.

Please acknowledge receipt of the comments and the readability of the disks.

Thank you--

Cheryl Langley

Bio_ORMP_Comments_August_15_2016.pdf
13761K

Cheryl Langley
5010 Mother Lode Drive
Shingle Springs, CA 95682

Shawna Purvines August 15, 2016
EDC Community Development Agency
Long Range Planning
2850 Fairlane Court, Bldg. C
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Ms. Purvines:
Thank you for the opportunity to comment on the draft Environmental Impact Report (dEIR) for the Biological Resources Policy Update (BRPU) and Oak Resources Management Plan (ORMP); I have the following comments.

Comment 1: "Option A" Project Alternative vs. Project Alternative 2: 30% Retention
Alternative 2 of the dEIR, "Minimum Oak Woodland Retention Requirement," is a misconstrued version of the public request for an equal-weight (co-equal) analysis of an Option A project alternative. Instead, what the consultant has provided is an alternative which requires 30% oak woodland retention on every project site. This is a more ridged project alternative than Option A. Where did this retention proposal come from? To my knowledge, the 30% retention value was not debated in the public forum; apparently this figure was developed without public or Board of Supervisor vetting, without any known source or basis.

An equal-weight (co-equal) Option A project alternatives analysis would provide the BOS with the information necessary to make an informed decision and possibly approve a project alternative that could effectively reduce significant impact to oak resources. Without such an analysis, it is doubtful this project alternative will be evaluated to the extent necessary to make such a determination. And, importantly, the BOS—in their July 22, 2015 meeting—*agreed* it was important to evaluate oak retention standards. But without an equal-weight analysis, a meaningful project alternative will not be prepared. Thus—by default—retention of Option A has been roundly rejected before a complete analysis has been conducted. In effect, it has been predetermined that the County is "not going there." This is contrary to the purpose and spirit of California Environmental Quality Act (CEQA) analysis. And it sends message to the public that "*your participation in the process is not welcome.*"

This asset—oak woodland—*is* worth protecting. And, retention of *Option A requirements in no way impedes development*—but it *does* serve to make certain a project has been assessed to determine if there is a way *the developer can meet project objectives while at the same time retain the maximum number of oaks possible on-site*. If it is *demonstrated* a projected cannot meet fruition under Option A oak retention standards, Option B "kicks in," and other on- or off-site options for oak mitigation become available.

An Option A project alternative makes sense, especially in light of CEQA guidelines that state EIRs must describe alternatives *"…which would feasibly attain most of the basic objectives of the project but would avoid or substantially lessen any of the significant effects of the project…"(14 CCR 1526.6[a]).* (In fact, there is probably no other alternative—other than the **No Project** alternative—that could reduce the project's significant impacts more than an alternative that includes Option A; it is a viable project alternative that deserves co-equal analysis.)

Please include in the final EIR:

- Prepare an equal-weight (co-equal) analysis of an Option A project alternative.
- A discussion of how the decision was made to use a 30% retention rate as the basis for project Alternative 2 (i.e., research papers, ordinances from other California counties, public input, etc.)
- Discuss why Option A was not used as a basis for a project alternative.

Comment 2: BRPU/ORMP Analysis is Based on a Flawed General Plan Update/EIR
As presented in the excerpt below, this project is based in part on analysis and conclusions reached under the Targeted General Plan Amendment/Zoning Ordinance Update (TGPA/ZOU) project:

> This chapter defines the baseline and cumulative conditions against which the environmental effects of the General Plan Biological Resources Policy Update, Oak Resources Management Plan, and Oak Resources Conservation Ordinance project (proposed project) are evaluated. Consistent with the El Dorado County Targeted General Plan Amendment and Zoning Ordinance Update (TGPA-ZOU) Environmental Impact Report adopted by the County BOS on December 15, 2015, the analysis considers impacts from General Plan implementation at 2025 and at 2035.

Source: dEIR, page 4-1 (41/270)

However, the validity of the TGPA/ZOU project/EIR is currently being litigated. If litigation shows that the TGPA/ZOU project and its EIR are not valid/viable—or portions of it are invalidated—it will likewise invalidate this project/EIR. The County would do well to withhold completion of BRPU/ORMP analysis until the TGPA/ZOU matter is "settled," as the outcome of legal action is likely to impact this project. That is, a judgement against one will inevitably negate the other.

As stated many times by the public during both BRPU/ORMP workshops and TGPA/ZOU hearings—the BRPU/ORMP and TGPA/ZOU analyses *should never have been separated;* the two projects are inextricably linked, and analysis should have taken place simultaneously.

Requested Action:

- Please withhold development of the final EIR until TGPA/ZOU litigation has concluded.
- Following litigation, provide in the final EIR a complete analysis of the impact on oak woodlands.

Comment 3: Measure E
Regarding Measure E, the dEIR states *"…the potential effects of this new regulatory condition are not reflected in the analysis of General Plan buildout…"* [1] Measure E has been certified; its impact *must* be evaluated in this EIR.

Requested Action:

- Please withhold development of the final EIR until Measure E implementation has has been established.
- After Measure E implementation parameters have been established, provide in the final EIR a complete analysis of the project's impact on oaks/oak woodlands/wildlife habitat.

Comment 4: 2004 General Plan vs TGPA/ZOU Impacts
The statement made in the dEIR that the impact to oaks/oak woodlands under the TGPA/ZOU is equivalent to the impact under the 2004 General Plan is false. It appears this statement is made based on the conclusion that under both under the 2004 General Plan and the TGPA/ZOU impacts to oaks/oak woodland are "*significant and unavoidable*." But this conclusory statement masks the degree of impact imposed by each version of the General Plan. There is a matter of degree to be evaluated here, too. For instance, this is discussed in the following excerpt:

[1] dEIR, page 4-2 (42/270)

> development projections used for this EIR analysis reflect both historic and recent development patterns in the County as well as the changes to those patterns anticipated as a result of the General Plan and zoning changes adopted under the TGPA-ZOU. Those changes primarily increased the number of locations where development of different types would be allowed within the County and increased the potential for higher intensity development to occur.

Source: dEIR, page 4-3 (43/270)

Thus, the TGPA/ZOU increases the "*number of locations*" and "*potential for higher intensity development*," over development projected under the 2004 General Plan. To say the impact is not greater because both EIRs conclude the impact is "*significant and unavoidable*" masks the fact that the TGPA/ZOU _will_ impact oaks/oak woodlands _*to a greater degree*_ than the 2004 General Plan.[2]

It appears the only area where it is acknowledged that the TGPA/ZOU will have a greater impact than buildout under the 2004 General Plan is in the area of scenic views/vistas. But this is downplayed by stating that because the viewer would be travelling at a high rate of speed along Highway 50, *"...the duration of the view is very limited*": (This is akin to saying the view of a decayed urban area is "not so bad" as long as your exposure to the view is brief.)

> In determining the level of significance of visual impacts related to loss of oak woodlands within the Marble Valley scenic view, it was necessary to consider factors such as the level of viewer exposure and level of expected visual change that would be seen by a given viewer group. The scenic view of Marble Valley that could potentially be affected by the loss of oak woodlands associated with future development would be from westbound Highway 50. Although the conversion of oak woodland to developed uses in this area could result in a change to the scenic view, the change would not be expected to be substantial considering the level of viewer exposure and expected visual change. Because this scenic view is experienced by motorists traveling at high rates of speed along westbound Highway 50, the duration of the view is very limited. Although the rate of oak woodland loss is unknown, future development

Source: dEIR, page 9-14 (208/270)

(**NOTE:** I believe the direction of travel should read "eastbound," not "westbound"—or perhaps it should include both directions.)

The added impact of the TGPA/ZOU, coupled with the elimination of 2004 General Plan mitigation measures (such as the Integrated Natural Resources Management Plan (INRMP) and the Plant and Wildlife Technical Advisory Committee (PAWTAC), when coupled with this proposed BRPU/ORMP (which enables 100% oak removal on any given development site) spells serious decline for oaks/oak woodlands/wildlife habitat in the County. It eliminates important evaluations and mitigation oversight.

The ORMP will have a serious impact on oaks, most specifically on *mature* oak woodlands. Allowing 100% removal of oaks/oak woodland via payment of an in-lieu fee ensures that even if replacement plantings are successful, oak woodlands—especially blue oak (*Quercus douglasii*) woodlands—will not reach an equivalent level of maturity, or attain a comparable wildlife habitat value, for a period in excess of a century.

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[2] Policies adopted under the TGPA/ZOU that will inevitably impact a greater amount of oak/oak woodland acreage are described under Comment 6: Development Densities in Community Regions & Rural Regions, but also include the provision that allows development on slopes ≥ 30%. In addition, it was concluded in the dEIR that the 2004 General Plan would have a "*less than significant*" impact on scenic views/vistas, while the TGPA/ZOU conclusion was that the TGPA/ZOU would have a "*significant and unavoidable*" impact on scenic vistas, even with mitigation implementation (dEIR, pages 9-12 & 9-13 [206 & 207 of 270]).

Please include in the final EIR:

- The impact and value of the reintroduction of the INRMP process and the PAWTAC. If either is deemed an inappropriate addition, discuss why the reintroduction is not feasible.

Comment 5: Development Potential under the Project

While the dEIR, page 4-1 states the proposed project "…*would not directly cause or lead to land development*…" it is clear it ***will*** facilitate development in areas historically constrained by more stringent oak retention standards (Option A, coupled with the absence of Option B). This proposed project will facilitate, and maximize, development as it allows 100% removal of oak resources on any given parcel. Thus, implementation of the proposed policies will lead to development on lands with previously protected tree cover, by a project of any size and density, in any location approved by the Planning Commission/Board of Supervisors (including those currently zoned low density, if granted a General Plan amendment/zoning modification).

The point is, while this dEIR states it is "conservative" in that it projects 100% removal while it "anticipates" lesser removal on development sites, it does not—in fact *cannot*—take into account all projects that will inevitably come forward and request—and be granted—General Plan amendments/zoning modifications. Therefore, the projected loss of **147,146 acres**[3] of woodland is likely, especially so because the majority of high-density development in the county is anticipated to occur at or below the 4,000 foot elevation—the very portion of the County occupied by oak woodlands. And, the highest density developments on the horizon are on land currently zoned lower density, and evaluated as such under this dEIR (by basing impact on 2004 General Plan/TGPA/ZOU development projections). This impact on oak woodlands is exacerbated by the fact that nearly **139,000 acres**[4] could be removed without mitigation because many project types (agriculture, road projects, etc.) are exempt from ORMP mitigation requirements.

The proposed policy will allow development on thousands of acres of oak woodlands important to wildlife—woodlands that may previously have been wholly or partially retained under the 2004 General Plan due to oak Option A retention standards. Retention is important: mature oak woodlands need to be protected—but this proposed project offers **no** protection for mature woodland. It is contrary to good planning, and contrary to what the majority of County residents value most (as revealed in a recent County resident survey).

Comment 6: Development Densities in Community Regions & Rural Regions

Often stated in the dEIR is the concept that project alternatives that limit impact to oaks/oak woodlands in Community Regions would inevitably result in a shift in development to the County's more "rural regions." [5,6,7,8,9,10,11] The problem with this concept is multiple:

- It assumes there is a *definite, established amount* of growth that *must* occur within the County that must be accommodated;
- It assumes high density development is a given—that lesser density development in Community Regions (designed to accommodate oaks/oak woodland) cannot accommodate the "necessary" amount of growth;

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[3] dEIR, page 11-10 (246/270)
[4] dEIR, page 11-11 (247/270)
[5] dEIR, page 10-5 (217/270)
[6] dEIR, page 10-7 (219/270)
[7] dEIR, page 10-8 (220/270)
[8] dEIR, page 10-9 (221/270)
[9] dEIR, page 10-20 (232/270)
[10] dEIR, page 10-22 (234/270)
[11] dEIR, page 10-23 (235/270)

- It ignores the fact that the Planning Commission/Board of Supervisors can shape and ultimately has the authority to limit/prohibit development proposed in "rural regions" of the County;
- It ignores/contradicts the policies/goals/objectives in the TGPA/ZOU that in fact *promote growth and development in the rural areas of the County*.

For instance:

> - The project includes Zoning Ordinance provisions for Agricultural Homestays (Section 17.040.170), Health Resort and Retreat Centers (Section 17.040.170), Agricultural and Timber Resource Lodging (Section 17.040.170) and Ranch Marketing (Section 17.040.260). These uses would be limited to lands where the primary use is agricultural (including forestry). Some uses would be allowable by right; others would require approval of an administrative permit or CUP; others would not be allowed, depending on the use and the zoning district. The project would also provide for farm and food supply stores (Section 17.040.070) and Public Utility Service, Intensive uses (Section 17.21.020) to be located in selected agricultural zoning districts upon approval of a CUP.
>
> The project would provide opportunities for expanded uses on TPZ-zoned land (e.g., Hunting And Fishing Club, Picnic Area, Hiking Trail Allowed By Right; Campground, Ski Area, Health Resort and Retreat Center allowable by CUP). The project would also allow limited residential uses under a CUP if it can be demonstrated that such uses will be compatible with the growing and harvesting of timber (Section 17.40.350). The project would also provide for Industrial, General and Public Utility Service Facilities, Intensive in the FR and TPZ zones (Section 17.21.020) upon approval of a CUP.

Source: TGPA/ZOU Final EIR, page 3.2-11

The TGPA/ZOU will also allow for "*Agricultural and Timber Resource* ***Lodging, of indeterminate size****, allowed by right in proposed AG zone…"* and additional activities to include ranch marketing, and ranch marketing events. [12]

The TGPA/ZOU also eliminated the prohibition on commercial and industrial land use in rural regions, and eliminated the requirement that industrial lands in rural regions have more limited industrial uses.[13] The TGPA/ZOU also allows high-intensity recreational facilities in rural regions (which may include hotel/motel, large amusement complexes, golf courses, ski areas, outdoor entertainment, off-highway vehicle recreation areas, and campgrounds).[14]

Industrial in FR and TPZ may include:

> Industrial, General use would be allowed in FR and TPZ with a CUP. The ZOU glossary characterizes Industrial, General uses as "[m]manufacturing, processing, assembling, or fabricating from raw materials to include any use involving an incinerator, blast furnace, or similar industrial process and any industrial process conducted wholly or partially indoors." Examples cited in the proposed ZOU include lumber mills, batch plants, truss manufacturing, co-generation plants, food, and byproducts processing plants, and fabric mills.

Source: Final EIR, TGPA/ZOU, page 3.2-19

[12] TGPA/ZOU final EIR, page 3.2-15.
[13] General Plan Policy 2.2.1.2; TGPA/ZOU final EIR, page ES 2
[14] Zoning Ordinance Section 17.25.010 and 17.25.020; TGPA/ZOU final EIR, page 3.4-24 & 25

This was done, presumably, to improve the "jobs/housing ratio" in rural areas:

> In addition, the County assumes more new jobs in the rural areas. A major assumption of the County's General Plan is that agriculture and timber industries will remain economically viable during time horizon of the Plan. The viability of these industries is critical to the maintenance of the County's customs, culture, and economic stability. Therefore, the County anticipates there will be a need to accommodate a more balanced jobs/housing ratio in the rural areas to support this economic base.

Source: Letter from D. Defanti to M. McKeever (SACOG) dated March 10, 2013.

Because the TGPA/ZOU policies open rural areas up for residential, commercial, industrial and recreational development on a scale not previously allowed, this negates the notion that rural areas will be "preserved," and high-density development in Community Regions is a necessity. Thus, while it is stated in the dEIR under "Alternatives Considered but Rejected" that a "No Net Loss of Oak Woodlands Alternative" would not be viable because…

> [redacted] This would drive more development into the County's rural areas, particularly those at higher elevations where oaks are less common. This would increase development intensity and habitat loss in those areas and require residents to drive further to reach the commercial and employment opportunities in the community regions, thus increasing air pollution and GHG emissions. Further, this would be incompatible with the General Plan's goals for arranging land uses by intensity, with higher-intensity, more urban and suburban uses in the Community Regions of El Dorado Hills and Cameron Park, which allows for the more rural communities to support lower-intensity land uses and retain their rural character. Specifically, this alternative would conflict with General Plan policies that encourage concentration of high-intensity uses in Community Regions and Rural Centers to preserve the remaining Rural Regions as open space and natural resource areas (including agriculture and timber).

Source: Page 10-5 (217/270)

...it becomes clear that this is a false assumption. Furthermore, unless the "open space" referred to in the final sentence of the excerpt above is protected via conservation easement, deed restriction, or some other mechanism, there is no real commitment to the preservation of that open space. So the questions become: Why isn't *oak retention* considered a viable path? Is it possible to adjust development in Community Regions *and* other areas slated for high-density development to accommodate oak woodland and wildlife habitat?

Please include in the final EIR:

- An analysis of reduced development densities in the Community Regions to accommodate Option A retention standards.
- A re-evaluation of project alternatives such as the "No Net Loss" alternative based on the knowledge that rural areas will be developed to a degree not revealed in the dEIR.

Comment 7: Historic vs. Projected Rate of Woodland Loss

The dEIR presents a County-wide oak woodland coverage reduction of 0.8% for a 13-year period (2002-2015)[15] and concludes, "…the *change in oak woodland coverage in the county indicates that large-scale oak woodland conversion is not occurring," and "[t]his relatively minimal loss of oak woodlands over time indicates that*

[15] dEIR, page 6-60 (134/270)

agricultural <u>*and other activities*</u> *have not resulted in large-scale, permanent oak woodland conversion"* [16] [emphasis added].

The problem here is that this conclusion assumes this reduction rate is a viable indicator, and is likely to apply under this proposed project as the County moves forward. The problem with this is that Option A—which requires oak retention—has been in effect, and has limited oak removal during this period. It is reasonable to assume oak/oak woodland loss would have been greater if Option A were not in effect—if 100% oak removal had been allowed. In addition—significantly—this time period includes the "Great Recession," the most substantial economic downturn since the Great Depression. The recession clearly impacted development in the County.

These "oversights" negate this estimate of oak/oak woodland loss as a relevant impact indicator—and justification—for policies that impact oak woodland. That is, historic loss cannot be applied to a future devoid of Option A oak retention requirements, and economic recession.

Please include in the final EIR:

- A realistic projection of County-wide oak woodland conversion.

Comment 8: Agriculture & Oak Woodland Protection

The impact of agricultural operations on oaks/oak woodlands will be significant, and unmitigated. The dEIR states, "*The Agricultural Activities Exemption could allow for up to 132, 281 acres of impact that are exempt from mitigation requirements*." [17]

With the expansion of activities allowed in agricultural zones by the TGPA/ZOU (entertainment venues, ag worker housing, etc.) it is important to evaluate oak retention/mitigation for agricultural operations as a possible path to oak retention, and retention of "rural character" in rural regions. Ag operations will be moving to a new level under the TGPA/ZOU—they will no longer simply be a family orchard or vineyard; they now include entertainment venues, health resorts and retreat centers, visitor serving uses, ranch marketing, etc.

Still necessary under the TGPA/ZOU is the requirement that agricultural operations meet Best Management Practices (BMPs) when making certain changes to their parcels. However, these BMPs have not been discussed/identified in either the TGPA/ZOU EIR, nor this dEIR. At a minimum, these practices need to be identified/defined, and their likely impact on oak resources, riparian habitat, and wildlife habitat explored.

Similarly, management requirements for agricultural grazing operations need to be identified/defined. (See C. Langley comments dated December 23, 2015, on grazing operations, beginning on page 9) (**NOTE:** Please also note that several comments/questions posed in that discussion have yet to receive responses.)

Regarding grazing operations, oaks enhance these operations, and this adds an incentive for both the County and ranchers to retain oaks:

> Oak woodlands have a productive understory of grasses that support approximately 60% of California's rangelands. For many years oaks were removed from ranchlands until it become clear that forage quality is enhanced by the presence of oaks and degrades in the years that follow the removal of oaks.[18]

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[16] dEIR, page 6-60 (134/270)
[17] dEIR, page 6-65 (139/270)
[18] 2016. California Wildlife Foundation, July 12, 2016, page 1.

Please include in the final EIR:

- Discuss possible oak retention guidelines for agricultural operations when those operations are expanded to include development other than food production activities (e.g. entertainment venues, ag worker housing, etc.)
- Identify/define BMPs for agricultural operations, and discuss how those requirements impact oaks/riparian habitat/wildlife habitat.
- Identify/define grazing restrictions for grazed lands, and discuss how those requirements impact oaks/riparian habitat/wildlife habitat.

Comment 9: Riparian Zone Evaluation & Valley Oak Impacts

It is unclear why riparian buffer zones (setbacks) were established under the TGPA/ZOU process and not under this BRPU/ORMP process. Riparian habitat is relatively scarce, and crucial to numerous wildlife species. In addition, valley oak (*Quercus lobata*)—a species of "special concern" (an endemic species of limited range in the County, and an element of "sensitive habitat") is often a component of riparian habitat. But the County has chosen to establish (and reduce) riparian buffers via the TGPA/ZOU project, and establish valley oak mitigation under the ORMP. This positions this habitat under two very different management scenarios—both of which are devoid of any meaningful acknowledgement/analysis of the biological value of riparian habitat.

The dEIR, page 5-12 (59-60/270), in an apparent attempt to meld the two issues states "*The proposed General Plan revisions are intended to establish a program for County-wide management of impacts to biological resources and mitigation for those impacts with the objective of conserving…wetland and riparian habitat*…" But wetland and riparian habitat are *not* evaluated and "conserved/mitigated" under this proposed project.

When riparian buffers were established (and reduced in size) under the TGPA/ZOU, it was clear there was no scientific basis to guide the establishment of buffer size, and no analysis of the impact of the reduction. This change in riparian buffers needs to be evaluated within this dEIR (along with other numerous impacts to biological resources that are the result of TGPA/ZOU-based revisions.) Importantly—based on the importance of riparian systems and the significant impact of the buffer revision—buffer revisions and/or additional mitigation measures are in order, and must be developed.

Please include in the final EIR:

- Develop riparian buffer/setback standards based on research (including research referenced in the C. Langley NOP comments dated December 23, 2015). Evaluate the impacts of the proposed buffer/setback on oak woodlands/wildlife.

Comment 10: In-Lieu Fee Use

It is important to clarify precisely what the in-lieu feel will be used for. For instance, while it is presumed to be used for purchase of conservation easements, it is unclear if this is in fact the case, especially because the mitigation description in the *Proposed Oak Resources Conservation Ordinance* (Appendix D) does not identify its application:

1. **Mitigation – Oak Woodlands Removal.** If identified Oak Woodlands will be impacted as part of the permit, the applicant shall mitigate for loss of oak woodlands. Mitigation shall occur at the ratio identified in Table 1 (Oak Woodland Mitigation Ratios) using one or more of the following options as specified in the ORMP:
   a. In-lieu Fee payment based on the percent of on-site Oak Woodland impacted by the development as shown in Table 5 (Oak Woodland In-Lieu Fee) in the ORMP;
   b. Off-site Deed Restriction or Conservation Easement acquisition for purposes of off-site oak woodland conservation consistent with Chapter 4.0 (Priority Conservation Areas) of the ORMP;
   c. Replacement planting within an area on-site for up to 50 percent of the total Oak Woodland mitigation requirement consistent with Section 2.4 (Replacement Planting Guidelines) of the ORMP. This area shall be subject to a Deed Restriction or Conservation Easement;
   d. Replacement planting within an area off-site for up to 50 percent of the total Oak Woodland mitigation requirement. Off-site replacement planting areas shall be consistent with Section 2.4 (Replacement Planting Guidelines) and Chapter 4.0 (Priority Conservation Areas) of the ORMP. This area shall be subject to a Deed Restriction or Conservation Easement;
   e. A combination of options a through d above.

Source: Appendix D, page XX-10 (12/14)

This description actually appears to *eliminate* the use of the in-lieu fee as a source of conservation easement acquisition. And, the definition section seems to do the same:

In-lieu Fee: Cash payments that may be paid into the County's Oak Woodland Conservation Fund by an owner or developer as a substitute for a Deed Restriction, Conservation Easement or replacement planting. In-lieu fee amounts for Individual Native Oak Trees, Heritage Trees, and Oak Woodlands as presented in the ORMP may be adjusted by the County over time to reflect changes in land values, labor costs, and nursery stock costs.

Source: Appendix D, page xx-4 (6/14)

Also problematic is the language in the fee study that states that in response to the Mitigation Fee Act (AB 1600; Government code Section 66000 et seq), the fees unexpended or uncommitted five years post-deposit will either be refunded to the current owner of record, or the county "*…may determine that the revenues **shall** be allocated for some other purpose for which fees are collected subject to Section 66000 of the Government Code*."

Reallocation of Remaining Revenues

If the administrative costs of refunding unexpended or uncommitted revenues exceed the amount to be refunded, the County, after a public hearing, notice of which has been published under Government Code Section 6061 and posted in three prominent places within the area of the development project, may determine that the revenues shall be allocated for some other purpose for which fees are collected subject to Section 66000 of the Government Code.

Source: El Dorado County Oak Resources In-Lieu Fees Nexus Study, June 16, 2015, page 50 of78 (53/81)

This puts oak mitigation in a precarious position; funds could easily be used to support numerous other perceived needs—or simply returned to the "owner of record

Please include in the final EIR:

- Define in the dEIR *precisely* what in-lieu fees will be used for.

- Revise language from ***"revenues shall be allocated for some other purpose*"** to **"*revenues shall be dedicated to land conservation or natural lands stewardship."*** This suggested language **provides some flexibility while keeping the use of the funds focused** in the event the County has difficulty expending all the funds for oak woodlands within the five year time frame.

Comment 11: Personal Use Exemption
"Personal use" of oak resources on an owner's property must be managed, otherwise, "pre-clearing" of a site under the guise of personal use is actually encouraged. Also, the exemption for non-commercial agricultural "operations" is excessive and likely to result in loss of oak woodland.

Please include in the final EIR:

- Explain what deters a property owner from "pre-clearing" oaks under the guise of "private use."
- Include a discussion—and some options for managing "personal use"—that may include restricting personal use to certain zoning classifications (i.e., residential parcels of 5 acres or less, for example) and eliminating from "personal use" land zoned for commercial, industrial, and other properties subject to planned development, area specific plans, etc.
- Include a discussion that evaluates incorporating measures that restrict for a period of time—say 10 years—the rezoning of land that has been pre-cleared, even if oak woodland was removed while the land was under a zoning district that *allows* oak tree removal for personal use (parcels of 5 acres or less, for example).

  This discussion is necessary (as is the provision of a measure designed to prevent such behavior) because it is well known—and documented—that sites within the County have been cleared of oak trees immediately prior to development. (Documentation provided upon request.)
- Discuss the impact/benefit of removing the personal use exemption for non-commercial agricultural operations.

Comment 12: Commercial Firewood Harvest
While commercial firewood cutting operations would be required to obtain a permit under the proposed plan, there is no mention of minimum retention standards; Shasta and Tehama counties adopted resolutions calling for 30% crown cover retention for commercial firewood cutting operations.[19]

Please include in the final EIR:
- The impact/benefit of establishing a 30% retention rate for commercial firewood cutting operations.
- The specific criteria (thresholds) used to determine the following:
  - "significant negative environmental impact";
  - "adequate regeneration";
  - "potential for soil erosion"; and
  - "sound tree management practices."

- Discuss specific criteria/thresholds/restrictions applied to restrict removal activity to a level that precludes impact to a level of "significant environmental impact," and that supports "adequate regeneration," avoids soil erosion, and institutes sound management practices.

[19] Standiford, et al., 1996. Impact of Firewood Harvesting on Hardwood Rangelands Varies with Region. California Agriculture, March-April, 1996. Available at: http://ucce.ucdavis.edu/files/repositoryfiles/ca5002p7-69759.pdf

Comment 13: Greenhouse Gas (GHG) Analysis
Attached is a letter provided by the California Wildlife Foundation/California Oaks, dated July 22, 2016 that discusses deficiencies in the GHG analysis performed under this dEIR.

Please include in the final EIR:
- Correct the deficiencies in the GHG analysis/mitigation that are identified in the California Wildlife Foundation/California Oaks letter.

Comment 14: Impact to Soils/Hydrology/Water Quality
The dEIR concludes, "..*the proposed project would have no impacts or less-than-significant impacts in the following resource areas…Hydrology and Water Quality*." [20] But the removal of 147,146 acres[21]--nearly 60% of the County's estimated oaks—will have an impact on these elements, especially when "*up to 138,704 acres of woodland impacts could occur with no mitigation required*" [22] Removal of this quantity of oaks/oak woodland will have a *profound* effect on hydrology and water quality. A July 12, 2016 letter from the California Wildlife Federation reads:

> Oak woodlands protect the quality of greater than two-thirds of California's drinking water supply. They stabilize soil, provide shade, and replenish groundwater.[23]

Comments submitted on the first Notice of Preparation for this proposed project included excerpts from *the Napa County Voluntary Oak Woodland Management Plan* [24] in support of the importance of oaks/oak woodland to soils/hydrology/water quality (see C. Langley comments dated August 17, 2015, pages 15 – 19, attached). And yet this dEIR ignores the importance of oak woodlands to these elements.

Please include in the final EIR:
- A complete assessment of the impact of oak/oak woodland removal on soils/soil stability, hydrology and water quality.

Comment 15: Acorn Replacement Planting
Enough cannot be said about the lack of viability acorn plantings will have in "real world" application. While McCreary is cited in the dEIR as a source in support of acorn planting, McCreary also cautions that the planting of acorns will be impacted by a whole host of factors such as conditions at the planting site, including the kinds of animals present. [25] Because acorns are an important food source for a whole host of animals, acorn plantings are difficult to protect. McCreary also warns that the type of care necessary for survival and growth may not be logistically feasible for remote planting sites,[26] making a difficult prospect more even more susceptible to failure.

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[20] dEIR, page 2-5 (19/270)
[21] dEIR, page 11-10 (246/270)
[22] dEIR, page 11-11 (247/270)
[23] 2016. California Wildlife Foundation, July 12, 2016.
[24] Napa County. 2010. Napa County Voluntary Oak Woodlands Management Plan. October 26, 2010; page 20. Available at: http://www.countyofnapa.org/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=4294973990
[25] McCreary, D.D. Undated. *How to Grow California Oaks*. University of California Oak Woodland Management. Available at: http://ucanr.edu/sites/oak_range/Oak_Articles_On_Line/Oak_Regeneration_Restoration/How_to_Grow_California_Oaks/
[26] McCreary, D.D. Undated. *Living Among the Oaks*: A Management Guide for Woodland Owners and Managers. University of California, Agriculture and Natural Resources, Oak Woodland Conservation Workgroup; publication 21538.

According to McCreary, [27] an effective alternative to directly sowing acorns is growing oak seedling in containers and then planting the saplings out in the field. McCreary indicates propagating oaks in this manner results in starts that "...have higher survivorship than directly planted acorns, but they also cost far more."

Oak woodlands—especially blue oak woodlands—are experiencing poor regeneration rates in many areas of the State. This troubling condition—that of poor regeneration—means the viability of acorn plantings, too, will be problematic, making replacement of woodlands via the planting of acorns a fragile, ineffective strategy.

Please include in the final EIR:

- Identify California counties that have used acorns for replacement plantings, and describe the viability (efficacy) of those plantings for each species of oak. (That is, discuss the locations and specific outcomes of such plantings, include the species planted, the care regime, mortality rate, and the size surviving saplings have achieved over a specified period of time.)

- Efficacy of mitigation needs to be demonstrated. The two studies described in the Dudek memorandum 17A (Hobbs, et al., 2001; Young, et al.,2005) actually *do not* support the supposition that acorn planting is "better" than planting larger stock. McCreary –also cited by Dudek—mentions multiple caveats to acorn planting—as presented in my comments of September 29, 2015. But the difficulties of acorn use have been largely ignored, presumably due to its lower mitigation cost.

Comment 16: Seedling/Sapling Replacement Planting
According to *A Planner's Guide for Oak Woodlands*:[28]

> …ecologists now recognize that replacing a century old tree with 1, 3, or 10 one-year-old seedlings does not adequately replace the lost habitat value of large trees. It has become evident that simply focusing on mitigation plantings based on a tree to seedling ratio is not a sufficient strategy to ensure the viability of oak woodlands. [R]eplacement seedlings as a mitigation measure for removal of older stands of trees cannot meet the immediate **habitat needs** of forest-dependent animal species.

It is apparent that preservation of oak woodland on-site is the preferred "mitigation." Short of on-site preservation, the purchase of oak woodlands that will remain undeveloped in perpetuity is to be preferred over on-site (or off-site) planting of saplings. Revegetation on- or off-site is a poor substitute for mature woodland, especially when value as wildlife habitat is part of the equation. It is likely that the loss of oak woodlands cannot be adequately mitigated under the current ORMP, especially in the absence of Option A retention requirements.

Please include in the final EIR:

- Please specify performance standards for mitigation plantings. For instance, in the Interim Interpretive Guidelines (IIG) (7)(b), page 10, and IIG (7)(c), page 11, replacement plantings are "designed" to achieve oak woodland canopy coverage equal to the canopy removed no more than 15 years from the date of planting. What is the performance standard for the mitigations described in the ORMP?
- Analyze and discuss the relative advantages of oak woodland retention vs. oak woodland replacement.

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[27] McCreary, D.D. Undated. *Living Among the Oaks: A Management Guide for Woodland Owners and Managers*. University of California, Agriculture and Natural Resources, Oak Woodland Conservation Workgroup; publication 21538.
[28] Giusti, G.A. et al (editors). 2005. *A planner's guide for oak woodlands*. University of California, Agriculture and Natural Resources, Publication 3491, second edition.

Comment 17: Mitigation Efficacy/Performance Standards
While mitigation strategies are *identified* in the ORMP, the strategies themselves do not represent vetted processes. *Efficacy* of the measures under "real-world" conditions must be *proven;* performance standards must be incorporated.

Please include in the final EIR:

- Evidence that research-based studies on oak replacement strategies have proven effective in practical application (i.e., do sapling/acorn plantings succeed under conditions/management strategies other than under research conditions).
- Include a discussion of mitigation efforts undertaken by the County. Discuss reason(s) for mitigation failures (such as the mitigation plantings adjacent to Serrano Village D2, and along road project sites within the County). If there have been successful mitigation efforts, describe the location of the plantings, the type of oak replanting that took place (i.e., acorns, container plants, etc.—including the size of the container plants), when they were planted, and the current status of the plantings (size, condition, mortality rate, etc.)
- Given the many examples of failed mitigation efforts in the County, discuss why the public should have confidence that future mitigations will be successful.
- Once again, efficacy based on achieving performance standards should dictate oak tree/woodland mitigation. Please identify in the final EIR specific performance standards (such as amount of canopy cover expected over a given [specific, identified] period of time).

Comment 18: Oak Regeneration
Despite all evidence to the contrary (see attached comments dated August 17, 2015, September 29. 2015 and December 23, 2015) the issue of oak regeneration as a mitigation element seems to have exerted some influence on this project. It is interesting—and confounding—that unsupported "evidence" verbalized by members of the development community during workshops has somehow gained precedence over studies conducted by respected researchers in the field of oak woodlands.

Relying on oak regeneration as a mitigating element for oak loss *is not mitigation*. Saying something will simply replace itself post-loss contradicts the meaning/purpose of mitigation. To identify *non-action* in this instance as mitigation defies logic; it is simply not credible. It is *not* supported by research on oak woodland dynamics.

I have cited numerous studies that discuss blue oak regeneration as inadequate to support the long-term survival of this woodland species in numerous areas of California (see discussion/citations in comments on the initial and second NOP, and in the September 29, 2015 comments to the BOS; reference materials are included for all documents [on disk] with this submitted material). These documents contain citations that describe the problems with blue oak regeneration (the species that will be most impacted [and replanted] as a result of development projects in EDC).

And yet, this reliance on regeneration seems to persist in discussions in this dEIR. For instance, Policy 7.4.4.2 contains the following language:

> **Policy 7.4.4.2:** Through the review of discretionary projects, the County, consistent with any limitations imposed by State law, shall encourage the protection, planting, restoration, and regeneration of native trees in new developments and within existing communities.

Source: dEIR, page 6-36 (110/270)

While it is unclear what "regeneration" means in this context, what *"…the County…shall encourage…regeneration of native trees in new developments…"* actually means, or how it may be "implemented," it is disturbing that this language has any place in this ORMP.

Likewise, under "Commercial Firewood Cutting," the dEIR states, "*In reviewing a permit application, the Planning Department shall consider the following…[w]hether replanting would be necessary to ensure adequate regeneration."* [29]

Not only is the concept of natural regeneration as a replacement for mitigation unacceptable, the Planning Department—a department devoid of expertise in the area of oak woodland management—is tasked with making the decision (in lieu of utilizing a registered arborist).

So what does this mean? Is there an expectation that oak regeneration will *replace* oak mitigation?

Please include in the final EIR:

- Language that removes oak regeneration as a mitigating factor for oak woodland replacement.
- Clarify if "oak regeneration" will *replace* oak mitigation under this ORMP.
- Provide the scientific basis (studies from reputable research institutions) for the adequacy/viability/efficacy of replacing oak mitigation with oak regeneration.
- Cite authorities under CEQA which condone/support/authorize reliance on a natural environmental process as mitigation for the removal of the impacted resource (in this instance, oak woodland).

Comment 19: Heritage Tree Size
Heritage tree size needs to be reduced to 24" diameter at breast height (dbh), if not for all species, for blue oak.

Due to slow growth, poor regeneration rates, and the fact that blue oak growth often ceases after trees reach 26" dbh [30] —it is necessary to establish a Heritage Oak threshold designation for blue oak that is less than the 36" dbh threshold now proposed. It is only reasonable (and necessary) to protect this resource with a separate Heritage Oak threshold.

Because blue oaks are slow growers, Tuolumne County has worked to establish a separate standard for blue oaks under their *old growth oaks* or "specimen oaks" category. [31] Given this acknowledgement that blue oaks—given their slow growth rates and poor regeneration rates—warrant separate consideration, it seems reasonable that El Dorado County establish a separate size requirement for blue oak /Heritage Oak designation.

Comment 20: Definition of "Woodland"
"Oak Woodland" needs to be redefined to include not only standing living oaks, "*…but also trees of other species, damaged or senescent (aging) trees, a shrubby and herbaceous layer beneath the oak canopy, standing snags, granary trees, and downed woody debris in conjunction with [oaks]*."[32] Existing oak woodlands need to be evaluated under these criteria and, *if on-site retention is not possible*, **<u>mitigation for the loss of *all* woodland components</u>** through either conservation easement or fee title acquisition in perpetuity of biologically equivalent (or greater) woodland must take place to ensure replacement of viable

[29] dEIR, page 6-39 & 6-40 (113 & 144/270)
[30] Ritter, L.V. *Blue Oak Woodland.* California Wildlife Habitat Relationships System, California Department of Fish and Game, California Interagency Wildlife Task Group. Available at: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=67340
[31] Michael Brandman Associates. 2012. Tuolumne County Biological Resources Review Guide. December 4, 2012; page 38. Available at: http://www.tuolumnecounty.ca.gov/DocumentCenter/View/204
[32] Michael Brandman Associates. 2012. Tuolumne County Biological Resources Review Guide. December 4, 2012; page 32. Available at: http://www.tuolumnecounty.ca.gov/DocumentCenter/View/204

woodland/wildlife habitat. (Napa County, for instance, evaluates all woodland components and employs a 60/40 retention in *sensitive water drainages*: 60% tree cover; 40% shrubby/herbaceous cover.)[33]

Please include in the final EIR:

- A redefinition of "oak woodland" to include other associated tree and shrub species (understory) to maintain wildlife habitat value; require mitigation to replace these elements as well as oaks.
- Discuss how the definition of oak woodland in the ORMP serves to limit mitigation effectiveness (in terms wildlife habitat value) and how the definition from Tuolumne County (above) supports the wildlife value of woodland.

Comment 21. Enforcement

The County has a poor ordinance enforcement track record; several oak mitigation sites are in poor condition, and there seems to be no effort to rectify failed mitigations. Because past performance is the best predictor of future performance, there is no confidence in the County's ability to ensure successful mitigation.

Please include in the final EIR:

- A discussion regarding the performance standard the County will be held to in terms of accomplishing mitigation success.
- Discuss how reestablishment of the PAWTAC—if tasked with mitigation oversight—could provide confidence that mitigation efforts would be successful. (Otherwise, what assurance does the public have that oak mitigation will be conducted in a manner that results in successful oak replacement?)

Comment 22: Response to NOP Comments

Several issues raised in comments submitted under the NOPs were not answered (e.g., I requested a discussion of how impact significance under Approaches A, B & C to ORMP development was derived, etc.)

I include by reference the comments/discussion included in the NOP comment submission I made on August 17, 2015 and December 23, 2015, and comments made to the Board of Supervisors on September 29, 2015 (attached). I attach these comments for your review and request inclusion of your responses to the issues/comments/questions raised in these documents in the final EIR, or a recirculated EIR. I have also included comments to the Board of Supervisors dated September 29, 2015 that support issues discussed in the NOP comments; I also request the issues raised in that document receive responses.

Conclusion

I thank you for the opportunity to comment and look forward to your response.

Attachments:

1. NOP comments dated August 17, 2015
2. NOP comments dated December 23, 2015
3. Comments to the BOS dated September 29, 2015
4. CA Oaks / CA Wildlife Foundation Letter dated July 22, 2016

References on disk:

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[33] Napa County. 2010. Napa County Voluntary Oak Woodlands Management Plan. October 26, 2010; page 20. Available at: http://www.countyofnapa.org/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=4294973990

- Brandman_TuolumneCounty
- CA_wildlife_foundation.7.12.16
- Defanti_Letter.3.10.15
- Findlay_Riparian
- Fryer_LiveOak
- Giusti_OakImpactMatrix
- Giusti_Planner'sGuide
- Harvey_SpatialDynamics
- Jones&Stokes_RiparianSetbackGuidance
- McCreary.RestoringOakRangelands
- McCreary.StockType
- McCreary_GrowOaks
- McCreary_LivingAmongOaks
- McDonald_Black Oak
- Napa_OWMP
- Phillips_BlueOakSeedlingGrowth
- Ritter_BlueOakWoodland
- Standiford_FirewoodHarvest
- Standiford_ModellingTreePlanting
- Swiecki_FactorsAffectingBlueOakRegene...
- Tecklin_RehabilitationBlueOak
- USDA FS_NortheasternCA_Report
- Verner_BlueOakFoothillPine
- Young_InitialMortality

Attachment 1

Cheryl Langley
5010 Mother Lode Drive
Shingle Springs, CA 95682

Ms. Shawna Purvines, Principal Planner August 17, 2015
EDC Development Agency, Long Range Planning Division
2850 Fairlane Court
Placerville, CA 95667

RE: Notice of Preparation for the Biological Resources Policies Update & Oak Resources Management Plan

Ms. Purvines:
Thank you for the opportunity to comment on the Biological Resources Policy Update (BRPU). I request the following information be included in the draft Environmental Impact Report (dEIR).

<u>Impact to Efficacy of the 2004 General Plan</u>

- Discuss how the removal of specific biological resources mitigation policies will impact the "legitimacy" and "viability" of the 2004 General Plan, since its approval was based in part on the presence of specific mitigation measures (e.g., the Integrated Natural Resources Management Plan, etc.).

- Because both the INRPM and Option A have been eliminated under the BRPU, include a discussion that specifies how the Oak Resources Management Plan (ORMP) satisfies the court decision brought relative to the Oak Woodlands Management Plan. How can both elements (INRMP and Option A) be deleted and yet satisfy mitigation requirements under that decision?

<u>Targeted General Plan Amendment/Zoning Ordinance Update (TGPA/ZOU) Approval/Implementation</u>

Multiple TGPA/ZOU policy changes will impact on oak woodlands—such as the TGPA/ZOU sanctioned conversion of open space to agricultural land—and *<u>will not be evaluated under any EIR</u>*: not under the TGPA/ZOU EIR, and not under the BRPU/ORMP EIR.

Impact to biological resources will be *<u>significant</u>* and *<u>adverse</u>* because agriculture is exempt from oak woodland protection measures (as well as other measures that protect biological resources—riparian protections, and so forth). The TGPA/ZOU will also **amend Policy 2.2.3.1** (**open space** in –PD zones); this will *"…reduce the open space available for wildlife habitat in –PD zones and thereby increase the potential to adversely impact special-status species.*" It will also exempt **Residential Agriculture** from the list of zoning regulations that provide for maintenance of permanent open space, allow development on slopes ≥30 percent, adversely impact riparian woodland, and impact the groundwater resources oak woodlands rely upon.

In addition, Dudek estimates of **<u>oak woodland acreage impacted</u>** are based on the 2004 General Plan, not on TGPA/ZOU policies. Specifically, Dudek excluded an estimate of oak woodlands on slopes ≥30 percent, but **the TGPA/ZOU will enable development on these slopes**. Thus, the estimates in Dudek's *Oak Woodland Impact and Conservation Summary Table* 5 are short-lived, if the TGPA/ZOU is adopted.

- Discuss the impact on the BRPU/ORMP if the TGPA/ZOU is approved. That is, discuss whether a revision of the BRPU EIR will be required to accommodate the additional impacts the TGPA/ZOU will have on elements in the BRPU.

- Explain how the BRPU can legitimately be separated from the TGPA/ZOU evaluation. (The current BRPU is evaluated only in the context of the 2004 General Plan.)
- The TGPA/ZOU was evaluated as if Option A, the INRMP, and *multiple* other mitigations were "viable." Because these mitigations have been stripped away under the proposed BRPU, will the TGPA/ZOU EIR be recirculated if the proposed ORMP is adopted? Please explain.
- Provide information on the TGPA/ZOU impact to oak woodlands (including its impact on oak woodlands in agricultural-zoned lands, and as a result of the reduction in open space requirements, allowance of construction on sites with > 30% slope, the depletion of groundwater that oak woodlands rely upon, etc.)

Support Information for Approaches A, B & C
County staff prepared documents for the November 21, 2014 Biological Resources Workshop that included three **approaches (A, B and C)** to facilitate the completion of the ORMP project description and environmental review (County documents 7A and 7B). On page 5 of Staff Memo 7B, staff included a table that presents three approaches and their relative level of "*significant and unavoidable impacts.*" When asked how these impact levels were derived, staff did not (or could not) answer. References (supporting documentation) were not supplied at that time, nor subsequent to the workshop. Despite the absence of supporting documentation, the Board of Supervisors made the decision to proceed with **Approach A**.

Thus, it is not known what information the impact levels were based upon. This information was not available to the public, and it is reasonable to assume it was not available to the decision making body (Board of Supervisors).

- I am requesting that the evidence/studies/science that served as the basis for the level of impact determinations for **Approaches A, B and C** be made available and included in the dEIR. Please include any and all documentation, (letters, emails, etc.) used to support the impact determinations (such as communications with outside agencies, etc.).

Mitigation Performance
According to *A Planner's Guide for Oak Woodlands*:[1]

> …ecologists now recognize that **replacing a century old tree with 1, 3, or 10 one-year-old seedlings does not adequately replace the lost habitat value of large trees. It has become evident that simply focusing on mitigation plantings based on a tree to seedling ratio is not a sufficient strategy to ensure the viability of oak woodlands.** [R]eplacement seedlings as a mitigation measure for removal of older stands of trees cannot meet the immediate **habitat needs** of forest-dependent animal species.

It is apparent that **preservation of oak woodland on-site is the preferred "mitigation."** Short of on-site preservation, **the purchase of oak woodlands that will remain undeveloped in perpetuity** is to be preferred over on-site (or off-site) planting of saplings. Revegetation on- or off-site is a poor substitute for mature woodland, especially when value as **wildlife habitat** is part of the equation. **It is likely that**

[1] Giusti, G.A. et al (editors). 2005. *A planner's guide for oak woodlands*. University of California, Agriculture and Natural Resources, Publication 3491, second edition.

the loss of oak woodlands cannot be adequately mitigated under the current ORMP, especially in the absence of <u>Option A retention requirements</u>.

<u>Mitigation Strategy</u>
The proposed mitigation options need to be defined—or actually— **<u>redefined</u>**.

According to *A Planner's Guide for Oak Woodlands*:[2]

> [T]he ultimate goal for planting mitigations should be tree establishment and long-term survival. The impact should be compensated for by replacing or providing substitute resources, such as **planting large container-grown trees**, **rather than seedlings or acorns** to expedite the recovery of the lost habitat component, or off-site mitigation actions, or mitigation banking**. However, off-site measures should be considered sparingly and should not be viewed as a convenient way to achieve mitigation objectives; off-site mitigation proposals should be carefully considered so that the strategy *<u>is not abused</u>***.

If replacement planting *is* chosen as a means of mitigation in the ORMP, the mitigation must meet **<u>performance standards</u>**:

- **<u>Please specify performance standards for mitigation plantings.</u>** For instance, in the Interim Interpretive Guidelines (IIG) (7)(b), page 10, and IIG (7)(c), page 11, replacement plantings are "designed" to achieve oak woodland canopy coverage equal to the canopy removed **<u>no more than 15 years from the date of planting</u>**. **What is the performance standard for the mitigations described in the ORMP?**

Acorn planting as mitigation for the removal of mature stands of oaks is wholly inadequate. While it has been stated during ORMP workshops that acorn planting is sometimes the preferred method of achieving oak mitigation, there are many caveats that make this method of oak woodland replacement ineffective.

According to McCreary,[3] the planting of acorns will be impacted by a whole host of factors such as conditions at the planting site, including the kinds of animals present. **<u>Because acorns are an important food source for a whole host of animals, acorn plantings are difficult to protect</u>**. McCreary also warns that the type of care necessary for survival and growth may not be **<u>logistically feasible</u>** for remote planting sites,[4] making a difficult prospect more even more susceptible to failure.

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[2] Giusti, G.A. et al (editors). 2005. *A planner's guide for oak woodlands*. University of California, Agriculture and Natural Resources, Publication 3491, second edition.

[3] McCreary, D.D. Undated. *How to Grow California Oaks*. University of California Oak Woodland Management. Available at: http://ucanr.edu/sites/oak_range/Oak_Articles_On_Line/Oak_Regeneration_Restoration/How_to_Grow_California_Oaks/

[4] McCreary, D.D. Undated. *Living Among the Oaks*: A Management Guide for Woodland Owners and Managers. University of California, Agriculture and Natural Resources, Oak Woodland Conservation Workgroup; publication 21538.

<u>Oak Regeneration and Acorn Plantings</u>

The issue of oak regeneration comes into play when acorn planting is chosen as the path to oak woodland replacement.

According to *A Planner's Guide for Oak Woodlands*:[5]

> …the same factors that prevent or limit **natural regeneration** can also take a heavy toll on artificial plantings. **To be successful, relatively intensive site preparation, maintenance, and protection must usually be provided for several years.**
>
> **There is substantial evidence suggesting that several species, including blue oak, valley oak,** and Engelmann oak (*Quercus engelmannii*) **are not reproducing at sustainable levels in portions of California. <u>Simply stated, there are not enough young seedlings or saplings to take the place of mature trees that die, raising questions about the future of these species in the state.</u>**
>
> **Numerous causes** have been cited, including **<u>increased populations of animals and insects that eat acorns and seedlings, changes in rangeland vegetation</u>, adverse impacts of livestock grazing (direct browsing injury, soil compaction, and reduced organic matter), and <u>fire suppression</u>.** Some people also suspect that **<u>climate change</u>** is a factor...

This troubling condition—that of poor regeneration—means the viability of acorn plantings, too, will be problematic, **<u>making replacement of woodlands via the planting of acorns a fragile, ineffective strategy</u>**.

According to McCreary, [6] **an effective alternative to directly sowing acorns is growing oak seedling in containers and then planting the saplings out in the field**. McCreary indicates propagating oaks in this manner results in starts that "...have higher survivorship than directly planted acorns, but they also cost far more."

Regarding acorn planting, I have the following requests for information:

- Please identify in the dEIR **<u>other counties that utilize acorn planting</u>** for mitigation and **<u>describe the success rate</u>** (efficacy) of such plantings **<u>for each species of oak</u>**. Describe locations at which such mitigation has taken place, and the date of plantings. Please include photographs of the site.
- The *Biological Resources Study and Important Habitat Mitigation Program Interim Guidelines (November 9, 2006),* pages 15-16 (under Discretionary Project Reporting Requirements) specify a **15 year (annual) monitoring period for oak regeneration projects that utilize acorns**. This monitoring period has been changed to 7 years (based most likely on Kuehl bill requirements). **<u>Explain in the dEIR the reason for the monitoring period reduction</u>**. (That is, explain why what

[5] Giusti, G.A. et al (editors). 2005. *A Planner's Guide for Oak Woodlands*. University of California, Agriculture and Natural Resources, Publication 3491, second edition.

[6] McCreary, D.D. Undated. *Living Among the Oaks: A Management Guide for Woodland Owners and Managers*. University of California, Agriculture and Natural Resources, Oak Woodland Conservation Workgroup; publication 21538.

was once acceptable/recommended has been reduced, given the more "protective" nature of the longer monitoring period).

- The IIG (7)(c), page 11 indicates maintenance and monitoring shall be required for a minimum of 10 years after the planting of trees (saplings, etc.) **Explain in the dEIR why this maintenance and monitoring period has been reduced under the ORMP**, given it was once acceptable/recommended and is more "protective."

Mitigation Efficacy

According to the California Environmental Quality Act **(CEQA) 15126.4a1(B)** "*Where several measures are available to mitigate an impact, each should be discussed and **the basis for selecting a particular measure should be identified.***" And, according to the Oak Woodland Impact Decision Matrix[7] conservation planning grounded in science-based information supports the development of sensitive planning scenarios. But, **while mitigation strategies are *identified* in the ORMP, the strategies themselves do not represent vetted processes. *Efficacy* of the measures must be *proven;* evidence must be provided.**

- Please include in the dEIR references for the science-based information used as a basis for mitigation strategies proposed in the ORMP.
- Include a discussion of mitigation efforts undertaken in the County. Discuss **failed mitigations**, and the **reason(s) for their failure**. (Such as the mitigation plantings adjacent to Serrano Village D2—see the following photos.)
- Describe mitigation efforts (oak replanting efforts) that have been **successful** in the County. Describe the location of the plantings, the type of oak replanting that took place (i.e., acorns, container plants, etc.—including the size of the container plants), when they were planted, and the current status (size, condition, mortality rate, etc.) Please include photographs of the site.
- Given the many examples of failed mitigation efforts in the County, discuss why the public should have confidence that future mitigations will be successful. (That is, **past performance is the best predictor of future performance**.)

The following photos were taken of **mitigation plantings** by Serrano Village D2 in "tree shelters." (This village was built around 2001-2003.) Photos taken **June, 2015**.

[7] Giusti, G., et al. 2008. *Oak Woodland Impact Decision Matrix: a guide for planner's to determine significant impacts to oaks as required by SB 1334 (Public Resources Code 21083.4*). UC Integrated Hardwood Range Management Program, 2008.

This is a photo of a "tree shelter" around a blue oak; it was probably planted around the time of adjacent village construction (2001-2003). Photo taken June, 2015.

Note the low success rate of blue oak plantings, even with tree shelters

The tree shelters in this area (as seen in foreground) are mostly devoid of trees (approximately 12-14 years after planting).

<u>Revised Definition of Woodland</u>

"Oak Woodland" needs to be redefined to include not only standing living oaks, "…*but also trees of other species, damaged or senescent (aging) trees, a shrubby and herbaceous layer beneath the oak canopy, standing snags, granary trees, and downed woody debris in conjunction with [oaks]*."[8] Existing oak woodlands need to be evaluated under these criteria and, *if on-site retention is not possible*, **<u>mitigation for the loss of *all* woodland components</u>** through either conservation easement or fee title acquisition in perpetuity of biologically equivalent (or greater) woodland must take place to ensure replacement of viable woodland/wildlife habitat. (Napa County, for instance, evaluates all woodland components and employs a 60/40 retention in *sensitive water drainages*: 60% tree cover; 40% shrubby/herbaceous cover.)[9]

- Explain why the ORMP defines oak woodland in the following manner, and not in the manner described above in the Tuolumne County document (that acknowledges oak woodlands as wildlife habitat):

> <u>Oak Woodlands:</u> An oak stand with a greater than 10 percent canopy cover or that may have historically supported greater than 10 percent canopy cover (California Fish and Game Code Section 1361).

Source: ORMP, page 27.

- Discuss how the definition of oak woodland in the ORMP serves to limit mitigation effectiveness, and how the definition from Tuolumne County (above) expands mitigation viability.

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[8] Michael Brandman Associates. 2012. Tuolumne County Biological Resources Review Guide. December 4, 2012; page 32. Available at: http://www.tuolumnecounty.ca.gov/DocumentCenter/View/204

[9] Napa County. 2010. Napa County Voluntary Oak Woodlands Management Plan. October 26, 2010; page 20. Available at: http://www.countyofnapa.org/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=4294973990

Exempt Actions

- **Exemption for Personal Use of Oak Woodland Resources**. ORMP, page 7: "*When a native oak tree, other than a Heritage Tree, is cut down on the owner's property **for the owner's personal use**.*" This provision for "personal use" is problematic.
  - **Explain what deters a property owner from "pre-clearing" oaks under the guise of "private use."**
  - Include a discussion—and some options for defining "personal use"—that may include **restricting personal use to certain zoning classifications** (i.e., residential parcels of 10 acres or less, for example) and eliminating from "personal use" land zoned for commercial, industrial, and other properties subject to planned development, area specific plans, etc.
  - Include a discussion that evaluates incorporating measures that **restrict for a period of time—say 10 years—the rezoning of land that has been pre-cleared, even if oak woodland was removed while the land was under a zoning district that *allows* oak tree removal for personal use** (parcels of 10 acres or less, for example).

    This discussion is necessary (as is the provision of a measure designed to prevent such behavior) because it is well known—and documented—that sites within the County have been cleared of oak trees immediately prior to development proposal. (Documentation provided upon request.)

- **Exemption for Non-Commercial Agricultural "Operations."** ORMP, page 7: "*Agricultural cultivation/operations, whether for personal or commercial purposes (excluding commercial firewood operations).*"
  - Include in the dEIR why this measure is necessary, and how much oak woodland is potentially impacted by this measure. The El Dorado Irrigation District (EID) is already on the threshold of eliminating a reduction in water rates for such operations, thus threatening their viability. Thus, while EID policies undercut such activity, the ORMP allows for the removal of oak resources minus mitigation. A reasoned outcome is that oaks are removed for a "hobby" agricultural operation that has little chance of being maintained.

Commercial Wood-Cutting Operations

There are too few restrictions placed on commercial firewood cutting operations. This lack of restrictions places oak woodland—especially blue oak woodland—in jeopardy.

The following is an excerpt from page 11 of the ORMP:

> Commercial firewood cutting operations shall also require a tree removal permit if not approved under an oak woodland removal permit. In reviewing a tree removal permit application for commercial firewood cutting operations, the County shall consider the following:
>
> - Whether the removal of the tree(s) would have a significant negative environmental impact;
> - Whether the tree proposed for removal is a Heritage Tree;
> - Whether replanting would be necessary to ensure adequate regeneration;
> - Whether the removal would create the potential for soil erosion; and
> - Whether any other limitations or conditions should be imposed in accordance with sound tree management practices.

- Please include in the dEIR the **specific criteria (thresholds)** used to determine the following:
    - o "significant negative environmental impact";
    - o "adequate regeneration";
    - o "potential for soil erosion"; and
    - o "sound tree management practices."

- Include in the dEIR a discussion of specific criteria/thresholds/restrictions applied to **restrict removal activity** to a level that precludes impact to a level of "significant environmental impact," and that supports adequate regeneration, avoids soil erosion, and institutes sound management practices.
- While **commercial firewood cutting operations** would be required to obtain a permit under the proposed plan, **there is no mention of minimum retention standards**. Shasta and Tehama counties adopted resolutions calling for **30 percent crown cover retention.**[i]

Photo Source: Standiford, et al., 1996. *Impact of Firewood Harvesting on Hardwood Rangelands Varies with Region.* California Agriculture, March-April, 1996.

Blue oak firewood en route to Bay Area markets.

Photo Source: Cobb, J. 2015. California Oaks, letter to the California Board of Forestry and Fire Protection and the California Air Resources Board dated June 29, 2015 (Attachment 1).

In-Lieu Fee Use

- **Define in the dEIR exactly what the in-lieu fee will be used for**. Include a discussion of the benefit of a clause that addresses unexpended funds in the following manner: change existing language from ***"revenues shall be allocated for some other purpose"*** to ***"revenues shall be dedicated to land conservation or natural lands stewardship."*** This suggested language **provides some flexibility while keeping the use of the funds focused** if the County has difficulty expending all the funds specifically for oak woodlands within the five year time frame.

Willing Sellers in Community Regions/Rural Centers

- Discuss how allowing **willing sellers** in Community Regions and Rural Centers to "sell" their property into **conservation easement** status would impact County conservation efforts. Discuss the reasoning behind *not* allowing willing sellers in these designations to sell, and discuss whether or not this restriction is based upon habitat evaluation (study).

Site Concurrence

- Include an evaluation of the viability/impact of **site concurrence by the California Department of Fish and Wildlife** (CDFW) in the process of establishing **conservation easements.** At least one county (Tuolumne) recommends dedication of such lands to a land conservation group **approved by the county with concurrence** by CDFW.[ii] Such concurrence would ensure easements provide the maximum benefit to wildlife.
- Discuss how this site concurrence by CDFW may assist developers with identification of appropriate conservation zones.

Advisory Body

- Evaluate in the dEIR the establishment of an **advisory body** (like PAWTAC) to review mitigation plans, mitigation implementation, and efficacy. (Ideally this advisory body would make recommendations to appropriate governing bodies, work with land conservation groups, and be responsible for homeowner education (protection of oaks in the landscape).

Initial Study
Following is a discussion of the Initial Study. The dEIR **will evaluate environmental impacts in the following areas**:

4.0 PROBABLE ENVIRONMENTAL EFFECTS AND SCOPE OF THE EIR

The EIR for the proposed project will focus on the resource areas/issues germane to this particular project. The EIR will evaluate the potentially significant environmental impacts of the proposed project and will evaluate whether there are feasible mitigation measures that may lessen or avoid such impacts. As the proposed project would amend the County's General Plan and influence development activities throughout the County and does not include any specific construction or development, the impact analysis will be programmatic and cumulative in nature. The EIR will also identify and evaluate alternatives to the proposed project. The EIR will evaluate potentially significant environmental effects related to the following environmental issues:

- Aesthetics
- Agricultural and Forestry Resources
- Biological Resources
- Greenhouse Gas Emissions
- Land Use and Planning

The following issues are not to be covered (although Greenhouse Gas Emissions [GHG] are listed in both areas—to be covered, and not to be covered, I assume from additional discussion in the Initial Study that GHGs will be covered, but would like this clarified).

As evaluated in the Initial Study, it is not anticipated that impacts would occur within the following environmental topic areas, and therefore these specific environmental issues will not be evaluated further in the EIR.

- Air Quality
- Cultural Resources
- Geology/Soils
- Greenhouse Gas Emissions
- Hazards and Hazardous Materials
- Hydrology/Water Quality
- Mineral Resources
- Noise
- Population/Housing
- Public Services/Utilities
- Transportation

Air Quality/Greenhouse Gas Emissions

While GHGs are listed on both the "to do" and "not to do" lists, the Initial Study acknowledges **GHG emissions** from the removal of oak woodlands "***could contribute to adverse climate change and could impair the ability of a region…to achieve GHG reductions required under state law***."

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
VII. GREENHOUSE GAS EMISSIONS – Would the project:				
a) Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?	☒	☐	☐	☐
b) Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of greenhouse gases?	☒	☐	☐	☐

El Dorado County Biological Resource Policy Update and Oak Resources Management Plan Project

a, b) The project proposes amendments to biological resources policies contained in the County's General Plan and adoption of an ORMP. While, the project does not include new construction or land uses that would generate greenhouse gas (GHG) emissions, development that proceeds under the proposed General Plan amendments and ORMP could alter and/or remove vegetation communities, including oak woodlands, and/or oak trees. Conversion of woodlands and other natural vegetation communities to developed uses could generate GHG emissions during the construction process. Further, oak woodlands and other natural vegetation communities serve as a carbon sink, in that they remove GHGs from the atmosphere and store carbon. Therefore, removal of woodlands and other natural vegetation communities could release GHGs into the atmosphere and reduce the natural absorption of GHG emissions. These effects could contribute to adverse climate change effects and could impair the ability of the region and the state to achieve GHG reductions required under state law. These effects will be evaluated in the EIR.

And yet, the following notation in the Initial Study stands in contradiction:

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
III. AIR QUALITY – Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☐	☒
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☐	☐	☒
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?	☐	☐	☐	☒
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☐	☒
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☐	☒

- Include in the dEIR a discussion of this contradiction.
- Discuss the impact on air quality caused by the increase in development—residential, commercial, industrial, etc.—and the associated increase in emissions from increased vehicular traffic, construction activities, etc. **(Developers are now constrained under Option A restrictions, in combination with the lack of an in-lieu fee option; now that numerous mitigation options will be available, growth/development will inevitably occur.)**
- Include in the dEIR a complete evaluation of Air Quality issues, including GHGs, and other emissions from commercial woodcutting operations, and the large-scale removal of oaks for planned development projects, specific area plans, agricultural operations, etc.
- Include in the dEIR a complete evaluation as required under AB 32, as described below.

Assembly Bill (AB) 32 (See also Attachments 1 & 2).
The goal of AB 32—the California Global Warming Solutions Act—is to **reduce** carbon dioxide (CO_2) emissions by 2020 to 1990 levels, with a further 80 percent CO_2 reduction by 2050. The bill emphasizes the evaluation of CO_2 associated with the conversion of forests to other uses. **Oak woodland CO_2 emission effects must be considered for projects that convert native forests to non-forest use.** Both direct CO_2 emission impacts from dead tree disposal and cumulative impacts due to the loss of future increases in live tree carbon sequestration represent a biological emission subject to CEQA analysis and mitigation. Live tree biomass (including roots), standing dead tree biomass, and wood lying on the ground are to be evaluated to measure oak woodland biological emissions under CEQA.

CEQA CO_2 questions to be answered include:

- how much potential CO_2 sequestration over the next 100 years will be lost due to impacts to live native trees three (3) inches or greater diameter at breast height (dbh); and
- how much sequestered CO_2 will be released if the live trees, standing dead trees or woody debris are burned?

The County *must* analyze and mitigate CO_2 biological emissions associated with the land use changes that result in the loss of oak woodland sequestration capacity (the conversion of oak woodlands to non-forest use) and CO_2 release from burning oak debris/wood. If such an analysis is not done, the County disregards not only CEQA, but the Office of Planning and Research (OPR) guidelines, California Attorney General opinions and Court decisions. (See Center for Biological Diversity, et al. v. City of Desert Hot Springs, et al. (2008) Riverside County Superior Court - Case No. RIC 464585 and Berkeley Keep Jets Over the Bay Committee vs. Board of Port Commissioners (2001) 91 Ca.App.4th 1344, 1370-71.)

Because California has designated CO_2 emissions a grave human health risk, local jurisdictions cannot invoke ministerial or overriding considerations in determining proportional mitigation for carbon biological emissions due to oak woodlands conversion to non-forest use. It is considered an abuse of discretion to declare an inadequately mitigated oak woodland conversion a **public benefit** when in fact woodland conversion represents a demonstrable **public health hazard**.

- Provide a complete analysis as required under AB 32.

Cultural Resources

Disregarding oaks and oak woodlands as important cultural resources is an error. Many cultural resources are closely associated with oaks and oak woodlands, and this important aspect needs to be evaluated in the dEIR.

A. CULTURAL/HISTORICAL

Artifacts of the Native American people who historically lived in Napa County tend to be co-located with oak woodlands, which provided them with the acorns they relied upon for food. According to local historian Lin Weber, shamans of the Wappo people would offer prayers for the health of the oak trees, and the Wappo named months of the year after the seasonal phases of oaks.[3] Present day oak stands or individual trees may have historical significance due to past events or structures that were associated with them. Many historical accounts mention the trees and the use of specific trees as landmarks or as boundary markers. The earliest European settlers found refuge from the hot valley sun for themselves and their livestock under oaks and benefited economically from the use of oaks for building material and firewood. Oak woodlands also created venues for recreation and public events. Napa County's remaining oak woodlands continue to serve as a reminder of our cultural and historical heritage.

Source: Napa County. 2010. *Napa County Voluntary Oak Woodlands Management Plan*. October 26, 2010. Page 8.

- Discuss in the dEIR the cultural significance of oaks. Identify specific oaks/oak woodlands/woodland areas that have historical significance in El Dorado County, and describe the basis for their significance.

Geology and Soils

While the Initial Study cites no impact to geology and soils from the anticipated removal of oaks and oak woodland, it is nonetheless known that numerous significant impacts can occur.

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
VI. GEOLOGY AND SOILS – Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☐	☒
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?	☐	☐	☐	☒
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?	☐	☐	☐	☒
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☐	☒

Removal of oaks—especially on sloped land—can cause serious soil erosion, and can cause slope instability (landslides). The presence of oak trees can also facilitate the uptake of moisture from septic systems and improve their performance (VI)(e).

In fact, the ORMP, page 8, cites the potential for erosion during woodcutting operations, and cites (page 4) the following benefits from the preservation of oaks and oak woodlands:

1.4 Economic Activity, Land, and Ecosystem Values of Oak Resources

Agriculture and recreation-based tourism are important economic generators in El Dorado County. Oak resources provide value for these activities, including forage value for ranching, soil retention and watershed function benefits that contribute to agricultural activities, and aesthetic value for agri-tourism. Oak resources contribute to soil retention and provide watershed benefits, which have benefits to the agricultural community. Deer and other game species are dependent on oak woodland habitat and provide recreational hunting opportunities, which can generate revenues for ranching land owners through hunting leases. Oak resources contribute to a high-quality visit for recreation tourists, whose activities may include camping, fishing, hiking, bird-watching, and equestrian trail riding.

Studies have also concluded that the presence of oak resources enhances property value by providing shade, wind breaks, sound absorption, land use buffers, erosion control, and aesthetic beauty. Oak resources also contribute to healthy lands and watersheds. They do this by providing habitat for animals, maintaining water quality, and improving soil characteristics. Oak resources have also been identified as a valuable component in greenhouse gas reduction, trapping and storing atmospheric carbon dioxide.

Other sources also identify oaks and oak woodlands as providing erosion control and soil stability.

C. Erosion Control

Oaks help control soil erosion in several ways. Oak woodland canopy intercepts raindrops and dissipates rainfall energy, reducing potential surface erosion. Oak leaf-fall and twigs that accumulate on the soil surface under oak woodland canopy also provide further protection against the erosive action of rainfall. In addition, tree roots and their associated symbiotic soil fungi promote the formation and stability of fine and course soil aggregates which help to promote soil cohesion and stability, reducing the risk of landslides and gully/ rill erosion. Oak woodlands located on soils and slopes prone to erosion can also help prevent degradation in water quality and uphold soil/ land productivity. The planting of oaks in areas historically known to support oak woodland that currently exhibit accelerated erosion from lack of tree cover can help to stabilize and prevent further erosion in these areas.

Source: Napa County. 2010. *Napa County Voluntary Oak Woodlands Management Plan*. October 26, 2010. Page 9.

- Provide in the dEIR a complete description of the potential impacts of oak tree/oak woodland removal, including the impact on soil stability, erosion, septic tank performance, etc.

Hazards/Hazardous Materials

In El Dorado County, the removal of oaks and oak woodland can disturb layers of soil and rock **containing asbestos.**

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
VIII. HAZARDS AND HAZARDOUS MATERIALS – Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☐	☒
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☐	☒
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒

- Include in the dEIR a discussion of oak woodlands that are located in areas known to be asbestos bearing. Describe and map those areas, and include the land use designations in those areas.

Hydrology/Water Quality

The removal of oaks/oak woodlands will have broad impact on hydrology/water quality; the dEIR needs to discuss/disclose these impacts. In fact, the ORMP, page 4 describes the benefit of oak tree/oak woodland retention on hydrology:

1.4 *Economic Activity, Land, and Ecosystem Values of Oak Resources*

Agriculture and recreation-based tourism are important economic generators in El Dorado County. Oak resources provide value for these activities, including forage value for ranching, soil retention and watershed function benefits that contribute to agricultural activities, and aesthetic value for agri-tourism. Oak resources contribute to soil retention and provide watershed benefits, which have benefits to the agricultural community. Deer and other game species are dependent on oak woodland habitat and provide recreational hunting opportunities, which can generate revenues for ranching land owners through hunting leases. Oak resources contribute to a high-quality visit for recreation tourists, whose activities may include camping, fishing, hiking, bird-watching, and equestrian trail riding.

Studies have also concluded that the presence of oak resources enhances property value by providing shade, wind breaks, sound absorption, land use buffers, erosion control, and aesthetic beauty. Oak resources also contribute to healthy lands and watersheds. They do this by providing habitat for animals, maintaining water quality, and improving soil characteristics. Oak resources have also been identified as a valuable component in greenhouse gas reduction, trapping and storing atmospheric carbon dioxide.

And yet, the Initial Study does not acknowledge this benefit, nor the impact the removal of oaks/oak woodland will have on hydrology—and, by association—water quality.

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
IX. HYDROLOGY AND WATER QUALITY – Would the project:				
a) Violate any water quality standards or waste discharge requirements?	☐	☐	☐	☒
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?	☐	☐	☐	☒
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	☐	☐	☐	☒
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☐	☐	☐	☒
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☐	☒
f) Otherwise substantially degrade water quality?	☐	☐	☐	☒
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☐	☒
i) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☒
j) Inundation by seiche, tsunami, or mudflow?	☐	☐	☐	☒

- Include in the dEIR a complete discussion of the impacts of oak/oak woodland removal on hydrology/water quality.
- Discuss the impact on oaks/oak woodland that will occur as a result of new development that is groundwater dependent, and the impact on County residents that rely on groundwater resources.

Below is a discussion of some issues related to oak/oak woodland removal and hydrology/water quality from other sources.

B. Flood Protection

The Napa River is historically prone to flooding, causing damage to homes and vineyards within its floodplains. Oak woodlands play a part in minimizing the strength and effect of the river's floodwaters. Oaks slow the eroding energy of rainfall with their canopies by temporarily hold rainwater on their leaf and stem surfaces during a rainstorm, increasing the amount of time rain takes to reach the ground and contribute to runoff. Oak woodland canopies capture 20-30% more rainfall than do grasslands, and their contribution to organic matter in the soil improves its water holding capacity.[4] As a result, they have a high capacity for detaining peak flows from rainfall events that would otherwise run in larger volumes and at higher velocities into streams, contributing to flooding, erosion, and sediment and nutrient concentrations that can harm water quality. The greatest flood protection/ attenuation benefits related to tree canopy cover are in watersheds that quickly concentrate flows and pose a risk of flash flooding and in areas where runoff conveyance is already near capacity. Oak trees also capture and transpire moisture from the soil during the growing season. Compared to annual vegetation, oaks can extract water from the soil profile to a greater depth. Consequently, soils under oak woodland canopy are able to absorb and hold greater amounts of rainfall than equivalent soils with only annual grassland cover. This extra storage capacity further reduces the potential for flooding during the rainy season and promotes groundwater recharge.

Source: Napa County. 2010. *Napa County Voluntary Oak Woodlands Management Plan*. October 26, 2010. Page 8 - 9.

D. Water Quality Protection

Oak woodlands, whether located on the hillsides or on level lands near streams, play an important role in protecting water quality. By minimizing soil erosion as noted above, oak woodlands can help reduce sediment transport and washing of fine sediments into local waterways. High levels of sediment in waterways can negatively impact the aquatic food supply by reducing habitat available for fish, aquatic invertebrates and other organisms important to the diets of fish and birds. The Napa River is currently listed as impaired for sediment and a Sediment Total Maximum Daily Load (TMDL) is in the process of being adopted by the State.

The contribution of oaks and other vegetation to erosion prevention near waterways is especially important if soils contain excessive nutrients, pathogens or high levels of toxic material (natural or human concentrated), such as chemical contaminants, mercury or other heavy metals. Putah Creek, for example, has elevated levels of mercury in the soils of the bed and banks of its tributaries and is the focus of State regulatory efforts (TMDL) to reduce mercury levels. Oaks and other vegetation also help reduce soil contamination by absorbing heavy metals, fertilizer nutrients, and pesticides from the soil and intercepting sediments containing these pollutants, thereby preventing these materials from reaching surface waters. Oaks and associated permanent vegetation along waterways can also reduce potential waterway contamination from airborne pesticide or herbicide drift, since oak foliage can intercept airborne pesticides/ herbicides.

Source: Napa County. 2010. *Napa County Voluntary Oak Woodlands Management Plan*. October 26, 2010. Page 9 - 10.

Noise
The large-scale removal of oaks for some projects—commercial woodcutting operations, planned development projects, specific area plan implementation, agricultural operations, etc., will have an impact on noise levels in the County.

- Please include in the dEIR a discussion of noise from the activities described above, and describe the mitigation measures that may be employed to reduce the impact (e.g., limitations on the hours of operation of chain saws, dozers, or other tree removal equipment).

Population/Housing
There will inevitably be an increase in the amount of housing (and therefore population) as a result of the adoption of the ORMP. As stated under Air Quality, **developers are now constrained under Option A restrictions, in combination with the lack of an in-lieu fee option. Now that numerous mitigation options will be available, growth/development will inevitably occur.**

- Discuss the impact of the increase in population on County services, etc., that will result from ORMP adoption.

Public Services/Utilities

	Potentially Significant Impact	Less Than Significant with Mitigation Incorporated	Less Than Significant Impact	No Impact
XVII. UTILITIES AND SERVICE SYSTEMS – Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒

The removal of oak trees/oak woodland can have a significant impact on the need to construct storm water drainage facilities (see discussion under Hydrology/Water Quality).

- Include in the dEIR a discussion of the impact of oak/oak woodland removal on hydrologic patterns, and how that may result in the need to construct new storm water drainage facilities, etc.

Project Alternatives
I respectfully request that the following project alternatives/alternative elements be evaluated:

Project Alternative 1. Retention of the Option A oak retention schedule. Oak retention should be *the* priority. Other alternatives/mitigations should be utilized **only after it has been determined the project cannot meet the Option A retention schedule through any reasonable means.** A discussion of the necessity of Option A retention follows.

The Standiford Study[10] (**NOTE:** This study was relied upon for development of the County's IIG.) According to Standiford, the results of this study (cited in the footnote below) call into question whether planted stands adequately mitigate the loss of mature stands. The mitigated blue oak stand wildlife species list (specific to the Sierra Nevada foothills) was compared to a natural blue oak stand, averaging 10 inches dbh, with a 30 percent canopy cover. The natural stand was assumed to have small and medium size downed wood, snags, acorns and trees with cavities and was projected to have 102 vertebrate wildlife species. The number of vertebrate species projected to occur in a mitigated stand—after 50 years—was 73 species (1 amphibian, 40 bird, 19 mammal, and 13 reptile species). The results of this study underscore the fact that blue oak woodlands develop habitat conditions slowly, and that it may take in excess of 50 years to replace mature habitat that is lost in a particular project.

The results suggest it is important to evaluate if tree planting is a viable method of mitigation, especially because many important habitat elements such as cavities, acorns, snags, and woody debris may not be mitigated—at least in the 50-year interval evaluated in the study. **Thus, it is important to conserve oak woodland in a natural state, whenever possible.**

At the June 22, 2015 Biological Resources meeting, the Board of Supervisors agreed it was important to evaluate the addition of oak retention standards to the ORMP process.

> **A motion was made by Supervisor Ranalli, seconded by Supervisor Veerkamp to Approve this matter, Adopt Resolution's 108-2015 and 109-2015 and direct staff to:**
> **Consider project alternatives as part of the environmental review process including:**
> **1) Adding oak resource retention standards;**
> **2) Options for Individual Oak Tree (IOT) replacement mitigation (e.g. acorn to 15 gallon potted tree) and associated analysis of the implications for the In-lieu Fee Nexus study based on these options, and**
> **3) Oak resource mitigation requirements related to discretionary and ministerial projects.**

Mitigation options should only be entertained for those projects that ***absolutely*** **cannot come to fruition without some deviation from Option A retention standards.** ***Incentivizing*** oak woodland retention rather than ***requiring*** retention is not an acceptable option, **nor is establishing a policy that allows 100 percent removal of oaks**.

For reasons cited in the Sandiford study (previously described), the following project alternatives should be considered as well.

Project Alternative 2. Redefinition of **"Oak Woodland"** to include other associated tree and shrub species (understory) to maintain wildlife habitat value; require mitigation to replace these elements as well.

Project Alternative 3. Redefinition of a Heritage Tree as 24" dbh—**if not for all oaks, for blue oaks** (*Quercus douglassi*). (A discussion follows that identifies why this change is essential.)

The Standiford Study[11] (**NOTE:** This study was relied upon for development of the County's IIG.)

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[10] Standiford, R., et al. 2001. *Modeling the Effectiveness of Tree Planting to Mitigate Habitat Loss in Blue Oak Woodlands.* USDA Forest Service General Technical Report PSW-GTR-184, 2002.

[11] Standiford, R., et al. 2001. *Modeling the Effectiveness of Tree Planting to Mitigate Habitat Loss in Blue Oak Woodlands.* USDA Forest Service General Technical Report PSW-GTR-184, 2002.

This study modeled development of blue oak (*Quercus douglasii*) stand structure over 50 years after planting. The growth model was based on actual blue oak stand age and structure data (Standiford 1997). For this study, data was collected from 55 sample blue oak trees in a ten-year old blue oak plantation at the Sierra Foothill Research and Extension Center in Yuba County, California.

In this study, two different management regimes were utilized, a **high management** intensity scenario that assumed these stands would **average 2 inches** dbh after **10 years**, and there would be a 90 percent seedling survival. A **moderate management** scenario assumed that the stands would **average 1.5 inches** dbh, with an 85 percent seedling survival. **These assumptions are based on actual plantation growth** (McCreary 1990, 1995a, 1995b; McCreary and Lippit 1996; McCreary and Tecklin 1993) **and observations of operational restoration projects.**

For a planting density of **200 trees per acre 10 years** after planting (under a high management intensity), it was anticipated trees would average 2 inches dbh with 90 percent survival; under moderate intensity management, trees were anticipated to average 1.5 inches dbh with 85 percent survival, and **20 years** after planting: 2.5, 2.0, respectively.

Canopy cover after 50 years was projected to range from 7 to 33 percent, with an average dbh after 50 years ranging from 3.4 to 4.1 inches. Even under fairly aggressive restoration efforts the largest mean diameter of the stand was quite small, only 3.9 inches, with a canopy cover of 33 percent.

The following photographs serve to illustrate the growth rates for blue oak.
The blue oaks depicted below are **10-16 years old**.[12]


- Large blue oaks are likely **153 to 390 years old** (White, 1966).
- Growth is extremely slow ***or even ceases*** after trees reach **26 inches dbh** (McDonald, 1985).[13] (**dbh**=diameter at breast height: 4 feet 6 inches from ground.) Thus, many blue oaks—although extremely old—**will never reach Heritage Tree status**.

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[12] Phillips, R. L., et al. 1996. Blue Oak Seedlings May be Older than they Look. California Agriculture, May-June 1996. Available at: http://ucanr.edu/repositoryfiles/ca5003p17-69761.pdf
[13] Ritter, L.V. Undated. *Blue Oak Woodland.* California Wildlife Habitat Relationships System, California Department of Fish and Game, California Interagency Wildlife Task Group.

The blue oaks on this page illustrate a point. Although one *has* achieved Heritage Oak status, one can see the tremendous size required to arrive at Heritage Oak status.

This blue oak **IS NOT** a Heritage Oak, it is **32.5” dbh**.

•

This blue oak **IS** a Heritage oak **by one inch**—**37” dbh**.

Because blue oaks are slow growers, **Tuolumne County** has worked to establish a separate standard for blue oaks under their *old growth oaks* or **"specimen oaks"** category.[14] Given this acknowledgement that blue oaks—given their slow growth rates—warrant separate consideration, it seems reasonable that **El Dorado County establish a separate size requirement for blue oak for Heritage Oak designation**.

In addition, it is known **blue oak regeneration** is a problem in many areas of the State. In fact, "***Few areas can be found in California where successful recruitment of blue oaks has occurred since the turn of the century" (Holland, 1976).***[15]

For these reasons—**slow growth, poor regeneration rates**, and the fact that **blue oak growth often ceases after trees reach 26" dbh**—it is necessary to establish a threshold for Heritage Oak designation for blue oak that is less than the 36" dbh threshold now proposed. It is only reasonable (and necessary) to protect this resource with a separate Heritage Oak threshold designation.

Growth Estimates for Black and Live Oak

The growth rates discussed previously for blue oak demonstrate what can be expected in terms of replant growth rates in the Western portion of El Dorado County. **But other oak species exhibit slow growth rates as well.** According to McDonald,[16] black oak (*Quercus kelloggii*) growth rates (from acorns) are estimated to be 3.4 inches dbh at 20 years and 9 inches dbh at 50 years. Interior live oak (*Quercus wislizeni*) is also reported as slow-growing.[17] These oaks, too—all oaks—would benefit from a redefinition of "Heritage Oak" to 24" dbh.

> **Project Alternative 4**. Require **sapling/specimen tree replacement** for oak mitigation; **eliminate the option for acorn planting**.
>
> **Project Alternative 5**. Establish a **minimum retention standard** for commercial firewood cutting operations, and define standards for site protection.
>
> **Project Alternative 6**. **Application of a more robust mitigation ratio.** A revision of the mitigation ratios to a 2:1 mitigation ratio (at a minimum), and up to 5:1 in the case of environmentally sensitive areas, would motivate the developer to look more seriously at oak woodland retention, and would ensure the preservation of more oak woodland.

[14] Michael Brandman Associates. 2012. Tuolumne County Biological Resources Review Guide. December 4, 2012; page 38. Available at: http://www.tuolumnecounty.ca.gov/DocumentCenter/View/204

[15] Ritter, L.V. Undated. Blue Oak Woodland. California Wildlife Habitat Relationships System, California Department of Fish and Game, California Interagency Wildlife Task Group. Available at: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=67340

[16] McDonald, P.M. Undated. *California black oak (Quercus kelloggii).* Available at: http://www.na.fs.fed.us/pubs/silvics_manual/volume_2/quercus/kelloggii.htm.

[17] Fryer, Janet L. 2012. Quercus wislizeni. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/ [2015, February 6].

Requests for Clarification

- Provide in the dEIR a **detailed map** of the Important Biological Corridors (IBCs) and Priority Conservation Areas (PCAs). This is necessary to provide the public with the information necessary to determine which parcels are included—or excluded—from the IBCs and PCAs.
- **BRPU Decision Point 3: "*Determine whether to require undercrossings for future four- and six-lane roadway projects to provide for wildlife movement, and if so, determine specific standards for undercrossings (i.e., size, location).*"**

  It is crucial to provide wildlife undercrossings (or overcrossings) particularly (although not exclusively) where roadways cross streams, creeks, seasonal creeks, other drainages, and riparian areas. Wildlife are most likely to frequent, and most likely to attempt roadway crossings at these sites. Providing wildlife undercrossings/overcrossings supports both wildlife preservation and motorist safety. However, some clarification is necessary in this instance.

  > **A motion was made by Supervisor Ranalli, seconded by Supervisor Frentzen to require, when necessary, undercrossings for future four (4)-, six (6)- and eight (8) - lane roadway projects to provide for wildlife movement.**
  >
  > **Yes:** 5 - Mikulaco, Veerkamp , Frentzen, Ranalli and Novasel

- Please specify in the dEIR the criteria that would meet the standard **"*when necessary*,"** established by the Board of Supervisors.

Oak Planting, Conservation, etc.

Some issues need to be resolved to ensure appropriate mitigation planning. For instance, the following measures need to be overseen by a PAWTAC committee, and/or by the concurrence of CDFW, or a land conservation organization, or—in the case of the first item—through examination by a qualified arborist.

- ORMP, page 14: States that **o**n-site planting is to be done "*to the satisfaction of the Planning Services Director.*"
- ORMP, page 14: Off-site planting: "The applicant may be permitted to procure an off-site planting area for replacement planting."
- ORMP, page 16: "Off-site mitigation may be accomplished through private agreements between the applicant and a private party."
- ORMP, page 21: The acquisition of parcels that constitute "opportunities for active land management to be used to enhance or restore natural ecosystem processes."
- ORMP, page 21: "Parcels that achieve multiple agency and community benefits."
- ORMP, page 24: the in-lieu fee payment **may be phased** to reflect timing of the oak resources removal/impact."

Assembly Bill 1600

It is important *not* to limit the in-lieu fee evaluation to the criteria included in AB 1600. It is vital to remember that other funding "tools" that lack the narrow findings required under AB 1600 can be enacted to acquire the necessary amount of mitigation funds: Propositions 62 and 218, for instance, can provide for a special tax (but require voter approval). And, while a fee study provides the quantified basis for imposition of fees, **the County is free to determine that the level of service it would like to provide cannot be met simply through the imposition of the impact fee.**

AB 1600 impact fees are often based on staff's *professional judgment* or *opinion* regarding potential impact—and on a County's growth projection—the basis for all conclusions must be supported by *substantial evidence*. Because El Dorado County's water supply is arguably "uncertain" at this time, it will be difficult to project potential growth realistically.

After all is said and done, it is important to remember that—while some individuals have requested that the in-lieu fees be kept as low as possible—this provision is intended to provide ***viable mitigation***, and as such must be adequate to mitigate loss. **Affordability is not a criterion under which the effectiveness of mitigation can legitimately be degraded**.

Oaks California Oaks

Attachment 1

California Board of Forestry and Fire Protection
P.O. Box 944246
Sacramento, CA 94244-2460
board.public.comments@fire.ca.gov

California Air Resources Board
P.O. Box 2815
Sacramento, CA 95812
dmallory@arb.ca.gov

June 29, 2015

Re: Oak Woodland Greenhouse Gas Emissions

California Board of Forestry and Fire Protection and California Air Resources Board Members:

California Oaks would like to raise the incongruity of the accompanying photo relative to the Board of Forestry and Air Resources Board joint policy regarding meeting AB32 Scoping Plan forest targets. Although the state's forest greenhouse gas (GHG) focus may be on "timberland," in fact California's GHG policies and laws apply equally to all native "forest land."

Blue oak firewood en route to Bay Area markets.

The 2008 AB32 Scoping Plan recognized the significant contribution that terrestrial greenhouse gas storage will make in meeting the state's GHG emissions reduction goals: "*This plan also acknowledges the important role of terrestrial sequestration in our forests, rangelands, wetlands, and other land resources*." The Scoping Plan set a "*no net loss*" goal for forest land carbon sequestration and "*stretch targets*" of increasing forest land CO_2 storage by 2 million metric tonnes by 2020 and 5 MMT by 2050.

California Oaks would appreciate a cogent explanation of how the pictured blue oak firewood is consistent with the state's natural and working lands sector targets, given that unregulated/unmitigated oak tree cutting for "commercial purposes" results in: (1) the loss of carbon sequestration capacity; (2) produces carbon dioxide, methane and nitrous oxide emissions from burning the firewood.

Sincerely,

Janet Cobb

Janet Cobb, Executive Officer

Oaks California Oaks

Attachment 2

Preserving and perpetuating California's oak woodlands and wildlife habitats

July 6, 2015

Community Development Agency
Long Range Planning Division
2850 Fairlane Court
Placerville, CA 95667
shawna.purvines@edcgov.us

Re: Biological Policy Update Project

Shawna Purvines, Principal Planner:

California Oaks appreciates the opportunity to comment on the Biological Policy Update Project. Review of the project finds that it fails to consider California Environmental Quality Act (CEQA) greenhouse gas (GHG) emission requirements concerning the conversion of native forest resources to another land use. Specifically, the DEIR provides no analysis regarding potential forest conversion carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) emission effects or proportional mitigation measures. This DEIR omission is contrary to California forest GHG policy and law.

The 2008 California Air Resources Board's AB32 Scoping Plan recognized the significant contribution that terrestrial greenhouse gas storage will make in meeting the state's GHG emissions reduction goals: "*This plan also acknowledges the important role of terrestrial sequestration in our forests, rangelands, wetlands, and other land resources*."[1] Gov. Brown reiterated this point in his January 2015 inaugural address: "*And we must manage farm and rangelands, forests and wetlands so they can store carbon*." Further, the CEQA Guidelines specifically address biogenic GHG emissions due to the conversion of forest land to non-forest use.[2] Biogenic GHG emissions are those derived from living plant cells. Fossil fuel GHG emissions are derived from living plant cells but are categorized differently.

The following 2009 Natural Resources Agency CEQA GHG Amendments response to comments quotation supports the contention that direct and indirect biogenic GHG emissions effects occur when native forest resources are converted. The response use of the word "and" clearly indicates that there are two potentially significant GHG emission effects to be analyzed regarding forest conversion to another land use. CEQA recognizes these secondary biogenic GHG emissions in the indirect effects language of Guidelines § 15358(2), "*... are later in time or farther removed in distance, but are still reasonably foreseeable*."

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[1] The AB32 Scoping Plan set a "no net loss" goal for forest land carbon sequestration and "stretch targets" of increasing forest land CO_2 storage by 2 million metric tonnes by 2020 and 5 MMT by 2050. http://www.climatechange.ca.gov/forestry/documents/AB32_BOF_Report_1.5.pdf

[2] Oak woodlands are defined as "forest land" by Public Resources Code Section 12220(g)(l). This section is referenced in CEQA Appendix G, forest resources checklist.

Natural Resources Agency Response 66-7

"*As explained in the Initial Statement of Reasons, conversion of forest lands to non-forest uses may result in greenhouse gas emissions and reduce sequestration potential.* (Initial Statement of Reasons, at pp. 63-64.)" See Exhibit A for a detailed CEQA discussion of forest conversion biogenic GHG emission effects.

When a native tree species is felled biomass carbon sequestration ceases. This immediate loss of biomass carbon sequestration capacity represents the direct forest conversion biogenic GHG emission effect. Upon disposal of the biomass carbon, the decomposition of biomass does in all cases result in indirect CO_2 and CH_4 emissions[3] and the combustion of biomass does in all cases result in indirect CO_2, CH_4 and N_2O emissions.[4] Thus, a CEQA oak woodlands GHG emission effects analysis requires carbon dioxide equivalent[5] estimations for both the direct effect from loss of carbon sequestration and the indirect effect due to biogenic emissions associated with oak forest biomass disposal. Notably, burning biomass emits GHG instantaneously, while biomass decomposition takes years and even decades. See Exhibits B, C and D for biomass decomposition and combustion biogenic GHG emission citations.

Summary

Substantial evidence has been presented that project biogenic GHG emissions due to forest land conversion will result in potentially significant environmental effects that have not been sufficiently analyzed or feasibly mitigated. The project has not made *"a good-faith effort, based to the extent possible on scientific and factual data, to describe, calculate or estimate the amount of greenhouse gas emissions resulting from a project"* (CEQA Guidelines § 15064.4(a)). Therefore the Biological Policy Update Project is deficient as an informational document, in that it fails to apprise decision-makers/public of the full range and intensity of the adverse GHG emission effects on the environment that may reasonably be expected if the project is approved.

Sincerely,

Janet Cobb

Janet Cobb, Executive Officer

attachments (4)

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[3] "Anaerobic digestion, chemical process in which organic matter is broken down by microorganisms in the absence of oxygen, which results in the generation of carbon dioxide (CO_2) and methane (CH_4) .... Sugars, starches, and cellulose produce approximately equal amounts of methane and carbon dioxide." Encyclopædia Britannica (2013). http://www.britannica.com/EBchecked/topic/22310/anaerobic-digestion

[4] "... the combustion of biomass does in all cases result in net additions of CH_4 and N_2O to the atmosphere, and therefore emissions of these two greenhouse gases as a result of biomass combustion should be accounted for in emission inventories under Scope 1" (at p. 11). World Resources Institute/World Business Council for Sustainable Development (2005).
http://www.ghgprotocol.org/files/ghgp/tools/Stationary_Combustion_Guidance_final.pdf

[5] AB32 defines *"Carbon dioxide equivalent"* to mean ... *"the amount of carbon dioxide by weight that would produce the same global warming impact as a given weight of another greenhouse gas, based on the best available science, including from the Intergovernmental Panel on Climate Change."* The IPCC's best available science lists methane as having 34 times more global warming impact than carbon dioxide over a 100-year time horizon and nitrous oxide as having 298 times more global warming impact than carbon dioxide over the same period. Myhre, G., D. et al., 2013: *Anthropogenic and Natural Radiative Forcing.* In: Climate Change 2013: The Physical Science Basis (at pp. 713, 714).

Letter 97

Kari Fisher
Associate Counsel
California Farm Bureau Federation

Tim Schmelzer
Legislative and Regulatory Representative
Wine Institute

November 10, 2009

Comment 97-1

Comment is introductory in nature and expresses the organizations' concerns on the guidance for analysis and mitigation for GHG emissions in the proposed amendments. The Natural Resources Agency should reevaluate and revise Appendix G, Section II: Agriculture prior to adopting the proposed amendments.

Response 97-1

The comments object generally to the inclusion of forestry resources among the questions in Appendix G related to agricultural resources. The Initial Statement of Reasons explained the necessity of the added questions:

> The proposed amendments would add several questions addressing forest resources in the section on Agricultural Resources. Forestry questions are appropriately addressed in the Appendix G checklist for several reasons. First, forests and forest resources are directly linked to both GHG emissions and efforts to reduce those emissions. For example, conversion of forests to non-forest uses may result in direct emissions of GHG emissions. (L. Wayburn et al., A Programmatic Approach to the Forest Sector in AB32, Pacific Forest Trust (May 2008); see also California Energy Commission Baseline GHG Emissions for Forest, Range, and Agricultural Lands in California (March, 2004) at p. 19.) Such conversion would also remove existing carbon stock (i.e., carbon stored in vegetation), as well as a significant carbon sink (i.e., rather than emitting GHGs, forests remove GHGs from the atmosphere). (Scoping Plan, Appendix C, at p. C-168.) Thus, such conversions are an indication of potential GHG emissions. Changes in forest land or timberland zoning may also ultimately lead to conversions, which could result in GHG emissions, aesthetic impacts, impacts to biological resources and water quality impacts, among others. Thus, these additions are reasonably necessary to ensure that lead agencies consider the full range of potential impacts in their initial studies. In the same

> way that an EIR must address conversion of prime agricultural land or wetlands as part of a project (addressing the whole of the action requires analyzing land clearance in advance of project development), so should it analyze forest removal. [¶] During OPR's public involvement process, some commenters suggested that conversion of forest or timber lands to agricultural uses should not be addressed in the Initial Study checklist. (Letter from California Farm Bureau Federation to OPR, February 2, 2009; Letter from County of Napa, Conservation, Development and Planning Department, to OPR, January 26, 2009.) As explained above, the purpose of the Proposed Amendments is to implement the Legislative directive to develop Guidelines on the analysis and mitigation of GHG emissions. Although some agricultural uses also provide carbon sequestration values, most agricultural uses do not provide as much sequestration as forest resources. (Climate Action Team, Carbon Sequestration (2009), Chapter 3.3.8 at p. 3.21; California Energy Commission, Baseline GHG Emissions for Forest, Range, and Agricultural Lands in California (2004), at p. 2.) Therefore, such a project could result in a net increase in GHG emissions, among other potential impacts. Thus, such potential impacts are appropriately addressed in the Initial Study checklist.

(Initial Statement of Reasons, at pp. 63-64.) Specific objections to the questions related to forestry are addressed below.

Comment 97-2

Amendments to Appendix G, Section II: Agriculture, adding forest resources, distort the section from its original intent of protecting agriculture resources and will subject projects to extensive and unnecessary analysis beyond what is already legally required. Amendments to Section VII: Greenhouse Gas Emissions will adequately address any significant impact a project may have on greenhouse gas emissions.

Response 97-2

The comment's assertion that the addition of questions related to forestry "specifically target[s] the establishment of [agricultural] resources for extensive and unnecessary analysis above and beyond what is already legally required," is incorrect in several respects. First, the addition of questions related to forestry does not target the establishment of agricultural operations. The only mention in the Initial Statement of Reasons of agricultural operations in relation to those questions was in response to comments that the Office of Planning and Research received indicating that only conversions of forests to non-agricultural purposes should be analyzed. Moreover, the text of the questions themselves demonstrate that the concern is *any* conversion of forests, not just conversions to other agricultural operations.

Second, analysis of impacts to forestry resources is already required. For example, the Legislature has declared that "forest resources and timberlands of the state are among the most valuable of the natural resources of the state" and that such resources "furnish high-quality timber, recreational opportunities, and aesthetic enjoyment while providing watershed protection and maintaining fisheries and wildlife." (Public Resources Code, § 4512(a)-(b).) Because CEQA defines "environment" to include "land, air, water, minerals, flora, fauna, noise, [and] objects of historic or aesthetic significance" (Public Resources Code, section 21060.5), and because forest resources have been declared to be "the most valuable of the natural resources of the state," projects affecting such resources would have to be analyzed, whether or not specific questions relating to forestry resources were included in Appendix G. (*Protect the Historic Amador Waterways v. Amador Water Agency* (2004) 116 Cal.App.4th 1099, 1109 ("in preparing an EIR, the agency must consider and resolve every fair argument that can be made about the possible significant environmental effects of a project, irrespective of whether an established threshold of significance has been met with respect to any given effect").) If effect, by suggesting that the Appendix G questions be limited to conversions to "non-agricultural uses," the comment asks the Natural Resources Agency to adopt changes that are inconsistent with CEQA, which it cannot do.

The comment's suggestion that the questions related to greenhouse gas emissions are sufficient to address impacts related to greenhouse gas emissions does not justify deletion of the questions related to forestry resources. As explained in the Initial Statement of Reasons, not only do forest conversions result in greenhouse gas emissions, but may also "remove existing carbon stock (i.e., carbon stored in vegetation), as well as a significant carbon sink (i.e., rather than emitting GHGs, forests remove GHGs from the atmosphere)." Further, conversions may lead to "aesthetic impacts, impacts to biological resources and water quality impacts, among others." The questions related to greenhouse gas emissions would not address such impacts. Thus, the addition of forestry questions to Appendix G is appropriate both pursuant to SB97 and the Natural Resources Agency's general authority to update the CEQA Guidelines pursuant to Public Resources Code section 21083(f). The Natural Resources Agency, therefore, rejects the suggestion to removal all forestry questions from Appendix G.

Comment 97-3

The amendment adding forest resources to Appendix G: Section II loses sight of the intent and purpose of the Legislature's directive in SB 97. The amendments do not further the directive or intent of SB 97 and unfairly attack and burden all types of agriculture, both crop lands and forest lands.

Response 97-3

SB97 called for guidance on the mitigation of greenhouse gas emissions or the effects of greenhouse gas emissions. (Public Resources Code, § 21083.05.) As explained in the Initial Statement of Reasons, forest conversions may result in direct greenhouse gas emissions. Further, such conversions remove existing forest stock and the potential for further carbon sequestration. (Initial Statement of Reasons, at p. 63.) Sequestration is recognized as a key mitigation strategy in the Air Resources Board's Scoping Plan. (Scoping Plan, Appendix C, at p. C-168.) Thus, the Natural Resources Agency disagrees with the comment, and finds that questions in Appendix G related to forestry are reasonably necessary to effectuate the purpose of SB97. Notably, such questions are also supported by the Natural Resources

Agency's more general authority to update the CEQA Guidelines every two years. (Public Resources Code, § 21083(f).)

The Natural Resources Agency also disagrees that the questions related to forestry "unfairly attack and burden all types of agriculture." Nothing in the text of the proposed amendments or the Initial Statement of Reasons demonstrate any effort to attack, or otherwise disadvantage, any agricultural use. Questions related to forestry impacts are addressed to any forest conversions, not just those resulting from agricultural operations. Further, the questions do not unfairly burden agriculture. To the extent an agricultural use requires a discretionary approval, analysis of any potentially significant impacts to forestry resources would already be required, as explained in Response 97-2, above.

Comment 97-4

The amendments adding forest resources to Appendix G: Section II go beyond the scope of mandate by SB 97 and will adversely affect California's agricultural industry. The only alternative is to recognize the loss of forest land or conversion of forest is only significant when it results in a non-agricultural use.

Response 97-4

The Natural Resources Agency finds that the addition of questions related to forest impacts are reasonably necessary to carry out the directive both in SB97 and the general obligation to update the CEQA Guidelines, as described in both the Initial Statement of Reasons and Responses 97-2 and 97-3, above.

Though the comment states "the proposed changes in Section II [of Appendix G] ... are highly onerous to the State's agricultural industry," the comment provides no evidence to support that claim. On the contrary, as explained in Responses 97-2 and 97-3, above, CEQA already requires analysis of forestry impacts, regardless of whether Appendix G specifically suggests such analysis.

The Natural Resources Agency declines to revise the forestry-related Appendix G questions as suggested. As explained in Response 97-2, above, exempting agricultural projects from the requirement to analyze impacts to forest resources is inconsistent with CEQA.

Exhibit B

Forest Land Conversion
Biomass Combustion and Decomposition GHG Emissions

California Air Resources Board

"California is committed to reducing emissions of CO_2, which is the most abundant greenhouse gas and drives long-term climate change. However, short-lived climate pollutants [methane, etc.] have been shown to account for 30-40 percent of global warming experienced to date. Immediate and significant reduction of both CO_2 and short-lived climate pollutants is needed to stabilize global warming and avoid catastrophic climate change .... The atmospheric concentration of methane is growing as a result of human activities in the agricultural, waste treatment, and oil and gas sectors." *Reducing Short-Lived Climate Pollutants in California*, 2014.

UN Framework Convention on Climate, Deforestation Definition

"Those practices or processes that result in the change of forested lands to non-forest uses. This is often cited as one of the major causes of the enhanced greenhouse effect for two reasons: 1) the burning or decomposition of the wood releases carbon dioxide and 2) trees that once removed carbon dioxide from the atmosphere in the process of photosynthesis are no longer present and contributing to carbon storage." http://www.gofc-gold.uni-jena.de/redd/sourcebook/Sourcebook_Version_June_2008_COP13.pdf

Stanford University Engineering

Biomass burning also includes the combustion of agricultural and lumber waste for energy production. Such power generation often is promoted as a "sustainable" alternative to burning fossil fuels. And that's partly true as far as it goes. It is sustainable, in the sense that the fuel can be grown, processed and converted to energy on a cyclic basis. But the thermal and pollution effects of its combustion - in any form - can't be discounted, [Mark] Jacobson said.

"The bottom line is that biomass burning is neither clean nor climate-neutral," he said. "If you're serious about addressing global warming, you have to deal with biomass burning as well." engineering.stanford.edu/news/stanford-engineers-study-shows-effects-biomass-burning-climate-health

Jacobson, M. Z. (2014). *Effects of biomass burning on climate, accounting for heat and moisture fluxes, black and brown carbon, and cloud absorption effects.*

European Geosciences Union

"Biomass burning is a significant global source of gaseous and particulate matter emissions to the troposphere. Emissions from biomass burning are known to be a source of greenhouse gases such as carbon dioxide, methane and nitrous oxide" (at 10457). *A review of biomass burning emissions, part I: gaseous emissions of carbon monoxide, methane, volatile organic compounds, and nitrogen containing compounds.* R. Koppmann, K. von Czapiewski and J. S. Reid, 2005.
http://www.atmos-chem-phys-discuss.net/5/10455/2005/acpd-5-10455-2005-print.pdf

Phoenix Energy

"As wood starts to decompose it releases roughly equal amounts of methane (CH_4) and carbon dioxide (CO_2)." 2014. http://www.phoenixenergy.net/powerplan/environment

Macpherson Energy Corporation

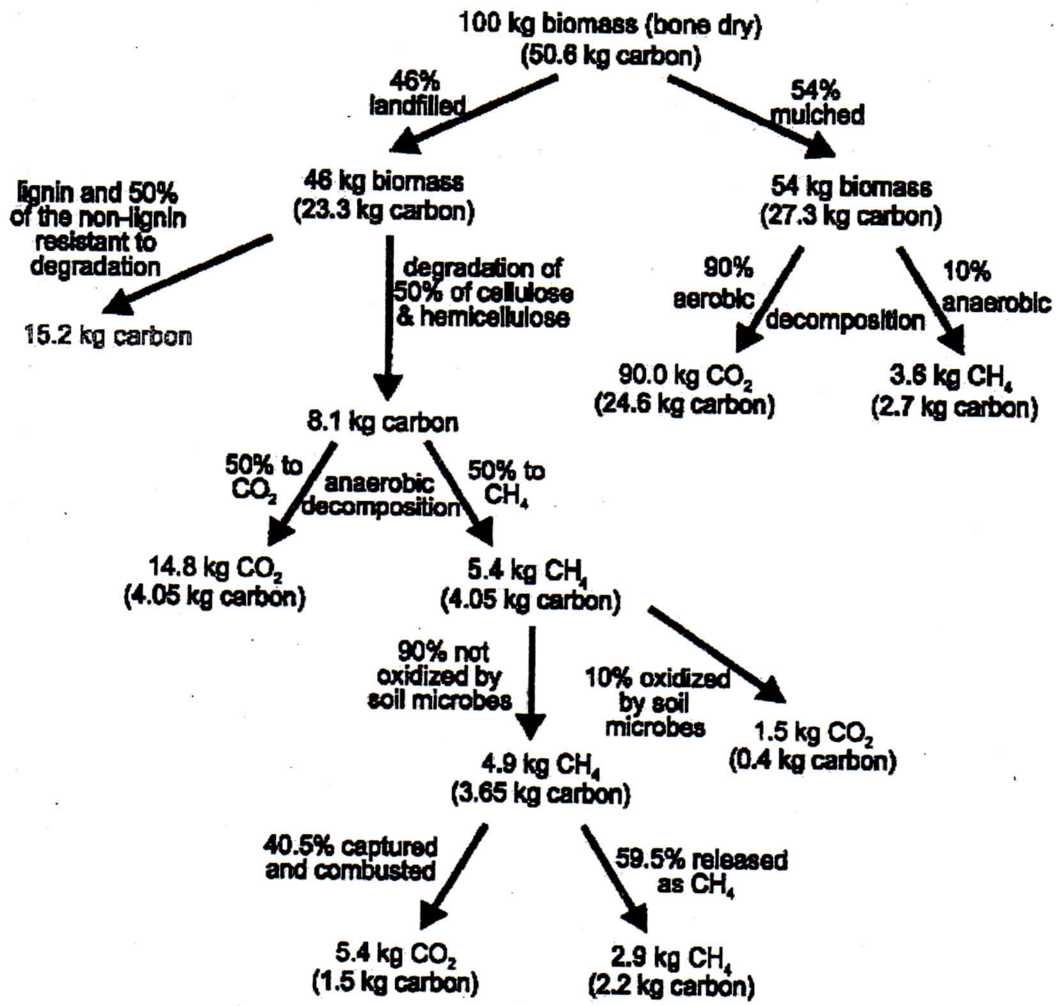
"Rotting produces a mixture of up to 50 percent CH_4, while open burning produces 5 to 10 percent CH_4." 2014. http://macphersonenergy.com/mt-poso-conversion.html

Exhibit C

Biomass Decomposition Greenhouse Gas Emissions

Biomass presentation by Alex Hobbs, PhD, PE to the Sierra Club Forum at North Carolina State University (November 24, 2009).

- If 100 kilograms of bone dry biomass were dispersed to a controlled landfill (46%) and mulched (54%) greenhouse gas emissions would be: 111.7 kilograms of CO_2 emissions + 6.5 kilograms of CH_4 emissions = 274.2 kilograms CO_2-equivalent emissions.



Landfill: 46 kg biomass/23.3 kg CO = 21.7 kg CO_2 + 2.9 kg CH_4 = 94.2 kg CO_2-equivalent.
Mulch: 54 kg biomass/27.3 kg CO = 90 kg CO_2 + 3.6 kg CH_4 = 180 kg CO_2-equivalent.
Total: 100 kg biomass/50.6 kg CO = 111.7 kg CO_2 + 6.5 kg CH_4 = 274.2 kg CO_2-equivalent.

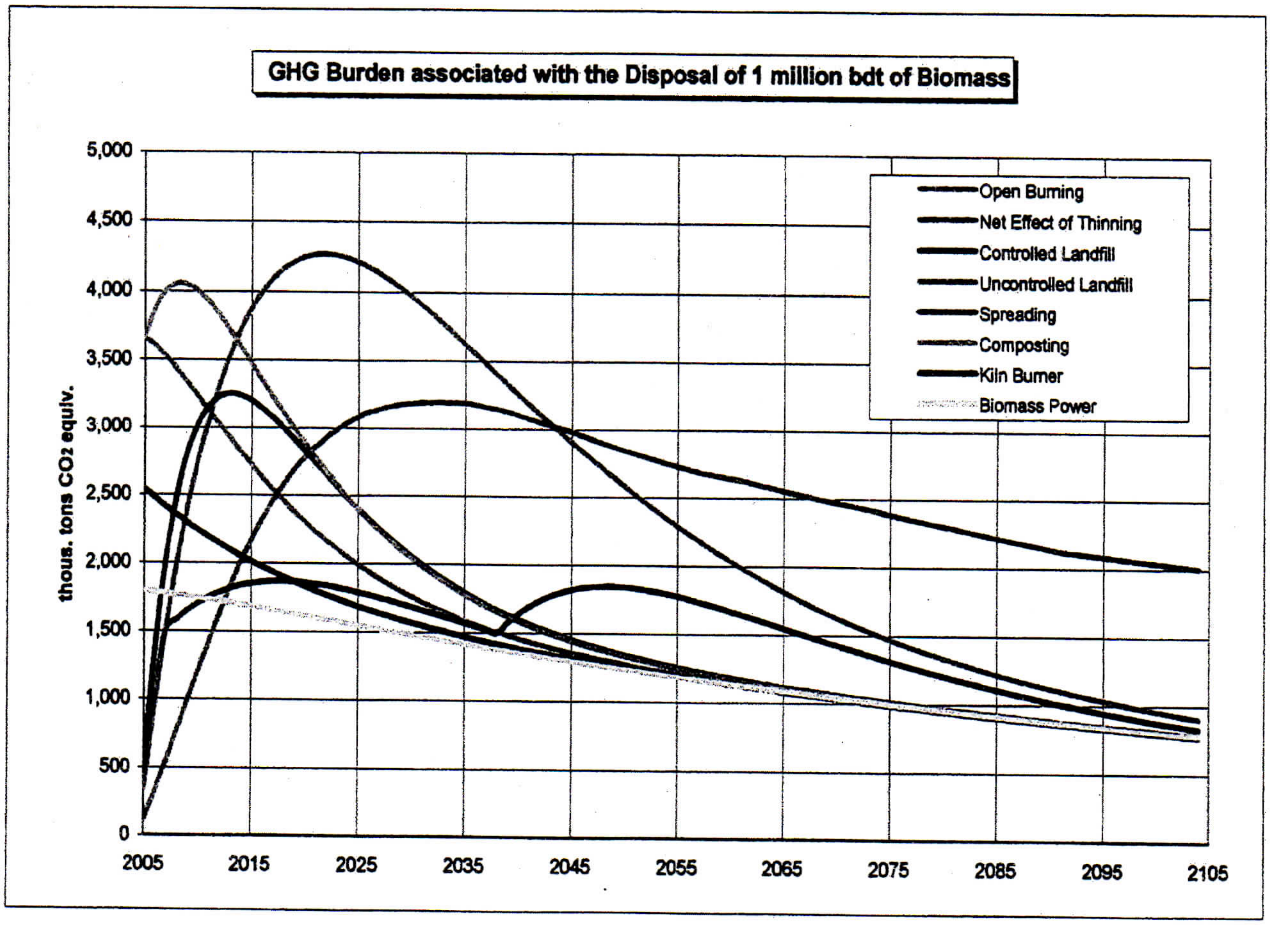
Exhibit D

Biomass Disposal Greenhouse Gas Emissions

The following chart illustrates the relative biogenic GHG emission effects from common methods of vegetation (biomass) disposal.[1] However, for a variety of reasons these chart values are too unrefined to be applied for project site-specific biogenic GHG emissions analysis.

Uncontrolled landfill disposal produces the greatest biomass GHG emissions followed by composting, open burning, mulching, forest thinning, firewood burning, controlled landfills and biomass power. Notably, biomass power emissions do not include methane and nitrous oxide emissions. The chart demonstrates that peak greenhouse gas emissions vary substantially depending on the means of biomass disposal.

Terminology: Net effect of thinning emissions apply to forest thinning emissions; Spreading emissions are equivalent to mulching emissions and Kiln Burner emissions are analogous to fireplace burning emissions.



Graphic: Gregory Morris, PhD. *Bioenergy and Greenhouse Gases*. Published by Pacific Institute (2008).

[1] One bone dry ton (bdt) is a volume of wood chips (or other bulk material) that would weigh one ton (2000 pounds, or 0.9072 metric tons) if all the moisture content was removed.

Attachment 2

Cheryl Langley
5010 Mother Lode Drive
Shingle Springs, CA 95682

Ms. Shawna Purvines, Principal Planner — December 23. 2015
EDC Development Agency, Long Range Planning Division
2850 Fairlane Court
Placerville, CA 95667

RE: Revised Notice of Preparation for the Biological Resources Policies Update & Oak Resources Management Plan

Ms. Purvines:
Thank you for the opportunity to comment on the revised Biological Resources Policy Update (**BRPU**) and Oak Resources Management Plan (**ORMP**).

In addition to comments submitted for this revised NOP, I have included comments submitted for the initial NOP (resubmitted here), and comments provided to the Board of Supervisors (BOS) at the September 29, 2015 meeting. (Specifically, I include the latter set of comments to support/add to discussion within this document.)

Based on these previously submitted comments, and other materials, I have the following requests for information to be included in the draft Environmental Impact Report (dEIR) for the BRPU/ORMP.

Retention of Option A

After reviewing the revisions to 2004 General Plan policies, the proposed ORMP, the BRPU, and Dudek memorandum (17A), it is clear that these policy revisions emphasize making oak mitigation the least onerous possible. This is good news for project applicants, but mitigation measures *must be effective*. The elimination of the Integrated Natural Resources Management Plan (INRMP), the disbanding of the Plant and Wildlife Technical Advisory Committee (PAWTAC), the elimination of Option A (oak retention standards), the reduction of tree sizes for mitigation plantings (from 15-gallon to acorns), the expansion of the number and kind of projects exempt from oak mitigation (including County road improvement projects) all signal a desire to make mitigation for the loss of oak woodland as "simple" and as affordable as possible, both for the County (which has struggled with oak mitigation projects), and for developers.

But this asset—oak woodland—*is* worth protecting. And, retention of ***Option A requirements in no way impedes development***—but it **does** serve to make certain a project has been assessed to determine if there is a way ***the developer can meet project objectives while at the same time retain the maximum number of oaks possible on-site***. If it is *demonstrated* a projected cannot meet fruition *and* Option A oak retention standards, Option B "kicks in," and other on- or off-site options for oak mitigation become available. **Why is this process—project evaluation as it relates to oak retention—deemed obstructive or impractical?** Aren't our oak resources worth a serious project evaluation?

Members of the public have *continually* requested Option A retention standards be retained, and requested an equal-weight (co-equal) project alternatives analysis. Such an analysis would provide the BOS with the information necessary to make an informed decision and possibly approve a project alternative that could effectively reduce or avoid significant impact to oak resources. Without such an analysis, it is doubtful this project alternative will be evaluated to the extent necessary to make such a determination. And, importantly, the BOS—in their July 22, 2015 meeting—*agreed* it was important to evaluate oak retention standards. But without an equal-weight analysis, a meaningful project alternative will not be prepared. Thus—by default—retention of Option A has been roundly rejected before a complete analysis has been conducted. In effect, ***i*t has been predetermined that the County is "not going there." This is contrary to the purpose and spirit of California Environmental Quality Act (CEQA) analysis.** And it sends message to the public that "*your participation in the process is not welcome here*."

This is disturbing, and perhaps more so because the resource at stake cannot be easily replaced. And, while BOS members are charged with making decisions that will impact this resource, at least some are not conversant in biological principles, and Dudek does not correct misconceptions when BOS members make statements that lay bare their lack of understanding. While it may at times prove uncomfortable to correct a BOS member during public discussions, the consultant is there to provide expertise. When they do not, this is a failure of their responsibility to the BOS, and to the public, and serves to undermine their own credibility. And most importantly, it is a disservice to the resource being impacted.

The result? BOS members vote—make important decisions with long-term implications—without understanding basic biological or legal principles, or the seriousness and longevity of their decisions. And, while it is not the responsibility of the *public* to educate the BOS, that is where the task has come to rest—in the three minutes granted to any given individual—during meeting opportunities that County staff has purposefully limited to meetings during the workweek days/hours that fundamentally ***limit public participation*** in this ***expedited*** process:

> **NOTE:** *"In recognition of the Board's desire to expedite completion of this process, this approach would potentially limit public input to focused Planning Commission and Board meetings. The TGPA/ZOU process has used this approach to receive public comment rather than the public outreach program currently identified for input on revisions to the policies."*
>
> (**Source:** Document 7B under *Meeting Details*, PROCESS APPROACHES FOR THE OAK WOODLAND MANAGEMENT PLAN.)

This expedited process—based on a request by development interests for an "**interim policy**"—was no more than suggested than taken up by Long Range Planning's Ms. Purvine who said—at the same meeting at which the request was launched—*"I'd actually like to look into that a little bit further and bring back a discussion on that."* [1] That initiated a cascade of activity that evolved into an *expedited* BRPU and ORMP. But repeated requests by members of the public to evaluate the retention of Option A have fallen on deaf ears.

Retention of Option A was vilified by suggesting it would impose constraints on economic development, and may even constitute "property taking" by rendering some properties undevelopable. [2] But no such results could come to pass with implementation of Option B, whose development is clearly one of the primary thrusts of this ORMP. In this instance, Option A would simply provide a "first screening" of projects; it would not be the "last word" on project development or on a project's ultimate impact on oak woodlands. But retention of Option A *could* serve to protect woodlands when a project *could* meet fruition while accommodating resident oaks.

[1] **Source of Quote**: Planning Commission meeting of Aug 15, 2014; TGPA/ZOU meeting RE: Biological Resources.

[2] Dudek. 2015. Memorandum from Kathy Spence-Wells to Shawna Purvines, September 18, 2015; 17A, page 8.

Request for Information

- **I request a co-equal analysis of a project alternative based on retaining Option A (oak retention standards)**.
- In the past, Option A was considered restrictive to development interests largely because Option B *was not available*. With the availability of Option B (contingent upon approval of this ORMP), explain why Option A is not being evaluated in a co-equal analysis, especially in light of CEQA guidelines that state EIRs must describe alternatives *"…which would feasibly attain most of the basic objectives of the project but would avoid or substantially lessen any of the significant effects of the project…"(14 CCR 1526.6[a]).* (In fact, there is probably no other alternative—other than the **No Project** alternative—that could reduce the project's significant impacts more than this alternative; it is a viable project alternative that deserves co-equal analysis.)

Oak Regeneration as a Mitigation Element

Because this notion of oak regeneration as a viable/plausible mitigation element seems to be persisting, it is necessary to expand on this topic.

First of all—this is not mitigation. Saying something will simply replace itself post-loss contradicts the meaning/purpose of mitigation. To identify *non-action* in this instance as mitigation defies logic, and it also defies scientific study on the topic. It is simply not credible. Even if this approach were *legally* defensible, **it is not supported by fact**.

I have cited numerous studies that discuss blue oak (*Quercus douglasii*) regeneration as inadequate to support the long-term survival of this woodland species in numerous areas of California (see discussion/citations in comments on the initial NOP, and in the September 29, 2015 comments to the BOS; reference materials are included for both documents [on disk] with this submitted material). These documents contain citations that describe the problems with blue oak regeneration (the species that will be most impacted [and replanted] as a result of development projects in EDC).

I add to this discussion on oak regeneration here. In a study by Swiecki, et al.,[3] an in-depth evaluation was undertaken to assess the status of blue oak regeneration and determine how environmental and management factors influence blue oak sapling recruitment. This study was conducted in the counties listed in the table below on study sites of at least 150 acres in size dominated by blue oak

County	Regeneration Adequate to Maintain Blue Oak Woodland?		Comments
	Yes	No	
Napa		X	This study site had the highest number of blue oak saplings but there were fewer plots with an increase in blue oak density than a decrease in density; there were few small seedlings.
Glenn		X	No blue oak saplings were present anywhere in the entire study site

[3] Swiecki, et al. 1993. *Factors Affecting Blue Oak Sapling Recruitment and Regeneration*. Prepared for: Strategic Planning Program, California Department of Forestry and Fire Protection. Contract 8CA17358, December 1993.

San Benito	X		The blue oak stand at this site appears to be viable; regeneration appears to be moderate—more plots showed an increase in blue oak density than a decrease
Yuba	X		More plots showed an increase in blue oak density than a decrease; about a quarter of the saplings originated as stump sprouts in an area where blue oaks were cut in 1989; 7 % of the sprout-oriented saplings were dead; mortality was higher among seedling-origin saplings (mesic site)
Mendocino		X	No blue oak saplings were present anywhere in the entire study area; a few seedlings were observed
Tulare		X	Recruitment was sparse; current levels of recruitment are insufficient to support offset mortality
Tehama		X	Blue oak saplings were uncommon, as were seedlings; sapling recruitment was inadequate to maintain current stand densities
Amador		X	Blue oak saplings and seedlings were uncommon; very little regeneration has occurred since the Gold Rush; current recruitment is insufficient to maintain stand; conversion to grassland appears inevitable
San Luis Obispo		X	Recruitment is insufficient to offset mortality
Monterey		X	Recruitment is insufficient to offset mortality
Madera		X	No blue oak saplings were seen in the study area; a few small seedlings were seen; there was no regeneration of woody species in the study area
Santa Clara		X	No blue oak saplings were seen in the study area but some seedlings were seen; this stand had the highest mortality of those studied
Contra Costa		X	Recruitment lags far behind mortality at this study site
Tulare		X	Mortality was far in excess of sapling recruitment

Tuolumne	Variable, but ultimately described as a site with more plots with "net loss" than "net gain"	Stump sprout-origin saplings outnumbered those of seedling origin (sprouts from previous tree removal) at this site (75% of saplings were of sprout origin); virtually the entire stand appeared to be second growth; a few seedlings were seen, particularly along creeks; although regeneration had apparently been successful in some portions of the site, blue oak had been eliminated from some large areas and no recolonization of these large clearings has occurred

Swiecki study conclusions include:

- *"…it appears that most locations are losing blue oak density at the stand level due to unreplaced mortality."*
- "*These observations support the assertion that current recruitment is inadequate to maintain existing tree populations in at least some areas."*
- *"…the conversion of blue oak woodland to grassland is not likely to be easily reversed."*
- *"…the extent of blue oak woodlands will continue to decrease due to unreplaced mortality…"*
- "*Because our study locations are distributed throughout the range of blue oak, we are confident that the trends we observed can be generalized over much of the range of blue oak."*
- *"In many stands, sapling blue oaks are absent or rare."*
- "*In most stands, the percentage of the stand area which is likely to show a decrease in blue oak density and canopy cover is greater than the percentage that may show an increase in density and canopy cover*."

Blue Oak Regeneration in EDC

During the various meetings and workshops on the BRPU/ORMP, some individuals have brought up the issue of oak regeneration—presumably in "defense" of oak removal—and have stated—anecdotally—that there are more trees in EDC now than in the past. There have also been figures brought up (undocumented) to "substantiate" gains in EDC oak woodland.

The most current study I was able to find to quantify blue oak woodlands in EDC was presented in the report "*Monitoring Land Cover Changes in California*." [4] (**NOTE:** The northeastern California project ares covers Amador, Butte, **El Dorado**, Lassen, Modoc, Nevada, Placer, Plumas, Sierra, Sutter, Yolo and Yuba counties.)

[4] USDA Forest Service & California Department of Forestry and Fire Protection Fire and Resource Assessment Program. 2002. *Monitoring Land Cover Changes in California; California Land Cover Mapping and Monitoring Program. Northeastern California Project Area, January, 2002.*

<u>Report findings are as follows</u>:

For **<u>blue oak woodland</u>** (all owners):

- 509 acres with small, moderate, large woodland decrease (1.55% decrease)
- 194 acres with small, moderate, large woodland increase (0.59% increase)

  32,878 acres total

  Net decrease of 315 acres or 0.96%

For **<u>blue oak/foothill pine woodland</u>** (all owners):

- 119 acres with small, moderate, large woodland decrease (0.66% decrease)
- 95 acres with small, moderate, large woodland increase (0.53% increase)
- 17,995 acres total

  Net decrease of 24 acres or 0.13%

0.67% decrease

<u>TOTAL</u> for <u>blue oak</u> and <u>blue oak/foothill pine</u> woodlands combined: ~~1.09% decrease~~

Table C-14 Acres of Classified Change in El Dorado County by Hardwood Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Blue Oak Woodland								
LDVC	0	0	0	0	17	0	17	0
MDVC	0	0	4	0	82	0	86	0
SDVC	5	6	11	1	390	1	406	1
NCH	71	93	1,576	97	30,386	97	32,033	97
SIVC	0	1	15	1	155	0	170	1
MIVC	0	0	0	0	22	0	22	0
LIVC	0	0	0	0	2	0	2	0
NVG	0	0	23	1	119	0	142	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	77	100	1,628	100	31,173	100	32,878	100
Blue Oak / Foothill Pine								
LDVC	0	0	0	0	3	0	3	0
MDVC	0	0	1	0	23	0	24	0
SDVC	0	4	3	0	89	1	92	1
NCH	4	82	1,097	99	16,637	99	17,738	99
SIVC	1	14	4	0	76	0	81	0
MIVC	0	0	0	0	14	0	14	0
LIVC	0	0	0	0		0	0	0
NVG	0	0	9	1	34	0	43	0
CLD/SHA	0	0	0	0		0	0	0
TOTAL	5	100	1,113	100	16,877	100	17,995	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Source: USDA Forest Service & California Department of Forestry and Fire Protection, *Monitoring Land Cover Changes in California; California Land Cover Mapping and Monitoring Program.*

McCreary [5] also weights in on this topic of regeneration.

For nearly a century, there has been concern that several of California's 20 native oak species are not regenerating adequately (Jepson 1910). Such concern was partially responsible for the establishment of the Integrated Hardwood Range Management Program (IHRMP) in 1986, a cooperative effort between the University of California, the California Department of Forestry and Fire Protection, and the California Department of Fish and Game to promote oak woodland conservation (Standiford and Bartolome 1997). Evidence indicating that there is an "oak regeneration problem" in California has been based largely on observations of a paucity of young seedlings and saplings in the understories of existing oak stands. Describing the foothill woodland in the Carmel Valley, White (1966) stated that "A prevailing characteristic . . . is the lack of reproduction . . . with very few seedlings." Bartolome and others (1987) also concluded that "current establishment appears insufficient to maintain current stand structure for some sites." And Swiecki and Bernhardt (1998) reported that of 15 blue oak locations evaluated throughout the State, 13 were losing stand density at the stand level due to unreplaced mortality.

The species that are having the most difficulty regenerating are all members of the white oak sub-genera of *Quercus*, and include blue oak (*Quercus douglasii*), valley oak (*Q. lobata*), and Engelmann oak (*Q. engelmannii*) (Muick and Bartolome 1987; Bolsinger 1988). Blue and valley oak are endemic to the State, while Engelmann oak, which actually has a far narrower distribution range than the other 2 species, does extend into Baja California (Griffin and Critchfield 1972). Concern about poor

Request for Information:

- Please include in the NOP a discussion of ***why*** oak regeneration is being evaluated as a possible "mitigation" element. Discuss what is to be accomplished by this approach—if accepted—and who will benefit. Discuss the impact on oak woodland mitigation if this approach is implemented.
- Describe the science that *supports* the notion that relying on oak regeneration is a plausible approach to impact mitigation. Also provide scientific studies that *refute* this approach to impact mitigation.
- Identify other California counties that have used—or entertained the idea of using—oak regeneration to "*offset development impacts to oak woodlands*." If other counties have used this approach, identify those counties and present their rationale for using this approach, and if this approach was actually pursued, the outcome of that decision (impact on oak resources).
- Describe what makes this approach viable under CEQA mitigation guidelines.
- Keeping in mind that blue oak is the species that will be most impacted by development projects—and that it is the species that will make up the bulk of mitigation efforts—discuss how its declining ability to regenerate can possibly be used as a mitigation element.
- From a workshop PowerPoint presentation (Document 5D), mitigation is identified as "*strategies to reduce impacts.* "Reducing impacts" implies an *active* process. How does relying on *a natural process* (especially one in decline), meet this criterion?

Use of Acorns for Oak Woodland Replacement

The poor natural regeneration of blue oak woodlands means the viability of acorn plantings, too, will be problematic, making replacement of woodlands via the planting of acorns a fragile, ineffective strategy. According to A Planner's Guide to Oak Woodlands: [6]

> …the same factors that prevent or limit **natural regeneration** can also take a heavy toll on artificial plantings. **To be successful, relatively intensive site preparation, maintenance, and protection must usually be provided for several years.**

[5] McCreary, D. and J. Tecklin. 2005. *Restoring Native California Oaks on Grazed Rangelands*. USDA Forest Service Proceedings RMRS-P-35.

[6] Giusti, G.A. et al (editors). 2005. *A planner's guide for oak woodlands*. University of California, Agriculture and Natural Resources, Publication 3491, second edition.

Thus, while it may be tempting to think planting acorns will provide a low-cost alternative to container-planting, acorns are prone to failure and could ultimately cost project developers *more* than container-planting. The excessive replacement of dying seedlings, the necessity for irrigation, weed and rodent control, and tree shelter or fencing placement (and replacement) means in-field acorn propagation will be costly and burdensome.

Studies have shown that mortality from direct seeding of acorns is high. According to Young, [7] "A*pproximately 40% of the field-planted acorns disappeared in the first two months after planting, probably taken by ground squirrels or other seed predators*." And, according to Swiecke: [8]

> A blue oak seedling observation plot was established just outside the study area in 1988 (Swiecki et al 1990), but was destroyed by ground squirrels before permanent markers could be installed. A second seedling plot located about 3 km south of the study area was resurveyed in July 1993, at which time only 6.5% of the seedlings tagged five years earlier were still surviving.

Not only is acorn planting fraught with difficulties and failure, the results—even under the best of circumstances—will be dismal. Blue oaks are slow growers. Harvey [9] showed that many of the blue oak saplings less than four feet tall were between 40 and 100 years old. (**NOTE:** Both sets of comments submitted previously [August 17, 2015; September 29, 2015] include a discussion of blue oak growth rates and additional studies/citations, which see.)

Request for Information

- If acorn planting is to be pursued as a mitigation element under this ORMP, provide specific details/requirements for planting that include specific site treatment, monitoring, replacement schedules, equipment, and measures that will be employed to ensure success.
- Describe (and establish) a **performance standard** for acorn *and* sapling (container) plantings. That is, commit to a canopy coverage standard to be attained within X number of years (say 5 years, for example).

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[7] Young, T.P. and R.Y. Evans. 2002. *Initial Mortality and Root and Shoot Growth of Oak Seedlings Planted as Seeds and as Container Stock Under Different Irrigation Regimes*. Department of Environmental Horticulture, University of California, Davis; Final Report.
[8] Swiecki, et al. 1993. *Factors Affecting Blue Oak Sapling Recruitment and Regeneration*. Prepared for: Strategic Planning Program, California Department of Forestry and Fire Protection. Contract 8CA17358, December 1993.
[9] L.E Harvey. 1989. *Spatial and Temporal Dynamics of a Blue Oak Woodland*. Ph.D. Thesis, University of California, Santa Barbara.

Cattle Grazing on Conservation Easements

From the draft revised ORMP, November, 2015; Page 24:

> ### *4.2 Management of PCAs*
>
> Existing oak woodlands within the PCAs identified as mitigation for project impacts, whether on or off a project site, will be protected from further development through a conservation easement granted to the County or a land conservation group approved by the County or by acquisition in fee title by a land conservation group. Management activities would be conducted by land conservation organizations and may include, but are not limited to, one or more of the following activities, as determined appropriate and/or necessary through monitoring of the sites: inspections, biological surveys, fuels treatment to reduce risk of wildfire and to improve habitat, weed control, database management, and mapping. Agricultural use (i.e., grazing) shall be allowed in conserved oak woodlands as long as the activity occurred prior to the establishment of the conservation easement, the spatial extent of the agricultural use is not expanded on conserved lands, and the agricultural use does not involve active tree harvest or removal (e.g., fuelwood operations, land clearing for crop planting, etc.).

Livestock grazing can have serious implications for oak woodlands and wildlife. For instance, research conducted by Swiecki [10] shows:

- Oak saplings are unlikely to be found in areas with high chronic levels of livestock browsing.
- In areas subject to at least moderate browsing, the majority of oaks are shorter than the browse line and show evidence of chronic browsing damage.
- Seedlings and saplings were more common in ungrazed natural areas than in grazed pastures.

To this end, Swiecki suggests:

- Alternative grazing regimes that reduce the duration and intensity of browsing pressure may help to reduce the negative impact of browsing on oak resources.
- In any gap-creating event (such as oak harvest or wildfire), livestock use should be minimized until oaks have grown taller than the browse line.

And McCreary [11]weighs in on this issue, too:

[10] Swiecki, et al. 1993. *Factors Affecting Blue Oak Sapling Recruitment and Regeneration*. Prepared for: Strategic Planning Program, California Department of Forestry and Fire Protection. Contract 8CA17358, December 1993.
[11] McCreary, D. and J. Tecklin. 2005. *Restoring Native California Oaks on Grazed Rangelands*. USDA Forest Service Proceedings RMRS-P-35.

Timing of Grazing Study

In 1989, a UC Davis graduate student named Lillian Hall initiated an experiment at the SFREC to evaluate how planted oak seedlings fare in pastures where cattle have access (Hall and others 1992). She planted 1-year-old blue oak seedlings in pastures grazed by cattle at different stock intensities, and included a control where cattle were excluded. She found that damage to seedlings was significantly less in the winter and fall when the deciduous oaks did not have foliage and were apparently less appetizing to the cattle. Cattle did not seem to seek out or prefer young oaks. However, in the spring green-forage season, they appeared drawn to clover patches near seedlings and browsed the oaks in the process. Heavy damage to seedlings in the summer at all cattle densities probably resulted from the fact that the young oaks were often the only green vegetation in the grazed pastures, and were therefore more palatable than the dry annual grasses. Within each season, total damage also increased with increasing stock density.

While some researchers suggest livestock management techniques can ***lessen*** the impact of grazing in oak woodlands, it is clear that **the best approach is to not graze these areas** unless absolutely necessary. For instance—speaking in terms of “real world” observation—while only spring grazing is done on the property north of Highway 50 by the Scott Road exit (in Sacramento County), it is clear that the blue oak woodland on these pastures is in decline; oak regeneration is largely absent.

Conservation easements should be managed for wildlife and woodlands—that is the purpose of a conservation easement. But if grazing *is* allowed on conservation easements, management (protection) of young oak trees must be actively performed. These protective practices may make cattle grazing on protected lands impractical/costly.

Request for Information

- Describe the grazing regime (management practices) that will/will not be allowed on conservation lands. For instance, will grazing be restricted to certain times of the year?
- Discuss/disclose the following: If the livestock owner is also the land owner, will this person receive a property tax reduction for the land being established as a conservation easement? Or, will they be charged a fee for use of a conservation easement for grazing purposes? And, if a fee is charged, will it go into a fund to be utilized for conservation easement acquisition?
- Similarly, discuss the situation described in the bullet above in the case where the livestock owner is *not* the landowner. Will “land rental fees” be levied, and if so how much, and how will the fees be used?

Discuss the following:

- How might the presence of grazing livestock on conservation easements impact wildlife and wildlife habitat?
- How might the presence of grazing livestock impact the oak woodland (specifically survival of young oaks)?
- How might the presence of grazing livestock impact water features, and the wildlife/ecology of those water features (e.g., vernal pools, seasonal creeks, drainages, ponds, etc.)

- If grazing is to be allowed on conservation easements, provide examples of EDC properties where grazing has occurred and oak regeneration is "active" (successful). Identify the amount of time grazing has occurred on the property (both in terms of years grazed and duration of grazing per season), the size and makeup of grazing herds (cattle, sheep, other), and the age classes and species of the oaks present.

Impact to Riparian Zones / Riparian Setbacks

While Long Range Planning staff touted the establishment of *permanent* riparian setback under the Targeted General Plan Amendment/Zoning Ordinance Update (TGPA/ZOU), it was not made clear that these setbacks were being *reduced* under the TGPA/ZOU. The BRPU had established the following interim guidelines:

From the BRPU, page 13D, page 10:

> Until standards for buffers and special setbacks are established in the Zoning Ordinance, the County shall apply a minimum setback of 100 feet from all perennial streams, rivers, lakes, and 50 feet from intermittent streams and wetlands. These interim standards may be modified in a particular instance if more detailed information relating to slope, soil stability, vegetation, habitat, or other site- or project-specific conditions supplied as part of the review for a specific project demonstrates that a different setback is necessary or would be sufficient to protect the particular riparian area at issue.

The TGPA/ZOU reduced these interim guidelines to the following:

Title 130, Zoning Ordinance; Article 3, page 11:

> Ministerial development, including single family dwellings and accessory structures, shall be set back a distance of 25 feet from any intermittent stream, wetland or sensitive riparian habitat, or a distance of 50 feet from any perennial lake, river or stream. This standardized setback may be reduced, or grading within the setback may be allowed, if a biological resource evaluation is prepared which indicates that a reduced setback would be sufficient to protect the resources.
>
> All discretionary development which has the potential to impact wetlands or sensitive riparian habitat shall require a biological resource evaluation to establish the area of avoidance and any buffers or setbacks required to reduce the impacts to a less than significant level. Where all impacts are not reasonably avoided, the biological resource evaluation shall identify mitigation measures that may be employed to reduce the significant effects. These mitigation measures may include the requirement for compliance with the mitigation requirements of a state or federal permit, if required for the proposed development activity.

> Any setback or buffer required by this subsection shall be measured from the ordinary high water mark of a river, perennial or intermittent stream, and the ordinary high water mark or spillway elevation of a lake or reservoir.

Because mitigation elements related to biological resources are the topic of this BRPU update, it is only reasonable that riparian setbacks should be evaluated, discussed, and developed under this BRPU process, not under the TGPA/ZOU process alone.

From the BRPU, 13C, page 35:

> **MEASURE CO-O**
>
> Prepare and adopt a riparian setback ordinance. The ordinance, which shall be incorporated into the Zoning Code, should address mitigation standards, including permanent protection mechanisms for protected areas, and exceptions to the setback requirements. The ordinance shall be applied to riparian areas associated with any surface water feature (i.e., rivers, streams, lakes, ponds, and wetlands) and should be prepared in coordination with Measure CO-B. [Policy 7.4.2.5]

When riparian setbacks were established under the TGPA/ZOU, it was clear that there was no scientific basis for setback size, and therefore no valid analysis of the impact of the reduction. This change in riparian setback distances needs to be evaluated within this dEIR (along with other numerous impacts to biological resources that are the result of TGPA/ZOU-based revisions.) Importantly—based on the importance of riparian systems—and the significant impact of the setback revision—setback revisions and/or additional mitigation measures are in order, and could be develop under this BRPU process.

For instance, it has been established that development and encroachment setbacks should include the entire *active floodplain*[12] of a creek or river to adequately preserve stream banks and associated riparian vegetation. And, while there is no single, abrupt, well-documented threshold setback width that would provide maximum benefits for all riparian functions (because riparian functions have different mechanistic bases and are affected by different site attributes), it is well known that most riparian functions would be affected if setbacks included a buffer of less than **66 feet beyond the active floodplain**.[13] Consequently, narrower widths are not adequate for long-term conservation of riparian functions. (This conclusion is based on a review of the scientific literature.) A recent study of riparian buffers states that for first and second order stream segments[14] **a minimum riparian setback that includes the entire active floodplain plus a buffer of 98 feet of adjacent land (on each side of the active floodplain)** is required; along higher order stream segments (i.e., third order and greater), and along those in or adjacent to conservation lands, **a setback of at least 328 feet—and preferably 656 feet from the active floodplain** is necessary to conserve stream and riparian ecosystem functions, including most wildlife habitat functions. Although these setbacks may seem large, even these setback distances would not be sufficient for the conservation of many wildlife species with large area requirements. (For instance, some species that live in riparian areas must move to other areas to reproduce, as is the case with pond turtles.)

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[12] *Active floodplain* means the geomorphic surface adjacent to the stream channel that is typically inundated on a regular basis (i.e., a recurrence interval of about 2–10 years or less). It is the most extensive low depositional surface, typically covered with fine over-bank deposits, although gravel bar deposits may occur along some streams.

[13] Jones & Stokes. *Setback recommendations to conserve riparian areas and streams in western Placer County*. 2005. February, 2005.

[14] *First order* stream segments are upstream segments that have no tributaries, and *second order* segments are formed by the junction of first order segments.

The problem is simple: land uses (including agricultural uses) within recommended buffer setbacks preclude the effectiveness of setbacks.[15] Conversion of large portions of a watershed to developed and agricultural land uses is associated with broad negative effects on riparian and stream ecosystems (Findlay and Houlahan 1996, Roth et al 1996, Booth and Jackson 1997, Magee et al. 1999, Doyle et al. 2000, Paul and Meyer 2001, Allan 2004, Hatt et al. 2004, Pellet et al. 2004, Wissmar et al 2004, and Jones & Stokes 2005).[16]

What Some Relevant Science "Says" About Stream/Riparian Setbacks

The following information was taken from Jones & Stokes, 2005.[17]

- Development and encroachment setbacks should include the entire *active floodplain* of a creek or river to adequately preserve stream banks and associated riparian vegetation. Because active floodplain boundaries are more stable and measurable than stream banks or the boundaries of riparian vegetation (that are dynamic and change with time), the boundary of the active floodplain—which can be readily delineated—is a preferable basis for determining setback widths rather than edges of stream banks, stream centerlines (or thalwegs), or any boundaries based exclusively on channel widths or vegetation.
- There is no single, abrupt, well-documented threshold width setback that would provide maximum benefits for all riparian functions. Rather, because riparian functions have different mechanistic bases, they are affected by different site attributes, and the relationship between setback widths and reduction of human effects differs among riparian functions. Nevertheless, several defensible arguments can be constructed regarding the appropriate width for a buffer to include within riparian setbacks. First, most riparian functions would be affected if setbacks included a buffer of less than 20 m (66 feet) beyond the active floodplain; consequently, narrower widths are not adequate for long-term conservation of riparian functions. This conclusion is based largely on a review of the scientific literature. In addition, stream incision and a discontinuous cover of woody plants reduces the benefits of narrow buffers. This variability in vegetation extent and structure reduces the effectiveness of narrow setbacks.

Recommendations for riparian setbacks are presented below:

- Apply to first and second order stream segments a minimum riparian setback that includes the entire active floodplain plus a buffer of 30 m (98 feet) of adjacent land (on each side of the active floodplain), or the distance to the nearest ridgeline or watershed boundary, whichever is less. (First order stream segments are upstream segments that have no tributaries, and second order segments are formed by the junction of first order segments.) Though the purpose of this setback would be to conserve stream and riparian functions; it would not be sufficient for the conservation of many wildlife species with large area requirements.
- Along higher order stream segments (i.e., third order and greater), and along lower order segments at selected sites (e.g., those in or adjacent to conservation lands), apply a setback of at least 100 m (328 ft), and preferably 150 m (656 ft), from the active floodplain for the purpose of conserving and enhancing stream and riparian ecosystem functions including most wildlife habitat functions. Along these larger stream segments, floodplains and riparian areas are more extensive, continuous, and structurally diverse than for lower order stream segments (e.g., first

[15] Jones & Stokes. *Setback Recommendations to Conserve Riparian Areas and Streams in Western Placer County.* 2005. February, 2005.
[16] *Ibid.*
[17]. *Ibid.*

and second order). These areas constitute corridors connecting a watershed's lower order stream segments, and, at a watershed scale, the riparian areas of these higher order segments contain particularly important habitats for most riparian-associated species.

- The conservation of wildlife habitat functions within these areas may be necessary for the persistence of their populations. For this reason, a wider setback, sufficient for the retention of wildlife habitat functions, is recommended along stream segments. Recommendations would result in a total setback width ranging from slightly more than 30 m (98 feet) on most first- and second order stream segments to over 150-200 m (492-656 feet) on higher-order streams.
- By basing these recommendations, in part, on the width of active floodplains, a variable, site-specific setback width that accounts for stream size is created. The width of the active floodplain provides a clear, functional basis for a variable width criterion that accomplishes the same purpose more directly than criteria based on stream order, slope, and other attributes of streams and their settings.

Riparian woodland restoration and enhancement measures should include:

- Where feasible, contiguous areas larger than 5 ha (12 ac) should be maintained, enhanced and linked to provide habitat refuge areas for sensitive species. These areas should be connected by riparian corridors more than 30 m (98 feet) wide on both sides of the channel wherever possible, in order to provide movement and dispersal corridors for wildlife.
- The preservation, restoration and linkage of large parcels of undeveloped and uncultivated lands adjacent to riparian areas will provide significant benefits to riparian species. Thus, large contiguous areas of riparian vegetation surrounded by "natural" uplands should be conserved to the greatest extent possible.
- Potential effects of adjacent land uses on riparian areas should be thoroughly evaluated during regional land use planning, and during the environmental review and permitting processes for specific projects, and these effects should be avoided to the maximum extent practicable.
- Re-creation of regular disturbance events (e.g., high water) on the floodplain will enhance vegetation and breeding bird populations in most systems (Riparian Habitat Joint Venture 2004).
- Within setbacks, most developed land uses would be incompatible with the conservation of stream and riparian functions. Developed land uses should be restricted to unavoidable crossings by roads and other infrastructure, because any structures or alterations of topography, vegetation or the soil surface are likely to affect both stream and riparian functions, and could result in substantial effects both on-site and downstream.
- For the purpose of long-term conservation of plant habitat functions, riparian setbacks should include the entire active floodplain, regardless of the current extent of riparian vegetation on that surface. The distribution of riparian vegetation is not static within the active floodplain, and the diversity of vegetative structure and species composition is strongly related to the hydrologic and geomorphic processes within the active floodplain. Therefore, conversion of any portion of the active floodplain to developed or agricultural land-cover types would affect hydrologic and geomorphic functions and affect plant habitat functions.
- Riparian-associated wildlife species differ in the specific habitat attributes they require in riparian systems. Consequently, structurally diverse vegetation, as well as the full range of naturally occurring physical conditions and disturbance regimes, are necessary to provide suitable riparian habitat for the entire community of associated wildlife species. Many riparian-

associated wildlife species use, and often require, both riparian and adjacent upland habitats for reproduction, cover, and/or foraging.

Recommendations for riparian setbacks by agricultural operations are presented below:

- Along first- and perhaps second-order streams, mitigation for adjacent agricultural uses would include filter strips and riparian buffers managed according to standards established by the National Resources Conservation Service. Such practices would improve the buffers' effectiveness for conserving some functions. Along first- and perhaps second-order streams, compatible developed land uses could include open space and low-density residential development, provided no impervious surfaces, infrastructure, or irrigation are placed within the setback.

Request for Information

- Please provide the scientific basis upon which riparian/stream setbacks were developed (such as peer-reviewed research documents, studies from universities, reports from State agencies with expertise in riparian/stream protection).
- Discuss why the riparian setback for a ministerial project is different from a discretionary project, given a hypothetically equivalent environment in each case.
- Discuss the criteria used to determine both the impacts/mitigations for discretionary development projects and the setback size(s) for discretionary projects.
- Include in the dEIR a discussion detailing whether the individual performing the Biological Resource Assessment will be required to consult with agencies with expertise in the field of riparian/stream protection, wildlife protection, etc., and include information from such consultations in the report.
- Discuss who will conduct the monitoring and reporting requirements for ministerial and discretionary projects. (If they will be conducted, who will conduct them, and the qualifications of individuals conducting the monitoring.)
- Describe any penalties or corrective actions that will be required for violations to prescriptive mitigations, and the criteria upon which these actions will be based.
- Identify actions that will be taken to revise ordinances and policies if mitigation measures established in the zoning ordinance are found not to be effective.
- Discuss the impact of livestock on riparian areas and identify the mitigation measures designed to reduce these impacts. If Best Management Practices (BMP)are employed, identify where those BMPs are documented, and discuss their efficacy in terms of mitigating impacts.
- It has been stated that developed land uses (including agricultural uses) within recommended buffer setbacks preclude the effectiveness of setbacks.[18] Discuss why this is/or is not the case.
- It is also widely believed that conversion of large portions of a watershed or region to developed and agricultural land uses is associated with broad negative effects on riparian and stream ecosystems.[19] Discuss why this is/is not the case.

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[18] Jones & Stokes. *Setback Recommendations to Conserve Riparian Areas and Streams in Western Placer County.* 2005. February, 2005.

[19] Findlay and Houlahan 1996, Roth et al 1996, Booth and Jackson 1997, Magee et al. 1999, Doyle et al. 2000, Paul and Meyer 2001, Allan 2004, Hatt et al. 2004, Pellet et al. 2004, Wissmar et al 2004, and Jones & Stokes 2005).

- Discuss whether the existing riparian setbacks will result in unbuildable parcels in EDC. Quantify how many would become unbuildable if riparian setbacks were increased to protective levels (as discussed in the Jones & Stokes report).
- Discuss whether EDC has developed a database of important surface water features, and if not, when this will be developed. Discuss whether it is possible/legal for EDC to approve development projects that will impact these resources prior to the development of this database.

BRPU, 13D, page 10:

Policy 7.3.3.3	The County shall develop a database of important surface water features, including lake, river, stream, pond, and wetland resources.

<u>Agricultural Operations and Evaluation Under AB 32</u>

Agricultural operations may be exempt from Public Resources Code 21083.4 (Kuehl) provisions under the TGPA/ZOU, but agriculture *<u>is not</u>* exempt from CEQA oak woodland biogenic greenhouse gas emissions (GHG) analysis. (There are no GHG exceptions or exemptions for any oak woodland conversion project.)

<u>Request for Information</u>

- Because the TGPA/ZOU adds 17,000 acres of agricultural land—some of which is currently designated Open Space—impact to oak woodlands is likely significant. While agricultural operations are exempt from oak mitigation (tree replacement measures), they are not exempt from the evaluation of impacts under AB 32. Therefore, this conversion of land from other zoning designations to agricultural land designations must be evaluated as an impact to oak woodlands under this dEIR.
- Discuss the following: Does the project fully account for direct and indirect oak woodland conversion biogenic soil/vegetation GHG emission effects, including carbon dioxide, methane, nitrous oxide and black carbon emission associated with biomass disposal (including from agricultural operations).

<u>Valley Oak Replacement / Request for Information</u>

- Include a discussion regarding valley oak (*Quercus lobata).* Specifically, given the designation of this species as a species of "*special concern*," why is there no recognition of this fact in terms of enhanced mitigation to protect/replace this species?
- Discuss what mitigation elements will be included to protect this species of special concern.
- If specific mitigation elements are not to be included for this species, discuss why this is the case.
- Quantify the estimated decline of this species if special protections are not provided.

Tree Replacement Scenarios

There seems to be some confusion regarding the tree replacement

> Replacement Tree Sizes:
>
> During its June 22, 2015 hearing, the Board requested further clarification and discussion on the potential for allowing different sized container trees to be planted for mitigation. Currently, the draft ORMP requires individual native oak trees to be replaced with 15-gallon sized trees and allows replacement planting for oak woodland mitigation to utilize a variety of smaller sized containers (1-gallon (or equivalent)) or acorns (with a 3:1 replacement ratio). [redacted]

Source: Dudek Memorandum, September 18, 2015; 17A, page 9.

I believe this is incorrect. The ORMP does not require "*…<u>individual native oak trees</u> to be replaced with 15-gallon sized trees…";* on page 13 of the May, 2015 ORMP (identical language/criteria is in the revised November 2915 ORMP) it states under "*<u>Individual Native Oak Tree and Heritage Tree Impacts</u>*":

> [redacted] Replacement tree sizes may vary and may include acorn plantings, based on documentation of inch-for-inch replacement consistency included in an oak resources technical report. If acorns are used, they shall be planted at a 3:1 ratio (3 acorns for every 1-inch of trunk diameter removed) [redacted]

Source: ORMP, May 2015; 13F, page 13. (Identical language/criteria as in the revised November 2915 ORMP.)

In any case, the formula will presumably work in this manner:

> [redacted] Under the tree-for-inch standard, tree planting would not replace the number of diameter inches removed. However, it would require planting of the same number of trees that would have been planted under an inch-for-inch standard that requires use of 15-gallon trees. To compare the two replacement standards, mitigation for removal of one 12-inch tree under the current draft ORMP would require a project applicant to plant 12 15-gallon oak trees; under the tree-for-inch mitigation standard mitigation for the same impact would require planting of 12 trees of any container size, or 36 acorns.

Source: Dudek memorandum of September 18, 2015; 17A, page 13.

Request for Information

- Once again, **<u>efficacy</u>** (and **<u>performance standards</u>**) should dictate oak tree/woodland mitigation, not an arbitrary formula. Please identify in the dEIR the efficacy of such an approach, and identify specific performance standards (such as canopy cover over time).
- Efficacy of mitigation needs to be demonstrated. The two studies described in the Dudek memorandum 17A (Hobbs, et al., 2001; Young, et al.,2005) actually *do not* support the supposition that acorn planting is "better" than planting larger stock. McCreary –also cited by Dudek—mentions multiple caveats to acorn planting—as presented in my comments of September 29, 2015. But the difficulties of acorn use have been largely ignored, presumably due to its lower mitigation cost.

Tree-for-Inch Mitigation

The tree-for-inch (as opposed to the inch-for-inch) mitigation represents another approach to lessening the cost of mitigation for the project applicant at the expense of oak woodland replacement. As written, this tree-for-inch standard can include replacement of one inch of tree with three acorns. Thus, a 12 inch oak could be replaced with 36 acorns (which are intended to yield 12 live trees, not 36 trees). Based on the growth rate of blue oaks (the species most likely to be removed and replaced via mitigation plantings) it could take a *very* long time to replace an oak.

The oak seedling at left is 8 to10 inches tall and **12 to 16** years old. Below is a 6 to 8 inch tall seedling estimated to be **10 to 15** years old.

Source: Phillips, et al., 1996

This cross section was derived from a blue oak that was 4.5 inches dbh. This oak was estimated to be 95 years old.

Photo Source: Don & Ellen Van Dyke

A study by Standiford[20] on blue oak growth rates revealed an average diameter at breast height (dbh) after 50 years that ranged from 3.4 to 4.1 inches. Even under fairly aggressive restoration efforts, the largest mean diameter of the stand was only 3.9 inches.

Request for Information

- How much "dilution" of mitigation can occur before "mitigation" is no longer mitigation? The following statement was taken from the Dudek memorandum dated September 18, 2015 (17A):

  The tree-for-inch standard would be the lesser burden for applicants.

  This is great for the applicant; not so good for oak woodland resources. After all is said and done, it is important to remember that—while some individuals have requested that mitigation costs be kept as low as possible—**mitigation must be adequate to mitigate loss**. Affordability is not a criterion under which the effectiveness of mitigation can legitimately be degraded.

  As this BRPU/ORMP process has moved forward, more approaches to cost/effort reduction have been inserted. Interestingly, I have not seen documentation in the record, nor heard public testimony requesting these cost-saving changes. Therefore, please disclose in the dEIR the motivation behind the changes. That is, are these modifications based on discovery of what other counties have instituted, or based on mitigation successfully performed in other counties—or are these approaches simply designed to reduce costs/effort for applicants, in spite of the fact that there appears to be *no evidence* to support this approach to mitigation? (And by mitigation I mean the successful replacement of oak woodland within a reasonable amount of time—say five to seven years.) If other counties have instituted these changes (acorn use, tree-for-inch replacement, relying on natural regeneration as a mitigation element, etc.,) please supply documentation that supports the efficacy of these measures in "real world" applications.

- Because it is looking less likely any of the mitigation proposals put forth will realistically mitigate for the loss of oak woodland in a reasonable amount of time, it is reasonable to assume the most effective "mitigation" will be either on-site retention (avoiding the impact in the first place), or the purchase of conservation easements that already contain viable oak woodlands. Therefore, in the dEIR, please evaluate this latter form of mitigation as the primary mitigation scenario. Identify the areas of EDC in which conservation easements are most likely to be established, and the anticipated acreage that is available for easement purchase. Also, identify the plant/wildlife component of these areas, and whether these conservation easements will adequately retain/protect a variety of plant/animal communities, or whether they are limited in scope in terms of diversity.

Oak Tree Replacement

According to the ORMP, "*any trees that do not survive the 7-year monitoring and maintenance period shall be replaced by the responsible party listed on the Oak Tree Removal permit and shall be monitored and maintained for 7 years.*"

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[20] Standiford, R, et al. 2001. *Modeling the Effectiveness of Tree Planting to Mitigate Habitat Loss in Blue Oak Woodlands.* USDA Forest Service General Technical Report PSW-GTR-184, 2002.

Request for Information

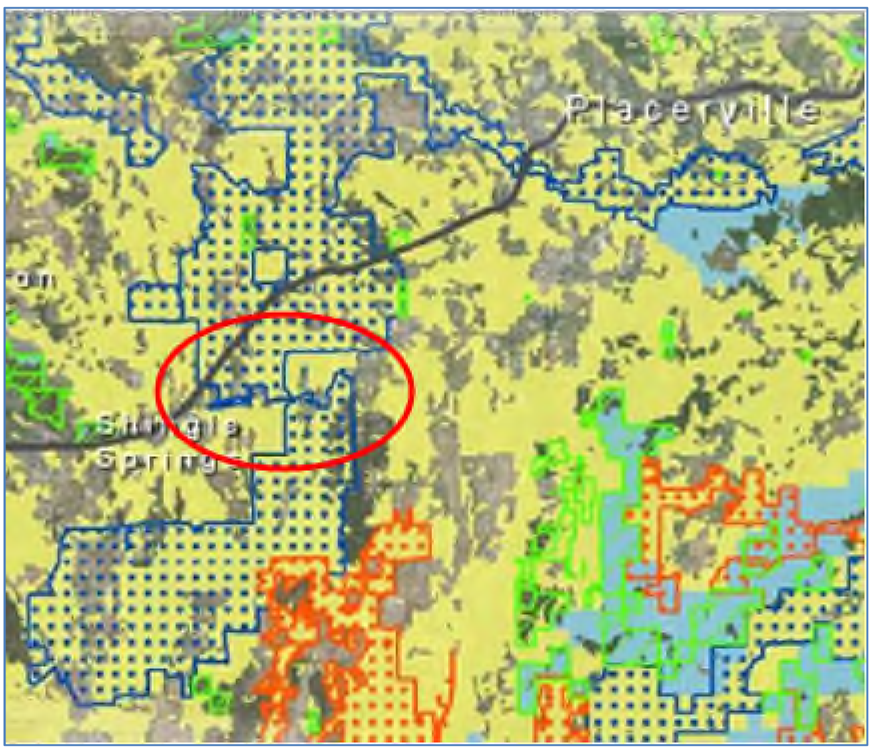
- Please explain in the dEIR how tree replacement is expected to work. That is, are dead trees monitored and replaced annually, or are dead trees only replaced at the end of the 7-year period?

Project Exemptions

- Discuss exemption for County road projects. This is a source of significant impact to oak resources. Bridge projects especially can disproportionately impact valley oak, a species of "special concern." Discuss—based on scheduled road widening/bridge projects—the anticipated impact to oak resources.

IBC and PCA Maps, etc.

Closer examination of the IBC/PCA maps raises more questions than answers. For instance, in this section of the map, it appears the IBC is greatly constricted in this particular area. Discuss the reason for this constriction—it appears to be artificial.



Request for Information

- Please provide better (more detailed) IBC/PCA maps for each planning area. Identify any outstanding anomalies, and characterize the importance/necessity of each area (what they are designed to protect/serve.)

In Conclusion

In closing I'd like to say the policies proposed in the ORMP represent a significant weakening of environmental protection policies developed under the 2004 General Plan. Therefore, please consider revision to the draft ORMP that strengthen biological resource protections.

Attachment 3

Public Comment
Board of Supervisors Meeting
September 29, 2015
Agenda Item #26; File No. 12-1203

Cheryl Langley
Shingle Springs Resident

RE: Biological Resources Policies Update & Oak Resources Management Plan

Board Members:
Thank you for the opportunity to comment on the Biological Resources Policy Update (BRPU) and Oak Resources Management Plan (ORMP).

OAK TREE RETENTION STANDARDS
I urge the Board to **retain the Option A retention standards**. Oak retention should be a priority. Woodland removal beyond Option A retention standards should be considered **only after it has been determined the project cannot meet these standards through any reasonable means.** This determination could be made in conjunction with preparation of the *Oak Resources Technical Report*.

OAK TREE REGENERATION
Several studies have shown that **blue oak regeneration is a problem in numerous areas of the State**. Consequently, evaluation of the role natural regeneration may play as mitigation for project impacts (in the EIR impact analysis) is a "non-starter." **Claims that oak regeneration can somehow mitigate for loss of oak woodland is not supported by scientific study**.

Ritter writes: [1]

> Most stands of blue oak woodland exist as medium or large tree stages with few or no young blue oaks present (White 1966, Holland 1976, Griffin 1977, Baker et al 1981). **Few areas can be found in California where successful recruitment of blue oaks has occurred since the turn of the century" (Holland, 1976).**

Teklin writes: [2]

> Natural regeneration of two endemic California oaks, blue oak (*Quercus douglasii*) and valley oak (*Q. lobata*), has been widely recognized to be a problem statewide on many sites (Bolsinger 1988, Griffin 1971, Muick and Bartolome 1987, Swiecki and Bernhardt 1993). Lack of recruitment to the sapling stage has been identified as a widespread occurrence. [redacted]

Verner writes of blue oak woodland: [3]

> The age at which they normally begin producing acorn crops in unknown (M. McClaran, pers. Comm.), but it likely takes several decades. Concern has been expressed for the long-term existence of this habitat (Holland 1976), because '*little regenerations has occurred since the late 1800s, as livestock, deer, birds, insects, and rodents consume nearly the entire*

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[1] Ritter, L.V. Undated. Blue Oak Woodland. California Wildlife Habitat Relationships System, California Department of Fish and Game, California Interagency Wildlife Task Group. Available at: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=67340

[2] Teckin, J., Conner, J.M., McCreary, D.D. 1997. Rehabilitation of a Blue Oak Restoration Project. USDA Forest Service General Technical Report, PSW-GTR-160.

[3] Verner, J. Undated. Blue Oak-Foothill Pine. California Wildlife Habitat Relationships System, California Department of Fish and Game, California Interagency Wildlife Task Group.

acorn crop each year. Of the few seedlings that become established a large proportion are eaten by deer' (Neal 1980:126). Furthermore, the absence of grazing livestock does not generally result in regeneration (White 1966), because many other animals eat acorns and seedling oaks. Moreover, introduced grasses…may compete directly with seedling oaks for light and nutrients, and may be allelopathic to the oaks.

And, according to *A Planner's Guide for Oak Woodlands*:[4]

> **There is substantial evidence suggesting that several species, including blue oak, valley oak,** and Engelmann oak (*Quercus engelmannii*) **are not reproducing at sustainable levels in portions of California. <u>Simply stated, there are not enough young seedlings or saplings to take the place of mature trees that die, raising questions about the future of these species in the state.</u>**
>
> **Numerous causes** have been cited, including **<u>increased populations of animals and insects that eat acorns and seedlings, changes in rangeland vegetation</u>, adverse impacts of livestock grazing (direct browsing injury, soil compaction, and reduced organic matter), and <u>fire suppression</u>.** Some people also suspect that **<u>climate change</u>** is a factor...

<u>REGENERATION & ACORN PLANTINGS</u>

This troubling condition—that of poor regeneration—means the viability of acorn plantings, too, will be problematic, **<u>making replacement of woodlands via the planting of acorns a fragile, ineffective strategy</u>**.

According to *A Planner's Guide for Oak Woodlands:* [5]

> …the same factors that prevent or limit **natural regeneration** can also take a heavy toll on artificial plantings. **To be successful, relatively intensive site preparation, maintenance, and protection must usually be provided for several years.**

Thus, while Dudek cites a 1996 study by McCreary as support for acorn plantings, McCreary, too, states that **an effective alternative to directly sowing acorns is growing oak seedling in containers and then planting the saplings out in the field**. McCreary indicates propagating oaks in this manner results in starts that "...**<u>have higher survivorship than directly planted acorns, but they also cost far more</u>**." [6]

The specific study cited by Dudek (17A, page 10) reveals that acorn mortality was the highest of any group (acorns, four-month old starts, one year old saplings), and McCreary concludes that *"acorns did have significantly less overall survival,"* and cautions about their usage "*if large numbers of acorn-eating rodents are present at the planting site..."* [7] And, note Dudek's numerous qualifiers to acorn use:

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[4] Giusti, G.A. et al (editors). 2005. *A Planner's Guide for Oak Woodlands*. University of California, Agriculture and Natural Resources, Publication 3491, second edition.

[5] Giusti, G.A. et al (editors). 2005. *A Planner's Guide for Oak Woodlands*. University of California, Agriculture and Natural Resources, Publication 3491, second edition.

[6] McCreary, D.D. Undated. *Living Among the Oaks: A Management Guide for Woodland Owners and Managers*. University of California, Agriculture and Natural Resources, Oak Woodland Conservation Workgroup; publication 21538.

[7] McCreary, D.D. 1996. The Effects of Stock Type and Radicle Pruning on Blue Oak Morphology and Field Performance. Annals des Sciences Forestieres, 53 (2-3), pp. 641-646.

Acorn and oak seedling (1-gallon and smaller) establishment success has been well-documented in field research, with several studies noting the successful establishment of planted oak seedlings in northern California sites[3,4,5]. In some cases, acorns and smaller containers can outgrow larger container-sized trees[6], primarily due to taproot development being more successful as it is not inhibited by excessive time in containers. In the study by McCreary[7], blue oak acorns and 4-month-old seedlings outgrew 1-year-old seedlings over a 4-year period once planted. The variation in seedling container sizes allows for flexibility in oak tree replacement projects that need to consider soil type, maintenance needs, access, and available irrigation.

Source: 17A, page 10.

The qualifiers include:

- "…several studies noting the successful establishment of planted oak **seedlings**" (not acorns);
- "**In some cases**…" (presumably "cases" in areas of intensive care, such as research plots); and
- "…need to consider **soil type**, **maintenance needs**, **access**, and available **irrigation**."

All citations listed by Dudek (3,4,5,6, & 7) are from studies by McCreary. However, according to McCreary,[8] the planting of acorns will be impacted by a whole host of factors such as conditions at the planting site, including the kinds of animals present. **Because acorns are an important food source for a whole host of animals, acorn plantings are difficult to protect**. McCreary also warns that the type of care necessary for survival and growth may not be **logistically feasible** for remote planting sites,[9] making a difficult prospect even more susceptible to failure.

According to *A Planner's Guide for Oak Woodlands*:[10]

> [T]he ultimate goal for planting mitigations should be tree establishment and long-term survival. The impact should be compensated for by replacing or providing substitute resources, such as **planting large container-grown trees**, **rather than seedlings or acorns** to expedite the recovery of the lost habitat component, or off-site mitigation actions, or mitigation banking**. However, off-site measures should be considered sparingly and should not be viewed as a convenient way to achieve mitigation objectives; off-site mitigation proposals should be carefully considered so that the strategy *is not abused***.

[8] McCreary, D.D. Undated. *How to Grow California Oaks*. University of California Oak Woodland Management. Available at: http://ucanr.edu/sites/oak_range/Oak_Articles_On_Line/Oak_Regeneration_Restoration/How_to_Grow_California_Oaks/

[9] McCreary, D.D. Undated. *Living Among the Oaks*: A Management Guide for Woodland Owners and Managers. University of California, Agriculture and Natural Resources, Oak Woodland Conservation Workgroup; publication 21538.

[10] Giusti, G.A. et al (editors). 2005. *A planner's guide for oak woodlands*. University of California, Agriculture and Natural Resources, Publication 3491, second edition.

MITIGATION EFFICACY & PERFORMANCE STANDARDS

It is essential that whatever mitigation option is chosen, **it must meet performance standards**. For instance, in the Interim Interpretive Guidelines (IIG) (7)(b), page 10, and IIG (7)(c), page 11, replacement plantings are "designed" to achieve oak woodland canopy coverage equal to the canopy removed **no more than 15 years from the date of planting**.

What is the performance standard for the mitigations described in the ORMP?

Performance standards are important. The following photos were taken of **mitigation plantings** by Serrano Village D2 in "tree shelters." (This village was built around 2001-2003.)
Photos taken **June, 2015**.

This is a photo of a "tree shelter" around a blue oak; it was probably planted around the time of adjacent village construction (2001-2003). Photo taken June, 2015.

Note the low success rate of blue oak plantings, even with tree shelters

The tree shelters in this area (as seen in foreground) are mostly devoid of trees (approximately 12-14 years after planting).

This effort at oak woodland mitigation is dismal. And unfortunately, **past performance is the best predictor of future performance**. What assurances do County residents have that mitigation efforts will be successful?

Woodland replacement is crucial—especially in terms of habitat value to wildlife. According to *A Planner's Guide for Oak Woodlands*:[11]

> …ecologists now recognize that **replacing a century old tree with 1, 3, or 10 one-year-old seedlings does not adequately replace the lost habitat value of large trees. It has become evident that simply <u>focusing on mitigation plantings based on a tree to seedling ratio is not a sufficient strategy to ensure the viability of oak woodlands</u>.** [R]eplacement seedlings as a mitigation measure for removal of older stands of trees cannot meet the immediate **habitat needs** of forest-dependent animal species.

It is apparent that **preservation of oak woodland on-site is the preferred "mitigation."** Short of on-site preservation, **the purchase of oak woodlands that will remain undeveloped in perpetuity** is to be preferred over on-site (or off-site) planting of saplings. Revegetation on- or off-site is a poor substitute for mature woodland, especially when value as **wildlife habitat** is part of the equation. **It is likely that the loss of oak woodlands cannot be adequately mitigated under the proposals in the ORMP, especially in the absence of <u>Option A retention requirements.</u>**

<u>TREE REPLACEMENT QUESTION</u>

Dudek presents the following:

> 8. <u>Replacement Tree Sizes:</u>
>
> During its June 22, 2015 hearing, the Board requested further clarification and discussion on the potential for allowing different sized container trees to be planted for mitigation. Currently, the draft ORMP requires individual native oak trees to be replaced with 15-gallon sized trees and allows replacement planting for oak woodland mitigation to utilize a variety of smaller sized containers (1-gallon (or equivalent)) or acorns (with a 3:1

Source: 17A, page 9.

I believe this is incorrect. The ORMP does not require "…*<u>individual native oak trees</u> to be replaced with 15-gallon sized trees…";* on page 13 of the ORMP it states under "*<u>Individual Native Oak Tree and Heritage Tree Impacts</u>*":

> [redacted] Replacement tree sizes may vary and may include acorn plantings, based on documentation of inch-for-inch replacement consistency included in an oak resources technical report. If acorns are used, they shall be planted at a 3:1 ratio (3 acorns for every 1-inch of trunk diameter removed) [redacted]

Source: ORMP, page 13.

So my question is, what is actually being proposed here? Apparently, Dudek sees the formula working in this manner:

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[11] Giusti, G.A. et al (editors). 2005. *A planner's guide for oak woodlands*. University of California, Agriculture and Natural Resources, Publication 3491, second edition.

> [redacted] Under the tree-for-inch standard, tree planting would not replace the number of diameter inches removed. However, it would require planting of the same number of trees that would have been planted under an inch-for-inch standard that requires use of 15-gallon trees. To compare the two replacement standards, mitigation for removal of one 12-inch tree under the current draft ORMP would require a project applicant to plant 12 15-gallon oak trees; under the tree-for-inch mitigation standard mitigation for the same impact would require planting of 12 trees of any container size, or 36 acorns.

Source: 17A, page 13.

But once again, **efficacy** (and **performance standards**) should dictate oak tree/woodland mitigation, not an arbitrary formula. As previously quoted in this document (Gusti 2005), "**focusing on mitigation plantings based on a tree to seedling ratio is not a sufficient strategy to ensure the viability of oak woodlands.**"

DEFINITION OF OAK WOODLANDS

It would be most appropriate to expand the definition of **"Oak Woodland"** to include not only standing living oaks, "*…but also trees of other species, damaged or senescent (aging) trees, a shrubby and herbaceous layer beneath the oak canopy, standing snags, granary trees, and downed woody debris in conjunction with [oaks].*"[12] Evaluate existing oak woodlands under these criteria and, *if on-site retention is not possible*, **mitigate for the loss of *all* woodland components** through either conservation easement or fee title acquisition in perpetuity to ensure replacement of viable woodland/wildlife habitat. (Napa County, for instance, employs a 60/40 retention in *sensitive water drainages*: 60% tree cover; 40% shrubby/herbaceous cover.)[13]

DEAD, DYING & DISEASED OAKS

The loss/removal of dead, dying and diseased oaks should be mitigated and not exempt from mitigation requirements. Trees in these states of decline are not "useless," they are an important element of an oak woodland. They provide nesting sites for cavity nesting birds (as is the case with dead trees or dead tree limbs [snags]), and food storage sites for others (e.g., acorn woodpeckers). These trees should not be excluded from the calculation of oak woodland—or from mitigation requirements—and should be left standing in on-site retained woodland as long as they do not present public safety issues.

In fact, this issue of retention of declining oaks raises important questions:

- **What is important to save**? **Oak trees alone, or oak trees and their attendant habitat?**
- **Where does value lie? In what people believe is useful/aesthetically pleasing, or in what wildlife finds useful/habitable?**

Answering these questions can help focus the ORMP.

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[12] Michael Brandman Associates. 2012. Tuolumne County Biological Resources Review Guide. December 4, 2012; page 32. Available at: http://www.tuolumnecounty.ca.gov/DocumentCenter/View/204

[13] Napa County. 2010. Napa County Voluntary Oak Woodlands Management Plan. October 26, 2010; page 20. Available at: http://www.countyofnapa.org/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=4294973990

REDUCTION OF HERITAGE TREE SIZE REQUIREMENT

I ask that Heritage Oak size be defined as 24" diameter at breast height (dbh), if not for all oak species, for blue oak. Why the necessity? Blue oak are slow growers. For instance, the blue oaks depicted in the following two photographs are **10-16 years old**.[14]

The oak seedling at left is 8 to10 inches tall and **12 to 16** years old. Below is a 6 to 8 inch tall seedling estimated to be **10 to 15** years old.

This cross section was derived from a blue oak that was 4.5 inches dbh. This oak was estimated to be 95 years old.

Photo Source: Don & Ellen Van Dyke

[14] Phillips, R. L., et al. 1996. Blue Oak Seedlings May be Older than they Look. California Agriculture, May-June 1996. Available at: http://ucanr.edu/repositoryfiles/ca5003p17-69761.pdf

Large blue oaks are likely **153 to 390 years old** (White, 1966). And, growth is extremely slow ***or even ceases*** after trees reach **26 inches dbh** (McDonald, 1985).[15] Creating a separate category for blue oaks is not unprecedented; **Tuolumne County** has worked to establish a separate standard for blue oaks under their *old growth oaks* or **"specimen oaks"** category.[16]

COMMERICIAL FIREWOOD HARVEST

While **commercial firewood cutting operations** would be required to obtain a permit under the proposed plan, **there is no mention of minimum retention standards**. Shasta and Tehama counties adopted resolutions calling for **30% crown cover retention** following firewood harvest.[17]

EXEMPTIONS FOR PERSONAL USE & NON-COMMERCIAL AGRICULTURAL OPERATIONS

"Personal use" of oak resources on an owner's property must be better defined, otherwise, "pre-clearing" of a site under the guise of personal use is actually encouraged. Also, the **exemption for non-commercial agricultural "operations" is excessive and likely to result in the needless loss of oak woodland.**

ADVISORY BODY

Establishment of an **advisory body** to review mitigation plans, implementation, and efficacy would be valuable. (Ideally this advisory body would make recommendations to appropriate governing bodies, work with land conservation groups, and be responsible for homeowner education (protection of oaks in the landscape).

In closing, I ask:

- **Please retain the Option A retention schedule**. Short of reinstatement, I ask that an **equal-weight analysis of this alternative be performed and included in the draft EIR.**
- Do not allow replacement of oak woodland with **acorn plantings**.
- Establish a **performance standard** for oak mitigations.
- **Define "Oak Woodland"** to include other associated tree and shrub species (understory) to maintain wildlife habitat value; require mitigation to replace these elements as well.
- Revise the **Heritage Oak size requirement**, if not for all oaks, for **blue oaks**.
- Establish a minimum retention standard for commercial firewood cutting operations.
- Define exemptions for personal use and for non-commercial agricultural operations.
- Establish an Advisory Body to review mitigation plans, mitigation implementation, and efficacy (similar to PAWTAC).

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[15] Ritter, L.V. Blue Oak Woodland. California Wildlife Habitat Relationships System, California Department of Fish and Game, California Interagency Wildlife Task Group. Available at: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=67340

[16] Michael Brandman Associates. 2012. Tuolumne County Biological Resources Review Guide. December 4, 2012; page 38. Available at: http://www.tuolumnecounty.ca.gov/DocumentCenter/View/204

[17] Standiford, et al., 1996. Impact of Firewood Harvesting on Hardwood Rangelands Varies with Region. California Agriculture, March-April, 1996. Available at: http://ucce.ucdavis.edu/files/repositoryfiles/ca5002p7-69759.pdf

Attachment 4

California Oaks

Preserving and perpetuating California's oak woodlands and wildlife habitats

July 22, 2016

Community Development Agency
Long Range Planning Division
2850 Fairlane Court
Placerville, CA 95667
shawna.purvines@edcgov.us

Re: Biological Policy Update Project

Shawna Purvines, Principal Planner:

California Oaks appreciates the opportunity to comment on the Biological Policy Update Project. While acknowledging California Oaks previous greenhouse gas (GHG) concerns, the DEIR has provided no meaningful or cogent responses to the issues raised. Specifically: (1) the failure to feasibly and proportionally mitigate the direct loss of sequestered carbon; (2) the failure to analyze or feasibly and proportionally mitigate the foreseeable indirect carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and black carbon emission effects due to removed biomass decomposition or combustion. These DEIR omissions represent a failure to proceed in the manner prescribed by the California Environmental Quality Act (CEQA). The project is also inconsistent with other aspects of California's GHG reduction policy.

Necessity
The stated CEQA purpose of Senate Bill 97 (2007) is "the feasible mitigation of greenhouse gas emissions or the effects of greenhouse gas emissions." The CEQA Appendix G checklist encourages that forest land conversion GHG biogenic emissions be considered. The direct effect biogenic emissions are due to the one-time loss of sequestered carbon. The indirect effect biogenic emissions are the result of biomass utilization or disposal of the carbon stored in the dead vegetation. CEQA recognizes the secondary GHG biogenic emissions in the indirect effects language of Guidelines § 15358(2), "... are later in time or farther removed in distance, but are still reasonably foreseeable."

DEIR: "Buildout of the General Plan could result in the loss of 6,442 acres of forest land by 2035 resulting in a significant and unavoidable impact." (at 7-9).

Comment 1: Please answer the following forest land conversion question:

1. Due to biomass decomposition or combustion, how many metric tonnes of CO_2, CH_4, N_2O and black carbon biogenic emissions are projected with buildout impacts to 6,442 acres by 2035?

DEIR: "The effect each GHG has on climate change is measured as a combination of the mass of its emissions and the potential of a gas or aerosol to trap heat in the atmosphere, known as it "global warming potential" (GWP). GWP varies between GHGs; for example, the GWP of CH_4 is 21, and the GWP of N_2O is 310" (at 8-2).

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Comment 2: The DEIR is quoting outdated GWP standards. The California Air Resources Board (CARB) current GWP standards list methane as having 25 times, nitrous oxide 298 times and black carbon 900 times more climate warming potential than CO_2 over a 100-year time horizon.[1]

DEIR: "The El Dorado County Air Quality Management District was part of the committee of air districts in the Sacramento region involved in the development of GHG thresholds of 1,100 metric tons CO_2e per year for the construction phase of projects or the operational phase of land use development projects ..." (at 8-12).

Comment 3: The El Dorado County air district and SMAQMD project GHG thresholds are knock offs of the 2010 Bay Area Air Quality Management District (BAAQMD) standards. They mimic the same forest conversion biogenic emissions accounting deficiencies as the BAAQMD project threshold. The following quote from the current Ciminelli vineyard conversion DEIR in Napa County (CAL FIRE lead agency) correctly recognizes that the BAAQMD project threshold excludes GHG biogenic emissions quantification:

"Although the [BAAQMD] Guidelines provide clear guidance on how to analyze GHG emissions from biogenic sources, which result from natural biological processes such as the decomposition or combustion of vegetative matter (wood, paper, vegetable oils, animal fat, yard waste, etc.), the Guidelines do not require the quantification of biogenic GHG emissions as part of the quantification of project-related GHG emissions and does not provide a GHG emission threshold for these sources for either operation and construction activities. The Guidelines require that only exhaust from construction equipment be included in the climate change analysis, similar to the analysis for criteria pollutants" (Ciminelli DEIR at 4.7-7).

The El Dorado County air district project threshold excludes forest land conversion biogenic emissions quantification, which is inconsistent with CEQA requirements. This omission is understandable given that forest land oversight is the purview of the State of California not the air districts. The state has chosen not to establish a forest land conversion threshold of significance.

A greenhouse gas project threshold of significance that excludes the entire category of forestry sector emissions cannot be claimed to unequivocally reduce all GHG impacts to less than significant. Since the El Dorado air district project threshold fails to account for forest land conversion biogenic emissions, these GHG emissions must be analyzed and mitigated independent of the air district project threshold of significance standard.

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[1] "Black carbon (BC, also referred to as black soot, black carbon aerosols, black carbon particles) refers to a solid particle emitted during incomplete combustion. All particle emissions from a combustion source are broadly referred to as particulate matter (PM) and usually delineated by sizes less than 10 micrometers (PM10) or less than 2.5 micrometers (PM2.5). Black carbon is the solid fraction of PM2.5 that strongly absorbs light and converts that energy to heat. When emitted into the atmosphere and deposited on ice or snow, black carbon causes global temperature change, melting of snow and ice, and changes in precipitation patterns. Roughly half of atmospheric BC comes from fossil fuel combustion, and the other half from biomass and biofuel burning. While BC is short-lived in the atmosphere (1-4 weeks), it is linked to strong regional climate effects and a large share (~30%) of recently observed warming in the Arctic."
http://www.unep.org/transport/gfei/autotool/understandingtheproblem/Black%20Carbon.pdf

DEIR: "A development that converts natural vegetation to a developed site results in potential release of sequestered carbon to the atmosphere as CO_2, which would not have been released had there been no change in land cover ... To evaluate the effect of oak woodland conversion on the Countywide GHG emissions inventory, this analysis uses available carbon sequestration data for oak woodlands to determine the loss of sequestration associated with the oak woodland impacts that would occur under the 2025 and 2035 General Plan buildout scenarios ... The analysis of the loss of carbon sequestration uses sequestered carbon content data derived from the Carbon Online Estimator (COLE) (Van Deusen and Heath 2016)" (at 8-16).

Comment 4: Stored carbon in dead biomass not only releases CO_2 into the atmosphere but also CH_4, N_2O and black carbon. Programmatic models like COLE are designed to measure the biomass carbon stocks for a given area. The end user takes the model's site-specific biomass information and translates it into GHG emissions. These models don't know what regulations, rules or laws they are being applied under. The end user has to adjust for those regulatory nuances. In California we have the uniqueness of CEQA, which recognizes GHG indirect biogenic emissions, which are delineated in Guidelines § 15358(2). COLE is a federal product from the USDA Forest Service. USDA neither knows nor cares about CEQA legal nuances so COLE doesn't address indirect biogenic emissions. Thus, the Cole programmatic model being used doesn't know how the biomass will be utilized or disposed.

1. Please explain how the DEIR can claim to make a "good faith effort" to measure forest conversion GHG biogenic emissions due to potentially removing 140,000 acres of oak woodland biomass when the programmatic model being used doesn't know how the biomass will be utilized or disposed?

DEIR: "These calculations assume a one-time loss of sequestered carbon resulting from conversion of existing oak woodlands to developed uses. This analysis also assumes that sequestered carbon from removed vegetation will be returned to the atmosphere; that is, the wood from the removed oak woodlands would not be re-used in another form that would retain carbon (e.g., furniture). This analysis of sequestered carbon impacts does not account for CO_2 emissions estimates associated with vegetation clearing or removal activities, or the transport and disposal of vegetative biomass. GHG emissions generated during project-specific construction activities, including clearing, tree removal and disposal, and grading, would be evaluated at the project level.

The ORMP requires mitigation in the form of conserving off-site oak woodlands and replanting (up to a maximum of 50% of the required mitigation). As outlined in the ORMP, mitigation ratios for oak woodland impacts may be 1:1, 1.5:1, or 2:1, depending on the extent of on-site impacts. The following summarizes potential mitigation scenarios under the 2035 General Plan buildout scenario:" (at 8-18).

Comment 5: The off-site conservation of existing forest coupled with the proposed replanting standards are inconsistent with scientific fact and 2008 AB 32 Scoping Plan forest sector policy targets. The already existing "conserved" trees aren't suddenly going to begin growing faster and sequester more carbon to reduce soil/vegetation GHG biogenic emission impacts in a timely manner. The appropriate means to feasibly and proportionally mitigate forest conversion biogenic emissions is by planting/maintaining the requisite number of replacement trees in El Dorado County to reduce emissions 80 percent by 2050.

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1. Please explain how the DEIR biogenic emissions mitigation measures will provide consistency with Executive Orders S-3-05 to reduce GHG emissions 80 percent by 2050.[2] See *Cleveland National Forest Foundation, et al. v. San Diego Association of Governments, et al.* ___ Cal.App.4th ___, 2014 and the 2015 California Supreme Court citation in *Center for Biological Diversity v. Department of Fish and Wildlife* (Exhibit A). Here the Supreme Court is giving CEQA practitioners a heads-up regarding an issue in its upcoming *Cleveland National Forest Foundation v. SANDAG* decision. The Court indicates it will confirm that the climate change executive order timeline thresholds established by Governors Schwarzenegger and Brown should be fully considered in CEQA documents. Pending Senate Bill 32 (Pavley) codifies Governor Brown's Executive Order B-30-15 establishing a midterm target to reduce GHG emissions by 2030, to 40 percent below 1990 levels.

2. Please explain and demonstrate mathematically how the proposed off-site conservation/replanting standards are consistent with the 2008 AB 32 Scoping Plan goals of "no net loss" for forest land carbon sequestration and "stretch targets" of increasing forest land CO_2 storage by 2 million metric tonnes by 2020 and 5 MMT by 2050.

3. Please explain and demonstrate mathematically how the off-site conservation of existing forest land feasibly and proportionally mitigates direct or indirect forest conversion biogenic emissions in a manner consistent with the state's 2020, 2030 and 2050 timeline thresholds.

4. Please explain how the DEIR GHG mitigation measures will provide consistency with the 2016 CARB Short-Lived Climate Pollutants Policy. The goal is by 2030 to cut yearly emissions of several pollutants from 2013 levels. CARB seeks to shrink black carbon pollution to 19 million metric tons of carbon dioxide equivalent ($MMTCO_2e$) from 39 $MMTCO_2e$ (50% reduction) by 2030 and methane to 71 $MMTCO_2e$ from 118 $MMTCO_2e$ (40% reduction). Pending Senate Bill 1383 (Lara) codifies these GHG reduction standards.

5. The DEIR appears to be piecemealing the project's near- and long-term GHG biogenic emissions by not fully estimating the countywide forest conversion biogenic emission impacts but instead delaying comprehensive GHG emission calculations to future "project-specific" analysis. Please explain why the piecemealing perception is incorrect and how the DEIR approach provides consistency with the state's 2020, 2030 and 2050 timeline thresholds.

DEIR: "In addition to the estimated oak woodland impacts from buildout of the General Plan with residential, commercial, retail, and industrial uses, there is a potential for an additional 138,704 acres of woodland that could be lost without mitigation under the exemptions in the ORMP. This could contribute an additional 1,070,210 MT CO_2e annually from release of sequestered carbon to the atmosphere. However, 132,281 acres of oak woodlands would be impacted without mitigation as a result of expanded agricultural production activities ..." (at 8-19).

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[2] Both forests and GHGs are analyzed over a 100-year planning horizon. However, California has climate change planning timelines that only extend out to the year 2050. So while for CEQA discussion and consistency purposes 80 percent of emissions must be reduced by 2050, in fact 80 percent of a project's forest conversion biogenic emissions are actually mitigated over a 100-year period. This allows enough time for feasible and proportional forest conversion biogenic emissions mitigation to occur.

Comment 6: Forest GHG emissions are measured over a 100-year planning horizon; not on an annual basis. The "additional 1,070,210 MT CO_2e annually" translates into 107,021,000 MMT CO_2e over 100 years. That's not counting the CO_2, CH_4, N_2O and black carbon emissions due to removed biomass decomposition and combustion over time.

Apparently El Dorado County has a reading comprehension problem. If the county is going to claim forest land conversion GHG biogenic emission exemptions it will need to provide statutory law citations to justify each exemption category. The Natural Resources Agency has already said no twice to agriculture regarding a forest land conversion CEQA GHG exemption. El Dorado County needs to take no for an answer:

Natural Resources Agency (2009)
"Moreover, the text of the questions themselves demonstrate that the concern is *any* conversion of forests, not just conversions to other agricultural operations."

"Second, analysis of impacts to forestry resources is already required. For example, the Legislature has declared that "forest resources and timberlands of the state are among the most valuable of the natural resources of the state" and that such resources "furnish high-quality timber, recreational opportunities, and aesthetic enjoyment while providing watershed protection and maintaining fisheries and wildlife." (Public Resources Code, § 4512(a)-(b).) Because CEQA defines "environment" to include "land, air, water, minerals, flora, fauna, noise, and objects of historic or aesthetic significance" (Public Resources Code, section 21060.5), and because forest resources have been declared to be "the most valuable of the natural resources of the state," projects affecting such resources would have to be analyzed, whether or not specific questions relating to forestry resources were included in Appendix G. *(Protect the Historic Amador Waterways v. Amador Water Agency* (2004) 116 Cal.App.4th 1099, 1109 ("in preparing an EIR, the agency must consider and resolve every fair argument that can be made about the possible significant environmental effects of a project, irrespective of whether an established threshold of significance has been met with respect to any given effect").) In effect, by suggesting that the Appendix G questions be limited to conversions to "non-agricultural uses," the comment asks the Natural Resources Agency to adopt changes that are inconsistent with CEQA, which it cannot do" (Responses to Farm Bureau and Wine Institute).

Please answer the following forest land conversion questions:

1. Due to biomass decomposition or combustion, how many metric tonnes of CO_2, CH_4, N_2O and black carbon biogenic emissions are projected with impacts to 138,704 acres?

2. Due to biomass decomposition or combustion, how many metric tonnes of CO_2, CH_4, N_2O and black carbon biogenic emissions are projected due to forest land conversion impacts by 2025?

3. Due to biomass decomposition or combustion, how many metric tonnes of CO_2, CH_4, N_2O and black carbon biogenic emissions are projected due to forest land conversion impacts by 2035?

4. Due to biomass decomposition or combustion, how many metric tonnes of CO_2, CH_4, N_2O and black carbon biogenic emissions are projected due to forest land conversion impacts by 2050?

EIR: "The proposed project would result in a significant and unavoidable impact related to GHG emissions. There is no feasible mitigation that would substantially reduce or avoid this impact. The proposed project would result in no impacts related to conflicts with plans, policies, and regulations related to GHG emissions and climate change, and, therefore, no mitigation is required for this impact" (at 8-22).

Comment 7: In fact there is feasible and proportional project mitigation available by planting/maintaining the requisite number of replacement trees in El Dorado County to reduce forest conversion GHG biogenic emissions 80 percent by 2050. The question becomes whether El Dorado County would have land available for planting oaks after developing 140,000 acres of oak woodland. The assertion that the DEIR is not in conflict with state climate change policy and law is specious.

Summary

The DEIR chose to apply the El Dorado air district project threshold and COLE model for its forest land conversion GHG emissions analysis. However, as the Ciminelli DEIR factually observes biogenic emissions exist but the El Dorado air district project threshold excludes direct and indirect biogenic emissions quantification. The COLE model doesn't account for indirect GHG biogenic emissions and the end user apparently wasn't cognizant of CEQA regulatory requirements. The DEIR doesn't account for the GHG biogenic emissions associated with biomass decomposition and combustion, which result in CO_2 emissions in combination with the much more potent CH_4, N_2O and black carbon emissions. At a time when the state is acting aggressively to significantly reduce methane and black carbon emissions, the DEIR is oblivious to the importance of immediately addressing these powerful GHG emissions. The project greenhouse gas impacts remain significant and appropriate mitigation/alternatives to reduce these impacts have not been adequately considered.

Greenhouse gas emissions, especially forest conversion emissions, stand out from all other CEQA effects. This is because only GHG emission impacts have been *decreed* a serious threat to the well-being of all Californians and the state itself. Further, forests are the only state GHG sector that sequesters carbon. The constant among court decisions regarding GHG analysis is that project emissions must be accurately and fully rendered in a CEQA document. This DEIR appears designed to obfuscate and minimize project forest land conversion GHG biogenic emissions, rather than a bona fide attempt to comply with CEQA's focus of ascertaining *"the feasible mitigation of greenhouse gas emissions or the effects of greenhouse gas emissions."*

Substantial evidence has been presented that project biogenic GHG emissions due to forest land conversion will result in potentially significant environmental effects that have not been sufficiently analyzed or feasibly mitigated. The project has not made "a good-faith effort, based to the extent possible on scientific and factual data, to describe, calculate or estimate the amount of greenhouse gas emissions resulting from a project" (CEQA Guidelines § 15064.4(a)). Therefore the DEIR is deficient as an informational document, in that it fails to apprise decision-makers/public of the full range and intensity of the adverse GHG emission effects on the environment that may reasonably be expected if the project is approved.

Sincerely,

Janet Cobb

Janet Cobb, Executive Officer
California Wildlife Foundation/California Oaks

Exhibit A

California Supreme Court - *Center for Biological Diversity v. Department of Fish and Wildlife* (2015)
A qualification regarding the passage of time is in order here. Plaintiffs do not claim it was improper for this EIR, issued in 2010, to look forward only to 2020 for a guidepost on reductions in greenhouse gas emissions, and we therefore do not consider the question whether CEQA required the EIR to address the state`s goals beyond 2020. Nevertheless, over time consistency with year 2020 goals will become a less definitive guide, especially for long term projects that will not begin operations for several years. An EIR taking a goal consistency approach to CEQA significance may in the near future need to consider the project`s effects on meeting longer term emissions reduction targets.[6]

[6] Executive Order No. S-3-05, signed by Governor Schwarzenegger on June 1, 2005, set reduction targets of 1990 levels by 2020 and 80 percent below 1990 levels by 2050. A.B. 32 codified the 2020 goal but did not indicate any intent to abandon the 2050 goal; indeed, the Legislature cited the executive order and indicated its intent that the climate policy efforts the order initiated continue. (Health & Saf. Code, § 38501, subd. (i).) More recently, in an update to the Scoping Plan, the Air Board noted the need for steep post-2020 reductions and proposed the state adopt a strong mid-term target for the year 2030, in the range of 35-50 percent below 1990 levels. (Air Resources Board, First Update to the Climate Change Scoping Plan: Building on the Framework (May 2014), p. 34.) Executive Order No. B-30-15, signed by Governor Brown on April 29, 2015, endorsed the effort to set an interim target of emission reductions for 2030. Pending legislation would codify this additional goal, directing the Air Board to establish a 2030 limit equivalent to 40 percent below 1990 levels. (Sen. Bill No. 32 (2015-2016 Reg. Sess.)

Tuolumne County

Biological Resources Review Guide

Draft

~~November 17, 2011~~ December 4, 2012

Prepared for:

County of Tuolumne
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Contents:

Introduction and Background

The Biological Resources Review Guide (BRRG) is an optional program designed to assist property owners and County staff in evaluating impacts to plants, wildlife and habitat and allow the development of fair, consistent and effective mitigation measures to address the impacts that result from land development in the County. These mitigation measures apply to land development projects that require a discretionary entitlement from Tuolumne County subject to review under the California Environmental Quality Act (CEQA). Examples of projects covered by the BRRG include the following:

- Residential, commercial, industrial or recreational development that requires a discretionary entitlement from the County
- Land divisions requiring a Tentative Parcel Map or Tentative Subdivision Map
- Grading Permits
- Road construction
- General Plan Amendments and Zone Changes that provide potential for additional development
- Water projects, e.g., hydroelectric, water supply, stream channelization, and flood control
- All other projects requiring a Site Development Permit (SDP), Conditional Use Permit (CUP) or Planned Unit Development Permit (PUD)

The BRRG may be used by applicants for land development projects in the County to mitigate impacts to wildlife and habitat. Alternatively, applicants may contract with a resource professional that is approved by the County as qualified to develop alternative mitigation proposals relative to the potential impact. For example a project that would result in potentially significant impacts on wetlands would require the input of a qualified professional with expertise in the area of wetland mitigation. This alternative proposal is subject to review and approval by the County and review by any applicable state and/or federal regulatory agency for concurrence with the proposed mitigation measures. Resource professionals may include botanists, ecologists, wildlife biologists, zoologists and foresters.

Implementation Program 4.J.a of the General Plan states that the County shall maintain a Biological Resources Conservation Program which requires a land owner and/or applicant requesting a discretionary entitlement subject to the California Environmental Quality Act (CEQA) to mitigate impacts to biological resources in the manner set forth in the Tuolumne County Biological Resources Conservation Handbook (BRCH). On December 26, 1996, the Board of Supervisors, through Resolution 230-96, designated the Tuolumne County Wildlife Handbook as the interim Handbook until adoption of the BRCH which would then supersede the Handbook.

The primary purposes of the Wildlife Handbook, adopted in 1987, were to: a) establish consistent mitigation for potential impacts to biological resources pursuant to the California Environmental Quality Act (CEQA); b) encourage a streamlined development process relative to biological resources; c) provide predictability for developers; and d) institute a sound approach for conserving biological resources without the necessity for project-by-project consultations with State and federal agencies. This set of criteria has been incorporated into the BRRG.

The BRRG is designed to be used in conjunction with site evaluations, aerial photographs, the Geographic Information System (GIS) database and the Tuolumne County Wildlife

Habitat Maps to mitigate cumulative impacts to wildlife and impacts to plants and oak woodlands resulting from land development.

The BRRG is structured using a priority system relative to biological resources. This priority system consists of a hierarchy with resources such as endangered species being on the upper tier of the system and common biological resources such as areas already disturbed by development at the lowest tier. Within the BRRG, this translates into the use of First, Second, Third and Fourth Priority Biological Resource designations to identify the relative sensitivity of a biological resource to disturbance from development; the wildlife habitat's relative value to plants, fish and wildlife; and the comparative abundance of the biological resource countywide. Once the value of the resource has been established using this hierarchy system, a series of mitigation measures are included to reduce any impact to the resource to a less than significant level. Due to continuing research in the fields of plant and animal biology and ecology, periodic updates of the BRRG will be necessary to maintain the program.

Environmental Setting

Tuolumne County ranges in elevation from 300± feet, in the vicinity of Rock River Road, in the southwestern-most portion of the county to more than 13,000± feet, atop Mount Lyell, in Yosemite National Park, and therefore encompasses a broad range of geologic and climatic variation. These factors give rise to a great diversity of vegetation and wildlife communities. Tuolumne County encompasses 33 natural vegetation communities as detailed in Chapter 8 of the BRRG Appendix. Tuolumne County is also home to more than 100 special status plants, fish and wildlife species, which are described in detail in the Appendix.

Land ownership in Tuolumne County is approximately 77% public and 23% private. Approximately 6.0% of the land in the County is zoned TPZ (Timberland Production) and 8.3% of the land is under Williamson Act land conservation contracts. Therefore, approximately 8.7% of the land in the County remains available for development. The BRRG addresses biological resources management on private land in Tuolumne County. Private land is generally located between 300± and 3,700± feet in elevation except for some scattered, small communities located along the State Route 108 corridor and in-holdings in the Stanislaus National Forest above 3,700± feet. Public land is mostly located between 3,700 and 13,000 feet. As a result of these elevational differences, habitat types located on private lands in Tuolumne County generally differ from those on public lands.

Chapter 1. General Approach

Chapter 1 describes the general approach of the Biological Resources Review Guide (BRRG). It covers the general overriding concerns for preservation of valuable wildlife and biological resources and presents alternatives to use of the BRRG.

1.1 Priority Approach

The BRRG uses a hierarchy system to identify the relative sensitivity of a biological resource to disturbance from development, the wildlife habitat's relative value to plants, fish and wildlife, and the comparative abundance of the biological resource countywide. This system is implemented by the use of First, Second, Third and Fourth Priority Biological Resource designations.

All priority categories (e.g. First, Second, Third and Fourth Priority) are based on:

- The wildlife habitat present on the site; or
- The presence of special status species occupying (or not occupying) the wildlife habitat; or
- A combination of both the wildlife habitat and special status species present on the site.

Each resource is described in detail in the following sections of this handbook:

- First Priority Biological Resource – Chapter 3
- Second Priority Biological Resource – Chapter 4
- Third Priority Biological Resource – Chapter 5
- Fourth Priority Biological Resource – Chapter 6

1.2 Mitigation Alternatives

To increase flexibility for mitigating impacts to First, Second and Third Priority Biological Resources, the BRRG describes alternative mitigation options to achieve a "less than significant" impact to biological resources. Specifically, once the resource priority is determined (i.e. First, Second, Third or Fourth), mitigation alternatives, in order of preference, are:

a. **Avoid** fully the resource on site

b. If full **Avoidance** is infeasible, reduce on-site impacts to the resource to the extent feasible and **Compensate** either on-site in-kind, or off-site for impacts to the resource.

c. If avoidance is not feasible for threatened, endangered or California Fully Protected Species, acquisition of an Incidental Take Permit, Biological Opinion or Habitat Conservation Plan may be warranted and consultation with the U.S. Fish and Wildlife Service or the California Department of Fish and Wildlife (depending on the listing agency) is required.

This approach reflects the "*Compensatory Mitigation Rule"* adopted by the U.S. Army Corps of Engineers (USACE) and U.S. Environmental Protection Agency (Federal Register Vol. 73, No. 70, Thursday, April 10, 2008/ Rules and Regulations) emphasizing and detailing the avoidance of on-site impacts to resources, reduction of on-site impacts ("minimization" per the EPA) when full avoidance on-site is infeasible, and compensation (acquiring generally equivalent habitat) for impacts to aquatic resources. A similar approach has been used by the United States Fish and Wildlife Service (USFWS) and the California Department of Fish and ~~Game~~ Wildlife (CDF~~G~~W) in formulating habitat conservation plans and habitat management plans.

1.3 Avoidance

Avoidance means prevention of all potential impacts to a biological resource. Measures to avoid impact include establishing resource setbacks and open space zoning within the project boundaries (i.e., on-site). Avoidance may also include measures to address indirect impacts to biological resources (e.g., on-site runoff into protected wetlands). Measures to achieve full avoidance may include, but are not limited to, conditions of project approval to eliminate temporary construction impacts, remove barriers to species dispersal, address ongoing vegetation management, limit use of pesticides or other long-term best management practices and related measures. To insure full avoidance is achieved to the extent possible, consultation with the jurisdictional agency (CDFW or USFWS) is required when a project has potential to impact a First Priority Biological Resource. Through consultation with the jurisdictional agency, mitigation beyond that identified in this BRRG may be required.

1.4 Reducing On-Site Impacts

Reducing on-site impacts means implementing measures to mitigate the impacts to that resource when full avoidance is not feasible. Measures to reduce on-site impacts when full avoidance is not feasible may include, but are not limited to: seasonal constraints on construction windows, encouraging or allowing species to vacate the site prior to construction, and erecting protective fencing around trees retained on the site.

1.5 Compensation

Compensation means the acquisition and long term management of habitat in perpetuity at an on-site or off-site location. On-site or off-site compensation normally will occur in conjunction with conditions of project approval to reduce on-site impacts to biological resources. Compensation for First**,** Second and Third Priority Biological Resources is described in Sections 3.3.1, 4.1.1 and 5.1, respectively.

Compensation will normally include:

a. Rezoning a portion of the property to O (Open Space) or O-1 (Open Space – 1). These areas may also be protected in AE-37 (Exclusive Agricultural, Thirty Seven Acre Minimum) zoning provided a management plan is prepared by a qualified professional and approved by the County after review by the California Department of Fish and ~~Game~~ Wildlife; or

b. Purchasing mitigation bank credits prior to ground, vegetation or other site disturbance; or

c. Payment of in–lieu fees.

For Third Priority Biological Resources, zoning of a portion of the project site to O (Open Space) or O-1 (Open Space -1) will be the preferred method of compensation. However, an alternative compensation plan may be proposed by the project proponent. Such alternative compensation could involve conserving equivalent habitat off-site or payment of in-lieu fees consistent with this BRRG. The alternative plan will require review and approval by the County with concurrence by the California Department of Fish and ~~Game~~ Wildlife. Compensation for impacts to waters of the United States, including wetlands, must be approved by the U.S. Army Corps of Engineers and would likely require measures other than those listed above. For more information regarding the regulatory program of the Army Corps of Engineers, visit their Sacramento District website at www.spk.usace.army.mil/regulatory.html.

O-1 (Open Space-1) zoning will typically be used to conserve First and Second Priority Biological Resources. O (Open Space) zoning will usually be used to conserve Third Priority Biological Resources. The primary difference in permitted uses between the two zoning districts is that the O (Open Space) district allows vegetation removal required by Chapter 15.20 of the Tuolumne County Ordinance Code (defensible space) subject to approval of the Community ~~Development~~ Resources Director, while the O-1 (Open Space-1) district does not.

1.6 Organization of the BRRG

The BRRG is organized into ten chapters as follows:

Chapter 1. General Approach

Chapter 1 covers the general approach of the BRRG along with the general overriding concerns for preservation of valuable wildlife and biological resources. It also presents some alternatives to the use of the BRRG.

Chapter 2. Getting Started

Chapter 2 lists the types of projects covered by the BRRG and discusses briefly the available alternatives to the BRRG. This Chapter has been prepared to assist in determining what resources are or may be present on a site, including habitat type, BRRG Priority, whether habitat is suitable for any special-status plant or wildlife species, and whether any wetlands or drainage features may be present. For each of these steps, a reference is provided to the pertinent BRRG chapter.

Chapter 3. First Priority Biological Resources

Chapter 3 describes the County's conservation approach and mitigation requirements for each First Priority Biological Resource and provides references to the Appendix chapters that contain detailed information about each resource.

Chapter 4. Second Priority Biological Resources

Chapter 4 lists all BRRG Second Priority Biological Resources and contains detailed information about each resource. It describes the County's conservation approach and mitigation requirements for each Second Priority Biological Resource and provides references to the Appendix chapters that contain detailed information about each resource.

Chapter 5. Third Priority Biological Resources

Chapter 5 lists all Third Priority Biological Resources and provides detailed information about each resource. It describes the County's conservation approach and mitigation requirements for Third Priority resources.

Chapter 6. Fourth Priority Biological Resources

Chapter 6 lists all resources classified as Fourth Priority Biological Resources. These are urbanized or otherwise altered areas that have low value for native plants and wildlife which generally require no mitigation.

Chapter 7. Oak Mitigation

Chapter 7 provides a mitigation program for impacts to oak woodlands consistent with Section 21083.4 of the Public Resources Code. This program is intended to be implemented in conjunction with the policies in the General Plan that provide for "no net loss" of valley oak woodlands and old growth oak woodlands.

Chapter 8. Mitigation Measures

Chapter 8 contains water quality and other measures typically required to mitigate impacts on biological resources.

Chapter 2: Getting Started

This section provides a step-by-step process for implementing the Biological Resources Review Guide (BRRG) conservation strategy including: determining the biological resources present, evaluating the sensitivity of those resources, and identifying any special measures to avoid or mitigate impacts. These steps are described in detail below, and are summarized in a flowchart presented in Figure 2-1.

2.1 Is the project subject to the BRRG?

The measures in the BRRG are intended to mitigate impacts to biological resources resulting from land development applications that require a discretionary entitlement from the County and are subject to the California Environmental Quality Act (CEQA). Discretionary entitlements include, but are not limited to, General Plan Amendments, Zone Changes, Tentative Subdivision Maps, Tentative Parcel Maps, Site Development Permits, Conditional Use Permits, Planned Unit Development Permits and Grading Permits. The BRRG does not apply to construction projects that are subject to the issuance of a ministerial permit, such as building, septic system or well permits or to other projects that have been determined to be exempt from environmental review under CEQA.

While not subject to the BRRG, construction projects requiring ministerial permits must still comply with applicable State and Federal regulations, including the Endangered Species Acts, the Clean Water Act and the Fish and Game Code. The BRRG does not apply to timber harvest operations conducted pursuant to a Timber Harvesting Plan approved by the California Department of Forestry and Fire Protection.

2.2 What are the alternatives to the BRRG?

The BRRG provides one alternative to mitigating potential impacts to biological resources in the County on private land. Landowners undertaking discretionary actions subject to CEQA where the County is the lead agency, have the following options for mitigating potential impacts to biological resources:

a. Implement mitigation in accordance with the BRRG; or

b. contract with a qualified consultant to develop an alternative mitigation proposal that addresses the potential project-specific and cumulative impacts of the application on biological resources. This alternative proposal is subject to review and approval by the County and any applicable state and/or federal regulatory agency for concurrence with the proposed mitigation measures. Resource professionals may include botanists, ecologists, wildlife biologists and foresters, among others.

2.3 How do I determine the resources present?

There are several steps in this process, which are discussed below. These steps are also summarized in a flow chart formula in Figure 2-1.

Step 1: Has the project site previously been subject to mitigation for impacts to biological resources?

If the project site was subject to mitigation for impacts to biological resources pursuant to the Tuolumne County Wildlife Handbook, this Biological Resources Review Guide, Section

21083.4 of the Public Resources Code or a biological study prepared by a qualified professional for a previous land development project, that mitigation may satisfy part or all of the mitigation required for a new land development application. While potential impacts to special status species may have not been addressed by previous mitigation, it is likely that cumulative impacts to wildlife habitat would have been mitigated by measures attached to previous land development projects.

Step 2: Determine the resources present on the site.

Review the County's Wildlife Habitat Maps, aerial photographs and the Geographic Information System (GIS) database to determine the wildlife habitat and other biological resources on the project site. Once these resources have been consulted, a field assessment of the site needs to be conducted to observe the actual vegetation communities on the site.

Step 3: Determine if there are occurrence records for any special-status species within the site or within a five-mile radius of the site.

The California Natural Diversity Data Base (CNDDB) and Tuolumne County Wildlife Database should be queried to make this determination. If occurrence records exist on the site or within five miles of the site, and suitable habitat for special status species is present, a determination will be made whether the habitat for these species will be disturbed by the proposed project. This determination will be made by County staff, in consultation with the jurisdictional agencies and qualified consultants, if necessary. If full avoidance of the habitat cannot be obtained through project design and the use of O (Open Space) or O-1 (Open Space–1) zoning, appropriate surveys will need to be conducted by qualified consultants in conjunction with the jurisdictional agencies to assure that appropriate mitigation measures are proposed to reduce the potential impacts to a less than significant level. If a documented occurrence record exists, the project proponent may contract with a qualified consultant to determine if the species is using the project site or the vicinity of the project site and if the proposed project would have an impact on the species. If the project is determined not to impact the species, no mitigation is required. Where survey protocols exist, they should be followed. Survey results must be submitted to the jurisdictional agency (CDFW, USFWS or both) for concurrence if a negative finding is determined. The survey results are good for one year.

Step 4: Determine the priority of each Biological Resource present.

Use the information gathered during the field assessment, review of the wildlife data and review of any special status species sightings in the vicinity of the project site to determine the priority of each habitat on the site. If potential habitat is present on a project site that is within the range of a special status species and no barriers exist that would prevent use of the site, impacts to the habitat must be evaluated regardless of whether occurrence records exist within five miles of the project site.

When a resource meets the criteria for classification in more than one priority category, the highest priority category (First Priority being the highest, Fourth Priority being the lowest) shall be used to determine the appropriate conservation approach for the resource. For example an area occupied by a species meeting the criteria for classification as either a First Priority (i.e. Great Gray Owl habitat) or Third Priority (i.e. montane hardwood) shall be governed by the mitigation strategy for a First Priority Biological Resource. The Community ~~Development~~ Resources Director will determine the priority of biological resources on a development site following review of all pertinent information and consultation with affected jurisdictional agencies (USFWS, ACOE and CDF~~G~~W). The decision of the Community

~~Development~~ Resources Director can be appealed to the Board of Supervisors. Any appeal must be accompanied by information from jurisdictional agencies ~~or~~ and qualified consultants supporting the reason for the appeal.

Habitats on a particular site are classified as *First Priority* if they support species listed as endangered, threatened or rare by the by the federal or State Endangered Species Acts, species that are candidates for listing or certain other special status species. A complete list of *First Priority Biological Resources* is found in Chapter 3. To insure full avoidance is achieved to the extent possible, consultation with the jurisdictional agency (CDFW or USFWS) is required when a project has potential to impact a First Priority Biological Resource. Through consultation with the jurisdictional agency, mitigation beyond that identified in this BRRG may be required.

If you have a First Priority Biological Resource, refer to Chapter 3 and continue.

Habitats are classified as *Second Priority*[1] if they support other special status species listed by the State, important habitat for migratory deer or habitats of limited distribution within the County. A complete list of *Second Priority Biological Resources* is found in Chapter 4.

If you have a Second Priority Biological Resource, refer to Chapter 4 and continue.

Habitats are classified as *Third Priority* if they support relatively abundant natural communities whose maintenance is required to support healthy native plant and wildlife populations, less important deer concentration areas or habitat for other special status species. A complete list of *Third Priority Biological Resources* is found in Chapter 5.

If you have a Third Priority Biological Resource, refer to Chapter 5 and continue.

Habitats are classified as *Fourth Priority* if they are urbanized or otherwise altered areas and have low or no value for native plants, fish or wildlife. A complete list of *Fourth Priority Biological Resources* is found in Chapter 6.

If you have a Fourth Priority Biological Resource, refer to Chapter 6 and continue.

If you have potential impacts related to oak woodland or Specimen Oak trees, refer to Chapter 7 and continue. *An oak woodland consists of a stand of three (3) or more native oak trees at least 5 inches in diameter at breast height that is at least one-half (0.5) acre in area where the canopy cover of the native oak trees is 10% or greater. Specimen oak trees include live oak, ~~blue oak,~~ California black oak and valley oak trees that are at least 18 inches in diameter at breast height (dbh) and blue oak trees that are at least 8-10 inches in dbh.*

Step 5: Is suitable habitat for special status plant species present?

Table 2-1, located in the Appendix, lists all special status plant species known to occur in the County by scientific name and common name and also provides a map code reference for the County's Wildlife Habitat Maps. Appendix **Table 2-~~2~~3** contains a listing of all special status plant species by habitat. Refer to this table and identify all special status plants that occur within the habitat types identified on the site. The individual species accounts, contained within the Appendix also provide the elevation range of the species and

[1] The BRRG does not include BLM and Forest Service sensitive species. These designations do not apply to species occurring on private lands.

appropriate habitat elements. Review the Tuolumne County Wildlife Maps to determine if any special status plants have been sighted within five (5) miles of the project site.

If this process identifies the potential for a special status plant species to occur on the project site, which may be directly or indirectly impacted by the proposed project, a baseline botanical survey shall be conducted by a qualified consultant to determine the potential of the project to impact the special status plant species. Baseline surveys must be conducted at the appropriate time of year to ensure species identification; typically this is during the blooming season. If upon the determination of the qualified consultant, the habitat containing the special status species will be directly or indirectly impacted by the proposed project, a qualified consultant shall conduct protocol level surveys for all identified plant species. When conducting protocol level surveys, a known reference population must be identified.

If the species for which suitable habitat is present is NOT a Priority 1 species, AND if all suitable habitat will be protected from both direct and indirect impacts and included in O (Open Space) or O-1 (Open Space-1) zoning (including areas required to maintain hydrology, where relevant) protocol level surveys are not required.

If special status plant species are identified on the site full avoidance is preferred; however, if full avoidance is not feasible consultation with the California Department of Fish and ~~Game~~ Wildlife (CDF~~G~~W) and/or the U.S. Fish and Wildlife Service (USFWS) is required to determine appropriate minimization and compensation measures. To insure full avoidance is achieved to the extent possible, consultation with the jurisdictional agency (CDFW or USFWS) is required when a project has potential to impact a First Priority Biological Resource. Through consultation with the jurisdictional agency, mitigation beyond that identified in this BRRG may be required.

Step 6: Is suitable habitat for special status wildlife species present?

Table 3-1 located in the Appendix lists all special status wildlife species known to occur in the County by scientific name, common name and also provides a map code reference for the County's Wildlife Habitat Maps. Appendix **Table 3-2** contains a listing of all special status wildlife species by habitat. Refer to this table and identify all special status wildlife that occur within the habitat types identified on the site. The individual species accounts, also contained within the Chapter provide the elevation range of the species and appropriate habitat elements.

If the potential exists for special status wildlife species on the project site, refer to **Tables 3-5** and **3-6** of the Appendix for mitigation measures. For some species, protocol level surveys conducted by a qualified biologist may be required. This determination will be made by the County if the County determines, in consultation with the jurisdictional agencies, that full avoidance cannot be achieved.

If special status wildlife species are identified on the site, full avoidance is preferred. However, if full avoidance is not feasible, consultation with the California Department of Fish and ~~Game~~ Wildlife (CDF~~G~~W) and/or the U.S. Fish and Wildlife Service (USFWS) is required. To insure full avoidance is achieved to the extent possible, consultation with the jurisdictional agency (CDFW or USFWS) is required when a project has potential to impact a First Priority Biological Resource. Through consultation with the jurisdictional agency, mitigation beyond that identified in this BRRG may be required.

Step 7: Is the site located within the U.S. Fish and Wildlife Service's vernal pool core recovery area?

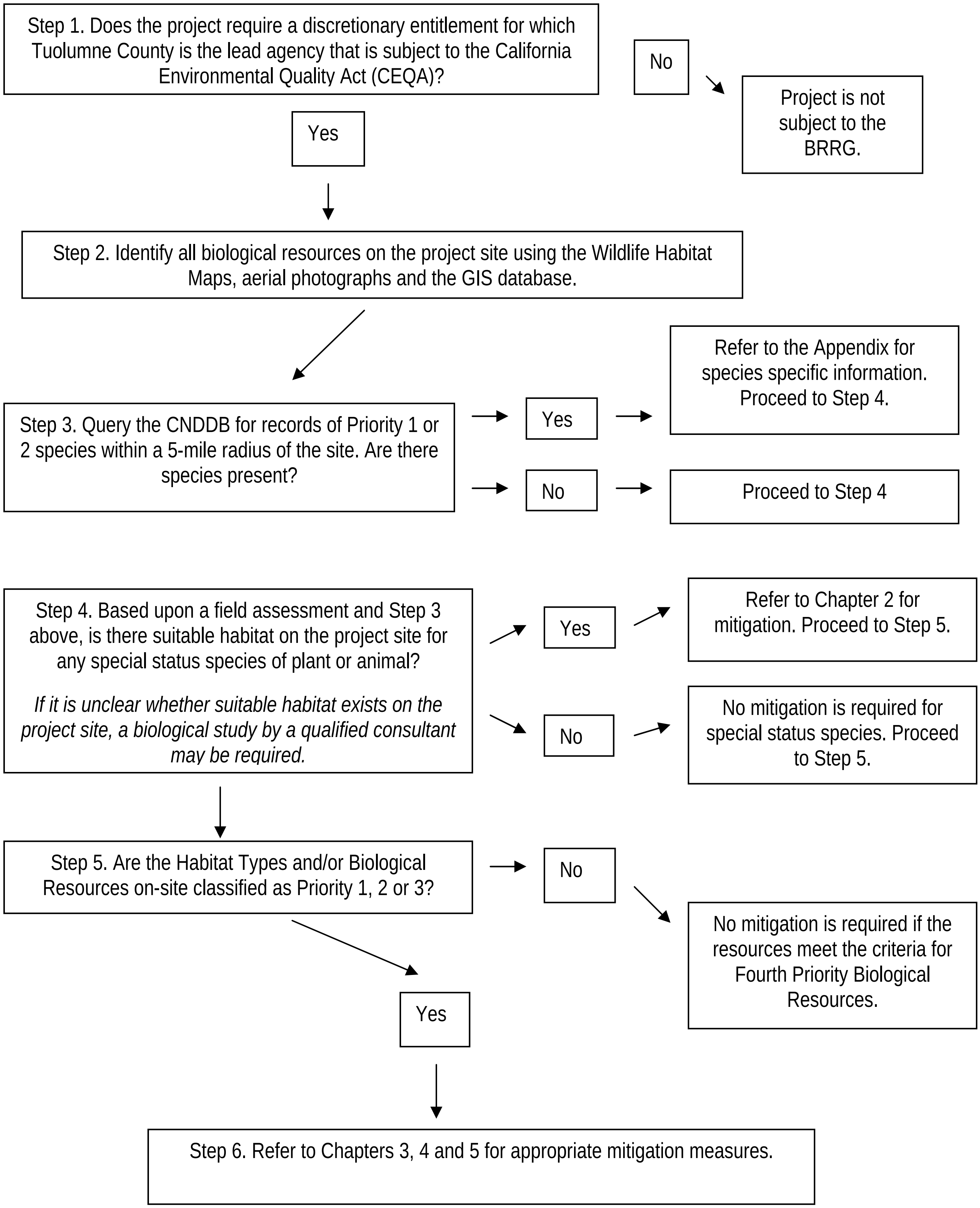
Refer to **Maps 5-1** through **5-8** provided in the Appendix. If the site is located within the vernal pool core recovery area, a qualified biologist must conduct a site visit to determine whether wetlands may be present.

Step 8: Are there any wetland or drainage features present?

Identification of wetland features should be conducted during the wet season (December – April) unless conducted by a qualified biologist or wetland scientist. If wetland or drainage features are present refer to Chapter 4 to determine requirements for full avoidance. If full avoidance is not feasible, a permit may be required through either the United States Army Corps of Engineers (USACE) (waters of the U.S., including wetlands), the Regional Water Quality Control Board (RWQCB) (waters of the State) or the California Department of Fish and ~~Game~~ Wildlife (CDF~~G~~W), or all. If the presence of wetlands, or the mapping of wetland boundaries, is considered questionable, the County may require wetland mapping by a qualified consultant.

The U.S. Army Corps of Engineers should be contacted if waters of the United States, including wetlands, occur on the project site. If permitting may be required through the U.S. Army Corps of Engineers, a wetland consultant approved by the Sacramento District Office should conduct a field evaluation of the site and any required wetland mapping and delineation. If a permit is required from the U.S. Army Corps of Engineers, the project will be subject to review under the National Environmental Policy Act (NEPA).

Figure 2-1: Process for Identifying Potential Resources on a Project Site



Chapter 3. First Priority Biological Resources

A habitat that is characterized by one or more of the following is determined to be a First Priority Biological Resource:

- Occupied by a species federally listed as endangered or threatened;
- Occupied by a species state listed as endangered, threatened or rare;
- ~~Occupied by a species ranked as critically imperiled (S1) by the California Natural Diversity Database;~~
- Occupied by a federal candidate species;
- Occupied by a state candidate species;
- Occupied by a state-designated California Fully Protected Species; (see Chapters 2 and 3 of the Appendix for a complete list of species)
- ~~Occupied by a California Native Plant Society (CNPS) List 1 species;~~
- Occupied by bald eagles or golden eagles;
- Identified in an adopted Recovery Plan as necessary for the survival of a federal listed species; or;
- Designated as Critical Habitat as described in Section 3.1.

Refer to Chapter 2, Section 2.3 or the corresponding flowchart if you are uncertain whether First Priority biological resources are present on a site. To insure full avoidance is achieved to the extent possible, consultation with the jurisdictional agency (CDFW or USFWS) is required when a project has potential to impact a First Priority Biological Resource. Through consultation with the jurisdictional agency, mitigation beyond that identified in this BRRG may be required.

3.1 Critical Habitat/Recovery Plans

There are six (6) species which have designated critical habitat within the County: the Sierra Nevada bighorn sheep and Central Valley steelhead, as well as four plant species: fleshy owl's clover (also called succulent owl's clover), Hoover's spurge, Colusa grass and Greene's tuctoria. In addition, there is one habitat type, vernal pools (VPL), for which a statewide recovery plan exists. The recovery plan covers 33 plant and animal species associated with vernal pools, 20 of which are federally listed as endangered or threatened. **Table 5-1** and **Maps 5-1** through **5-8** contained within the Appendix list the species/habitats and the recovery documents that provide additional information regarding the species/habitats and the precise boundaries of the designated critical habitat.

3.2 Areas Occupied by State or Federally Listed Species

Refer to **Tables 2-1 and 3-1** in the Appendix for a full account of each species and to **Tables 2-5, 3-5** and **3-6** for measures for fully avoiding impacts to each species.

The BRRG recognizes that additional species may be listed as rare, threatened or endangered at any time. Upon listing, those species and their habitat would become first priority biological resources regardless of whether they are identified in the BRRG. Similarly, if a species is delisted, that species and its habitat would cease to be a first priority biological resource under the BRRG. The status of such species would be revised in the BRRG at the next periodic update.

3.3 Conservation Approach

Most First Priority Biological Resources involve the presence of a federally or state listed species. Appendix **Tables 2-5**, and **3-5** and **3-6** provide detailed measures by species for achieving full avoidance of impacts; thereby, reducing potential impacts to a level of less than significant pursuant to the California Environmental Quality Act (CEQA). To insure full avoidance is achieved to the extent possible, consultation with the jurisdictional agency (CDFW or USFWS) is required when a project has potential to impact a First Priority Biological Resource. Through consultation with the jurisdictional agency, mitigation beyond that identified in this BRRG may be required.

Where a potential to impact a state and/or federally listed species exists, *consultation* with the listing agency (i.e., U.S. Fish and Wildlife Service for federally-listed species, California Department of Fish and Game for state-listed species) may be required pursuant to federal and/or State law, as documented in Section 3.3.2.

If full avoidance of a First Priority Biological Resource cannot be achieved through the use of O (Open Space) or O-1 (Open Space–1) zoning along with appropriate mitigation measures, consultation with the listing agency pursuant to Section 3.3.2 is required unless otherwise specified herein. Consultation with the listing agency may still also be required even though full avoidance is achieved if a permit is required from the U.S. Army Corps of Engineers pursuant to Section 404 of the Clean Water Act.

3.3.1 Reducing On-Site Impacts and Providing Compensation Off-Site

Avoidance is the prevention of all potential impacts to a biological resource. Where avoidance of a First Priority Biological Resource cannot be fully achieved, mitigation measures will be implemented to minimize on-site impacts to biological resources to the maximum extent feasible and to require **compensation** either on-site or off-site. Pursuant to the BRRG, this alternative to full avoidance may be considered only upon consultation with the listing agency pursuant to Section 3.3.2 unless otherwise specified herein. The consultation process may require the preparation of a Habitat Conservation Plan (federally-listed species) and/or an Habitat Management Plan Incidental Take Permit (state-listed species) pursuant to the federal and/or state endangered species acts.

Compensation approaches for First Priority Biological Resources, include:

- Mitigation bank credits purchased prior to initiation of any construction related activities as determined during the consultation process (the mitigation bank must be a State-approved bank to serve as State Endangered Species Act credits);
- Payment of in-lieu fees determined during the consultation process; or
- Granting a conservation easement, fee title transfer or endowment to an entity qualified to accept such a grant.

3.3.2 Consultation with Federal or State Regulatory Agencies

If review of the Wildlife Habitat Map, the California Natural Diversity Database (CNDDB) and/or the field assessment for the project site reveals the potential for special status species of plants or wildlife on the project site, the listing agency (U.S. Fish and Wildlife Service and/or California Department of Fish and ~~Game~~ Wildlife) shall be notified by the County. Notification by the County shall take the form of an Advisory Agency letter of the proposed project along with any pertinent studies performed on the project site. The County shall continue to work with the listing agency throughout the project review.

Unlike the federal consultation process; consultation with the California Department of Fish and ~~Game~~ Wildlife (CDF~~G~~W) is an integral part of the CEQA process. The CDF~~G~~W is a Trustee Agency pursuant to the State CEQA Guidelines. As a Trustee Agency, CDF~~G~~W must be notified when CEQA projects involve potential impacts on fish, and wildlife of the state, rare and endangered native plants, designated wildlife areas, and ecological reserves. Although the Department cannot approve or disapprove a project as a Trustee Agency, lead and responsible agencies are required to consult with the Department. As the trustee agency for fish and wildlife resources, the Department provides requisite biological expertise to review and comment upon CEQA documents, and makes recommendations regarding those resources held in trust for the people of California (Fish and Game Code, Section 1802). Merely sending environmental documents to the State Clearinghouse for distribution to CDF~~G~~W does not satisfy a property owner's responsibility to consult. If a project may result in take of a state-listed special status species, CDF~~G~~W must be notified regardless of the result of the CEQA process. Similarly, if a project may result in take of a federally-listed special status species, the U.S. Fish and Wildlife Service (USFWS) must be notified.

To insure full avoidance is achieved to the extent possible, consultation with the jurisdictional agency (CDFW or USFWS) is required when a project has potential to impact a First Priority Biological Resource. Through consultation with the jurisdictional agency, mitigation beyond that identified in this BRRG may be required.

Chapter 4. Second Priority Biological Resources

A habitat that is characterized by one or more of the following is determined to be a Second Priority Biological Resource:

- Areas known to be occupied by a state species of special concern;
- Areas known to be occupied by a species ranked as critically imperiled (S1) or imperiled (S2) by the California Natural Diversity Database;
- Areas known to be occupied by a wildlife species ranked as vulnerable (S3) by the California Natural Diversity Database;
- Areas known to be occupied by a CNPS List 1 or 2 species;
- Areas known to be occupied by state-designated Birds of Prey subject to Section 3503.5 of the California Fish and Game Code (see **Table 3-4** in the Appendix for a complete list of species);
- ~~Areas known to be occupied by a state-designated California Fully Protected Species; (see Chapters 2 and 3 of the Appendix for a complete list of species)~~
- Areas that function as wildlife nursery sites, colonial nesting sites or colonial roosting sites for native species;
- Areas that function as important wildlife movement corridors – stream crossings, streams;
- Areas that function as highly critical winter range, critical winter range, fawning areas, major holding areas or major migration corridors for migratory deer herds;
- Habitat that is rare in the County including the following:
  - *Montane riparian woodland (MRI)*
  - *Valley-foothill riparian woodland (VRI)*
  - *Aspen grove (ASP)*
  - *Old-growth conifer forest (OGC)*
  - *Native perennial grassland (PGS)*
  - *Valley oak woodland (VOW)*
  - *Old growth oak (OGO)*
- Blue line streams identified on a United States Geological Survey (USGS) map*;

  **Perennial and intermittent streams are indicated on the USGS topographic base maps by solid and dashed lines, respectively.*

  This designation may take in drainage channels with a clearly defined bed, bank and channel that are not shown on the USGS maps, including ephemeral streams. Determination of perennial, intermittent and ephemeral streams will be confirmed by the California Department of Fish and ~~Game~~ Wildlife.
- Ditches (DIT);
- Lake, Reservoir or Pond (LAK);

- Vernal pool (VPL) (vernal pool habitat may include upland areas necessary to maintain the hydrology of the pool);
- Natural spring or seep (SPR) (natural spring or seep habitat may include upland areas necessary to maintain the hydrology of the spring or seep);
- Fresh emergent wetland/marsh (FEW) (fresh emergent wetland/ marsh habitat may include upland areas necessary to maintain the hydrology of the wetland or vernal pool);
- Wet meadow (WTM) (wet meadow habitat may include upland areas necessary to maintain the hydrology of the wet meadow); or
- Seasonal wetland (SW) (seasonal wetland habitat may include upland areas necessary to maintain the hydrology of the seasonal wetland).

Refer to **Chapter 2, Section 2.3** or the corresponding flowchart if you are uncertain whether Second Priority biological resources are present within a site.

4.1 Conservation Approach

The overriding conservation approach for Second Priority Biological Resources is "no net loss." The avoidance measures listed below for habitats that are Second Priority Biological Resources should be included as mitigation measures in order to assure "no net loss". For mitigation measures for specific species of wildlife, refer to **Chapter 3** in the Appendix.

Aspen Grove (ASP)

ASP-01: Conserve all ASP habitat in O (Open Space) or O-1 (Open Space-1) zoning including associated stands of willows (including shrubby growths) and Wet Meadows.

ASP-02: Avoid building new structures and new or improved roads and all vegetation clearing unless there is a demonstrated need and no feasible alternative.

ASP-03: Avoid altering natural drainage patterns through wet meadows, by roadbeds, pipelines, and other features that would block surface or subsurface flows.

ASP-04: Manage livestock grazing to prevent damage to the vegetation to avoid disturbance of does with young fawns, because these are important fawning areas.

ASP-05: Implement Water Quality Conservation Measures **WQ-01** through **WQ-08** (**Chapter 8**).

Ditches (DIT)

DIT-01: Where water supply ditches are associated with riparian vegetation or provide habitat value for wildlife movement, conserve an area a minimum of fifty (50) feet from the centerline on both sides in O (Open Space) or O-1 (Open Space-1) zoning unless the zoning conflicts with the requirements of an entity, such as the Tuolumne Utilities District, to maintain or service the ditch. Where those conflicts exist along ditches with habitat values, the County shall require alternative conditions that allow the maintenance while still providing habitat protection. Where ditches are not associated with riparian vegetation and do not provide habitat value for wildlife movement, no O or O-1 zoning shall be required.

DIT-02: A project involving modification or replacement of water supply ditches or the water flow in them must include the mitigation of impacts on wildlife identified by the environmental review for that project. The project proponent must contact the CDFW Lake and Streambed Alteration Unit to determine whether a Lake/Streambed Alteration Agreement is necessary.

DIT-03: Ditches that carry landscape runoff and/or natural flow that are connected from waters of the United States and flow into other waters of the United States are subject to permitting under Section 404 of the Clean Water Act.

DIT-04: Implement Water Quality Conservation Measures **WQ-01** through **WQ-08** (**Chapter 8**).

Lake, Reservoir or Pond (LAK)

Perennial

LAK-01: For LAK habitat fed by a perennial stream(s), conserve all LAK habitat in O (Open Space) or O-1 (Open Space-1) zoning encompassing a minimum of 150 feet from the Ordinary High Water Mark (OHWM) of the lake, pond or reservoir and sufficient to preserve hydrological features (e.g., springs, creeks, swales, drainages) necessary to maintain the habitat. This O or O-1 zoning may be reduced to 100 feet in urban areas.

LAK-02: For LAK habitat fed by a perennial stream(s), require construction setbacks of 200 feet from the OHWM. These building setbacks may be reduced to 100 feet in urban areas.

Intermittent

LAK-03: For LAK habitat fed by an intermittent stream(s), conserve all LAK habitat in O (Open Space) or O-1 (Open Space-1) zoning encompassing a minimum of 75 feet from the OHWM of the lake, pond or reservoir and sufficient to preserve hydrological features (e.g., springs, creeks, swales, drainages) necessary to maintain the habitat.

LAK-04: For LAK habitat fed by an intermittent stream(s), require construction setbacks of 100 feet from the OHWM. These building setbacks may be reduced to 75 feet in urban areas.

Ephemeral

LAK-05: For LAK habitat fed only by an ephemeral drainage(s), conserve all LAK habitat in O (Open Space) or O-1 (Open Space-1) zoning encompassing a minimum of 75 feet from the OHWM of the lake, pond or reservoir and sufficient to preserve hydrological features (e.g., springs, creeks, swales, drainages) necessary to maintain the habitat. This O or O-1 zoning may be reduced to 50 feet in urban areas.

LAK-06: For LAK habitat fed only by an ephemeral drainage(s), require building setbacks of 75 feet from the OHWM. These building setbacks may be reduced to 50 feet in urban areas.

General

LAK-07: For all LAK habitat, these conservation areas and construction setbacks may be reduced if the County, in consultation with CDF~~G~~W, finds that a narrower setback is justified by unique circumstances on the project site such that a narrower setback:

- would not increase the potential for erosion, due to substantial existing vegetation cover and soil and slope stability;

- would still encompass the 100-year floodplain;
- would not reduce identified setbacks necessary to protect a special status species as prescribed in the BRRG;
- would not increase the potential for degrading water quality;
- would fully protect existing riparian vegetation at the site;
- would not result in an ongoing disturbance to resident wildlife; and
- would still provide for adequate wildlife movement along the lake boundary.

LAK-08: For all LAK habitat, these conservation areas and construction setbacks may be decreased if the County, in consultation with CDF~~G~~W, finds that this would be appropriate given existing development near the lake, pond or reservoir, or is necessary to avoid a "taking" of private property. If so, careful design measures shall be required to protect riparian habitat (e.g., limit the amount of clearing and fencing allowed, and locate it on the side of riparian habitat away from the lake, pond or reservoir).

LAK-09: For LAK habitat below ~~300~~ 1,500 feet in elevation, consultation is required with the California Department of Fish and ~~Game~~ Wildlife and the U.S. Fish and Wildlife Service for potential impacts to the California tiger salamander.

LAK-10: Implement Water Quality Conservation Measures **WQ-01** through **WQ-08** (**Chapter 8**).

LAK-11: If a project will impact a lake or its associated habitat, the CDFW Lake and Streambed Alteration Unit shall be notified of the project. If a Lake or Stream Alteration Agreement must be obtained, mitigation beyond that identified in this BRRG may be required by CDFW.

Fresh Emergent Wetland (FEW)

FEW-01: Conserve all FEW habitat in O (Open Space) or O-1 (Open Space-1) zoning along with adjacent habitat sufficient to preserve the hydrological features (e.g., springs, creeks, swales, drainages) necessary to maintain the habitat

FEW-02: Avoid filling or ground-disturbing activities that would disturb these habitats.

FEW-03: Require suitable erosion control measures to avoid sedimentation of these habitats.

FEW-04: Require that the water supply for wetlands be maintained at a sufficient quantity and quality to maintain the existing habitat conditions by protecting on-site water sources through O (Open Space) or O-1 (Open Space-1) zoning.

FEW-05: Implement Water Quality Conservation Measures **WQ-01** through **WQ-08** (**Chapter 8**).

Old Growth Conifer Forest (OGC)

OGC-01: Conserve all OGC habitat in O (Open Space) or O-1 (Open Space-1) zoning.

OGC-02: Maintain a minimum lot size of 37 acres, if not already smaller. If smaller than 37 acres, do not reduce the existing lot size.

OGC-03: Avoid removal of trees greater than 24 inches in diameter at breast height (dbh), except where there is no feasible alternative for siting permitted roads and structures (i.e., potentially significant adverse impacts would be increased by alternative siting) or when required for public safety.

OGC-04: Harvesting of timber from OGC habitat is permitted if conducted consistent with a forest management plan or timber harvesting plan prepared by a Registered Professional Forester and approved by the California Department of Forestry and Fire Protection.

OGC-05: Avoid clearing of downed wood except that necessary to maintain defensible space around residences. Downed wood may be rearranged or removed where there is no feasible alternative for siting necessary improvements.

OGC-06: Avoid snag removal except where required for public safety, including fire protection.

Natural Spring or Seep (SPR)

SPR-01: Conserve all SPR habitat in O (Open Space) or O-1 (Open Space-1) zoning encompassing, at a minimum, 150 feet from the wetland boundary of the spring or seep (or from the outermost edge of hydrophytic vegetation) and sufficient to preserve hydrological features (e.g., springs, creeks, swales, drainages) necessary to maintain the habitat. Allow reductions in this area only where the jurisdictional agencies (CDF~~G~~W, ACOE, USF~~&~~WS) concur that the habitat value would not be compromised.

SPR-02: Avoid filling or ground-disturbing activities that would disturb these habitats.

SPR-03: Require that the water supply for wetlands associated with the spring or seep be maintained at a sufficient quantity and quality to maintain the existing habitat conditions by protecting on-site water sources through O (Open Space) or O-1 (Open Space-1) zoning.

SPR-04: Implement Water Quality Conservation Measures **WQ-01** through **WQ-08** (**Chapter 8**).

SPR-05: For SPR habitat below 1,500 feet in elevation, consultation is required with the California Department of Fish and ~~Game~~ Wildlife and the U.S. Fish and Wildlife Service for potential impacts to the California tiger salamander.

Vernal Pool (VPL)

VPL-01: Conserve all VPL habitat in O (Open Space) or O-1 (Open Space-1) zoning encompassing, at a minimum, 250 feet from the wetland boundary of the pool and an area sufficient to preserve hydrological features (e.g., springs, creeks, swales, drainages) that are necessary to maintain the habitat. Allow reductions in this area only where the jurisdictional agencies (CDF~~G~~W, ACOE, USF~~&~~WS) concur that the habitat value would not be compromised.

VPL-02: Implement Water Quality Conservation Measures **WQ-01** through **WQ-08** (**Chapter 8**).

VPL-03: For VPL habitat below 1,500 feet in elevation, consultation is required with the California Department of Fish and ~~Game~~ Wildlife and the U.S. Fish and Wildlife Service for potential impacts to the California tiger salamander.

Valley Oak Woodland (VOW)

VOW-01: Avoid removal of valley oak trees greater than 5 inches in diameter (at a height of 4.5 feet), except where required for public safety, including fire protection, and minimize removal of smaller valley oak trees, including seedlings.

VOW-02: Limit residences to one per 10 acres, and avoid commercial structures. Locate roads to avoid crossing within the dripline of valley oak trees, if possible, or otherwise to minimize such disturbance.

VOW-03: In order to facilitate reproduction of oak trees, avoid clearing or grading in the understory of valley oak woodland, except in a limited area around each residence. If clearing or grading is allowed, valley oak seedlings, saplings and young trees shall be conserved to the extent feasible.

VOW-04: Prohibit off-road vehicles in valley oak woodland to avoid compaction of soils and disturbance of young oak trees.

VOW-05: Regulate grazing in valley oak woodland to allow adequate oak reproduction. Regulatory measures could include limiting grazing to certain times of the year, restricting grazing to specific areas or directing access to water sources.

VOW-06: If a valley oak tree having a diameter at breast height between 5 and 18 inches must be removed, the property owner shall comply with Measures **OW-01** through **OW-08**, except that an impact will result from any disturbance of the existing canopy. If a valley oak tree having a diameter at breast height of 18 inches or greater must be removed, the property owner shall comply with Measures **SVO-01** through **SVO-05**.

Wet Meadow (WTM)

WTM-01: Conserve all WTM habitat in O (Open Space) or O-1 (Open Space-1) zoning, including associated stands of willows (including shrubby growths and aspen groves) and an area sufficient to preserve hydrological features (e.g., springs, creeks, swales, drainages) necessary to maintain the habitat and sufficient area of surrounding habitats to preserve the integrity of the ecotone as determined by the California Department of Fish and ~~Game~~ Wildlife or a qualified professional.

WTM-02: Avoid building new structures. Avoid constructing new or improved roads and all vegetation clearing unless there is a demonstrated need and no feasible alternative.

WTM-03: Avoid altering natural drainage patterns through wet meadows (e.g., by roadbeds, pipelines, and other features) that would block surface or subsurface flows.

WTM-04: Implement Water Quality Conservation Measures **WQ-01** through **WQ-08** (**Chapter 8**).

WTM-05: If a project will result in impacts to WTM habitat, the U.S. Army Corps of Engineers shall be consulted.

If Cliff (CLF), Native Perennial Grasslands (PGS), or Serpentine (SER) habitat is determined to be present on a project site, the following mitigation measures shall apply:

Cliff (CLF)

CLIFF-01: Conserve cliff habitat for nesting birds and bats in O (Open Space) or O-1 (Open Space-1) zoning.

CLIFF-02: Limit recreational use of cliff habitat where use by nesting birds or bats is known or suspected.

CLIFF-03: Where cliff habitat must be impacted, habitat improvement or conservation of additional similar habitat can provide for no net loss of habitat values.

Native Perennial Grasslands (PGS)

PGS-01: Conserve PGS habitat in O (Open Space) or O-1 (Open Space-1) zoning.

PGS-02: Avoid building new structures and new or improved roads and all vegetation clearing unless there is a demonstrated need and no feasible alternative.

PGS-03: Avoid altering natural drainage patterns through PGS habitat (e.g., by roadbeds, pipelines, and other features that would block surface or subsurface flows).

Stream (ST), Montane Riparian (MRI) and Valley Foothill Riparian (VRI)

Perennial (Perennial streams are indicated on the USGS topographic maps by solid blue lines.)

ST-01: In non-urban areas, conserve habitat in O (Open Space) or O-1 (Open Space-1) zoning to 150 feet on both sides of perennial streams and prohibit vegetation clearing within 150 feet of perennial streams, except to remove invasive plant species or improve wildlife habitat. Vegetation removal for defensible space fire protection is permitted within the O (Open Space) zoning district. These distances will be increased where necessary to conserve MRI or VRI habitat. Establish construction setbacks 200 feet from the stream. These setbacks will be increased where MRI or VRI habitat extends beyond 150 feet. Conservation areas and construction setbacks shall be measured from the midline of the stream.

ST-02: In urban areas, conserve habitat in O (Open Space) or O-1 (Open Space-1) zoning to 100 feet on both sides of perennial streams. Prohibit vegetation clearing within 100 feet of perennial streams, except to remove invasive plant species or improve wildlife habitat. Vegetation removal for defensible space fire protection is permitted within the O (Open Space) zoning district. These distances will be increased where necessary to conserve MRI or VRI habitat. Establish construction setbacks 100 feet from the stream. These setbacks will be increased where MRI or VRI habitat extends beyond 100 feet. Conservation areas and construction setbacks shall be measured from the midline of the stream.

ST-03: Areas where vegetation clearing is prohibited shall be protected by O (Open Space) or O-1 (Open Space-1) zoning. Limited clearing shall be allowed, however, if it is part of a wildlife habitat enhancement plan, approved by the County.

ST-04: Minimize the number of road and utility crossings of streams, and design crossings to be perpendicular to streams, to minimize impacts on riparian habitat. Roads and utilities should utilize the same crossings to the extent feasible. Prohibit off-road vehicles and heavy construction equipment within the setbacks of streambeds unless there is a demonstrated need and no feasible alternative.

ST-05: Water projects shall be required to maintain in-stream flows in natural waterways adequate to maintain the fisheries and riparian vegetation, and in no case should these flows be lower than the average yearly minimum (later summer flows).

ST-06: For in-stream projects such as bridges and channel alterations, County staff will cooperate with the Department of Fish and Game to obtain adequate fish and wildlife protection through Streambed Alteration Agreements, when required and will consult with the U.S. Army Corps of Engineers prior to permitting fill of waters of the United States.

ST-07: Implement Best Management Practices to reduce the effects of grazing when appropriate (e.g. to mitigate direct impacts on riparian habitat). Best Management Practices utilized should be approved by the Central Valley Regional Water Quality Control Board.

ST-08: No introductions of fish or amphibians shall be permitted in aquatic habitats without (a) full consultation with the Department of Fish and Game, and (b) a finding by a qualified biologist that no target amphibians are likely to breed in the site or be adversely affected by dispersal of the introduced species within the watershed.

ST-09: Implement suitable erosion control measures to avoid increasing sedimentation of aquatic habitats.

ST-10: Culverting, piping or lining of perennial streams by private entities is discouraged unless no alternative is feasible. Where valuable riparian habitat is destroyed by such necessary action, alternate habitat improvements may be required on or off-site. Prior to permitting such work, the County will consult with the U.S. Army Corps of Engineers.

Intermittent (Intermittent streams are indicated on the USGS topographic maps by dashed blue lines.) This designation may include drainage channels with a clearly defined bed, bank and channel that are not shown on the USGS maps.

ST-11: In non-urban areas, conserve habitat in O (Open Space) or O-1 (Open Space-1) zoning to 100 feet on both sides of intermittent streams and prohibit vegetation clearing within 100 feet of intermittent streams, except to remove invasive plant species or improve wildlife habitat. Vegetation removal for defensible space fire protection is permitted within the O (Open Space) zoning district. These distances will be increased where necessary to conserve MRI or VRI habitat. Establish construction setbacks 100 feet from the stream. These setbacks will be increased where MRI or VRI habitat extends beyond 100 feet. Conservation areas and construction setbacks shall be measured from the midline of the stream.

ST-12: In urban areas, conserve habitat in O (Open Space) or O-1 (Open Space-1) zoning to 75 feet on both sides of intermittent streams. Prohibit vegetation clearing within 75 feet of intermittent streams, except to remove invasive plant species or improve wildlife habitat. Vegetation removal for defensible space fire protection is permitted within the O (Open Space) zoning district. These distances will be increased where necessary to conserve MRI or VRI habitat. Establish construction setbacks 75 feet from the stream. These setbacks will be increased where MRI or VRI habitat extends beyond 75 feet. Conservation areas and construction setbacks shall be measured from the midline of the stream.

ST-13: Also implement **ST-03** through **ST-10**.

Ephemeral (Ephemeral streams flow during and shortly after rainfall events.)

ST-14: Construction and clearing setbacks of up to 75 feet shall be required on both sides of ephemeral streams if the County, in consultation with the California Department of Fish and ~~Game~~ Wildlife, finds that it is necessary to conserve relatively undisturbed riparian woodland or other valuable wildlife habitat. Areas where vegetation removal is prohibited shall be conserved through O (Open Space) or O-1 (Open Space-1) zoning. Vegetation removal for defensible space fire protection is permitted within the O (Open Space) zoning district.

ST-15: Also implement **ST-03** through **ST-10**, if applicable.

General

ST-16: For perennial, intermittent or ephemeral streams and MRI or VRI habitat, these conservation areas and construction setbacks may be reduced if the County, in consultation with CDF~~G~~W, finds that a narrower setback is justified by unique circumstances on the project site such that a narrower setback:

- would not increase the potential for erosion, due to substantial existing vegetation cover and soil and slope stability,
- would still encompass the 100-year floodplain,
- would not reduce identified setbacks necessary to protect a special status species as prescribed in the BRRG,
- would still provide for adequate wildlife movement along the stream corridor,
- would not increase the potential for degrading water quality, and
- would fully protect existing riparian vegetation at the site.

ST-17: For perennial, intermittent and ephemeral streams and MRI or VRI habitat, these conservation areas and construction setbacks may be decreased if the County, in consultation with CDF~~G~~W, finds that this would be appropriate given existing development near the stream in the vicinity, or is necessary to avoid a "taking" of private property. If so, careful design measures shall be required to protect riparian habitat (e.g., limit the amount of clearing and fencing allowed, and locate it on the side of riparian habitat away from the stream).

ST-18: For perennial, intermittent and ephemeral streams and MRI or VRI habitat, implement Water Quality Conservation Measures **WQ-01** through **WQ-08** (**Chapter 8**).

ST-19: If a project will result in impacts to perennial, intermittent or ephemeral streams or MRI or VRI habitat, the U.S. Army Corps of Engineers shall be consulted.

ST-20: If a project will impact the bed, bank or channel of a stream, the CDFW Lake and Streambed Alteration Unit shall be notified of the project. If a Lake or Stream Alteration Agreement must be obtained, mitigation beyond that identified in this BRRG may be required by CDFW.

Migratory Deer

Second Priority Biological Resources associated with migratory deer include highly critical winter range, critical winter range, fawning areas, major holding areas and major migration corridors associated with the three migratory deer herds in the County: the Tuolumne Herd, Stanislaus Herd and Yosemite Herd. Highly critical winter range for the Tuolumne Herd is confirmed and mapped on the Tuolumne County Wildlife Maps. For the Stanislaus Herd, the upper Phoenix Lake Basin and the Ruby Hill Springs – Schaeffer area near Jupiter have been identified as highly critical winter range by the California Department of Fish and ~~Game~~ Wildlife and are outlined on the Wildlife Maps. For the Yosemite Herd, the areas north and east of the Pine Mountain Lake Subdivision near Groveland have been identified as highly critical winter range and are outlined on the Wildlife Maps.

CD-01: Maintain large-parcel zoning (37 acres or more) in highly critical winter range.

CD-02: Maintain large-parcel zoning (37 acres or more) in major migration corridors that have been confirmed and mapped on the Wildlife Maps.

CD-03: At least 20% of the land area shall be preserved through O (Open Space) or O-1 (Open Space-1) zoning, conservation easement, or other comparable restriction, subject to the requirements of Section 5.1. These areas may also be protected in AE-37 (Exclusive Agricultural, Thirty Seven Acre Minimum) zoning provided a management plan is prepared by a qualified professional and approved by the County after review by the California Department of Fish and ~~Game~~ Wildlife. Off-site habitat may be substituted only if it is of comparable value to the same migratory deer herd as determined by CDF~~G~~W. Habitat improvements may be required on the areas conserved as deer habitat upon the recommendation of CDF~~G~~W.

CD-04: Construction setbacks of 1,000 feet shall be provided from known fawning areas that are mapped on the Tuolumne County Wildlife Maps and/or the latest CDF~~G~~W Migratory Deer Herd Maps.

CD-05: Construction setbacks of 500 feet, or as identified by the California Department of Fish and ~~Game~~ Wildlife through the CEQA process, shall be provided from major migration corridors, major holding areas, important shelter areas and travel routes that have been confirmed and mapped on the Tuolumne County Wildlife Maps. These areas may require increased setbacks from perennial streams (VRI, MRI, perennial streams).

CD-06: Construction setbacks of 250 feet shall be provided from perennial streams and 200 feet from important shelter areas and travel routes regardless of other mitigation measures for second priority wildlife habitats.

CD-07: Fencing shall be designed as wildlife-friendly fencing and the selected design approved by CDF~~G~~W prior to final project approval. Barbed or smooth wire fences limited to five or fewer strands with no strand lower than 16 inches or higher than 48 inches above the ground are considered wildlife-friendly.

CD-08: When locating O (Open Space) or O-1 (Open Space-1) zoning and building setbacks give priority to conserving riparian, wet meadow, and aspen habitats and key feeding and shelter areas.

CD-09: Locate buildings on the least environmentally sensitive portions of the parcel to the maximum extent feasible, cluster buildings where possible and minimize clearing of oaks, other trees and shrubs except as required pursuant to wildlife enhancement plans for deer habitat.

CD-10: Prior to project approval, submit a deer habitat management plan to CDF~~G~~W for review and approval for development of parcels 100 acres in size or greater. Include, to the maximum extent feasible, the preceding measures. Incorporate, as feasible, additional habitat improvement measures including, but not limited to: a) clearing or prescribed burning of dense brush fields to create openings of 10 – 50 acres with suitable cover at the edge of each opening; b) planting preferred native food plants, c) removing small trees encroaching on the edges of meadows, d) and similar measures.

CD-11: Include measures as necessary to offset potential hazards to deer and humans associated with deer crossings of roadways that are established or may become more active as a result of the project.

CD-12: Permanently block temporary roads created for construction after construction is completed.

CD-13: Eliminating an existing water source or access to an existing water source is prohibited unless allowed based on consultation with CDF~~G~~W. Where the project involves the elimination of a water source (e.g., spring, pond); require the installation of a guzzler or similar replacement water source.

CD-14: Dogs shall be enclosed or leashed. This measure shall be recorded in a Notice of Action and included in Subdivision Covenants, Conditions and Restrictions (CC&R's), if applicable.

4.1.1 Compensation and Measures to Reduce On-Site Impacts (Does not include impacts to oak woodland; for oak woodland requirements refer to Chapter 7)

Where Avoidance of Second Priority Biological Resources, as referenced in Section 1.3, is infeasible or cannot be fully achieved, compensation is required in combination with measures to reduce on-site impacts to achieve “no net loss”.

Compensation for Second Priority Biological Resources may include the following:

A. O (Open Space) or O-1 (Open Space-1) zoning off-site to preserve comparable habitat or on-site in conjunction with the creation of replacement habitat (i.e. the creation of wetland to replace existing wetland that will be impacted on-site); or

B. Payment of in-lieu fees where a fund has been established and the mitigation is agreed to by the jurisdictional agency (for oak woodlands refer to Chapter 7, Sections 7.4, 7.5 and 7.6); or

C. Mitigation bank credits at the following compensation ratios.

Vegetation Community	No Net Loss Compensation Ratio	Description
Second Priority Biological Resource – Not a Wetland or Other Water	As required by the jurisdictional agencies (generally 1:1 to 3:1)	For example: Three acres of Preserve acquired, enhanced and managed in perpetuity for each acre of habitat not conserved as open space (3:1).
Second Priority Biological Resource - Wetlands or Other Waters	As required by the jurisdictional agencies (generally 1:1 to 3:1)	Three examples at 3:1: 1. Create one acre of habitat and preserve two existing acres of habitat 2. Create two acres of habitat and preserve one acre of existing habitat 3. Create three acres of habitat and preserve zero acres of existing habitat

Compensation for impacts to wetland habitats may be subject to approval by the U.S. Army Corps of Engineers.

Chapter 5. Third Priority Biological Resources

Third Priority Biological Resources are relatively abundant natural communities whose maintenance is required to support healthy native plant and wildlife populations and include the following:

- Chamise chaparral (chc)
- Mixed chaparral (mch)
- Montane hardwood conifer (mhc)
- Montane hardwood (mhw)
- Montane chaparral (mcp)
- Ponderosa pine (ppn)
- Sierran mixed conifer (smc)
- Blue Oak-Foothill Gray Pine (bop)
- Blue Oak Woodland (bow)

Third Priority Biological Resources also include Jeffrey pine (jpn), Lodgepole pine (lpn), Red fir (rfr), Subalpine conifer (scn) and White fir (wfr) habitats. These habitats are found extensively on private timberlands and land under federal ownership and are rarely found on land available for development within Tuolumne County. Therefore, potential impacts to these habitats from development on private lands would not be significant and no mitigation is required.

- Serpentine soils (SER) (if the serpentine soils support special status plant species, this habitat would be a First or Second Priority Biological Resource).

Third Priority Biological Resources species include:

- Nest Sites for bird species subject to the Migratory Bird Treaty Act (that are not otherwise First or Second Priority Biological Resources).
- Areas of migratory or resident deer concentration or that function as important deer movement corridors.
- ~~Areas occupied by a California Native Plant Society (CNPS) List 4 species.~~
- Areas occupied by a plant species ranked as vulnerable (S3) by the California Natural Diversity Database.

Refer to **Chapter 2, Section 2.3** or the corresponding flowchart if you are uncertain whether Third Priority biological resources are present within a site.

5.1 Avoidance

For habitat meeting the criteria for classification as a Third Priority Biological Resource, the following measures shall be undertaken to achieve avoidance of the resource:

A. Where a Third Priority Biological Resource is located on a proposed development site, twenty percent (20%) of the area supporting the Third Priority Biological Resource shall be conserved in O (Open Space) or O-1 (Open Space-1) zoning. Third Priority Biological Resources may also be conserved in AE-37 (Exclusive

Agricultural, Thirty Seven Acre Minimum) zoning provided a habitat management plan is prepared by a qualified professional and approved by the County after review by the California Department of Fish and ~~Game~~ Wildlife. Portions of the project site that are conserved to avoid First or Second Priority Biological Resources shall count toward this requirement. This percentage may be reduced if habitat quality is substantially improved by other measures as determined by the County after review by the California Department of Fish and ~~Game~~ Wildlife.

B. Open space will normally have greater value when it is at least two (2) acres in size when viewed in conjunction with existing or likely future open space. Where conservation of twenty percent (20%) of the area supporting Third Priority Biological Resources would result in an area of habitat less than two (2) acres in size, the County will evaluate the value of the specific habitat on the project site based on adopted criteria and, where the habitat value would not provide measurable benefit through retention of the best habitat, the property owner shall have the option to select compensation or conservation.

C. Where Avoidance measures are infeasible, or cannot be fully achieved for a Third Priority Biological Resource, Compensation may be used to mitigate potential impacts through the following methods.

i. Purchase of appropriate mitigation bank credits, or

ii. Payment of in-lieu fees, or

iii. Off-site preservation of comparable habitat.

One acre shall be acquired and/or enhanced and managed in perpetuity through one of the preceding methods for each acre of Third Priority habitat that is not or cannot be included as part of the conservation requirement described in Paragraph A (Compensation Ratio 1:1). In this situation, the property owner will have the option to select the method of compensation.

D. Policy 4.J.1 and Implementation Program 4.J.b of the Conservation and Open Space Element of the Tuolumne County General Plan direct the County to recognize the open space provided by agricultural and timberlands by exempting lands designated on the General Plan land use diagrams as Timber Production (TPZ), or Agricultural (AG) when the parcel is 37 acres or larger and supports an agricultural or residential land use or is vacant, from the County's programs for conserving non-targeted biological resources. Therefore, no mitigation is required pursuant to the BRRG for impacts to third or fourth priority biological resources on parcels that meet these criteria.

E. Where a land development project proposing urban development is proposed on a project site that is located within an urban development boundary defined by the General Plan or is adjacent to land designated for urban land uses for at least 50% of its perimeter, the mitigation described in Paragraph A for impacts to Third Priority Biological Resources will be reduced from 20% to 10% of the area of the Third Priority Biological Resources. This measure is designed to encourage development in already urbanized areas and reduce sprawl.

F. Where a project proposes affordable housing as defined in Chapter 17.04 of the Tuolumne County Ordinance Code, the mitigation described in Paragraph A for impacts to Third Priority Biological Resources will be reduced proportionally based upon the percentage of affordable housing units proposed. For example, a housing development that proposes 25% affordable units would be required to conserve 15%

of the area of the Third Priority Biological Resource rather than 20%. This measure will be applied after any reduction allowed pursuant to Paragraph E.

5.2 Nest Sites for Bird Species Subject to the Migratory Bird Treaty Act

Birds subject to the Migratory Bird Treaty Act (MBTA) are Third Priority Biological Resources, unless other regulations discussed herein elevate the status of the area occupied by the species to a First Priority Biological Resource or a Second Priority Biological Resource (**Chapters 3 and 4**).

For all projects containing suitable nesting habitat for bird species subject to the Migratory Bird Treaty Act, the following mitigation measures shall be required;

NEST-01: Vegetation and/or construction activities, including removal of vegetation, should occur outside the nesting season (typically February 1 through September 1). If vegetation, removal or construction must occur during the nesting season; surveys for active bird nests shall be conducted by a qualified biologist within ~~250~~ 500 feet of the project site no more than two weeks prior to initiation of construction activities. If an active nest is identified:

A. No work will occur within ~~250~~ 500 feet of the nest until fledging has occurred unless a longer time period is deemed necessary by a qualified biologist; OR,

B. The appropriate regulatory agency (i.e. California Department of Fish and ~~Game~~ Wildlife and/or U.S. Fish and Wildlife Service) shall be consulted to determine whether this buffer can be reduced based upon individual species sensitivity and nest location.

5.3 Minimize Impacts to Deer Habitat

Third Priority Biological Resources include resident deer concentration areas and concentration areas of migratory deer herds exclusive of highly critical deer winter range, critical deer winter range, deer concentration areas, fawning areas, major holding areas and major migration corridors, which are Second Priority Biological Resources. These areas shall be subject to the following mitigation measures:

DEER-01: At least 20% of the land area shall be preserved through O (Open Space) or O-1 (Open Space-1) zoning, conservation easement, or other comparable restriction subject to the requirements of Section 5.1. These areas may also be protected in AE-37 (Exclusive Agricultural, Thirty Seven Acre Minimum) zoning provided a management plan is prepared by a qualified professional and approved by the County after review by the California Department of Fish and ~~Game~~ Wildlife. Off-site habitat may be substituted only if it is of comparable value to the same migratory deer herd or resident deer as determined by CDF~~G~~W. Habitat improvements may be required on the areas conserved as deer habitat upon the recommendation of CDF~~G~~W.

DEER-02: Construction setbacks of 250 feet shall be provided from perennial streams and 200 feet from important shelter areas and travel routes regardless of other mitigation measures for second priority wildlife habitats.

DEER-03: Fencing shall be designed as wildlife-friendly fencing and the design approved by CDF~~G~~W prior to final project approval. Barbed or smooth wire fences with five or fewer strands and no strand lower than 16 inches or higher than 48 inches above the ground are considered wildlife-friendly. Pre-existing fencing between a project site and adjacent agricultural land is not subject to this measure and may be maintained as necessary for the agricultural use. If the project site is zoned AE-37 or is located adjacent to agricultural land, refer to Mitigation Measure OSP-04.

DEER-04: Within deer concentration areas, use O (Open Space) or O-1 (Open Space-1) zoning and building setbacks to protect riparian, wet meadow, and aspen habitats and key feeding and shelter areas. These areas may also be protected in AE-37 (Exclusive Agricultural, Thirty Seven Acre Minimum) zoning provided a management plan for those areas to be protected is prepared by a qualified professional and approved by the County after review by the California Department of Fish and ~~Game~~ Wildlife.

DEER-05: Locate buildings on the least environmentally sensitive portions of the parcel to the maximum extent feasible, cluster buildings where possible and minimize clearing of oaks, other trees and shrubs except as required pursuant to wildlife enhancement plans for deer habitat.

DEER-06: Prior to project approval, submit a deer habitat management plan ~~to CDFG~~ for review and approval by the County after review by the California Department of Fish and ~~Game~~ Wildlife for parcels 100 acres in size or greater. Include, to the maximum extent feasible, the preceding measures. Incorporate, as feasible, additional habitat improvement measures including, but not limited to:

- clearing of dense brush fields to create openings of 10 – 50 acres with suitable cover at the edge of each opening;
- planting preferred native food plants;
- removing small trees encroaching on the edges of meadows; and
- similar measures.

DEER-07: Post signs to address potential hazards to deer and humans associated with deer crossings of roadways that are established or may become more active as a result of the project.

DEER-08: Permanently block temporary construction roads to vehicle traffic after construction is completed.

DEER-09: Eliminating an existing water source or access to an existing water source shall be prohibited unless allowed based on consultation with CDF~~G~~W. Where the project involves the elimination of a water source (e.g., spring, pond); the installation of a guzzler or similar replacement water source shall be required.

DEER-10: Dogs shall be maintained under control at all times.

DEER-11: Maintain adequate access for deer to move through parcels by locating home sites (or clusters of home sites) at least 300 feet apart, where feasible.

DEER-12: For potential barriers to deer movement other than roads, such as large pipelines or steep-sided canals, provide deer crossings at suitable intervals (e.g., by burying pipelines or providing suitably designed ramps across canals).

Chapter 6. Fourth Priority Biological Resources

Fourth Priority Biological Resources pursuant to the BRRG include urbanized or otherwise altered areas that have low or no value for native plants, fish or wildlife.

The following criteria shall be met for a resource to be classified as a Fourth Priority Biological Resource:

- The site is not identified as a First, Second or Third Priority Biological Resource.

- The site is mapped as residential park (rsp), annual grassland (ags), irrigated pasture (pas) cropland (crp) or barren (bar) on the Tuolumne County Wildlife Habitat Maps.

  If a project site is mapped as rsp and is greater than five (5) net acres in size, the field assessment may include a reclassification of the site to an appropriate habitat designation(s) included in the Third Priority Biological Resource category.

- The site is not known or likely to be occupied by a special status species.

  Portions of a project site that has been mapped as a Fourth Priority Biological Resource may contain biological resources that are consistent with First or Second Priority resources (for example habitat for a special status species or a blue-line stream). The portion of the project site containing those resources shall be re-classified to the appropriate priority designation regardless of the size of the parcel.

- The site does not provide an important linkage (i.e., readily available alternatives are not available to the species) between First, Second or Third Priority Biological Resources bordering the project site, and the project site is not essential to the movement of species from one location to another.

No Avoidance, Minimization, Compensation or other mitigation measures are necessary for Fourth Priority Biological Resources.

Chapter 7: Oak Mitigation

7.1 Purpose of Mitigation

State regulations direct the County to determine the significance of impacts to native oak woodlands, and, when appropriate, to mitigate those impacts. An oak woodland is defined as a stand of three (3) or more native oak trees <u>at least 5 inches in diameter at breast height</u> that is at least one-half (0.5) acre in area where the canopy cover of the native oak trees is ten percent (10%) or greater. A project site may have one or more oak woodlands on it. Oak woodland may include not just standing live oak trees, but also trees of other species, damaged or senescent (aging) trees, a shrubby and herbaceous layer beneath the oak canopy, standing snags, granary trees, and downed woody debris in conjunction with an oak woodland. These elements create the structural diversity that is essential for many species of wildlife.

Section 21083.4 of the Public Resources Code/California Environmental Quality Act (CEQA) requires the County to determine whether projects “may result in a conversion of oak woodlands that will have a significant effect on the environment.” When it is determined that such a project may have a significant effect, specific mitigation standards are required.

These standards apply to all native oak species in the County, except California black oak (*Quercus kelloggii*) trees that are growing on land that does or did previously support commercial conifer species as determined by the California Department of Forestry and Fire Protection. These species include *Quercus douglasii* (blue oak), *Quercus lobata* (valley oak), *Quercus garryana var. breweri* (Brewer’s oak), *Quercus wislizeni* (interior live oak), *Quercus chrysolepis* (canyon live oak), California black oak not growing in conjunction with commercial conifers and hybrids of these species. The following program has been established to identify and mitigate significant impacts to oak woodland ecosystems. This program has been developed in consultation with the California Department of Fish and ~~Game~~ <u>Wildlife</u>. Unless stated otherwise in Mitigation Measure **OW-0~~9~~<u>8</u>**, the mitigation measures specified in this section will be required in addition to those identified in **Chapters 3, 4** and **5** to mitigate impacts on First, Second and Third Priority Biological Resources.

7.2 Impact Identification

This program shall apply to land development projects that:

1. Require a discretionary entitlement subject to review under the California Environmental Quality Act (CEQA), and

2. Will have a potential significant adverse impact on an oak woodland other than a Valley Oak Woodland (VOW) or a single Specimen Oak (SO) or Specimen Oak trees contained within an oak woodland.

Land development impacts to oak woodlands result from indirect impacts and direct impacts. Direct impacts are caused by project construction. They include, but are not limited to: removal of trees, damage to trees through physical injury, soil compaction, root damage resulting from grade changes; and fragmentation of “intact” oak woodland habitat into patches too small to support native plants and wildlife. Indirect impacts result from activities or effects associated with a project, which are not directly caused during project construction. They include (in part) increased access by people and/or pets, changes to hydrology or water table, introduction of horticultural plant species from adjacent landscaping, increased risk of wildfire, and increased wildlife road-kill.

A significant adverse impact to an oak woodland is one that will adversely affect 10% or more of the canopy of that oak woodland either directly or indirectly.

Valley Oak Woodland (VOW) is a Second Priority habitat and shall be retained and protected in accordance with the requirements for Second Priority resources (**Chapter 4**) except where public health and safety are at risk. For mitigation of impacts to VOW, refer to **Chapter 4**, Second Priority Resources.

Specimen oaks shall be protected in accordance with the specific requirements contained in Sections 7.5 and 7.6 except where public health and safety are at risk.

In order to determine the extent of the impact on oak woodlands, a tree evaluation plan may be required by the Community ~~Development Department~~ Resources Agency in conjunction with an application for the required discretionary entitlements for a development project. The tree evaluation plan shall identify the location and total acreage of oak woodland on the project site, along with representative samples of the species and sizes of all native oaks five inches (5") or larger in diameter at breast height (dbh) that exist on the project site. The tree evaluation plan shall also indicate the oak woodland area to be removed or impacted by the proposed development. A tree evaluation plan will also be required in conjunction with a replanting plan.

7.3 Exemptions

Removal of oak woodlands is exempt from this program under the following circumstances:

A. The conversion of oak woodlands on agricultural land that includes land that is used for the purpose of producing or processing plant and animal products for commercial purposes.

B. Land development projects on a project site where all three of the following conditions apply:

   1) the site is classified as a Fourth Priority Biological Resource on the Wildlife Habitat Maps, including annual grassland (ags), irrigated pasture (pas), cropland (crp), barren (bar) or residential park (rsp), and

   2) the site is defined as "severely degraded oak woodland"; and

   3) the site is located within an adopted urban development boundary or is within a defined community and has an existing urban General Plan land use designation of High Density Residential (HDR), Medium Density Residential (MDR), Low Density Residential (LDR), Mixed Use (MU), Neighborhood Commercial (NC), General Commercial (GC) or Heavy Commercial (HC).

   A land development project that includes a General Plan Amendment to change the land use designation from a non-urban designation to an urban designation is not included in this exemption.

C. Removal of trees necessary to comply with defensible space fire protection regulations or tree removal undertaken as part of a fuel reduction/fire safety program in conformance with commonly accepted County or CalFire policies.

D. Affordable housing projects for lower income households, as defined pursuant to Section 50079.5 of the Health and Safety Code, that are located within an urbanized area, or within a sphere of influence as defined pursuant to Section 56076 of the Government Code.

E. Removal of trees associated with construction, maintenance or safety improvements for County maintained roads and other roads or public utilities within existing road or public utility easements when approved by the Community Resources Agency.

~~F. Thinning and sanitizing of oak woodlands pursuant to a management plan prepared by a qualified professional to create a healthy oak woodland that is approved by the Community Resources Agency.~~

~~G~~F. Land development projects where the property owner can demonstrate that the project would not have a significant adverse impact on oak woodlands or specimen oaks. This could be accomplished by conserving 90% or more of the oak woodlands and all specimen oaks, except those required to be removed for public health and safety, through building setbacks, O (Open Space) or O-1 (Open Space-1) zoning or conservation easements, establishing building envelopes outside oak woodlands or other methods approved by the County.

~~H~~G. Removal of hazard trees or diseased trees when recommended by a qualified professional and approved by the Community Resources Agency.

7.4 Mitigation Measures

OW-01: Residential land division projects located on a site that contains oak woodlands, is not exempt pursuant to Section 7.3 and propose parcels less than two (2) acres in area shall mitigate impacts of oak woodland conversion as follows. If the project site is less than two (2) acres in size, the property owner shall contribute a fee to the Tuolumne County Oak Woodland Conservation Fund based upon the following formula:

Fee = acres of impacted land x current land value

Impacted land shall be determined as fifty percent (50%) of the parcel size for parcels less than one acre and one-half (0.5) acre for parcels equal to or greater than one acre. The property owner may submit plans demonstrating that less acreage of oak woodland per parcel would be disturbed than assumed in this measure. If approved by the Community Resources Agency, the reduced acreage of impact would be used for calculation of mitigation fees.

If the project site is two (2) acres or larger, the property owner shall conserve oak woodlands in an amount equal to that which would be impacted by the development proposed. Existing native oak trees on or off the project site shall be protected from future development through a conservation easement or fee title dedication to a land conservation group approved by the County with concurrence by the Department of Fish and Game, or O (Open Space) or O-1 (Open Space-1) zoning under the Tuolumne County Ordinance Code. These areas may also be protected in AE-37 (Exclusive Agricultural, Thirty Seven Acre Minimum) zoning provided a management plan is prepared by a qualified professional and approved by the County after review by the California Department of Fish and ~~Game~~ Wildlife. Determination of the amount of oak woodland disturbed may utilize the formula identified for a project site less than two (2) acres in size or other method approved by the County with concurrence of the Department of Fish and ~~Game~~ Wildlife.

The current land value is the value of one acre of agricultural land as determined each year on March 1 by the County Assessor based upon sales of parcels not larger than 40 acres in area during the previous 12-month period or other method determined appropriate by the Assessor. This value is used since it is likely that the fees collected would be used to acquire agricultural parcels of this size to conserve oak woodland.

OW-02: Residential land division projects located on a site that contains oak woodlands and proposes parcels at least two (2) acres in area shall protect existing native oak trees on or off the project site from future development through a conservation easement or fee title dedication to a land conservation group approved by the County with concurrence by the Department of Fish and ~~Game~~ Wildlife, or O (Open Space) or O-1 (Open Space-1) zoning under the Tuolumne County Ordinance Code. These areas may also be protected in AE-37 (Exclusive Agricultural, Thirty Seven Acre Minimum) zoning provided a management plan is prepared by a qualified professional and approved by the County after review by the California Department of Fish and ~~Game~~ Wildlife. The amount of area to be protected shall be as shown below:

Proposed Parcel Size	Amount of Area to be Protected per Parcel
≥2 to 2.99 acres	0.75 acre
≥3 to 9.99 acres	1.0 acre
≥10 to 19.99 acres	2.0 acres
≥20 acres to 40 acres	3.0 acres

The property owner may submit plans demonstrating that less acreage of oak woodland per parcel would be disturbed than assumed in this measure. If approved by the Community Resources Agency, the reduced acreage of impact would be used for calculation of mitigation measures. Conservation land offered as mitigation must be configured in such a manner as to best preserve the integrity of the oak ecosystem and minimize the ratio of edge to area. The land should be contiguous to existing or proposed O (Open Space) or O-1 (Open Space-1) zoning or a conservation easement either on or off-site, and must provide or enhance a system of wildlife corridors in the area of the project site.

OW-03: As an alternative to conserving land, the landowner may pay an in-lieu fee as mitigation for conversion of oak woodland. The fee shall consist of a contribution to the Tuolumne County Oak Woodland Conservation Fund using the following formula:

Fee = acres of impacted land (based upon the amount of area reflected above in Mitigation Measures **OW-01** or **OW-02**) x current land value

For land division projects, the in-lieu fee may be prorated among the parcels created and collected at the time of issuance of the first building permit on each parcel.

OW-04: For all projects, that have the potential to impact oak woodland, *except* residential land division projects, the project proponent shall mitigate through one of the following measures:

A. Conserve one (1.0) acre of native oak woodland with a species and age composition similar to that of the project site for every one (1.0) acre of impacted woodland. The area of oaks to be protected shall have the same or greater habitat value as the area being disturbed, shall be conserved through O (Open Space), O-1 (Open Space–1) zoning or a conservation easement, and shall be subject to County approval with concurrence by the California Department of Fish and ~~Game~~ Wildlife. These areas may also be protected in AE-37 (Exclusive Agricultural, Thirty Seven Acre Minimum) zoning provided a management plan is prepared by a qualified professional and approved by the County after review by the California Department of Fish and ~~Game~~ Wildlife.

B. In lieu of conserving oak woodland either on or off-site, the landowner may pay an in-lieu fee to the Tuolumne County Oak Woodland Conservation Fund as mitigation for disturbance to oak woodland based upon the following formula:

Fee = acres of impacted land x current land value

OW-05: Any project that has the potential to impact oak woodland may be mitigated through the restoration of oak woodland. The oak woodland restoration shall consist of one (1.0) acre of oak woodland for every one (1.0) acre of impacted oak woodland on the project site. Restoration shall only apply to lands that should naturally support oak woodlands but due to human intervention currently do not support oak woodland. Restoration should result in species composition and density similar to the project site and appropriate to the restoration site. Restored lands should be conserved through a conservation easement or fee title dedication to a land conservation group approved by the County with concurrence by the Department of Fish and ~~Game~~ Wildlife or O (Open Space) or O-1 (Open Space -1) zoning under the Tuolumne County Ordinance Code. This option requires the preparation of a restoration and maintenance plan and is subject to County approval and concurrence by the California Department of Fish and ~~Game~~ Wildlife. These areas may also be protected in AE-37 (Exclusive Agricultural, Thirty Seven Acre Minimum) zoning provided a management plan is prepared by a qualified professional and approved by the County after review by the California Department of Fish and ~~Game~~ Wildlife.

OW-06: Planting of replacement trees may be utilized as a mitigation measure on parcels equal to or greater than five (5) acres in size, and the replanting area shall be conserved through a conservation easement or fee title dedication to a land conservation group approved by the County with concurrence by the Department of Fish and ~~Game~~ Wildlife, or O (Open Space) or O-1 (Open Space–1) zoning under the Tuolumne County Ordinance Code. These areas may also be protected in AE-37 (Exclusive Agricultural, Thirty Seven Acre Minimum) zoning provided a management plan is prepared by a qualified professional and approved by the County after review by the California Department of Fish and ~~Game~~ Wildlife. This mitigation shall not fulfill more than fifty percent (50%) of the mitigation requirement for the project pursuant to Section 21083.4 of the California Environmental Quality Act (CEQA), and; therefore, must be combined with another mitigation measure contained within this section. If replanting is not a viable option, the fee referenced in Mitigation Measure **OW-04** may be paid in lieu of the replanting.

In order to utilize this mitigation measure, the landowner must submit a tree evaluation plan pursuant to **Section 7.2** to the Community ~~Development Department~~ Resources Agency in conjunction with an application for the required discretionary entitlements for a development project.

Oak trees of five inches (5”) or more in diameter removed from the project site shall be replaced with the same species at the following ratios unless otherwise allowed by an approved tree evaluation plan:

1:1 replacement for trees 5-12” dbh removed.

3:1 replacement for trees >12” up to the limits identified for Specimen Oaks (SO).

Planting of the replacement oaks shall require the submittal of a replanting plan prepared by a qualified consultant which shall address the existing topography, irrigation options, soils and land available for replanting to ensure that this constitutes a viable replacement oak woodland option. This plan shall be reviewed and approved by the Community Resources Agency following concurrence of the California Department of Fish and Game. Tree replanting shall be consistent with the approved plan and shall be inspected by a qualified consultant, approved by the Community ~~Development Department~~ Resources Agency and paid for by the applicant prior to commencement of construction of any improvements or recording of a final map.

Replanting areas shall be contiguous with existing or proposed O or O-1 zoning and/or an existing or proposed conservation easement unless otherwise allowed by an approved tree evaluation plan, security shall be posted to assure annual monitoring, and a maintenance entity shall be established to ensure a minimum eighty percent (80%) survival rate over seven (7) years consistent with the approved tree evaluation plan. If the maintenance entity consists of a Homeowner’s Association (HOA), the Covenants, Conditions and Restrictions (CC&R’s) for the HOA shall reflect the requirements for maintaining the replacement trees.

OW-07: Oak trees that must be removed or impacted to facilitate development may be relocated in lieu of other mitigation measures. Relocation shall require approval of a plan designating the relocation site and describing the methods that will be utilized to conserve the trees. Development entitlements issued by the County shall require other measures to address the possibility that the trees could die as a result of relocation.

OW-08: A land development application that has the potential to impact oak woodland, is located on land designated as montane hardwood-conifer (mhc), montane hardwood (mhw), blue oak-foothill gray pine (bop) or blue oak woodland (bow), or otherwise meets the criteria of an oak woodland, and is subject to the requirements of Chapter 5 regarding mitigation for cumulative impacts to a Third Priority Biological Resource shall be credited for fifty percent (50%) of the area zoned O (Open Space) or O-1 (Open Space -1) toward compliance with Section 7.4. Credit shall also be applied for land that is conserved through a conservation easement or that is protected in AE-37 (Exclusive Agricultural, Thirty Seven Acre Minimum) zoning provided a management plan is prepared by a qualified professional and approved by the County after review by the California Department of Fish and ~~Game~~ Wildlife. This credit is based upon the premise that the oak woodland conserved to mitigate cumulative impacts to wildlife also serves a dual function as oak woodland habitat.

OW-09: Measures applied to a land development project to achieve no net loss of Specimen Oak (SO) or Specimen Valley Oak (SVO) trees pursuant to Sections 7.5 or 7.6 shall be credited toward mitigation required for the same project for conversion of oak woodland required pursuant to this section.

~~**OW-10:** Mitigation of impacts from oak woodland conversion may be accomplished through thinning and sanitizing of overstocked oak woodlands. To accomplish this, a management plan shall be prepared by a qualified consultant and approved by the County following review by the California Department of Fish and Game. The management plan shall, at a minimum, describe the existing and desired stocking levels of oak trees and other tree species, the prescription for thinning the oak woodland, the ratio of acres thinned for mitigation to acres of oak woodland impacted by the project, and measures to conserve the wildlife habitat value of the oak woodland following thinning. To be considered mitigation, the treated oak woodlands must be zoned O (Open Space), O-1 (Open Space -1) or AE-37~~

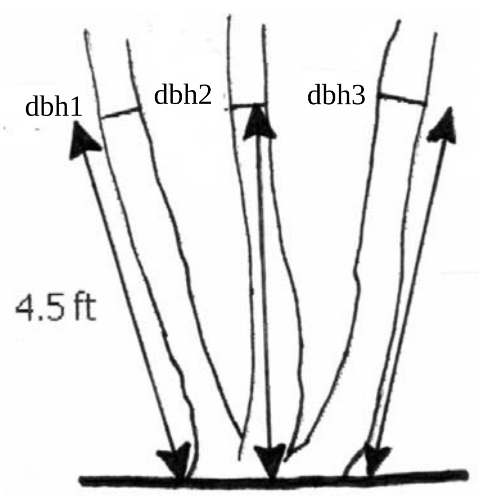
~~(Exclusive Agricultural, Thirty Seven Acre Minimum), or conserved through a conservation easement.~~

OW-1~~1~~0: Where a land development project that proposes urban development is proposed on a project site that is located within an urban development boundary defined by the General Plan or is adjacent to land designated for urban land uses for at least 50% of its perimeter, the mitigation described in this section for conversion of oak woodland shall be reduced by 50%. This reduction shall be calculated prior to application of any reduction in oak woodland conserved to mitigate impacts to First, Second or Third Priority Biological Resources described in Mitigation Measure **OW-08**. This measure is designed to encourage development in already urbanized areas, reduce sprawl and minimize impacts to oak woodlands.

OW-1~~2~~1: Where a project proposes affordable housing as defined by Chapter 17.04 of the Tuolumne County Ordinance Code, the mitigation described in this section for conversion of oak woodland may be reduced proportionally based upon the percentage of affordable housing units proposed. This reduction shall be calculated prior to application of any reduction for oak woodland conserved to mitigate impacts to First, Second or Third Priority Biological Resources described in Mitigation Measure **OW-08**. This reduction will be applied after any reduction allowed pursuant to Mitigation Measure **OW-1~~1~~0**.

7.5 Specimen Oaks other than Valley Oaks

Policy 4.J.6 and Implementation Program 4.J.d of the General Plan require new development which is subject to review under the California Environmental Quality Act (CEQA) to achieve “no net loss” of habitat values for Old Growth Oak (OGO) hereinafter referred to as Specimen Oaks. Specimen Oak (SO) trees include valley oaks, interior live oaks, canyon live oaks, ~~blue oaks,~~ California black oaks and other native oak trees that are at least 18 inches in diameter at breast height (dbh) and blue oak trees that are 8 to 10 inches in dbh, unless a qualified professional determines that such trees do not exhibit characteristics of old growth oak trees. For oak trees that have more then one trunk, the following method will be used to determine if the tree is a SO:



$$dbh = \sqrt{dbh1^2 + dbh2^2 + dbh3^2}$$

In order to assure no net loss of SO in the County, all of the following mitigation measures shall be applied when any SO are impacted by a project:

SO-01: Specimen Oaks (SO) shall be avoided to the maximum extent feasible. No more than fifty percent (50%) of the SO trees on a project site may be impacted, unless approved by the County.

SO-02: A SO is impacted when intrusion occurs into 50% or more of the area under the dripline of the tree. If intrusion cannot feasibly be avoided and pervious paving materials are used, the tree will not be considered to be impacted. Mitigation for impacting or removing each SO tree shall consist of the following:

Payment of a fee per the following formula to the Tuolumne County Oak Woodland Conservation Fund:

Fee = 0.1 x current land value

In order to mitigate the temporal loss and achieve no net loss of SO habitat values, an additional fee shall be paid for each SO that is impacted or removed. The additional fee shall be equivalent to planting and monitoring three (3) replacement trees. The cost of planting and monitoring each replacement tree is currently $200 per tree. This additional fee shall be paid to the Tuolumne County Oak Woodland Conservation Fund.

SO-03: In lieu of making all or a portion of the payment required by Mitigation Measure **SO-02**, the project proponent may conserve additional land through a conservation easement, O (Open Space) or O-1 (Open Space-1) zoning. These areas may also be protected in AE-37 (Exclusive Agricultural, Thirty Seven Acre Minimum) zoning provided a management plan is prepared by a qualified professional and approved by the County after review by the California Department of Fish and ~~Game~~ Wildlife. The area conserved must contain Specimen Oak (SO) trees of the same species and must be at least 0.1 acre in area. To obtain full credit for the required payment, the area conserved must be at least 0.1 acre in area per each SO removed or which has 50% or more of the area under the dripline impacted and must contain at least as many SO as would be removed or impacted.

SO-04: SO that must be removed or impacted to facilitate development may be relocated in lieu of other mitigation measures. Relocation shall require approval of a plan designating the relocation site and describing the methods that will be utilized to conserve the trees. Other measures to conserve SO trees that would be impacted by development may be approved by the County, including the use of pervious paving materials. Development entitlements issued by the County may require other measures to address the possibility that the trees could die as a result of relocation or despite other measures to conserve SO trees.

7.6 Specimen Oaks that are Valley Oaks

Policy 4.J.6 and Implementation Program 4.J.d of the Tuolumne County General Plan require new development which is subject to review under the California Environmental Quality Act (CEQA) to achieve "no net loss" of habitat values for Valley Oak Woodland (VOW) and Old Growth Oak (OGO) hereinafter referenced as Specimen Valley Oaks (SVO). SVO trees include valley oak trees that are at least 18 inches in diameter at breast height, unless a qualified professional determines that such trees do not exhibit characteristics of old growth oak trees. Therefore, in order to assure no net loss of SVO in the County, all of the following mitigation measures shall be applied when any SVO is impacted by a project:

SVO-01: Specimen Valley Oak (SVO) shall be avoided to the maximum extent feasible. No more than fifty percent (50%) of the SVO trees on a project site may be impacted, unless approved by the County.

SVO-02: A SVO is impacted when intrusion occurs into 50% or more of the area under the dripline of the tree. If intrusion cannot feasibly be avoided and pervious paving materials are used, the tree will not be considered to be impacted. Mitigation for impacting or removing each SVO tree shall consist of the following:

Payment of a fee per the following formula to the Tuolumne County Oak Woodland Conservation Fund:

Fee = 0.1 x current land value

In order to mitigate the temporal loss and achieve no net loss of SVO habitat values, an additional fee shall be paid for each SVO that is impacted or removed. The additional fee shall be equivalent to planting and monitoring six (6) replacement trees. The cost of planting and monitoring each replacement tree is currently $200 per tree. This additional fee shall be paid to the Tuolumne County Oak Woodland Conservation Fund.

SVO-03: In lieu of making all or a portion of the payment required by Mitigation Measure **SVO-02**, the project proponent may conserve additional land through a conservation easement, O (Open Space) or O-1 (Open Space-1) zoning. These areas may also be protected in AE-37 (Exclusive Agricultural, Thirty Seven Acre Minimum) zoning provided a management plan is prepared by a qualified professional and approved by the County after review by the California Department of Fish and ~~Game~~ Wildlife. The area conserved must contain SVO trees and must be at least 0.1 acre in area. To obtain full credit for the required payment, the area conserved must be at least 0.1 acre in area per each SVO removed or which has 50% or more of the area under the dripline impacted and must contain at least as many SVO as would be removed or impacted.

SVO-04: SVO that must be removed or impacted to facilitate development may be relocated in lieu of other mitigation measures. Relocation shall require approval of a plan designating the relocation site and describing the methods that will be utilized to conserve the trees. Other measures to conserve SVO trees that would be impacted by development may be approved by the County. Development entitlements issued by the County may require other measures to address the possibility that the trees could die as a result of relocation or despite other measures to conserve SVO trees.

7.7 Protection of Oak Trees During and After Construction Activities

OAK-01: For all oak trees that will be retained, including those within 25 feet of any development activity, the following protective measures shall be implemented prior to any construction activities:

A. Brightly colored construction fencing (mesh or silt) shall be placed around the outermost edge of the dripline of each tree or group of protected trees on the sides facing the construction.

B. No construction activities shall be conducted within this area, including but not limited to:
   1. Storage of any equipment
   2. Parking or storage of any vehicles
   3. Dumping of any trash, soils, fuels, or liquids

C. The construction fencing shall remain in place until all construction activities are completed.

OAK-02: The existing grade shall be maintained around protected trees to the maximum extent possible. Retaining walls shall be utilized where required and no fill shall be allowed within the dripline of any Specimen Oak (SO) or Specimen Valley Oak (SVO) tree.

OAK-03: If utility installation must occur within the dripline of any SO or SVO tree all utility trenching shall be performed under the supervision of a certified arborist or other qualified consultant. All directions provided by the arborist shall be implemented.

OAK-04: If paving must occur within the dripline of any SO or SVO tree, pervious paving only should be used. If paving within the dripline cannot feasibly be avoided and pervious paving materials are used, the tree will not be considered to be impacted.

OAK-05: Trees that have been identified for retention on a project site, in conjunction with project approval and a tree protection plan, shall be identified with a readily visible marker attached to the tree or immediately nearby. This shall occur prior to issuance of a final occupancy permit, recording of a final map or a similar definitive time period.

OAK-06: For commercial and industrial development the following additional mitigation measures shall be implemented:

A. no plantings shall occur within the dripline of any retained oak tree;

B. no irrigating or fertilizing shall occur within the dripline of any retained oak tree;

C. no placement of fill shall occur within the dripline of any retained oak tree; and

D. no storage of any equipment, vehicles, or other materials shall occur beneath the dripline of any retained oak tree~~, and~~.

OAK-07: For Residential Development the project proponent shall provide the homeowner a copy of "Living Among the Oaks" and "Care of California Native Oaks".

7.8 Premature Removal of Oak Trees

Chapter 9.24 of the Tuolumne County Ordinance Code is intended to discourage the premature removal of native oak trees. This chapter establishes penalties, mitigation requirements and an enforcement procedure should premature removal of oak trees in anticipation of development occur.

7.9 Tuolumne County Oak Woodland Conservation Fund

The Tuolumne County Oak Woodland Conservation Fund was established by the Board of Supervisors on February 5, 2008 through adoption of Resolution 14-08 for collection of mitigation fees for impacts to oak woodlands and old growth oak trees. The fund may be used to purchase land in fee or conservation easements for the protection of native oak woodlands or otherwise mitigate the impacts associated with the conversion of oak woodlands or impacts to old growth oak trees. The fees collected in the Fund shall only be allocated by the Board of Supervisors.

Chapter 8. Standard Mitigation Measures

This section contains the mitigation measures commonly required for land development projects. These standard mitigation measures are typically required (as applicable) in addition to those mitigation measures required for specific habitats and specific species as identified in Chapters 3, 4, and 5 and the Appendix.

8.1 Protecting Water Quality

To properly assess the functions and values of waters of the United States that occur on a project site, the U.S. Army Corps of Engineers should be contacted prior to commencement of construction. When jurisdictional wetlands would be affected by a land development project, the appropriate permits must be obtained from the U.S. Army Corps of Engineers, pursuant to Section 404 of the Clean Water Act, and the Central Valley Regional Water Quality Control Board, pursuant to Section 401 of the Clean Water Act, prior to commencing construction.

To protect water quality during project construction, the following measures shall apply to all land development projects:

WQ-01: Limit equipment storage, working areas, spoils, and equipment to project staging areas.

WQ-02: Limit equipment refueling and maintenance to areas approved by the County.

WQ-03: Control wastewater runoff into ditches, streams, lakes, ponds and other wetlands or other waters through implementation of Best Management Practices (BMPs) including containment and disposal of water which has contacted wet concrete outside of the ditches, streams, lakes, ponds and other wetlands or other waters.

WQ-04: Avoid washing construction vehicles or other equipment in drainage paths to ditches, streams, lakes, ponds and other wetlands or other waters.

WQ-05: Prevent solid debris from the construction site or from other activities associated with the proposed project from entering ditches, streams, lakes, ponds and other wetlands or other waters through the use of construction fencing.

WQ-06: Collect all temporary construction materials from ephemeral drainages upon completing work.

WQ-07: The applicant shall stabilize and revegetate disturbed soils and all other disturbed areas as soon as possible and before the rainy season begins (but no later than October 15th of the construction year) in accordance with the County and Caltrans landscape guidelines and specifications. Only certified seed shall be used for reseeding.

WQ-08: Prior to working in or near any river, stream, drainage or waterway, equipment shall be thoroughly cleaned to prevent introduction of invasive aquatic species.

8.2 Fencing and Signage

FEN-01: When wildlife-friendly fencing requirements are identified in the BRRG as project mitigation for residential subdivisions, require the inclusion of illustrated wildlife fencing design in the Covenants, Conditions and Restrictions (CC&R's) and design guidelines. Require County review and approval of these CC&R's requirements prior to filing a final map.

FEN-02: Wildlife friendly fencing may also be appropriate outside of major deer areas (Mitigation Measure **DEER-04**), and the use of such fencing should be evaluated on a project by project basis dependent on the need for unobstructed wildlife corridors. For projects where fencing is identified in plans or project conditions, identify wildlife friendly fencing design requirements and require the installation of fencing in compliance with those requirements prior to issuance of final occupancy permits, recording a final map or similar method, when feasible.

SGN-01: Install small signs to identify environmentally sensitive areas and the habitat of protected species in order to make it easier for construction and maintenance crews and subsequent property owners to recognize these areas. These signs shall be permanent ESA signs with reference to the Community Resources Agency and contact information.

8.3 Open Space Protection

OSP-01: Install temporary fencing along O (Open Space) and O-1 (Open Space-1) boundaries facing the construction prior to commencing ground and/or vegetation disturbance. Where fencing may be infeasible require installation of signs to warn construction crews of the need to stay out of O or O-1 zoning districts.

OSP-02: For land development projects, the physical boundary of O (Open Space) and O-1 (Open Space-1) zoning districts may be required to be clearly delineated on each lot or parcel to assist the property owner in determining its location.

OSP-03: Building setbacks for wildlife habitat conservation and areas of O (Open Space) and O-1 (Open Space-1) zoning shall be clearly shown on parcel maps and final maps.

OSP-04: If O (Open Space) or O-1 (Open Space-1) zoning is proposed adjacent to land designated Agricultural (AG), under Williamson Act contract or within an agricultural preserve, the owner of the adjacent agricultural land shall be consulted regarding the proposed mitigation. Fencing may have to be designed to meet the needs of livestock as well as wildlife, maintenance of required fencing may need to be shared between the property owners, and other identified effects on the adjacent agricultural operation may need to be addressed.

8.4 Noxious Weeds

NW-01: All hay, straw, hay bales, straw bales, seed, mulch or other material used for erosion control or landscaping shall be free of noxious weed seeds and propagules. Noxious weeds are defined in Title 3, Division 4, Chapter 6, Section 4500 of the California Code of Regulations and the California Quarantine Policy – Weeds.

NW-02: All equipment brought to a project site for construction shall be thoroughly cleaned of all dirt and vegetation prior to entering the site, in order to prevent importing noxious weeds.

NW-03: All material brought to a project site, including rock, gravel, road base, sand, and top soil, shall be free of noxious weed seeds and propagules.

NW-04: The property owner shall maintain and implement an effective program for the monitoring and control of noxious weeds.

CALIFORNIA WILDLIFE FOUNDATION
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July 12, 2016

To the Honorable Board of Supervisors, County of San Luis Obispo:

The California Oaks program of the California Wildlife Foundation commends you on the protections under consideration today as you deliberate the appropriate response to the clear cutting of oak trees at Justin Vineyards, the Adelaida, and other sites. This testimony is submitted in support of the Interim Zoning/Urgency Ordinance. The focus is on oak woodlands, in keeping with our program's dedication to sustaining California's primary old growth resource.

Senate Bill (SB) 1334, passed in 2004 and signed by Governor Schwarzenegger, brought the conversion of oak woodlands under the purview of the California Environmental Quality Act (CEQA), but it exempted oak woodlands on agricultural lands. An estimated 82% of oak woodlands are privately held with little or no protection.[1] We respectfully offer that oak woodland protections are vital conserving the natural and agricultural heritage of the county.

Oak Woodlands support San Luis Obispo County's high value cropping systems and natural heritage: California's oak woodlands and oak forested lands form an ecological backbone that supports the economy and environment. These lands sustain healthy watersheds, sequester carbon, and provide habitat for diverse plants and wildlife—generating benefits that extend across property lines.

Oak woodlands protect the quality of greater than two-thirds of California's drinking water supply.[2] They stabilize soil, provide shade, and replenish groundwater. Oaks are also drought-tolerant, with deep roots that reach groundwater resources, and a root system that extends into the granite matrix to access nutrients and soil moisture.[3] These resilient characteristics will gain importance as the changing climate introduces greater variability in weather patterns.

Oak woodlands have a productive understory of grasses that support approximately 60% of California's rangelands. For many years oaks were removed from ranchlands until it became clear that forage quality is enhanced by the presence of oaks and degrades in the years that follow the removal of oaks.[4]

Oak woodlands provide food and critical habitat for California's native species, including 2,000 plants, 5,000 insects, 80 amphibians and reptiles, 160 birds and 80 mammals—many of which

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[1] Sulak, A., Huntsinger, L., Barry, S., Forero, L., Public land grazing for private land conservation? Presented at the *Sixth California Oaks Symposium: Today's Challenges, Tomorrow's Opportunities*, US Forest Service, Pacific Southwest Research Station, held in Rohnert Park, CA, October 2006.
[2] O'Geen, A.T., Dahlgren, R.A., Swarowsky, A., Tate, K.W., Lewis, D.J., Singer, M.J., Research connects soil hydrology and stream water chemistry in California oak woodlands, *California Agriculture*, Volume 62, Number 2, April-June 2010.
[3] Allen, M.F., *How Oaks Respond to Water Limitation*, Presented at the Seventh California Oak Symposium: Managing Oak Woodlands in a Dynamic World, US Forest Service, Pacific Southwest Research Station, held in Visalia, CA November 2014.
[4] Pavlik, B.M., Muick, P., Johnson, S., and Popper, M., *Oaks of California*, Chacuma Press and California Oak Foundation, 1991, rev. 2006. Page 113,

www.californiaoaks.org Oaks

are listed as threatened, endangered, or species of special concern by the state or the federal government.[5]

An estimated 675 million metric tons of carbon dioxide is stored in oak trees as well as the understory in oak woodlands.[6] Net present value of greenhouse gas emissions forms the foundation of the state's carbon dioxide (CO_2) reduction objectives stated in the Global Warming Solutions Act of 2006 (Assembly Bill 32, Pavley), as well as the California Forest Protocol preservation standards. Thus, a ton of carbon currently sequestered by oak woodlands is more critical than a ton of oak woodland carbon stored in the future. Additionally, every ton of CO_2 released into the atmosphere by oak woodland conversion—alongside the loss of the woodland's role in carbon sequestration—represents a measurable potential adverse environmental effect.

Economic Value for Agricultural Producers: Conservation easements on oak woodlands can add economic value to working landscapes, providing an important incentive to protect natural resource values. Voluntary conservation easements provide tax benefits for landowners if legally defined resource values are protected in the easement.[7]

The Importance of Maintaining Healthy Oak Woodlands: Intact regenerative natural resources continue to provide ecosystem services over time, differing from built infrastructure that depreciates. Oak restoration, while important, is on balance, a small step towards restoring the many ecosystem services of a mature oak woodland. Oak seedlings require many years to reach maturity. Thus, assuming the replanted oaks are able to reach maturity, the net result is many years of lost watershed function, and carbon sequestration, wildlife and plant habitat, following the destruction of the oak woodland.

Thank you very much for your consideration and for your leadership in conserving San Luis Obispo County's invaluable oak resources.

Sincerely,

Janet Cobb
Executive Officer
California Wildlife Foundation/
California Oaks

Angela Moskow
California Oaks Information Network
Manager/California Oaks Coalition

---

[5] Meadows, R., Oaks—Research and outreach to prevent oak woodland loss. *California Agriculture,* Volume 61, Number 1 January-March 2007.

[6] Gaman, T. *An Inventory of Carbon and California Oaks*. California Oak Foundation, 2008.

[7] Sulak, A., Huntsinger, L., Standiford, R., Merenlender; A., and Fairfax, S.A., Strategy for Oak Woodland Conservation: The conservation easement in California, *Advances in GeoEcology*, 2004.

COMMUNITY DEVELOPMENT AGENCY
LONG RANGE PLANNING

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Phone (530) 621-4650, Fax (530) 642-0508

March 10, 2015

Michael McKeever
Executive Director
Sacramento Area Council of Governments
1415 L Street, Suite 300
Sacramento, CA 95814

Subject: El Dorado County Long Range Planning Staff Comments on SACOG's 2016 MTP/SCS Update

Thank you for the opportunity to review and comment on SACOG's 2016 MTP/SCS Update. Our Long Range Planning staff has been working closely with your team relating to baseline information for use in SACOG's and El Dorado County's Travel Demand Models. County staff has also been coordinating with the El Dorado County Transportation Commission to comment on the list of roadways for the MTP update.

We have found that the 2012 baseline information prepared by SACOG is largely consistent with the County's baseline data for the same year. We did find minor variations in both jobs and housing with the differences between the two models being near 3% or less, which is an acceptable margin given the difference of methodology used to gather the data to determine the baseline. The County and SACOG have agreed to continue working together to refine the methodologies and resulting data to reduce the differences, thereby further refining both agencies baseline data as it is frequently updated.

El Dorado County recognizes that SACOG's regional MTP/SCS Update must meet specific Federal and State requirements, including the balancing of region-wide transportation/circulation revenues and expenditures over the 25-year planning period and supporting attainment of air quality standards to meet regional federal air quality requirements. Therefore, the purpose of forecasting for a regional Council of Governments' MTP/SCS will be somewhat different that the requirement for planning at a local level. For example, local forecasting must be consistent with its adopted general plan, a requirement that a regional planning agency does not have to meet. Therefore it is expected that there will be differences between a local jurisdiction's forecast and a regional planning agency's forecast. To highlight the differences between El Dorado County's 2010-2035 forecast vs SACOG's 2012-2035 forecast, see Table 1 below:

Table 1: SACOG Projections (2012-2036) vs El Dorado County Projections (2010-2035)

	Jobs Growth Estimates				Housing Estimates (units)			
	SACOG		EDC		SACOG		EDC	
	# of Jobs	% Jobs	# of Jobs	% Jobs	# of Units	% Housing	# of Units	% Housing
Rural Communities	284	1.5%	3,344	20.9%	1,202	10.9%	4,375	25.0%
Community Regions	18,422	98.5%	12,689	79.1%	9,782	89.1%	13,125	75.0%
Total	18,706		16,033		10,984 (0.70% average annual growth rate)		17,500 (1.03% average annual growth rate)	

*Excludes the Cities of Placerville and South Lake Tahoe

The difference in the growth rates between the County and SACOG is attributed to difference in timeframe, methodology and goals for forecasting as discussed above. Fundamentally, SACOG's forecast is based on a requirement for regional distribution of growth that will assist with meeting the MTP/SCS goals and requirements. El Dorado County's forecast is based on historical growth rates and consistency with achieving the goals and objectives of our adopted General Plan.

In addition, there is a significant difference in how SACOG and the County anticipate housing and job growth distribution. SACOG's distribution is concentrated in the El Dorado Hills/Cameron Park area with very little forecasted outside of this area. For example, SACOG anticipates only approximately 60 new residential units and 20 new jobs on average annually outside the areas of El Dorado Hills and Cameron Park. The County's forecasted growth (excluding Lake Tahoe and the City of Placerville) is distributed in a manner consistent with the County's adopted General Plan goals, objectives and policies, and more consistent with historical development patterns.

In addition, the County assumes more new jobs in the rural areas. A major assumption of the County's General Plan is that agriculture and timber industries will remain economically viable during time horizon of the Plan. The viability of these industries is critical to the maintenance of the County's customs, culture, and economic stability. Therefore, the County anticipates there will be a need to accommodate a more balanced jobs/housing ratio in the rural areas to support this economic base.

We look forward to continuing to work with SACOG on the MTP/SCS. If further information is required from our agency, please feel free to call me at (530) 621-5342 or via e-mail at david.defanti@edcgov.us.

Sincerely,

David Defanti
Assistant Director, Community Development Agency

c: Steve Pedretti, CDA Director
Claudia Wade, CDA Long Range Planning Division
Shawna Purvines, CDA Long Range Planning Division
Natalie Porter, CDA Long Range Planning Division
Kacey Lizon, SACOG
Bruce Griesenbeck, SACOG
Jennifer Hargrove, SACOG
Sharon Scherzinger, EDCTC
Woody Deloria, EDCTC

Findlay and Houlahan 1996, Roth et al 1996, Booth and Jackson 1997, Magee et al. 1999, Doyle et al. 2000, Paul and Meyer 2001, Allan 2004, Hatt et al. 2004, Pellet et al. 2004, Wissmar et al 2004, and Jones & Stokes 2005

Referenced/cited in:

Jones & Stokes. *Setback Recommendations to Conserve Riparian Areas and Streams in Western Placer County.* 2005. February, 2005.

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Quercus wislizeni

Table of Contents

INTRODUCTORY

An interior live oak woodland in Mariposa County, California. Photo courtesy of Charles Webber © California Academy of Sciences.

AUTHORSHIP AND CITATION:
Fryer, Janet L. 2012. Quercus wislizeni. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/ [2015, December 18].

FEIS ABBREVIATION:
QUEWIS
QUEWISW

QUEWISF

COMMON NAMES:
For *Quercus wislizeni* (the species) and *Quercus wislizeni* var. *wislizeni* (the typical variety):
interior live oak
Sierra scrub oak

For *Quercus wislizeni* var. *frutescens*:
scrub interior live oak
dwarf interior live oak

TAXONOMY:
The scientific name of interior live oak is *Quercus wislizeni* A. DC. (Fagaceae) [75,107,126,192,198]. It is in the red or black oak subgenus (*Lobatae*) [34,58]. There are 2 varieties of interior live oak [75,192,198]:

Quercus wislizeni A. DC. var. *wislizeni*, typical variety of interior live oak
Quercus wislizeni A. DC. var. *frutescens* Englem., scrub interior live oak

Most information on interior live oak is written at the species level. In this review, "interior live oak" refers to the species as a whole, and the varieties are referred as "the typical variety" or "scrub interior live oak".

Hybridization: Facile hybridization among red oaks makes the separation of species within that subgenus a taxonomic challenge. Among California's red oaks, interior live oak hybridizes frequently with coast live oak (*Q. agrifolia*) [45,46,59,61,126,198,204], Santa Cruz Island oak (*Q. parvula*) [59], California black oak (*Q. kelloggii*) [59,198,199], and oracle oak (*Q.* × *moreha* Kell.) [126]. Oracle oak is a stable California black oak × interior live oak hybrid [198].

In California, all red oak species show some degree of introgression with other red oaks. Interior live oak populations in northern California show genetic evidence of considerable introgression with coast live oak and Shreve oak (*Q. parvula* var. *shrevei*); all 3 taxa are evergreen. Interior live oak populations show less introgression with California black oak, which is deciduous [57,58]. Backcrossing and hybrid swarms are most common between interior live oak and coast live oak [61], which genetic tests show are the most closely related of California's red oaks [58,61]. Dodd and others [62] suggest that coastal populations of interior live oak, which have high amounts of introgression overall, should be reclassified as Santa Cruz Island oak, with gene flow from interior live oak to coast live oak, then to Santa Cruz Island oak, making separation of the 3 species difficult in coastal locations. Interior live oak and Santa Cruz Island oak are sometimes treated as synonyms [62], but are treated as distinct species in this review.

SYNONYMS:
Quercus wislizenii A. DC. [68,96]

LIFE FORM:
For *Quercus wislizeni* var. *wislizeni*:

Tree-shrub

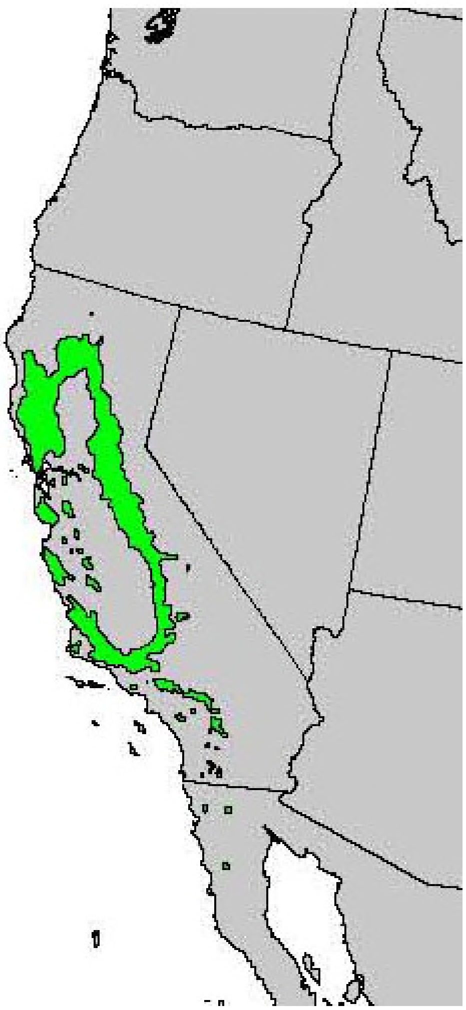
For *Quercus wislizeni* var. *frutescens*:
Shrub-tree

DISTRIBUTION AND OCCURRENCE

SPECIES: Quercus wislizeni

- GENERAL DISTRIBUTION
- SITE CHARACTERISTICS AND PLANT COMMUNITIES

GENERAL DISTRIBUTION:



1976 USDA, Forest Service map provided by [193]

Interior live oak is a native California-Baja California endemic. It occurs over about 16% of California's landscape [165]. Interior live oak is most common in the Inner Coast Ranges, the foothills of the southern Cascade Range [181], and the Sierra Nevada [125,126]. It also occurs on Santa Cruz Island [125]. Both varieties are common in northern California. Scrub interior live oak is most common in southern California, especially in the Transverse and Peninsular ranges [155]. The distributions of both varieties extend to Baja California Norte [75].

As of 2011, only one English-language publication provided information on interior live oak populations in Baja California Norte, so except for that source [143], all geographical locations referred to in this review are in California.

States and provinces [125,200]:
United States: CA
Mexico

SITE CHARACTERISTICS AND PLANT COMMUNITIES:

Site characteristics: Interior live oak mostly grows on harsh sites that other oaks cannot tolerate.

Climate and moisture regime: Interior live oak grows strictly in a mediterrean climate, which is characterized by mild, wet winters and hot, dry summers [18,22,23]. It is adapted to dry sites [102]; among California's red oaks, interior live oak has the highest tolerance for xeric conditions [60,179]. Mean annual precipitation across interior live oak's distribution in California ranges from 15 to 50 inches (380-1,300 mm) [155]. Except for the deserts, the oak (*Quercus* spp.) woodland/grassland regions of the Sierra Nevada are driest areas in California [202], typically receiving <25 inches (625 mm) of precipitation annually. During the fire season, maximum summer temperatures in interior live oak foothill communities sometimes reach 105° F (41° C), with ≤5% relative humidity [23].

Interior live oak's evergreen leaves help protect it from desiccation, but it is not well adapted to snowy or cold sites. The branches do not hold snow loads well, and the evergreen leaves freeze easily. California black oak, which is better adapted to snow and cold, usually replaces interior live oak on upper foothills [155].

Interior live oak sometimes grows in riparian and other wetland areas. It may be frequent to dominant in riparian zones, especially in southern California [174,214]. In the East Bay Hills, it is a component of coast live oak communities on hillside springs [4].

Elevation and topography: A major vegetation survey (>17,000 plots) across California's oak communities found interior live oak had the greatest elevational range among California's 5 most frequently dominant oaks: blue oak (*Q. douglasii*), California black oak, canyon live oak (*Q. chrysolepis*), interior live oak, and valley oak (*Q. lobata*). Survey data suggested that interior live oak was becoming more common in montane regions compared to its 1930s distribution [195].

Interior live oak grows from 1,000 to 6,200 feet (300-1,900 m) elevation across its range [68]. It tends to occur at lower elevations in northern than in southern California. Mixed-oak woodlands with interior live oak, valley oak, and/or blue oak occur from 3,000 to 4,000 feet (914-1,218 m) along the entire west slope of the Sacramento River valley [171]. Interior live oak chaparral may occur in scattered clumps at the highest elevations (>5,500 feet (1,700 m)) of foothills in southern California [136]. Scrub interior live oak grows at elevations from 1,000 to 6,600 feet (300-2,000 m) across its range [96], occurring at elevations up to 2,000 feet (600 m) in northern California [137] and usually from 3,500 to 6,200 feet (1,200-1,900 m) in southern California [68,99].

Landforms with interior live oak include dry valleys, canyons, and foothill slopes [68,96]. Interior live oak prefers north-facing or other relatively mesic slopes within these dry habitats [120,190]. A 1932 publication noted that on the basalt table mountains above San Joaquin Valley, interior live oak was dominant on north-facing slopes and had a scattered presence on south- and west-facing slopes. All slopes had mostly shallow soils and ephemeral streams, so they were dry for most of the year [76].

Soils: Interior live oak tends to occur on shallow soils in chaparral and on deeper soils in oak woodlands. Chaparral soils are nearly always dry and shallow [98]. On sites with minimal soil development, interior live oak roots may force their way through fractured rock to reach groundwater [48,124]. The soils of California's oak woodlands are typically deep and productive [21,23]; hence, the frequent management of oak woodlands as rangelands. Interior live oak woodlands may occur on shallow to deep soils, but they generally occupy shallower soils than those of other oak series. In the San Bernardino Mountains, canyon live oak stands grade into interior live oak stands on shallow soils and ridgetops [51]. However, interior live oak and other oak chaparral communities usually occur on relatively more productive and deeper soils than soils supporting chamise (*Adenostoma fasciculatum*) or manzanita (*Arctostaphylos*) chaparral [151].

Interior live oak typically grows in soil of igneous [24,128] or granitic [213] origin. Interior live oak communities in Tehama County have formed over volcanic breccia. Soils are 2.5 to 5 feet (0.8-1.5 m) deep and slightly acid [24]. In the San Luis Obispo Valley, scrub interior live oak grows in siliceous sandstone [210]. Interior live oak is rarely associated with serpentine soils [155]. It does not grow with gray pine (*Pinus sabiniana*) on serpentine sites, but it is commonly associated with gray pine on nonserpentine sites [93,98]. Interior live oak does, however, grow in serpentine and other ultramafic soils in knobcone pine (*P. attenuata*) communities of the Klamath Mountains and the North Coast Ranges [98].

Interior live oak grows in soils of all textures. Interior live oak-blue oak communities in Sutter County occur on gravelly loams and shallow to moderately deep (<41 inches (100 cm)), well-drained sandy loams. One blue oak-interior live oak series had a claypan layer from 15 to 30 inches (38-76 cm) deep. Wood production of interior live oak and blue oak was greatest on sites with moderately deep soils without claypans [128].

Plant communities:

Interior live oak communities on Table Mountain and in Coal Canyon, Butte County. Photo by Mark W. Skinner @ USDA-NRCS PLANTS Database.

Interior live oak occurs in chaparral, oak woodland, and conifer-oak woodland [96] communities. Typically, communities dominated by nonnative annual grasses [27] and/or chaparral shrubs [21] bound or form a mosaic with oak woodlands at low elevations, and oak woodlands meld into ponderosa pine (*Pinus ponderosa*) communities on upper foothills [27]. Interior live oak scrub chaparral merges into interior live oak woodlands on some sites; a more frequent fire-return interval and/or drier soils apparently helps maintain the scrub type [98]. Two interior live oak vegetation types were identified on the San Bernardino National Forest: chaparral and forest. Interior live oak chaparral occurred on steep ($\bar{x}$ = 45°), dry slopes, and associated vegetation was mostly sprouting, sun-tolerant chaparral species including chaparral whitethorn (*Ceanothus leucodermis*) and chamise. Interior live oak forest occurred on more moderate ($\bar{x}$ = 20°), mesic slopes with a sparse, mixed understory of "obligate seeders" (that is, species that are killed by fire and establish afterwards from seed) and shade-tolerant sprouting shrubs such as Pacific poison-oak (*Toxicodendron diversilobum*). These types were not discrete on most sites; instead, the 2 types formed a blended continuum [211].

Gray pine and California buckeye (*Aesculus californica*) commonly associate with interior live oak across the ranges of all 3 species [15,18,155]. Pacific poison-oak is widespread in most woodlands with interior live oak (for example, [2,42,90,212]). As well as dominating California's annual grasslands, nonnative annual grasses comprise most of the groundlayer vegetation in California's chaparral [6] and oak woodlands [3]. These annuals also dominate the groundlayer of chaparral ecosystems in Baja California [143]. Wild oat (*Avena fatua*), ripgut brome (*Bromus diandrus*), soft chess (*B. hordeaceus*), and hare barley (*Hordeum murinum* subsp. *leporinum*) are typical annual grass dominants [87,183,196]. Composition of the groundlayer prior to European settlement is unknown [3]. Interior live oak may finger into annual grasslands on valley floors. For example, interior live oak is an occasional species in annual grasslands of El Dorado County [213].

Chaparral: "Chaparra" translates from Spanish to "scrub oak" in English. Scrub oak chaparral, in which scrub interior live oak is often a primary component, comprises about 15% of the chaparral landscape of California. Codominant and associated species in scrub oak chaparral are mostly shrubs such as chamise and deer brush (*C. integerrimus*) [33]. The associated shrubs are often a mix of species that sprout after fire, such as chamise, and obligate seeders [56] such as wedgeleaf ceanothus (*C. cuneatus*) [108].

Interior live oak usually dominates the "scrub" or "live oak" chaparral vegetation types in the Inner Coast Ranges and the Sierra Nevada [23,98,106,120]. About 25% of interior live oak's total population lies within chaparral ecosystems [195]. Sawyer and others [178] place a plant community in the interior live oak scrub series if >60% of the overstory is shrubby interior live oak. If cover of shrubby interior live oak is less, the series is classified as mixed chaparral [178]. Interior live oak-dominated chaparral typically occurs on slopes; soils may be alluvial or derived from bedrock, and they are often rocky. Chamise, wedgeleaf ceanothus and other *Ceanothus*, and barberry-leaved scrub oak (*Q. berberidifolia*) often codominate with interior live oak in chaparral communities [27].

Northern California: In interior northern California, interior live oak is typically the dominant evergreen in scrub oak communities [49]. Interior live oak scrub communities are most common on north-facing slopes [120]. Chamise, manzanita, wedgeleaf ceanothus [23], and whitethorn ceanothus (*C. cordulatus*) [178] are common codominants or associates. Interior live oak occurs in and sometimes dominates montane chaparral in the Sierra Nevada [120]. Van Wagtendonk [201] describes the montane chaparral-woodlands of Yosemite National Park as overstories of interior live oak, canyon live oak, and gray pine with whiteleaf manzanita (*A. viscida*), deer brush, birchleaf mountain-mahogany (*Cercocarpus montanus* var. *glaber*), and other chaparral shrubs in the midstories. A foothill mixed-chaparral type is described along the Kaweah River in Sequoia National Park. Interior live oak, California buckeye, and canyon live oak codominate the mix. Tree cover is around 40% to 60%, shrub cover from 30% to 60%, and cover of annual herbs around 50% to 75%. There has been some influx of forest conifers that is attributed to fire exclusion [203].

Interior live oak is a minor to important associate in scrub oak communities dominated by other oaks, usually coast live oak [66] or canyon live oak [194]. Interior live oak is rare in barberry-leaved scrub oak communities of Sonoma County [40].

Interior live oak is a characteristic to dominant species in mixed chaparral of northern California; chamise, and sometimes barberry-leaved scrub oak, are usually codominant [98,140]. In the Outer North Coast Ranges of Santa Cruz County, interior live oak is "quite common" in the chaparral belt [105]. In mixed chaparral near Lakeport, interior live oak and Eastwood manzanita (*A. glandulosa*) tend to dominate on north- and west-facing facing slopes, while chamise tends to dominate on south- and east-facing slopes [190].

Southern California: Interior live oak scrub communities of southern California are likely maintained by frequent fire [178]. Coast live oak, canyon live oak [106], barberry-leaved scrub oak, and/or coastal sage scrub oak (*Q. dumosa*) [98] often codominate. Generally, interior live oak or coastal sage scrub oak dominate oak scrub of the Inner Southern Coast Ranges, while barberry-leaved scrub oak dominates oak scrub of the Outer Southern Coast Ranges [111]. The interior live oak scrub vegetation type is common on xeric slopes, often sandwiched between mixed chaparral at low and conifer forests at high elevations. Shrubby interior live oaks may spread into mixed chaparral in intermittent stream draws [157]. In the San Bernardino Mountains, interior live oak may dominate the upper reaches of barberry-leaved scrub oak and coastal sage scrub oak types [100]. Interior live oak is the primary dominant in some oak scrub series in the western Transverse Mountains, where it codominates with canyon live oak, barberry-leaved scrub oak, birchleaf mountain-mahogany, chamise, and/or chaparral whitethorn. It is occasional in riparian coast live oak and other riparian oak woodlands [41].

Mexico: Interior live oak was rare in barberry-leaved scrub oak chaparral of the Sierra de San Pedro Mártir in Baja California. It was found on west-facing slopes near 5,200 feet (1,600 m) elevation [143].

Oak woodlands and forests: Interior live oak-dominated woodlands and occasional forests are most common in northern California, occupying west slopes of the Southern Cascade Range and the Sierra Nevada. In 1844, the explorer John Fremont made the first recorded observation of interior live oak when descending into the Sacramento Valley near the American River from upper slopes of the Sierra Nevada: "At every step the country improved in beauty; the pines were rapidly disappearing and oaks became the principal trees of the forest. Among these the prevailing tree was the evergreen live oak" [155]. Interior live oak gains dominance with elevation in the foothills; interior live oak-gray pine woodland/annual grasslands extend from about 1,000 to 2,500 feet (300-800 m) elevation in the Sierra Nevada [178].

The interior live oak series is placed in the mixed broadleaved, evergreen-cold deciduous woodland formation. The series often grades in from lower-elevation interior live oak scrub. Woodlands and occasional forests dominated by tree-sized interior live oaks occur on valleys, slopes, and ridgetops; these landforms often have moderately to excessively drained, shallow soils [178]. On foothills surrounding the Sacramento and San Joaquin valleys, interior live oak tends to dominate the drier slopes of the Sierra Nevada, while coast live oak tends to dominate the relatively wetter slopes of the Coast Ranges [45]. Shrubs are typically chaparral types such as toyon (*Heteromeles arbutifolia*), wedgeleaf ceanothus, and whiteleaf manzanita. In the Sierra Nevada, interior live oak woodlands ranged from a low of 1,144 feet (249 m) for the interior live oak-gray pine/whiteleaf manzanita subseries to 2,120 feet (646 m) for the interior live oak/yerba santa (*Eriodictyon californicum*)/annual grass subseries [2]. Interior live oak woodlands are rare in Pinnacles National Monument, and they are the only oak woodlands in the Monument. Sprouting shrubs, including toyon, creeping snowberry (*Symphoricarpos mollis*), and Pacific poison-oak are common in the type [90]. In the San Bernardino Mountains, interior live oak may dominate upper reaches of canyon live oak woodlands [158].

Interior live oak is frequent to codominant in many blue oak woodlands [11,16]. Interior live oak-blue oak-gray pine communities lie just beneath the ponderosa pine belt [117]. Blue oak-interior live oak/annual grass woodlands typically occupy the lowest foothills, with gray pine often codominating [1,2,5,98]. They average about 1,550 feet (500 m) elevation [2]. Near Clear Lake, blue oak-interior live oak communities tend to occupy north-facing slopes, while chamise or mixed manzanita (*Arctostaphylos*)-chamise chaparral occupies south-facing slopes [26]. Interior live oak is common, but rarely dominant, in blue oak communities in the low foothills of Sequoia National Park [11]. A blue oak-interior live oak/whickerbrush (*Leptosiphon ciliatus*) community occurs on fine loamy soils in northern Santa Barbara County [35].

Many mixed-oak woodland communities contain interior live oak as an associated or codominant species. Codominant oaks may include coast live oak, blue oak, valley oak, and/or Oregon white oak (*Q. garryana*) in the northern portion of interior live oak's distribution and Engelmann oak (*Q. engelmannii*) [15,18], barberry-leaved scrub oak, and/or coastal sage scrub oak [27] in the south. Interior live oak is a characteristic species in some Oregon oak woodlands of the North Coast Ranges [50,98] and the Klamath Mountains [98]. On the Hopland Research Station in Mendocino County, interior live oak codominates with coast live oak, blue oak, and California black oak [43]. Latting [120] describes a northern oak woodland type that occurs inland from redwood (*Sequoia sempervirens*) forests north of the Bay Area. These woodlands are composed of Oregon white oak, California black oak, canyon live oak, interior live oak, and other broadleaved species. They range from 3,000 to 5,000 feet (900-2,00 m) elevation in the North Coast Ranges and the Yolla Bolly Mountains [120].

Interior live oak is incidental to dominant in riparian oak or other hardwood riparian communities of northern California [174], and it may be frequent in riparian zones of otherwise dry slopes in southern California [214]. In riparian areas, interior live oak cover is sometimes dense enough to form a closed-canopy forest (see the photo of Coal Canyon Creek area). Interior live oak riparian communities occur below about 3,000 feet (900 m) in northern California and above about 6,000 feet (2,000 m) in southern California [98]. In Sequoia National Park, riparian interior live oak-blue oak-California buckeye communities occur at low elevations (1,300-3,300 feet (390-1,000 m)), with denser stands than those of upland blue oak-interior live oak communities [174]. The typical variety of interior live oak is occasional in riparian woodlands in the San Gabriel Mountains [120].

Conifer-oak: Interior live oak is a component of many pine-oak and other conifer-oak communities. It may finger into [120], and sometimes codominate in, ponderosa pine communities. In Monterey County, ponderosa pine-interior live oak-canyon live oak communities occur around 3,000 feet (900 m) elevation [86]. Scrub interior live oak associates with knobcone pine in the North Coast Ranges [5,12]. Interior live oak is an associated species in Coulter pine (*P. coulteri*) communities in the Machesna Mountain Wilderness [37] and other locations on the Los Padres National Forest [38]. It codominates with Coulter pine at high elevations 4,890 to 4,920 feet (1,490-1,500 m) of the Santa Lucia Range [84]. Interior live oak associates with bishop pine (*P. muricata*) on Santa Cruz Island [5].

Mixed-evergreen and mixed-conifer zones may support interior live oaks, with interior live oaks becoming increasingly scattered with increasing elevation. The interior live oak-Pacific madrone (*Arbutus menziesii*)/Pacific poison-oak series occurs on mesic foothills at around 1,500 feet (450 m) in the North Coast Ranges and the Sierra Nevada [1]. Interior live oak is a minor [103] to characteristic [179] associate in Douglas-fir-tanoak (*Pseudotsuga menziesii-Lithocarpus densiflorus*), Douglas-fir-Pacific madrone, and other mixed-evergreen forests. In Santa Cruz County, it was noted in a redwood-mixed evergreen-hardwood forest in Big Basin Redwoods State Park [101]. Interior live oak was rare in redwood forests of southern Monterey County [39]. In the Sierra Nevada, it is sometimes associated in the mixed-conifer overstory with ponderosa pine, Douglas-fir, white fir (*Abies concolor*), sugar pine *(Pinus lambertiana*), Jeffrey pine (*Pinus jeffreyi*), and/or red fir (*A. magnifica*) [67,145,166]. In mixed-evergreen forests of the Santa Lucia Range, interior live oak codominates with bristlecone fir (*A. bracteata*), coast live oak, and canyon live oak [191]. On the eastern Transverse Ranges, it fingers into bigcone Douglas-fir (*Pseudotsuga macrocarpa*) communities from lower-elevation (~780 feet (230 m)) chamise chaparral [139]. In the San Gabriel Mountains, interior live oak is confined to north-facing slopes and draws; bigcone Douglas-fir and canyon live oak are commonly associated species [97]. Scrub interior live oak sprouts are often prominent in early postfire, seral bigcone Douglas-fir woodlands [5].

See the Fire Regime Table for a list of plant communities in which interior live oak may occur and information on the fire regimes associated with those communities.

BOTANICAL AND ECOLOGICAL CHARACTERISTICS

SPECIES: Quercus wislizeni

GENERAL BOTANICAL CHARACTERISTICS:

Twig of an interior live oak near Redding, California. Photo by Julie Kierstead Nelson.

Botanical description: This description covers characteristics that may be relevant to fire ecology and is not meant for identification. Keys for identifying California's oak species are available in these sources: [68,96]. However, identifying oaks is often difficult due to hybridization, and interior live oak hybrids are common. Tucker [199] pointed out that scrub oak hybrids do not "key down" well. Brophy and Parnell [45] provide a key to help identify interior live oak-coast live oak hybrids.

The varieties of interior live oak are distinguished by their growth form. The typical variety (*Q. wislizeni* var. *wislizeni*) grows as a tree, and scrub interior live oak (*Q. wislizeni* var. *frutescens*) grows as a shrub [96]. The typical variety reaches from 33 to 75 feet (10-23 m) tall [96,159]. Open-grown trees have a dense, rounded crown [155,164], with branches that may extend to the ground [164]. Trunks are one to several [164]. Scrub interior live oak typically reaches 7 to 20 feet (2-6 m) tall [96] and is intricately branched [137]. In Tehama County, interior live oak is typically 8 to 10 feet (2-3 m) tall and shrubby in form [24]. Limited water in the substrate may be a factor driving the shrub or scrub form [89], although frequent fire may produce the same result.

Interior live oak typically has numerous, short branches, regardless of form. In a study comparing leaf and branch architecture of 6 cooccurring sclerophyllous tree species in Mendocino County, interior live oak had more densely packed branches and leaves than Pacific madrone, canyon live oak, tanoak, giant chinquapin (*Chrysolepis chrysophylla*), and California bay (*Umbellularia californica*); this was true for both sun- and shade-grown interior live oaks [102].

Interior live oak wood is strong, dense, and close-grained [137]. The bark is relatively thin [78,164] on most trees and is composed mainly of live cambium that is susceptible to fire damage. Bark of a 3-inch (7 cm) diameter interior live oak was 0.1 inch (0.3 cm) thick with a very thin layer of outer bark; bark of a 12-inch (30.5 cm) diameter tree was 0.3 inch thick with a "small amount of dead bark" on the outer surface [164]. Bark of large trees can be up to 3.0 inches (7.5 cm) thick [137].

The leaves and fruits of interior live oak are relatively small. The leaves are evergreen and sclerophyllous; the margins may be spine-toothed to entire [96,164]. The leaves are elliptical and about 1 to 3 inches (2.5-8 cm) long [155]. Male catkins are about as long as the leaves [102]. The smaller, female flowers are born in the leaf axils in clusters of 2 to 4 [159]. The fruits are acorns, a type of nut [96]. They are about 0.3 to 0.5 inch (0.8-1.3 cm) wide [164].

Interior live oak is deep-rooted. In a review comparing maximum root depths of sclerophyllous species around the globe, interior live oak had greatest average root depths of all oaks and most other species that were compared; only *Eucalyptus* had greater maximum root depths [48]. A study in Placer County found interior live oak roots extended at least 24.3 feet (7.4 m) feet through fractured rock before reaching groundwater [124].

Interior live oak is apparently not long-lived. Trees may live 150 to 200 years, although studies of interior live oak's longevity are few [164]. Because interior live oaks sprout, their root systems may be several generations older than their trunks [164].

Interior live oak does not tolerate flooding. When the Terminus Reservoir near Visalia flooded, interior live oaks died if water covered the soil around their trunks for more than 1 week [92].

Raunkiaer [170] life form:
Phanerophyte

SEASONAL DEVELOPMENT:
Interior live oak's growing season peaks in early spring; in the Sierra Nevada, most vegetative occurs in March [175]. Interior live oak flowers [68] and sheds pollen in late spring. Photoperiod evidently regulates release of interior live oak pollen [204]. Acorns ripen from mid-August [160] to October [144,207]. The leaves are retained for 2 years [137,159]. Acorns germinate slowly over fall and winter [131,132].

In the Santa Lucia Mountains, time of germination initiation varied with elevation but regardless of elevation, interior live oak germination took several months to complete. Acorns began germinating in November at low elevations (76 feet (23 m)); they began germinating in

December at high elevations (4,460 feet (1,360 m)). Germination was complete for acorns at low and midelevations (1,840 feet (560 m)) by February, while acorns at high elevations finished germination by March [132].

REGENERATION PROCESSES:

- **Pollination and breeding system**
- **Seed production**
- **Seed dispersal**
- **Seed banking**
- **Germination**
- **Seedling establishment and plant growth**
- **Vegetative regeneration**

Interior live oak is a hardy oak that can regenerate from acorns or by sprouting. Sprouting is apparently the most common method of interior live oak regeneration.

Interior live oak is well adapted to regenerating after fire or cutting. The Hopland Research Field Station was nearly de-wooded from 1959 to 1965 in the belief that removing trees would provide more livestock forage and increase water yields (see Other Management Considerations for a discussion of this practice). After almost complete clearcutting except for a few large trees left for shade and a prescribed fire in 1965, a different management practice was started: Trees were allowed to regenerate. Despite the cutting and burning, oak regeneration on slopes ranging from 0° to 40° was significantly higher in 1996 compared to pretreatment levels in 1952 (P>0.05). Among tree species, interior live oak had gained greatest cover (28.4%) by 1996. This was attributed mainly to sprouting after cutting and burning [43].

Pollination and breeding system: Wind disperses interior live oak pollen [57,58].

Interior live oak is monoecious [34]. Dodd and Kashani [60] suggest that past population fragmentation has resulted in a metapopulation structure for interior live oak. Pollen-mediated gene flow is relatively free among interior live oak populations, and introgression with other red oaks contributes to interior live oak's genetic diversity [57,58,59] (see Hybridization). For successful pollination between interior live oak and other red oaks, genetic studies show that climate compatibilities of interior live oak and the other parent are more important than distance from the pollen source [59].

Seed production: There are usually 5 to 7 years between large crops of interior live oak acorns (reviews by [34,159]).

Seed dispersal: Gravity and animals disperse interior live oak acorns. Scrub jays cache acorns in the ground, where unretreived acorns are likely an important source of oak regeneration [85].

Seed banking: Oaks have a transient seed bank [34]. After falling off the tree, acorns remain viable only through that growing season [144].

Germination: Interior live oak acorns require 2 years of development on the tree to complete maturation [45,68,96].

Fresh interior live oak acorns are not dormant [159], so when there is enough moisture, they may germinate soon after dispersal. Fully mature, fresh acorns have germinated in the laboratory a few days after collection (review by [47]), and interior live oak seedlings may begin germinating in late fall in the field. Momen and others [146] suggest that for germination and seedling establishment, interior live oak and other evergreen oaks are adapted to use soil moisture from late-fall rains, when deciduous species are dormant. Interior live oak showed 75% mean germination after 30 to 60 days of cold stratification in the laboratory. Increased rates of interior live oak germination after cold stratification in the laboratory (review of Bonner's [34] laboratory studies) suggest that winter temperatures enhance its germination rates in the field.

Seedling establishment and plant growth: Little information was available as of 2011 on rates of interior live oak seedling establishment. Interior live oak showed widely different degrees of establishment on 4 sites. In Eastwood manzanita-interior live oak chaparral on Mt Tamalpais, interior live oak seedlings and saplings had an average density of 26,980 plants/ha, while interior live oak was absent from plots in Eastwood manzanita-interior live oak chaparral at Northridge. Neither site had burned for at least 56 years [109,110]. For acorns planted in interior live oak's natural elevational ranges, interior live oak showed 18% mortality at seedling emergence on the Santa Lucia Range and 2% to 5% mortality at seedling emergence in the Sierra Nevada [132].

Limited information suggests that interior live oak is reproducing at rates adequate to maintain its populations ([148], review by [182]). Some data suggest that interior live oak is maintaining the expected age-class distributions of more seedlings than saplings and more saplings than mature trees [14], but a few studies suggest rates of interior live oak regeneration may be lower than historical rates. Urban encroachment into oak woodlands poses a serious threat to interior live oak regeneration [74]. Forest Inventory and Analysis data from 2001 to 2005 showed that across California's forestlands, interior live oak numbered about 275 million seedlings (diameter class of 1.0-2.9 inches (2.5-7.5 cm)); 125 million saplings (3.0-4.9 inches (7.6-22.9 cm)), and about 2 million relatively large trees (9.0-10.9 inches (23-27.7 cm)). Compared to California black oak, interior live oak showed higher rates of regeneration but also had higher rates of mortality [14]. Bartolome and others [17,149] reported widespread presence of interior live oak saplings in the late 1980s, but saplings did not outnumber mature trees. Ratios of saplings:mature plants were ≤1:1 in the North Coast Ranges and Klamath-Siskiyou regions and from 1:1 to 1:2 in the Central Coast Ranges and Sierra Nevada [149]. In manzanita chaparral in northern California, scrub interior live oak regeneration averaged ≤1.2 seedlings/m^2. Most were between 0 and 20 inches (8 cm) tall (Parker unpublished data cited in [153]). Some interior live oaks had apparently grown into the canopy since the last fire [153].

There is evidence that in general, many oak species in the blue oak woodland belt are failing in the pole stage [186], but as of this writing (2011), information of interior live oak in particular was sparse.

On 192 plots in Madera, Fresno, Tulare, and Kern counties, 75% of plots had interior live oak seedlings and 48% had saplings. Interior live oak regeneration was not significantly associated with grazing or elevation. Solar radiation, however, was positively associated with interior live oak seedling presence (P=0.1). The authors predicted that because sclerophyllous interior live oak is more drought-tolerant than deciduous blue oak, it might regenerate more successfully and dominate on drier sites than blue oak [185].

Interior live oak is reported as slow-growing [159]. This is may be due to the dry habitats it typically occupies, but studies exploring interior live oak growth rates on moist vs. dry sites were not available of as 2011.

Heavy mule deer [54] or other browsing can reduce or eliminate interior live oak regeneration. One year following a stand-replacement wildfire on Quail Ridge Reserve near Lake Berryessa, mule deer had browsed 95% of new interior live oak sprouts. The authors suggested that mule deer's preferential selection of interior live oak and blue oak sprouts was hindering postfire regeneration of the oaks [10]. After domestic sheep were removed from Sequoia National Park in the 1890s, there was a flush of oak (*Quercus* spp.) seedling establishment. The authors claim that unlike fire exclusion, which can favor shrubs over trees, density of woody species has increased since cessation of livestock grazing, but this has not resulted in a shift in species composition towards shrubs [174].

Vegetative regeneration: Interior live oak sprouts after top-kill by fire [87,98], cutting [127], or herbicide use [94]. Field experiments in the Santa Lucia Range and the Sierra Nevada showed that damaged interior live oaks may sprout in low numbers (2%-13%) even during stages of epicotyl emergence [131]. Large trees may produce epicormic sprouts after fire [87] or other injury to the bole.

A study in Mendocino County suggests that some interior live oaks may sprout after top-killing disturbances in most seasons. Sprouting responses of cut interior live oak and other oaks were compared throughout the year at the Hopland Field Station. In general, more interior live oaks sprouted after cutting compared to blue oaks; a similar number of interior live oaks and California black oaks sprouted; and fewer interior live oaks sprouted compared to barberry-leaved scrub oaks. Sprouting response of interior live oak was strongest from February through April, with 100% of cut interior live oaks sprouting during that time. Sprouting response was least in July (20%) but increased to 50% in September. Sprouts originated from both the base and the sides of interior live oak stumps. The author concluded that interior live oak was relatively insensitive to season of cutting [127]. This study did not explore sprouting response in late fall. Biswell and Gilman [24] observed that interior live oaks top-killed by fire in late fall sprouted the next spring.

SUCCESSIONAL STATUS:
Interior live oak is more frequent in open or early-seral communities than in late-seral communities. It is moderately shade tolerant; young plants are more tolerant than mature individuals [164]. In the North Coast Ranges of Mendocino County, interior live oak saplings were found in the understory of a mixed-evergreen forest, but they rarely grew over 0.3 foot (1 m) tall [104].

Interior live oak may replace valley oak successionally on valley-foothill interfaces [81]. (See the discussion of Griffin's study [81] in Plant response to fire for more information.) Conversely, Douglas-fir may replace interior live oak on favorable sites in mixed-evergreen communities of Mendocino County [104]. Chaparral and oak woodlands usually remain distinct, with little conversion of one type to another [120].

Fire is important in maintaining interior live oak chaparral and woodlands. Some consider relatively high-elevation interior live oak scrub a fire-maintained community, with ponderosa pine and other conifers replacing interior live oak without frequent fire [98]. See Postfire successional patterns for further information on interior live oak succession.

FIRE EFFECTS AND MANAGEMENT

SPECIES: Quercus wislizeni

- FIRE EFFECTS
- FUELS AND FIRE REGIMES
- FIRE MANAGEMENT CONSIDERATIONS

FIRE EFFECTS:

- **Immediate fire effect on plant**
- **Postfire regeneration strategy**
- **Fire adaptations and plant response to fire**

Burned interior live oak-manzanita chaparral above pasture in San Diego County 's Daley Ranch Park. Photo courtesy of the San Diego Wildfires Education Project.

Immediate fire effect on plant: Fire top-kills most interior live oaks [78,83,163]. Low-severity fire causes little mortality for age classes, although it may kill some seedlings. Moderate-severity fire may kill small trees [87], and severe fire may kill even large interior live oaks [88]. Fire-scarred interior live oak trees were common on 7 sites across interior live oak's range in California [184].

Interior live oak's thin bark makes young trees susceptible to fire kill. Although the bark of mature trees is still relatively thin and has a high live tissue**:**dead outer bark ratio [164], mature trees may survive fire without top-kill [88,164]. Plumb and Gomez [164] observed that mature interior live oaks with heavily charred bark suffered no scarring and lost little bark to sloughing. They reported that surface fires rarely burned through to the wood, and repeated fires resulted in a hard, fire-cured bark surface [164]. Haggerty [88], however, reports that fire scars large interior live oaks easily.

Fuel mastication in oak-knobcone pine or other communities may result in fires that are more lethal than fires in communities with unmanipulated fuels. In a California black oak-knobcone pine community in Whiskeytown National Recreation Area, sites where fuels were masticated prior to spring burning had higher flame lengths, higher fire temperatures in the litter layer, and greater mortality of overstory and pole-sized oaks—including California black, interior live, and canyon live oaks—than sites where fuels were not manipulated. Mastication was done in November, and the study sites were burned under prescription in April. Interior live oak and canyon live oak were overstory associates [42].

Postfire regeneration strategy [188]:
Tree with adventitious buds and a sprouting root crown
Tall shrub, adventitious buds and a sprouting root crown

Fire adaptations and plant response to fire:
Fire adaptations: Interior live oak has adapted to fire by sprouting from perennating buds on the root crown [88,138,202]. It may sprout even in the seedling stage [88]. Among large-fruited taxa that grow in chaparral, interior live oak is one of the most successful postfire sprouters on north-facing slopes, where it typically shades out most obligate seeders in early postfire years [138]. Plumb and MacDonald [165] summarize the need of interior live oak and other California oaks for frequent fire:

"Although fire is anathema to individual oak trees, it is essential for continuation of oak stands under natural conditions, especially on commercial timber sites where inherently taller conifers are more competitive. By destroying the conifers, the oaks are free to sprout. Because of rapid sprout growth, the oaks capture the area and are perpetuated."

Although the relationship between fire frequency and *Quercus* regeneration is unclear, several studies show that frequent fire favors oak regeneration, reduces ladder fuels in the understory, and helps control acorn predators such as the filbert weevil and filbert worm (review by [183]).

Plant response to fire: Interior live oak sprouts from the root crown after top-kill by fire [24,25,28,69,83,87,98,109,181]. Postfire recovery is usually rapid [98]. Keeley [109] classified interior live oak as an "obligate resprouter" after fire. Biswell and Gilman [24] rated it a "vigorous" sprouter after fire, showing a stronger sprouting response than associated deciduous oaks such as California black oak and blue oak. Interior live oaks often have multiple stems as a result of repeated top-kill by fire and postfire sprouting [157]. Top-killed interior live oaks may sprout soon after winter, spring, or summer fires (see Vegetative regeneration). With summer fires, sprouts may appear as early as postfire week 3, but with late fall fires, sprouting does not usually begin until the next spring [24].

Large, old trees may survive fire without being top-killed [87] but more often, large trees are located in areas that have not burned for 50 to 100 years [157]. Large trees may produce epicormic sprouts after surface fire [87] that scorches the branches.

Fire may kill interior live oak in areas with heavy fuels, particularly in chaparral or communities with a chaparral understory. In a blue oak-interior live oak-gray pine/wedgeleaf ceanothus woodland in Madera County, a prescribed 5 August fire killed 75% of interior live oaks. In postfire year 9, interior live oak comprised 15% of total woody plant species composition. A similar prescribed fire in Madera County resulted in 90% kill of interior live oak. In postfire year 7, interior live oak comprised 15% of total woody plant species composition. Chaparral whitethorn and wedgeleaf ceanothus dominated the community [25]. Prefire composition of these plant communities was not provided.

Interior live oak may establish from acorns after fire, but postfire sprouting is far more important [87]. One year following a stand-replacement wildfire on Quail Ridge Reserve near Lake Berryessa, density of interior live oak seedlings was not significantly different between burned and control plots. It ranged from 7 to 100 seedlings/ha. However, basal sprout regeneration was significantly greater in burned than in control plots ($P<0.05$) [10]. Surveys of 91 interior live oak-dominated plots on the San Bernardino Forest found no interior live oak seedlings in interior live oak chaparral, while interior live oak forests averaged 10 interior live oak seedlings/0.1 ha. The authors suggested that longer fire-return intervals on forest plots allowed formation of the forest stand structure and establishment of interior live oak seedlings [211]. Minnich [138] stated that because chaparral taxa do not rely on off-site seed dispersal onto burned sites, they are not vulnerable to fire size.

Fire scars can be ports of entry for heart-rot fungi. To date (2011), however, little research had been conducted on the relationships between fire, oaks, and heart-rot fungi [165].

Postfire recovery: A qualitative study on the Los Padres National Forest found interior live oak sprouted from the root crown after the Marble-Cone Wildfire of August 1977. The fire burned 178,000 acres (72,000 ha); most of this acreage was mixed chaparral. Scrub interior live oaks "were seldom completely consumed by the chaparral crown fires; they usually remained as charred trunks, perhaps five to ten feet tall, standing above the ashes". Within a month after the wildfire, they were sprouting from the root crowns and by November, the sprouts were "several feet tall". A portion of the higher-elevation, mixed-evergreen canyon live oak-tanoak-interior live oak forest also burned in the Marble-Cone Wildfire, with a mix of surface and crown fire that varied in severity from low to high. Scrub interior live oak also "sprouted readily" from the base after top-kill in this mixed-evergreen forest [83].

No interior live oak mortality was observed in postfire month 10 (July) after severe wildfire in September 1947 on the Tehama Deer Winter Range. All interior live oaks were top-killed, with an average sprout height of 24.9 inches (63.2 cm) in postfire month 10. Mule deer browsed the sprouts heavily the 2nd winter after the wildfire [24].

Prescribed fire and clearcutting may result in similar interior live oak coverage. Eight years after a moderate-severity, prescribed September fire in the Santa Ynez Mountains, interior live oak had similar densities—10 sprouts/900 m²—on burned plots and on clearcut, unburned fuelbreaks [36].

Although interior live oak sprouts may be dense in early postfire years, stem density usually decreases with succession. Many sprouts of chaparral species do not survive if the site burned when root crowns and roots were water-stressed and/or had low carbohydrate reserves [175]. Heavy postfire browsing may reduce or eliminate interior live oak postfire regeneration [95], especially on small burns. After a 1,100-foot² (100 m²) test plot in interior live oak chaparral near Santa Cruz was burned under prescription, mule deer browsed interior live oak and California coffeeberry (*Rhamnus californica*) sprouts so heavily that many plants of both species died, and bigberry manzanita, which was not browsed, became dominant [80].

Two studies, one in Sequoia National Park and the other in Madera County, show a short-term reduction in interior live oak after fire, with interior live oak showing rapid recovery in early postfire years.

In Sequoia National Park, a 26 June 1987 arson fire reduced interior live oak abundance for at least 2 postfire years. Fire conditions were "extreme", with a mean daytime air temperature of 86° F (30° C), relative humidity of 17%, and fine fuel moisture of 3.5%. Slopes ranged from 20° to 39°; mostly, dry annual grasses carried the wildfire [87]. Fire severity was mixed, varying from low to high [88]. Fire severity became moderate after midnight, when relative humidity rose to 50%. Fire effects and postfire responses were measured the fall after the wildfire and in postfire year 2. As measured that fall, postfire mortality of interior live oak was low: only one "very small diameter" stem had been killed. Crown scorch of interior live oaks and blue oaks combined ranged from 18% on west-facing slopes to 61% on ridgetops; bole char height ranged from 8 inches (20 cm) on west-facing slopes to 39 inches (100 cm) on east-facing slopes. Nine interior live oak seedlings were found on study sites; all were determined to have established before the fire. All 9 seedlings sprouted after the fire, but 1 seedling had died by postfire year 2 [87].

In postfire year 2, all large (82.6-133.4 inches (32.5-52.5 cm) diameter), crown-scorched interior live oaks had live crowns and had produced epicormic sprouts, but most smaller trees were dead [87]. Most crown-scorched interior live oaks were <82 inches in diameter, so mortality was highest in smaller size classes [88]. Mortality also increased with degree of crown scorch; overall, all interior live oaks with 100% crown scorch were dead, while none with <51% crown scorch had died [87]. Some surviving crown-scorched individuals grew both epicormic and basal sprouts. Chances of interior live oak stem survival (vs. top-kill) increased with tree size ($P<0.001$), and 86% of large trees bore scars from previous fires. Over half of top-killed interior live oaks (n=154 individuals) had basal sprouts [88].

Mortality was higher for interior live oaks than for blue oaks in postfire year 2: 11% of tagged, burned interior live oaks and 6% of tagged, burned blue oaks were dead. Survival rates of postfire sprouts were higher for interior live oak than for blue oak [87], however, and interior live oak had more sprouts/root crown [88]. More than half of interior live oaks that sprouted the fall after fire had surviving sprouts in postfire year 2, while only 2 top-killed blue oaks still had live sprouts [87].

The author concluded that the wildfire reduced interior live oak density in the short term due to aboveground mortality of small trees, but because most large trees survived, there was little change in interior live oak's basal area [87]. See the Research Paper of this study for further details on fire effects on and postfire responses of interior live oak and blue oak.

Mechanical and prescribed fire treatments reduced interior live oak cover for about 6 years in Madera County. On the Ellis Ranch, a private cattle ranch spanning elevations from 2,500 to 3,250 feet (750-975 m), 600 acres (240 ha) of interior live oak and blue oak woodlands were thinned, then the shrub understory crushed, in July 1986. During thinning, all interior live oaks were cut for firewood but most blue oaks were retained for shade. After mechanical treatments, the site was burned under prescription in August 1986. The goals were to increase browse available for cattle and wildlife, reduce canopy cover of interior live oak, and reduce understory fuels [71,135].On 2 of 5 plots, these treatments significantly reduced interior live oak cover in postfire year 1 compared to pretreatment cover ($P<0.05$) [71].

Interior live oak cover, density, and firewood volume after thinning, crushing, and prescribed fire in Madera Cou calculated from 5 interior live oak-blue oak or blue oak-interior live oak stands [71,135].

Variable	Pretreatment (1986)	After mechanical treatments (1987)	Postfire year 1 (1987)	Postfire year 2 (1988)	Postfir (1989)
Cover (%)	36.6	17	4.4	10	8.2
Density (stems/0.2 acre)	26.6	23.6	0	1.8	not ava
Firewood volume (cords (feet^3))	1.17 (149.76)	0.72 (92.16)	0.72 (92.16)	0.17 (21.76)	0.03 (3

In the short term, interior live oak canopy cover and volume were reduced the most on sites where interior live oak was dominant before treatments; this was attributed more to cutting than burning. Crushing and burning successfully reduced shrub density, cover, and height, so more browse was available as forage [135]. Interior live oak was returning to pretreatment density by postfire year 2, particularly on plots where it dominated before treatments. On all sites, wedgeleaf ceanothus and yerba santa comprised about half of the new canopy by postfire year 3 [71,135]. A follow-up prescribed fire in 3 to 4 years was recommended to once again reduce abundance of interior live oak and the shrubs [71]. Repeat burning was not accomplished, however, so by postfire year 8, canopy cover of shrubs was similar to pretreatment levels. Interior live oak regeneration had not regained tree size, so on sites where interior live oak dominated before treatments, stand structure had shifted from an overstory of interior live oak trees to an overstory of shrubs. Blue oak was the sole overstory dominant in former blue oak-interior live oak stands [135].

Postfire successional patterns: Fire generally favors interior live oak [181] successionally. In a survey of 5 blue oak sites in Sequoia National Park, interior live oak was most frequent (15%) on a site that burned 5 years previously. The other 4 sites had not burned for about 40 years, and interior live oak frequency ranged from 5% to 10% on those sites [44]. Minnich [140] noted that interior live oak and other spouting species dominated early postfire succession in Coulter pine-canyon live oak woodlands on the eastern Transverse Ranges. Vegetation from <1-year-old to 37-year-old burns was surveyed. Interior live oak was described as a dominant in early postfire succession. Interior live oak and other sprouting woody vegetation provided up to 9% cover in postfire years 0 to 9; 85% cover in postfire years 10 to 19; 75% cover in postfire years 20 to 29; and 77% cover in postfire years 30 to 37 (Minnich 1978 field data cited in [140]).

Surveys in southern California show that interior live oak chaparral remains stable over time. On a site that burned in a 1919 wildfire on the San Dimas Experimental Forest, Angeles National Forest, crown cover of interior live oak had not changed from that recorded in a survey conducted in postfire year 14 (1933) and in a survey conducted in postfire year 34 (1950). Interior live oak and toyon were the 2 most common species in the mixed chaparral community. Interior live oak showed minimal gains in crown cover on a similar site that had gone 55 years without fire prior to wildfires in 1933 and 1936 [114].

Surveys conducted by Griffin [81] in the Santa Lucia Mountains suggest that fire-return intervals that are longer than those that occurred historically favor interior live oak and other evergreen oaks over valley oak in high-elevation (4,575 feet (1, 525 m)) savannas. He noted that interior live oak, canyon live oak, and tanoak were replacing valley oak successionally on high-elevation sites, while coast live oak was replacing valley oak on lower-elevation sites. He suggested that this successional replacement may be occurring because in the past, frequent, low-severity surface fires favored valley oak over the evergreen oaks [81].

FUELS AND FIRE REGIMES:

- **Fuels**
- **Fire regimes**

Fuels: The chaparral belts in which interior live oak grows contain highly flammable vegetation [105,134]. This, coupled with the hot, dry conditions that occur during the fire season (see Climate and moisture regime), makes chaparral sites easily ignitable [23]. When vegetation is dense, the often interlocking chaparral crowns ensure fire spread due to highly flammable and continuous fuels [161], especially with high winds [23]. In interior live oak chaparral, vegetation may be so dense that it is impenetrable except during the first 5 to 10 years after a fire. Mature interior live oak chaparral stands reach about 12 feet (4 m) tall and are usually denser than adjacent, mature chamise stands [120]. Mixed chaparral stands in Santa Cruz County formed an "almost impenetrable growth" of interior live oak, California coffeeberry, and other sclerophyllous species. Overstory shrubs ranged from 4 to 12 feet (1-4 m) high, with a 0.5- to 3.0-inch (1.3-7.6 cm) litter layer. The author deemed the community "a high fire hazard" [105].

Compared to many sclerophyllous species, however, interior live oak foliage [138] and litter are relatively nonflammable. One comparison of the flammability of chaparral vegetation listed interior live oak as low in flammability relative to manzanita and ceanothus species, tanoak, and California black oak [209]. Interior live oaks did not ignite during a 3 August prescribed fire in wedgeleaf ceanothus chaparral in Kern County. Interior live oaks on the site had a rounded form, with branches extending to the ground. However, the author observed that the fire "failed to affect this species" because fuels beneath interior live oak trees were scant and did not carry the fire [122].

Interior live oak's sclerophyllous leaves may be slow to decay. Latting [120] described the litter layer of interior live oak stands at the ponderosa pine-oak woodland ecotone as "slippery piles of leathery oak leaves that defy decomposition". The interior live oaks were small, with little understory beneath their crowded crowns [120].

Litter accumulation beneath interior live oak can vary depending, in part, on time since the last fire. Plumb and Gomez [164] report that the litter layer of interior live oak is typically thick. In southern California, Halsey [89] found barberry-leaved scrub oak-interior live oak-Muller's scrub oak (*Q. cornelius-mulleri*) chaparral had a "moderate" leaf litter layer (~7 inches (18 cm) thick). These communities typically occur on north-facing slopes below 3,000 feet (900 m) and on all aspects above that elevation. Overstory oaks are 4 to 12 feet (1-4 m) tall [89]. An interior live oak-valley oak community in Tehama County had a mean litter depth of 0.5 inch (1.3 cm) in September; dried annual grasses comprised a far larger proportion of the ground layer (26.3%) than did evergreen leaves (0.6%). The canopy averaged 13.5 feet (4.1 m) tall with 25.2% closure; tree basal area averaged 7.8 m^2/ha [196]. After a fire in chaparral or oak woodlands with interior live oak, the ground layer may accumulate interior live oak debris until the decay rate equals or exceeds the rate of biomass accumulation. In burned, mixed-chaparral sites on the San Dimas Experimental Forest, biomass of interior live oak litter and woody debris increased linearly from postfire years 1 to 11 at an average rate of 0.082 ton/acre/year but then decreased without further fire [114].

From 1991 to 1994, the Forest Inventory and Analysis Program found that the greatest volume of live trees and coarse woody debris (CWD) of interior live oak was in the southern Sierra Nevada region (336.3 million $feet^3$ live trees, 69.0 million $feet^3$ CWD), and the least volume was in the North Coast Ranges (17.1 million $feet^3$ live trees, 7.1 million $feet^3$ CWD) (n=3,316 transects on 495 plots). Interior live oaks were considered tree-size when ≥5 inches (13 cm) DBH [197].

Pillsbury and Kirkley [162] provide equations to estimate total aboveground volume, wood volume, and saw-log volume of interior live oak and other California hardwoods.

With fire exclusion, interior live oak may become a ladder fuel in blue oak, valley oak, and other communities that historically burned less often than interior live oak-dominated communities. In oak woodland/annual grassland, dry herbaceous vegetation is the main fuel that carries fire [28];

however, ingrowth of understory interior live oak and ponderosa pine can increase fuel loads in and flammability of blue oak woodlands [82,154].

Fire regimes: Interior live oak is adapted to stand-replacing fires in chaparral [84] and frequent surface fires in oak and oak-pine woodlands ([98,180,183], review by [49]). Relatively frequent, recurring crown fires help maintain interior live oak chaparral [49]. In both chaparral and oak woodlands, most wildfires historically burned down from higher-elevation conifer ecosystems [70,201]. Lightning ignitions are infrequent in chaparral and oak woodlands; historically, American Indians, miners, and ranchers were probably responsible for most fires in these communities [70]. With a long history of fire use by American Indians and then European settlers, it is difficult to separate natural and anthropogenic fire regimes in oak woodlands [183]. Interior live oak woodlands, and blue oak [180,183] and oak-conifer ([98], review by [49]) woodlands with a substantial interior live oak component, historically experienced mostly short return-interval surface fires, although these woodlands may also experience mixed-severity fires [156].

Chaparral: Chaparral ecosystems have short to moderate intervals between stand-replacement fires [113,211]. Minnich [138] describes a "smolder and run" behavior of chaparral fires. The fire cycle is irregular due to variations in weather and stand configurations of annual grassland-chaparral-oak woodland mosaics, but chaparral remains "remarkably stable under a wide range of fire regimes" that can vary from 20 to 100 years between fires [138]. Fire intensity is generally high but varies with fuels and weather. Most fires occur in summer, although Santa Ana winds can drive large wildfires in autumn [111].

Because fire scar records are rare to lacking in chaparral ecosystems, it is difficult to determine historic fire-return intervals. They may range from 10 [175] to as long as 60 ([113], reviews by [49,70]) or 100 [138] years. Rundel [175] pointed out that chaparral vegetation can burn after only a few years of postfire growth. Kittredge [114] reported that an interior live oak chaparral site on the San Dimas Experimental Forest reburned 3 years after a previous wildfire.

Short fire-return intervals favor sprouting species such as interior live oak, while relatively long fire-return intervals favor a mix of sprouters and obligate seeder species such as wedgeleaf ceanothus [24] and common deerweed (*Lotus scoparius*) [113]. Pioneer accounts of fire patterns in southern California chaparral suggest that before 1919, chaparral fires varied in severity across the landscape, with the low fuel loads of recent burns supporting less severe fires than the higher fuel loads of sites that had not burned in decades [142].

Fire exclusion may have had little effect on either fire frequency or fire size of chaparral, although experts disagree on this. Minnich [141,142] claims that in chaparral, fire size, rate of spread, and severity during extreme fire weather conditions have increased since attempts at fire exclusion. With the more even-aged structure of contemporary chaparral, Santa Ana winds tend to drive fires without the reductions in fire severity historically provided by young chaparral stands [142]. However, Keeley and others [112] contend that neither fire size nor severity have increased with attempts at fire exclusion in chaparral ecosystems. Their analyses of chaparral in southern California found fire frequency increased during the last half of the 20th century, but average fire size decreased. They attributed these changes to increased anthropogenic ignitions—

mostly from arson—and fire suppression. Keeley [111] suggests that the 30- to 40-year fire-return interval typical of California chaparral during the last half of the 20th century is more frequent than fire-return intervals of the past.

Oak woodlands: Oak woodlands, including interior live oak and blue oak-interior live oak communities, have a long history of intentional burning by American Indians and ranchers [187]. Interior live oak woodlands and forests historically experienced mostly frequent understory surface fires [211]. Fire-scar evidence is difficult to obtain from interior live oak and other oaks due to the prevalence of heart rot in old oaks, so fire-scarred conifers growing in oak communities are usually used to obtain fire histories [187]. Fire-scarred ponderosa pines recorded the fire history of an interior live oak-canyon live oak-California black oak/whiteleaf manzanita (*Arctostaphylos viscida*)-toyon woodland in El Dorado County. From 1850 to 1952, fire-return intervals on 3 sites ranged from 2 to 18 years and averaged 7.8 years. Stand structure was likely open during that period. There was no significant difference in mean fire-return intervals among the 3 sites despite large differences in slope (5%, 30%, and 55%). Cattle ranching was the primary land use during the time studied, and the author surmised that fires were set frequently by ranchers to improve cattle forage. Before the mid-1800s, the area had been a community center for the Miwoks; unfortunately, there were no ponderosa pine trees or stumps old enough to record the fire history of that time. By the 1990s, successional changes with fire exclusion had led to a dense stand structure of 1,635 trees/ha; 75% of the basal area was oaks [187]. Roy and Vankat [174] claim that excluding fire from oak woodlands can lead to a shift in species composition, with successional replacement of decadent overstory oaks by understory chaparral shrubs.

California's oak/grass woodlands historically experienced surface fires every 5 to 25 years [183]. These frequent fires burned at low severities, which tended to kill shrub seedlings and keep the shrub layer short [88,202]. Grasses likely fueled these mostly fast-moving fires [88]. Occasional mixed-severity fires also occurred [156]. Because these communities form a mosaic with or lie between chaparral and low-elevation ponderosa pine woodlands, chaparral shrubs or conifers formed pockets where fire crowned, resulting in more lethal effects to vegetation, especially nonsprouting species [202].

Yosemite National Park's fire records from 1930 to 1983 show that lightning ignitions were relatively infrequent in the canyon live oak-interior live oak-chaparral ecosystem, but when fire occurred, it was "very intense". Fire occurrence was disproportionately low in the ecosystem (4.2% of the Park but 1.9% of fires), with a fire-return interval of about 20 to 30 years. Excepting fires <10 acres (4 ha) in size, area burned averaged 177.5 acres (71.8 ha). Because canyon live oak-interior live oak chaparral-woodlands lie outside wilderness areas of the Park, fires in this ecosystem were suppressed during the time under investigation [201].

Oak-conifer woodlands: Frequent fires are needed to maintain the oak component of California's oak-conifer ecosystems (for example, [187]), although as of 2011, information on fire regimes in interior live oak-conifer ecosystems in particular were lacking. Ponderosa pine-oak woodlands with an interior live oak component historically experienced mostly short-interval, low-severity surface fires that favored both pines and oaks (review by [49]). Scrub interior live oak is prominent on new burns in bigcone Douglas-fir woodlands [5]. Little fire history was available on bigcone Douglas-fir communities as of 2011. However, bigcone Douglas-fir communities lie next to California's chaparral belt and burn often. Bigcone Douglas-fir generally survives and sprouts after surface but not after crown fires [139], so surface fires likely help maintain bigcone Douglas-fir communities. Walter and others [208] suggest that fire-return intervals in Coulter pine communities are variable. Areas going 100 or more years without fire may develop into open forests with an overstory of Coulter pine, canyon live oak, and interior live oak and an understory of chaparral whitethorn, Eastwood manzanita, and other chaparral species [208].

Because California's oak-conifer communities usually occur near chaparral or conifer forest ecotones and often have chaparral species in the understory, they may experience mixed or stand-replacement fires. Knobcone pine communities, in which interior live oak and other scrub oaks are often important components of the vegetation [5,12], primarily have stand-replacement fires at intervals long enough that the knobcone pine can establish and produce its serotinous cones before the next fire [98]. Knobcone pines must be at least 10 years old to produce cones [206].

See the Fire Regime Table for further information on fire regimes of vegetation communities in which interior live oak may occur. Find further fire regime information for the plant communities in which this species may occur by entering the species name in the FEIS home page under "Find Fire Regimes".

FIRE MANAGEMENT CONSIDERATIONS:
Fire is a vital component of chaparral and woodland communities with interior live oak. Frequent fires can encourage new growth of interior live oak and other sprouting species on rangelands [24,24]. Where oak woodland/annual grassland communities form mosaics or blend with chaparral, fires at 20- to 25-year intervals may best balance the regeneration requirements of sprouting species and those that regenerate solely from seed, such as wedgeleaf ceanothus [24].

Chaparral is not usually burned under prescription because of the high flammability of many chaparral species. Green [77] noted that chaparral can rarely be burned successfully under prescribed weather conditions because under the prescription window for weather, the shrubs are usually too moist to burn. Typically, litter and small twigs are consumed but larger stems are not, and the prescribed fire skips over large patches of brush [77]. If prescribed burning is planned and reducing oak cover is a fire management goal, he recommended prefire preparation that top-kills and desiccates the brush, such as crushing or herbicides, with herbicides most effective on oaks and other species with thick, stout stems. See his 1977 publication [77] for detailed instructions on these prefire treatments, and his 1980 publication [78] for recommendations on preparing a prescription for burning in chaparral.

Plumb and MacDonald [165] consider fire an "almost inescapable occurrence" in California oak woodlands and state that trying to exclude fire from these woodlands is not practical. Periodic surface fires in oak woodlands reduce fuel loads, especially the shrub understory, and help prevent severe wildfires that can be lethal to oaks. Hence, they recommend allowing or prescribing frequent, low-severity surface fires in oak woodlands to reduce fuel loads and interference with oak growth from associated shrubs [165].

Fires in oak woodland-chaparral communities can favor mule deer. Near Clear Lake, does averaged higher rates of ovulation on brushlands burned under prescription compared to unburned brushlands, and bucks were heavier. Blue oak-interior live oak-gray pine and chamise chaparral communities formed a mosaic in the area [26].

MANAGEMENT CONSIDERATIONS

SPECIES: Quercus wislizeni

FEDERAL LEGAL STATUS:
None

OTHER STATUS:
Information on state- and province-level protection status of plants in the United States and Canada is available at NatureServe.

IMPORTANCE TO WILDLIFE AND LIVESTOCK:
Use as rangeland: Oak communities with interior live oak are important rangelands [15] for wild and domestic ungulates. Blue oak-interior live oak-foothills pine woodland/annual grasslands of the Sacramento and San Joaquin valleys are particularly prized as productive rangelands [22]. Mule deer [13,20,54] and feral hogs [13] use oak woodlands with interior live oak as their primary habitats. In the Sacramento Valley, mule deer used oak woodlands as often as expected, and wedgeleaf ceanothus chaparral more than expected, based on availability. Feral hogs used interior live oak woodlands more than expected [13].

Interior live oak is an important deer food. In Lake County, mule deer browsed interior live oak year-round, with heaviest use in spring and summer [20]. Use may also be high in winter, when deciduous species have shed their leaves, and in spring, when new shoots are available [24]. A study on the Tehama Winter Deer Range found acorns and dry oak leaves were the primary components (65% of total) of the mule deer diet in October and November. Mule deer used interior live oak as much as expected based on its availability [123].

Oak/annual grassland types are California's primary livestock grazing lands [3,23,63,196]. Cattle [13] and domestic sheep [20] forage in oak woodlands on low foothills. Cattle use flat, open woodlands, while mule deer generally prefer more closed sites with rockier terrain [13]. In Lake County, domestic sheep browsed interior live oak mostly in late spring and summer [20].

Many wildlife species consume interior live oak acorns, including bears [89,189], mule deer [9,24], squirrels [9,81], other rodents [81], acorn woodpeckers [9,116], scrub jays [9], and band-tailed pigeons. Acorns, including those of interior live oak, are a winter staple for band-tailed pigeons [150]. American black bears in the Transverse Ranges consumed large volumes of acorns (canyon live oak and interior live oak, 13%-19% of total diet); behind garbage, acorns were their primary food source [189]. Historically, the California grizzly bear, the largest race of grizzly bears [89], also consumed acorns [81]. Chaparral was a preferred habitat of California grizzly bears [89].

Acorns can be important cattle feed; however, acorns are low in protein and become available after annual herbs have died, so cattle consuming large amounts of acorns require a protein supplement [207].

Habitat use: Oak woodlands, including those with interior live oak, are tremendously important wildlife habitat [183]. A study on the Central Coast Ranges found mule deer generally preferred a mixed-oak woodland habitat over chamise chaparral, but they preferred a chamise community after a prescribed fire. Mule deer used the chamise chaparral burn as primary habitat from about postfire year 2.0 to 2.5, then resumed using the mixed-oak woodland as their primary habitat [115]. On the Sierra Foothill Range Field Station, a 3-year study found wildlife species diversity was directly related to diversity of the mixed-oak woodland. Hutton's vireo, orange-crowned warblers, and Wilson's warblers were positively associated with interior live oak. Over 60 bird species bred and resided year-round in the oak woodland, and many others used the area as winter habitat. Several rodent and herptile species, such as brush mice and western fence lizards, were positively associated with the oak woodlands ($P<0.1$ for all variables). See Block and Morrison [30] for a list of these wildlife species. In a Kern County study, salamanders were positively associated with interior live oak-foothill pine woodlands on north-facing slopes. Except for the ground layer, vegetation cover was higher in salamander habitats than on sites without salamanders ($P<0.05$). Ensatina was the most commonly captured amphibian [31]. Black-bellied, California slender, and yellow-blotched salamanders are also positively associated with interior live oaks [32].

On 2 sites in the Sierra Nevada and 1 in the Tehachapi Mountains, Nuttall's woodpeckers foraged heavily in interior live oak-gray pine woodlands outside the breeding season, but they used blue oak woodlands during the breeding season. Interior live oaks selected for foraging were larger than average, but acorn woodpeckers typically selected large gray pines over large interior live oaks for foraging [29]. Surveys across California's oak woodlands found Nuttall's woodpeckers used live oaks, including interior, canyon, and coast live oaks, for foraging about 19% of the time. They used blue oak (51% use) more than the evergreen oaks but less than other deciduous oaks or gray pine [147].

See these sources for lists of birds using oak woodlands with interior live oak as habitat: [167,172,205].

Interior live oak woodlands are high-quality dusky-footed woodrat habitats [121]; in part, because they provide important food. On the San Dimas Experimental Forest in the San Gabriel Mountains, acorns of scrub interior live oaks were the primary food stored in dusky-footed woodrat nests at high elevations (>4,500 feet (1,400 m)), even though canyon live oak acorns were more plentiful and larger [99].

Many insects use interior live oaks as habitat. Interior live oak hosts Cynipidae gall wasps [52]. The pan-like depressions that are created by scar tissue around branch breaks collect water in spring; these depressions are habitat to maturing insects including mosquitoes, midges, syrphid flies, and moth-flies [215].

Palatability and nutritional value: New spring growth and sprouts arising after fire or other top-killing events are highly palatable to mule deer [24]. Livestock also find interior live oak palatable, and they utilize it increasingly as annual grasses dry and lose nutritional value [129].

Overall nutritive value of interior live oak appears low. In a laboratory experiment using captive mule deer and domestic sheep, total digestible nutrient content of interior live oak was less than that of alfalfa (*Medicago sativa*) or chamise. The authors concluded that interior live oak was of little to no value as a source of protein but overall, it was a fair source of total digestible nutrients [20]. However, interior live oak provides a little protein in late fall and winter months, when deciduous browse species have shed their leaves. Bissell and Strong [19] found interior live oak protein content peaked in June at 8% and was least in December and February at 1%. See these sources for further details on the nutritional value of interior live oak browse: [19,20,176].

Browse of interior live oak and other evergreen oaks is generally less palatable than that of deciduous oaks due to higher concentrations of tannins and lignins in the leaves [155]. However, domestic goats usually find interior live oak moderately to highly palatable [79]. In the Sierra Nevada, they ate interior live oak stems "avidly" (observations by [79]). In mixed chaparral in southern California, domestic goats ate 5-year-old, postfire scrub interior live oak about as much as expected, preferring sprouts of birchleaf mountain-mahogany, redberry buckthorn (*Rhamnus crocea*), and barberry-leaved scrub oak over sprouts of interior live oak [79].

Cover value: Oak woodlands provide vitally important cover for wildlife. Squirrels and cavity-nesting birds often prefer cavities in oak branches or boles for nesting, while rodents, skunks, and foxes dig and den in the roots or in downed interior live oak logs [9].

Many wildlife species may prefer interior live oak and other evergreen oaks as cover in late fall and winter, when deciduous trees lack foliage. Feral hogs in the Sierra Nevada used interior live oak woodlands as bedding and forage sites. Their use increased in winter, when associated blue oaks had lost their leaves and provided less cover [13]. In urban Sacramento, yellow-billed magpies selected interior live oaks as communal roosts over all other tree species during the December through May study period. Evergreen species in general were selected over deciduous species [53].

In a blue oak woodland on the San Joaquin Experimental Range, understory interior live oaks apparently helped protect California towhee nests from predation. On cattle-grazed sites, California towhees preferred interior live oaks for nesting (25% frequency vs. 8% frequency for all other nest-trees), and nesting success was greater in interior live oaks than in other nest-trees. For cover near the actual nest-tree, successful nests were built on sites with more understory interior live oak cover than occurred on nest-predated sites (*P*=0.003). Western scrub-jays were responsible for most nest predation. On ungrazed sites, California towhees preferred to nest in wedgeleaf ceanothus (18%, 4%, and 12% use for wedgeleaf ceanothus, interior live oak, and other nest-trees, respectively). Nest failure was significantly higher on ungrazed than on grazed sites (*P*=0.008) [168].

VALUE FOR REHABILITATION OF DISTURBED SITES:
Interior live oak provides watershed protection [105] and is recommended for erosion control [99]. See these sources for propagation and planting information: [34,99].

OTHER USES:
Interior live oak produces good-quality firewood [164,173]. Much interior live oak was cut for cordwood around the turn of the 20th century [173]. The wood has little value as lumber [155].

Acorns of interior live oak and other oaks were a staple of California Indians [8,130]. In order to produce new sprouts for basketry, Indian women used fire regularly to top-kill interior live oaks. They preferred 1-year-old sprouts for making baskets [7].

OTHER MANAGEMENT CONSIDERATIONS:
See Plumb and MacDonald [165] for a guidebook on managing California's oaks.

Interior live oak is apparently resistant to sudden oak death disease. As of 2003, it was the only red oak in California in which the disease had not been detected in the field [60].

Possible impacts of climate change on interior live oak are uncertain. Models of McBride and Mossadegh [133] suggest the distributions of most California's oak species, including interior live oak, will not shift with climate change. However, paleobotanical investigations by Davis [55] revealed distributions of California's oak species have shifted in the past with climate change, and he predicts that the distributions of California's oaks will shift with new changes in climate. Large-scale vegetation monitoring (>17,000 plots) across California suggests that the elevational range of interior live oak is extending upslope [195].

Although interior live oak's value for wildlife and livestock is now appreciated, it has been disparaged in the past. In the 1950s and 1960s, some management plans called for removing oaks in general and interior live oak in particular from California's foothills in order to increase herbaceous livestock forage and water yields [21,43,64,94].These efforts greatly increased rates of soil erosion on steep slopes [43,65] and had inconsistent results regarding herbaceous forage yield production after oak removal [183]. Studies have shown decreases [72], no clear trends [169], or increases in forage production [73] after interior live oak removal. In general, oak removal did little to increase water yields on foothill slopes [25,65], although some studies showed increased water yields on valley bottoms after oaks were cut [25].

On the San Joaquin Experimental Range, forage production was greater beneath interior live oak canopies than in the open during 2 drought years. The 1st year of the drought, herbaceous forage biomass peaked in May, at about 700 kg/ha more under interior live oak canopies than in the open. The 2nd year, forage production peaked in May at about 1,000 kg/ha more under interior live oaks than in the open. Herbaceous production early in the growing season (November-January) was similar under interior live oaks and in the open, but it was significantly greater under interior live oaks from March through May (P=0.05) [73]. In general, late-successional annual grasses such as wild oat and ripgut brome were more common under interior live oak than in open areas. Filaree (*Erodium* spp.), clover (*Trifolium* spp.), sixweeks grass (*Vulpia* spp.), and other early-successional species were most common in open areas (review by [183]).

Contrary to expectations, studies at 6 sites in northern and central California did not find a pattern of higher rates of available soil nitrogen beneath deciduous oak compared to evergreen oak species. Available soil nitrogen beneath interior live oak's canopy was similar to that beneath deciduous valley oak and higher than that beneath evergreen blue oak and deciduous California black oak (P=0.1) [152].

APPENDIX: FIRE REGIME TABLE

SPECIES: Quercus wislizeni

The following table provides fire regime information that may be relevant to interior live oak habitats. Find further fire regime information for the plant communities in which this species may occur by entering the species name in the FEIS home page under "Find Fire Regimes".

<table>
<tr><td colspan="6">Fire regime information on vegetation communities in which interior live oak may occur. This information is taken from the LANDFIRE Rapid Assessment Vegetation Models [119], which were developed by local experts using available literature, local data, and/or expert opinion. This table summarizes fire regime characteristics for each plant community listed. The PDF file linked from each plant community name describes the model and synthesizes the knowledge available on vegetation composition, structure, and dynamics in that community. Cells are blank where information is not available in the Rapid Assessment Vegetation Model.</td></tr>
<tr><td colspan="6">California
California Grassland
California Shrubland
California Woodland
California Forested</td></tr>
<tr><td rowspan="2">Vegetation Community (Potential Natural Vegetation Group)</td><td rowspan="2">Fire severity*</td><td colspan="4">Fire regime characteristics</td></tr>
<tr><td>Percent of</td><td>Mean</td><td>Minimum</td><td>Maximum</td></tr>
</table>

		fires	interval (years)	interval (years)	interval (years)
California Grassland					
California grassland	Replacement	100%	2	1	3
California Shrubland					
Coastal sage scrub	Replacement	100%	50	20	150
Coastal sage scrub-coastal prairie	Replacement	8%	40	8	900
	Mixed	31%	10	1	900
	Surface or low	62%	5	1	6
Chaparral	Replacement	100%	50	30	125
Montane chaparral	Replacement	34%	95		
	Mixed	66%	50		
California Woodland					
California oak woodlands	Replacement	8%	120		
	Mixed	2%	500		
	Surface or low	91%	10		
Ponderosa pine	Replacement	5%	200		
	Mixed	17%	60		
	Surface or low	78%	13		
California Forested					
California mixed evergreen	Replacement	10%	140	65	700
	Mixed	58%	25	10	33
	Surface or low	32%	45	7	
Coast redwood	Replacement	2%	≥1,000		
	Surface or low	98%	20		
Mixed conifer (north slopes)	Replacement	5%	250		
	Mixed	7%	200		
	Surface or low	88%	15	10	40
Mixed conifer (south slopes)	Replacement	4%	200		
	Mixed	16%	50		

	Surface or low	80%	10		
Jeffrey pine	Replacement	9%	250		
	Mixed	17%	130		
	Surface or low	74%	30		
Mixed evergreen-bigcone Douglas-fir (southern coastal)	Replacement	29%	250		
	Mixed	71%	100		
Interior white fir (northeastern California)	Replacement	47%	145		
	Mixed	32%	210		
	Surface or low	21%	325		
Red fir-white fir	Replacement	13%	200	125	500
	Mixed	36%	70		
	Surface or low	51%	50	15	50

*Fire Severities—
Replacement: Any fire that causes greater than 75% top removal of a vegetation-fuel type, resulting in general replacement of existing vegetation; may or may not cause a lethal effect on the plants.
Mixed: Any fire burning more than 5% of an area that does not qualify as a replacement, surface, or low-severity fire; includes mosaic and other fires that are intermediate in effects.
Surface or low: Any fire that causes less than 25% upper layer replacement and/or removal in a vegetation-fuel class but burns 5% or more of the area [91,118].

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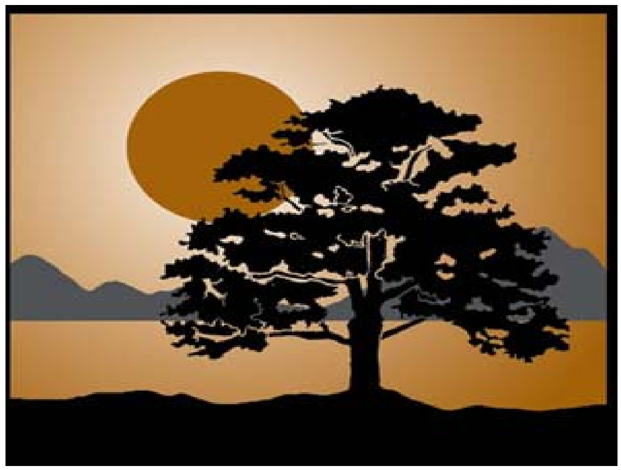

Oak Woodland Impact Decision Matrix

A Guide for Planner's to Determine Significant Impacts to Oaks
as Required by SB 1334.
(Public Resources Code 21083.4)

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Introduction

In 2004 the California Environmental Quality Act (CEQA) was amended with the passage of SB 1334, (Chapter 732, and Statutes of 2004). As amended, CEQA now requires a county to determine whether a project within its jurisdiction may result in a conversion of oak woodlands that will have a significant effect on the environment. According to the law (PRC 21083.4) if a county determines that a project will result in a significant effect to oak woodlands, the county shall require one or more oak woodland mitigation alternatives to mitigate for the significant effect associated with the conversion of oak woodlands.

In response to numerous inquiries from county planners, developers and concerned citizens on how to implement this new provision of CEQA, the University of California (UC) Integrated Hardwood Range Management Program (IHRMP) convened a working group comprised of the California Department of Fish and Game, the California Department of Forestry and Fire Protection and the Wildlife Conservation Board (WCB). The purpose of the working group was to develop information to assist county planners with the process of determining project significance including, what types of projects fall under the purview of the law, what constitutes a "significant impact," compliance standards, effective strategies to conserve oak woodlands and how to determine suitable, appropriate mitigation.

In addition to this report, tools such as a web-based decision key, PowerPoint presentations and visual comparison standards for assessing oak woodland impacts will be made available through the IHRMP web site. This represents an ongoing effort to assist county planners on how to protect and conserve critical oak woodland resources and comply with new regulations.

What Science Tells Us About County Conservation Planning

Given the variety of regional situations that face county planners, it is important to first consider broad, conceptual conservation goals and then develop applicable tools that allow the concepts to be visualized "on the ground." Forman and Collinge (1997) maintain that in order to conserve biological diversity conservation planning should be done before more than 40 percent of the natural vegetation is altered or removed from the landscape. Conservation planning grounded in science-based information allows for the development of sensitive planning scenarios that if initiated in the early stages of the development process can prevent environmental crises.

The Ecological Society of America (ESA) provides a basis for the conceptual approach to planning that should be included in conservation planning. In their Land Use Committee Guidelines for Land Use Planning and Management (Dale and others 2000) the ESA recommends;

1) Examine the impacts of local decisions in a regional context;
2) Plan for long-term change and unexpected events;
3) Preserve rare landscape elements and associated species;
4) Avoid land uses that deplete natural resources over a broad area;

5) Retain large contiguous or connected areas that contain critical habitats;
6) Minimize the introduction and spread of non-native species;
7) Avoid or compensate for effects of development on ecological processes; and
8) Implement land use and land management practices that are compatible with the natural potential of the area.

Furthermore, it is broadly recognized that a gap exists between conceptual planning designs and pragmatic implementation in the politically charged reality of county planning. Given this reality, it is important that scientifically valid approaches be included in the planning process. Also, well articulated decision-making tools need to be developed that specifically address the idiosyncrasies of oak woodlands. These tools must strive to incorporate the current conventional wisdom pervasive throughout the literature that identifies those elements or characteristics most important for maintaining the integrity of oak woodlands, i.e., old trees/forests, maintaining rare and representative habitats, riparian corridors, water quality and quantity, ecosystem functions and natural connectivity. Additionally, any planning tools should strive to assist planners in promoting compatible land uses to avoid or minimize habitat loss and fragmentation whenever possible.

All current projects should be viewed in context of past events.

In order to address the issue of "*significance*" there needs to be recognition that each project site has a peculiar history and situation. This history of site-specific land use practices may result in sites whose qualities span from relatively undisturbed sites to properties whose oak woodlands have been entirely altered.

We propose a decision matrix, described herein, that uses a process beginning with establishing a baseline site condition from which to initiate decision making process. It relies on the judgment of the resource professional and their ability to objectively determine is likely to have a significant impact.

What is a Woodland?

There are two very different approaches to address what appears to be a relatively straight-forward question.

- The first is to answer this question with a definition of oak woodland;
- The second is to use a *description* of oak woodland.

1. The first is a prescriptive, arbitrary standard or definition that is used to define a woodland, i.e., 10% canopy closure; trees of a certain diameter size class; number of trees per acre, etc.
2. The second option uses other qualitative standards such as soil type, or plant classifications that describe where different types of woodlands are expected to occur, i.e., valley oak woodland soil types. This approach can also be used to describe where woodlands are capable of occurring based on site attributes.

Both options have merit. A jurisdiction has the freedom to decide which option better suits its particular needs.

There are eight major oak species that are generally recognized to occur across California;

- **Blue oak**, **valley oak**, **Oregon white oak** and **Engelmann oak** are all deciduous and members of the white oak group.

- **Coast live oak**, **interior live oak**, and **canyon live oak** are three important evergreen oaks in the red oak group. **California black oak** is a deciduous oak in the red oak group.

Oaks can be found in a wide range of canopy densities depending on site characteristics and landscape characteristics (e.g. aspect, soil type, vegetation community type) as well as historical land use practices (e.g. burning, clearing). Small isolated stands (less than 1 acre) with lower than 10 percent cover are often not considered to be part of a woodland but rather represent remnant trees which can have ecological value but may not be part of a functioning woodland.

It is not unusual for woodlands to have both multiple oak species and other non-oak associates growing in close approximation including madrones, alders, maples, sycamores, and Douglas-fir.

For information on how to identify California's tree oaks, their biology, and the associated plants that are commonly found with them, please see http://danr.ucop.edu/ihrmp/oaks.html.

Step I: Getting Started—Establishing Site Condition

To use this matrix a planner must first establish the condition of the site (*for a review of the CEQA guidelines on establishing site condition see §15125 and §15126*). Site condition should evaluate either the oaks as individual trees, or the condition of the oaks as a component of a larger forest. Significance at both scales can then be determined based on the alterations being proposed and how these alterations might affect the ability of the site to continue providing the ecological goods and services currently in place.

By assessing past, present and future impacts on oak woodlands this matrix is designed to help address potential *Cumulative Impacts* as part of the assessment of significance. Significance criteria for cumulative impacts to biological resources may include:

- The cumulative contribution of other approved and proposed projects that lead to fragmentation of oak woodlands in the project vicinity.

- The net loss of sensitive habitats and species.

- Increased fragmentation of woodlands and loss of habitat connectivity.

- Contribution of the project to urban expansion into natural areas.

- The potential for the proposed project to increase run-off, nutrients and other pollutants into adjacent waterways.

- Isolation of open space within the proposed project by future projects in the vicinity.

To evaluate the quality and ecological condition of a site, we propose that a planner should ascertain if the site represents an oak woodland whose ecological functions are still relatively “intact,” “moderately degraded,” or “severely degraded.” This relative comparison is intended to classify the current state of the site to what would be considered undisturbed oak woodland.

Intact?

The site is currently in a “wild state” being managed for grazing, open space, recreation, etc., where all of the ecological functions are still being provided, i.e., shade, ground water filtration, wildlife/fish habitat, nutrient cycling, wind/noise/dust abatement, carbon sequestration, etc. In this condition roads and buildings are rare across the site. Trees, both dead and alive, dominate the landscape and the site is capable of natural regeneration of oaks and other plant species. The site allows for movement of wildlife and the existing development is localized and limited to a small number of residences with service buildings or barns. The site is relatively undisturbed and is recognized as ***Intact.*** Examples of an ***Intact*** woodland may include large to moderately (even relatively small parcels may qualify) sized private ranches; expansive oak woodlands zoned for agriculture, open space, scenic corridors, etc.

Some latitude is necessary to allow a site to be classified as ***Intact***. There are very few private lands in California that are entirely free from land use and ecological impacts. Virtually all oak woodland-grass communities are dominated by exotic grasses and forbs in the understory. Also, fire exclusion has affected the density and species composition of oak woodlands in many locations. The designation ***Intact*** refers mainly to being free from destructive land use practices that inhibit or limit the oak woodland to naturally sustain itself and its associated flora and fauna.

If a site is classified as ***Intact***, any proposed project that would substantially change its conditions may be determined to have significant impacts. That determination should be based on the findings of an impact assessment process; an example is described in the next section of this matrix.

Moderately Degraded?

In this case, the site has obviously been altered from a “wild” condition but is currently in a state where oak trees are present; natural regeneration is capable of occurring; limited ecological services are still being provided and the site still provides for utilization by wildlife. Roads and stream crossings are present but limited or clustered. Developed areas are centralized and concentrated over a small percentage of the site. The site is recognized as being ***Moderately Degraded***. Examples of ***Moderately Degraded*** oak woodlands may include some golf courses, large ranches that have been subdivided into large parcels, oak woodland subdivisions that share “common grounds” of woodland acres.

A ***Moderately Degraded*** site has been changed in one or more ways that has reduced its potential for providing ecological and socially important services. For example, it may have been partially developed resulting in the net loss of trees; the canopy or understory may have been reduced or eliminated over all or part of the site; past grazing or soil disturbance may have impaired regeneration in some areas or it may be a situation where “ranchettes” dot the landscape.

Severely Degraded?

Here a site has been dramatically altered and is currently in a condition that has no trees or very few remain; it is being managed in such a way that natural regeneration is not possible or practical; the soil is compacted or contaminated; and/or has been used for residential, commercial or industrial purposes. Roads and stream crossings are commonplace and fencing and other obstructions limit wildlife access and movement. This site should be considered ***Severely Degraded***.

> Some isolated rare oak trees, even though found in a severely degraded site, such as valley oak or Englemann oak may warrant special consideration based on their overall distribution within a county. These types of trees or small stands should be evaluated on the basis of regional occurrence and site potential for restoration. Additionally, some jurisdictions may have local statutes that provide additional protection to heritage trees.

Although a site in a severely degraded state may perform limited or no ecological or socially important functions, it may have potential for restoration or enhancement as part of a proposed development. That said, it should not simply be dismissed without considering possibilities for mitigating past damage. Restoring or improving the woodland on the site could provide benefits such as improving connectivity or patch size for locally important wildlife habitat.

Step II: Assessing Thresholds of Significance

> The Guide to CEQA, 11th edition states: “In the absence of an impact necessarily deemed significant, the lead agency has discretion to adopt standards for determining whether an impact is significant. In recent years interest has focused on encouraging agencies to develop standardized “thresholds of significance”, rather than to continue making ad hoc determinations in the context of particular projects…” See CEQA Guidelines § 15064.7 for more on establishing thresholds.

As with the determination of existing conditions, the evaluation of potential impacts of a project should be considered at three scales: (1) landscape, (2) site and (3) individual trees or groves. A project may have significant impacts at one scale but not at another. Or, in some cases, it may have significant impacts at all scales. For example, a project in an oak woodland deemed ***Intact*** that results in the removal of some trees but retention of other woodland qualities such as species composition and canopy cover may only have significant impacts at the tree scale. Another project that creates a barrier, such as a road that interrupts wildlife migrations, may have significant impacts at the landscape scale even if few trees are removed.

The determination of significance in an impact assessment is by no means simple. Any assessment should consider and address more than simply the impacts to the trees; the planner should consider the potential impacts to the other tangible aspects of the woodland.

Many jurisdictions have arbitrarily established thresholds of significance to aid in the determination process. The vast majority of examples to date have focused on the tree scale. [Only a few examples exist of counties developing spatial thresholds, i.e., Lake County's grading ordinance specifies one quarter acre of native vegetation as a threshold.] These include: individual tree diameter limits established in tree ordinances; soil disturbance limits often contained in grading ordinances; heritage tree designations initiating a discretionary permit review process prior to removal.

Here we propose another means of determining thresholds through a process of pre-determining those oak woodlands whose site qualities qualify them to be recognized according to there existing condition. By using spatially derived images (aerial photos, GIS data, etc) a planner can determine contiguous acreages of oak woodlands that may qualify as ***Intact*** woodlands; using other available planning tools areas could be identified as ***Moderately Degraded*** and the same could be done for ***Severely Degraded*** areas. Conceptually, this approach mimics other planning designations identified through zoning.

Developing a System Using Impact Prediction as a Means of Determining Significance

An important consideration dealing with *significance* in wildlands is the assessment and prediction of both the nature and extent of the potential impacts. Predictions can be based on simplified conceptual models of how natural processes function. Models range in complexity from those that are very intuitive to those based on explicit assumptions about environmental processes. We propose a combination of intuition and strict quantitative assessment to help make a determination. Criteria that can be used to describe the nature and duration of an impact may include:

Determination of Impact Magnitude

Spatial Extent

1) At the site scale:

What proportion of the woodland will be removed or changed to the extent that ecological functions or goods and services will be impaired? Metrics that can be evaluated include:

1. Road density pre and post development.
2. Percent canopy cover pre and post development.
3. Oak species present pre and post development.

4. Vegetation composition pre and post development.

2) At the landscape scale:

Would changes at the site cause fragmentation, loss of connectivity or interruption of processes such as wildlife migration, water flow, or increased fire risk over a larger geographic area? Metrics that can be evaluated include:

1. Road density within 1 km of the site,
2. Results in reduced distance between woodlands and urban development.
3. Changes in size and configuration of woodland habitat patches and increased edge habitat.
4. Severe wildlife corridors or habitat linkages thereby impacting animal and plant movement.

Temporal Extent

Does the proposal result in long-term impacts to the structure and ecological services being provided? Metrics that can be evaluated include:

5. What is the duration of the proposed impacts?
6. Are the impacts reversible?
7. Does the project protect oaks and other oak woodland components from future potential impacts to the site?
8. Are exotic and weedy species likely to increase at the site?

Impact Prediction Checklist—Intact Woodlands

If a project is being proposed for ***Intact*** woodland, the following criteria could be considered to determine significance.

- ✓ Net loss of oak woodland acreage.
- ✓ Increase habitat fragmentation.
- ✓ Loss of vertical and horizontal structural complexity.
- ✓ Loss of understory species diversity.
- ✓ Loss of food sources.
- ✓ Loss of nesting, denning, burrowing, hibernating, and roosting structures.
- ✓ Loss of habitats and refugia for sedentary species and those with special habitat requirements, i.e., mosses, lichens, rocks, native grasses and fungi.
- ✓ Net loss of oak woodland acreage.
- ✓ Road construction, grading, trenching, activities affecting changes in grade, other road-related impacts.
- ✓ Stream crossings, culverts, and road associated erosion and sediment inputs.

Although mitigation measures may help to diminish some of the negative aspects of a project, they can not ensure that the cumulative effects would not result in long-term changes affecting the ecological processes associated with an ***Intact*** woodland. Therefore, cumulative impacts may have to be considered when predicting the affect of a project proposed for designated ***Intact*** woodland.

Impact Prediction Checklist—Moderately Degraded Woodlands

Moderately Degraded woodlands may be the most frequently encountered oak woodland condition found in California. When a site is determined to be moderately degraded, the baseline conditions may be such that further perturbations will have a significant impact. Conversely, a proposed development may present opportunities for improving or enhancing site conditions.

If a project is being proposed for woodland you determine to be Moderately Degraded, the following criteria could be considered to determine significance:

- ✓ Net loss of oak woodland acreage.
- ✓ Increase habitat fragmentation.
- ✓ Loss of vertical and horizontal structural complexity.
- ✓ Loss of understory species diversity.
- ✓ Loss of food sources.
- ✓ Loss of nesting, denning, burrowing, hibernating, and roosting structures.
- ✓ Loss of habitats and refugia for sedentary species and those with special habitat requirements i.e. mosses, lichens, rocks, native grasses and fungi.
- ✓ Net loss of oak woodland acreage.
- ✓ Road construction, grading, trenching, activities affecting changes in grade, other road-related impacts.
- ✓ Stream crossings, culverts, and road associated erosion and sediment inputs.
- ✓ Road building activities that aggravate existing conditions.
- ✓ Changes in environmental conditions that prevent existing residual trees the ability to naturally regenerate.
- ✓ Proposed project designs that result in the construction of obstacles that pose as barriers to wildlife or fish passage.
- ✓ Proposed project designs that result in the probable introduction of invasive plants and animals.

Impact Prediction Checklist—Severely Degraded Woodlands

If the project is being proposed for a ***Severely Degraded*** woodland, consideration of the following impacts should be recognized to determine potential significance. In order for a site to be initially classified as ***Severely Degraded*** it should be highly altered, fragmented or in such a state as to make it virtually unrecognizable as ever having been an oak woodland. These sites may be urban, suburban or agricultural sites whose only link to its past natural heritage is found in the name of the community. In these sites, the oaks remain only as a relic of the past and the reality of oak regeneration is highly unlikely and constrained.

Take note that these sites may have significance if the relic trees represent a resource protected by local ordinance or statute. Additionally, the site may have significance if the relic trees are considered in a spatial context of what may have been found throughout the county prior to development, and though mitigation may never fully recover the lost biological attributes of a forest, it may serve as a strong source of civic pride that should be considered as part of the determination of significance.

The conversion of these resources may not lead directly to the loss or reduction of sensitive habitat or species but in a cumulative sense may be significant. Thus, impacts to ***Severely Degraded*** *sites may be less than significant* when dealing with individual trees on a small scale, but some projects, depending on specific attributes, may in fact be significant.

Scenarios where the loss of trees may be considered significant in a ***Severely Degraded*** oak woodland:

- ✓ Loss of individual heritage tress that are recognized and/or protected by ordinance or statute.
- ✓ Loss of appropriate recruitment sites for recognized and/or protected heritage tree species.
- ✓ Loss of individual trees in a county where the natural range and occurrence of the species has been dramatically reduced and/or altered thereby affecting the recruitment/restoration potential for the species.
- ✓ The removal of even a few individual trees, taken in spatial context of the county and species being considered, may represent a significant portion of the existing population of that species.

Scenarios that may be **less than** significant under this classification may include:

- ✓ Removal of a small number of immature trees for a road-widening project.
- ✓ Removal of a single tree(s) from a residential property associated with a remodeling project.
- ✓ Actions associated with tree care, maintenance and health, i.e., pruning, shaping, etc..
- ✓ Removal and replacement of street trees.
- ✓ Removal and replacement of landscape trees associated with existing developments.
- ✓ Removal of hazard trees where the threat of a tree failure could injure people or property.

Designing an Oak Woodland Decision Matrix

As has been previously stated, the matrix being proposed here relies on the planner making an assessment of the proposed project based on:

1. the site condition of the oak woodlands at the project site; and
2. the degree to which the initial site condition will be changed as a result of the project.

When developing your matrix start by using a set of broadly defined criteria as a means to identify rudimentary thresholds of significance in simple terms. These criteria apply subjective reasoning to determine the level of impact being proposed (Table 1).

Conceptually, your matrix should compare the site condition (Step I) to the relative impacts being proposed (Step II) thus, the matrix will provide both the planner and the applicant a relatively straight-forward and economically cost effective assessment of environmental impacts and their potential significance.

Table 1. Conceptual sample of how the decision matrix is intended to demonstrate the determination of ***significance*** by comparing the initial condition of the site with the proposed impacts of the project.

	Site Condition		
Degree of Impact	Undisturbed (Intact)	Moderately Degraded	Severely Degraded
Low	Moderately Significant	Least likely significant	Least likely significant
Moderate	Highly likely significant	Moderately likely significant	Less likely significant
High	Significant	Highly likely Significant	Most likely significant

If a county has pre-determined designated lands that are assigned a condition rating of ***Intact***, ***Moderately Degraded*** or ***Severely Degraded***, it will facilitate the process.

Table 2 provides example criteria that can be considered when trying to qualify impacts at a project level (Table 3). Supporting documents to consider should include maps, aerial photos, landsat imagery or areas/trees with special designation (rare, threatened or endangered habitats, heritage trees, zoning overlays, etc.)

Table 2. Criteria for consideration when rating of impact magnitude and significance. (Adapted from Rossouw 2003).

Impact Magnitude and Significance Rating	Examples
HIGH Of the highest order possible within the bounds of impacts that could occur. In the case of adverse impacts, there is no possible mitigation that could offset the impact, or mitigation is difficult, expensive, time consuming or some combination of these. Site scale—Typically on a small scale (less than 3 acres) a high impact would result in the removal of a majority of the existing trees. Landscape scale—Does the loss of trees result in habitat fragmentation because the site is located within a larger continuous patch of woodland. Existing threshold limits delineating significant impacts currently in use in California range from ¼ acre to 3 acres.	Examples include alterations/conversion of oak woodlands resulting in: ✓ Loss of vertical and horizontal structural complexity. ✓ Loss of understory species diversity. ✓ Loss of food sources. ✓ Loss of nesting, denning, burrowing, hibernating, and roosting structures. ✓ Loss of habitats and refugia for sedentary species and those with special habitat requirements, i.e., mosses, lichens, rocks, native grasses and fungi. ✓ Net loss of oak woodland acreage. ✓ Road construction, culverts, grading and other road-related impacts. ✓ Stream crossings, culverts, and road associated erosion and sediment inputs.
MODERATE A second order or tier impact. In the case of adverse impacts, mitigation or minimization of impacts is sometimes possible to offset overall alterations. Site scale—Both tree and non-tree components of the oak woodland are being considered for removal or alteration. Removal of trees will result in the creation of more edge impacts. Landscape scale—Increased edge habitat but less than 1 kilometer. Complete loss of habitat resulting in a disturbance envelops less than 3 acres. Existing threshold limits delineating significant impacts currently in use in California range from ¼ acre to 3 acres.	Examples of moderate impacts at a site scale may include: ✓ Understory removal. ✓ Thinning of existing trees. ✓ Removal of snags and other wildlife elements. Examples of moderate impacts at a landscape scale may include: ✓ Right of way clearing. ✓ Road alignments. ✓ Road expansion.
LOW A third tier or order of proposed impacts. In the case of adverse impacts, minimal disturbance is anticipated or can easily be avoided, minimized or mitigated.	Examples of low impacts at a site scale – Less than 10 trees: Large scale—No change to the stand structure and immeasurable impacts on canopy cover.

Table 3. This illustrates an example matrix and how it might be used to help determine significance.

	Initial Site Condition		
Impact Level	**Intact Woodland**	**Moderately Degraded Woodland**	**Highly Degraded Woodland**
Low Impact	Minimal disturbance to stand structure and composition and habitat features resulting in no increased edge habitat or fragmentation; road and stream crossings are not being considered; activities will not result in the introduction of exotic or invasive species. [Minimal site or spatial disturbance may still result in significant impacts to an intact or core woodland.]	Regeneration potential is being maintained across the site; expansion of developed areas are maintained and centralized; new road and stream crossings are not being considered. [In the absence of special circumstances, statutes or ordinances this may represent a non-significant impact.]	Majority of remnant trees are retained; understory removal or road widening protects existing tree health; individual tree removal on a residential, commercial or industrial site. [In the absence of special circumstances, statutes or ordinances this may represent a non-significant impact.]
Moderate Impact	Detectable change or reduction in canopy, structure or composition; loss of some habitat features, subtle impacts increasing fragmentation, edge creation or loss of connectivity (roads, fences, other introduced artificial barriers or buffers). [These impacts are considered significant.]	Regeneration potential is being marginalized; develop areas are expanding into previously undeveloped sites; new roads or stream crossing are being proposed; habitat features are being lost; activities being proposed will add to the existence of exotic and invasive species. [These impacts are considered significant.]	Loss of a majority of existing trees; activities will inhibit or harm residual tree health and vigor; barriers are constructed that increase fragmentation and connectivity; [These impacts may be significant.]
High Impact	Obvious change or reduction or loss in canopy, structure or composition loss of most of the existing habitat features and services; fragmentation and or parcelization of contiguous ownerships; introduction of roads or stream crossings; creation of edge habitats previously absent; construction of barriers (fences). [These impacts are considered significant.]	Large scale impacts including loss of habitat resulting in habitat fragmentation and increased edge. Loss of woodland structure and changes in composition occurring in large continuous patch of woodland. [These impacts are considered significant.]	Loss of remnant trees or stand increases fragmentation across the landscape through the loss of connectivity. [In the absence of special circumstances, statutes or ordinances this may represent a non-significant impact to oak woodlands.]

Step III: Identifying Potential Mitigatory or Remedial Actions

CEQA does not mandate similar mitigation for all similar projects. Nothing in CEQA requires a local legislative body to enact legislation which uniformly applies a certain level or standard of mitigation to all similar project submitted for environmental review within its jurisdiction. Guidelines § 15130.

Projects predicted to have significant impacts at the individual tree, site (or stand) and/or landscape scale should include mitigation measures designed to avoid, minimize or compensate the impacts. If that is not feasible, a project with residual significant impacts cannot be approved without a finding of overriding considerations by the approving jurisdiction. Mitigation measures may be proposed to reduce the level of impacts, restore impacted resources or enhance degraded resources. In some cases, on-site mitigation will not be practical and so provisions must be made for off-site mitigation or even compensation. Off-site compensation may include both direct measures at other suitable locations or contribution of in-lieu fees. To some extent, the existing conditions at a site, whether ***Intact, Moderately Degraded*** or ***Severely Degraded***, will determine the nature and feasibility of on-site mitigation. For example, although on-site mitigation is always preferred, a project within ***Severely Degraded*** oak woodland may have few options. Consequently, only off-site compensation may be feasible.

Appropriate Mitigation measures may include:

- ✓ Old trees with irreplaceable characteristics are retained.
- ✓ Snags are maintained or recruited where safe and feasible.
- ✓ Snags are well represented by size, specie, and decay class.
- ✓ Measures are initiated to minimize storm water runoff and other sources of non-point source pollution.
- ✓ Stream crossings include measures to minimize water quality degradation and facilitate fish passage.
- ✓ Hydrologically disconnect effects of impervious surfaces from waterways.
- ✓ Areas are designated to serve as seedling/sampling receptor sites or are designed to facilitate natural oak recruitment.
- ✓ Appropriate sites for long-term oak recruitment should be identified within the project impact area, e.g., roadside right-of-ways, utility easements, publicly owned open space, etc.
- ✓ Replacement of like-species of trees.
- ✓ Use of like-species of trees in off-site planting sites.
- ✓ A county-wide policy stipulating a percentage of native oaks be planted in all projects requiring landscape design approval.

- ✓ In-lieu fees, or the Wildlife Conservation Board or County department in order to provide a funding source to expand the impact of oak restorative actions across a larger spatial context on publicly maintained sites and roadways.

The matrix you develop for your particular jurisdiction should be fluid and elastic over time. As information becomes available, the decision matrix you use should be adaptable to address the challenges of your county.

Appendix I: Mitigation Considerations

The following recommended process was developed to help estimate a compensation fee listed as a mitigation option in California Public Resources Code 21083.4. This text will be incorporated into the implementation Section III of the overall decision-support document.

1. The WCB or Counties themselves are the only entities that can receive funds under option 3 of California Public Resources Code 21083.4[1].

2. Consider where in the County oak woodlands should be conserved to protect the natural communities they harbor and associated natural resource values. Ultimately, these are areas where funds will be required to protect privately-owned oak woodlands in the county. Existing regional land conservation plans developed by the county, stakeholders, or conservation organizations can be used. If no such plan exists, large continuous areas of mixed oak woodlands that are in need of protection from land conversion should be identified through a planning process (see Planners Guidelines – link to order).

3. Acquire all recent sales (1-3 years) data from woodland properties that are a priority for land conservation identified in step 2. Using this data, determine median value per acre for purchasing land in its entirety and the price range for acquiring a conservation easement from properties in these areas. If the project area falls within the area of interest for conservation then these values should also be determined based on the area impacted by the project. We encourage you to use a qualified property appraiser who has met the educational requirements for General Certification pursuant to the Appraisal Qualifications Board of the Appraisal Foundation and who holds a designation from a recognized professional appraisal organization. The appraiser should be familiar with conservation easement valuation and should follow best practice guidelines (web link here to SCAOSD guidelines).

4. Calculate the impact area of the project and include; the building envelope, new roads, landscaping, all areas enclosed by a fence that prohibits animal movement, and include a border surrounding the building envelope which will likely be impacted by activities associated with development such as pets and invasive weeds. Development results in human-created woodland edges where the natural habitat

---

1

[1] (3) Contribute funds to the Oak Woodlands Conservation Fund, as established under subdivision (a) of Section 1363 of the Fish and Game Code, for the purpose of purchasing oak woodlands conservation easements, as specified under paragraph (1) of subdivision (d) of that section and the guidelines and criteria of the Wildlife Conservation Board. A project applicant that contributes funds under this paragraph shall not receive a grant from the Oak Woodlands Conservation Fund as part of the mitigation for the project.

ends and abuts the human-altered parts of the landscape. These edges can result in strong negative physical and biological impacts detectable as far as 1,640 feet into forested systems (Laurance 1995); therefore woodlands immediately adjacent to development will be impacted and should be considered as part of the impact area of the project.

5. Determine an appropriate mitigation ratio to determine the amount of in-kind (i.e. same type of woodland such as blue, valley or mixed) area that should be protected to compensate for the likely impacts associated with the proposed project.
    a. If you go with a 1:1 replacement this means that 50% of the woodland resources could ultimately be lost to development over the long-run.
    b. A 2:1 replacement will more fully compensate for the land impacted by the proposed development.

6. Calculate fee based on the cost of purchasing protected land in its entirety or through a conservation easement in the area identified as a priority for woodland conservation. The amount of protected land to base the fee on can be based on the number of acres impacted by the proposed (see #4) project times the mitigation ratio.

7. If the development being proposed is simply an addition to an existing structure or an outbuilding adjacent to an existing structure that will require the removal of a few trees; then compensation may best be approached through estimating the costs of replacing the trees removed. These estimates can be provided by a certified arborist or consult the International Society of Arboriculture standards for valuing trees of different sizes.

8. Sending this fee to the WCB satisfies the CEQA mitigation requirement detailed in California Public Resources Code 21083.4. The funds will remain with the WCB for future land conservation projects within that county. This allows for a transparent public process for reallocation of these funds to protect public trust benefits.

9. If the County is going to receive the money for compensation rather than the WCB they should consider:
    a. Collecting a fee for stewardship including compliance and resource monitoring. These fees often range from 5-10% of the total.
    b. The county should develop and continually update (every 5 years at least) a land acquisition plan that is approved by the county.
    c. The county should establish an independent spending authority to provide checks and balances to protect the public interest.
    d. County legal counsel will be responsible for ensuring that the public trust interests are protected through CEQA and for every negotiated conservation easement.
    e. The county will be responsible for compliance and resource monitoring of any conservation easements that they hold.

f. The funds collected as mitigation should not be transferred to a private company or non-profit without public oversight.
g. The time lag between collecting the fee and purchasing land as compensation should be minimized, while still allowing for enough funds to be accumulated to implement a beneficial acquisition.
h. If funds are held for a period of time, interest should be accrued in order to offset expected increases in land values.

Appendix II: PRC 12220

PUBLIC RESOURCES CODE SECTION 12220

12220. Unless the context otherwise requires, the definitions in this article govern the construction of this division.

(a) "Applicant" means a landowner who is eligible for cost-sharing grants pursuant to the federal Forest Legacy Program (16 U.S.C. Sec. 2103 et seq.) or who is eligible to participate in the California Forest Legacy Program and the operation of the program, with regard to that applicant, does not rely on federal funding.

(b) "Biodiversity" is a component and measure of ecosystem health and function. It is the number and genetic richness of different individuals found within the population of a species, of populations found within a species range, of different species found within a natural community or ecosystem, and of different communities and ecosystems found within a region.

(c) "Board" means the State Board of Forestry and Fire Protection.

(d) "Conservation easement" has the same meaning as found in Chapter 4 (commencing with Section 815) of Title 2 of Part 2 of Division 2 of the Civil Code.

(e) "Conversions" is a generic term for situations in which forest lands become used for nonforest uses, particularly those uses that alter the landscape in a relatively permanent fashion.

(f) "Department" means the Department of Forestry and Fire Protection and "Director" means the Director of Forestry and Fire Prevention.

(g) "Forest land" is land that can support 10-percent native tree cover of any species, including hardwoods, under natural conditions, and that allows for management of one or more forest resources, including timber, aesthetics, fish and wildlife, biodiversity, water quality, recreation, and other public benefits.

(h) "Landowner" means an individual, partnership, private, public, or municipal corporation, Indian tribe, state agency, county, or local government entity, educational institution, or association of individuals of whatever nature that own private forest lands or woodlands.

(i) "Local government" means a city, county, district, or city and county.

(j) "Nonprofit organization" means any qualified land trust organization, as defined in Section 170(h)(3) of Title 26 of the United States Code, that is organized for one of the purposes of Section 170(b)(1)(A)(vi) or 170(h)(3) of Title 26 of the United States Code, and that has, among its purposes, the conservation of forest lands.

(k) "Program" means the California Forest Legacy Program established under this division.

(l) "Woodlands" are forest lands composed mostly of hardwood species such as oak.

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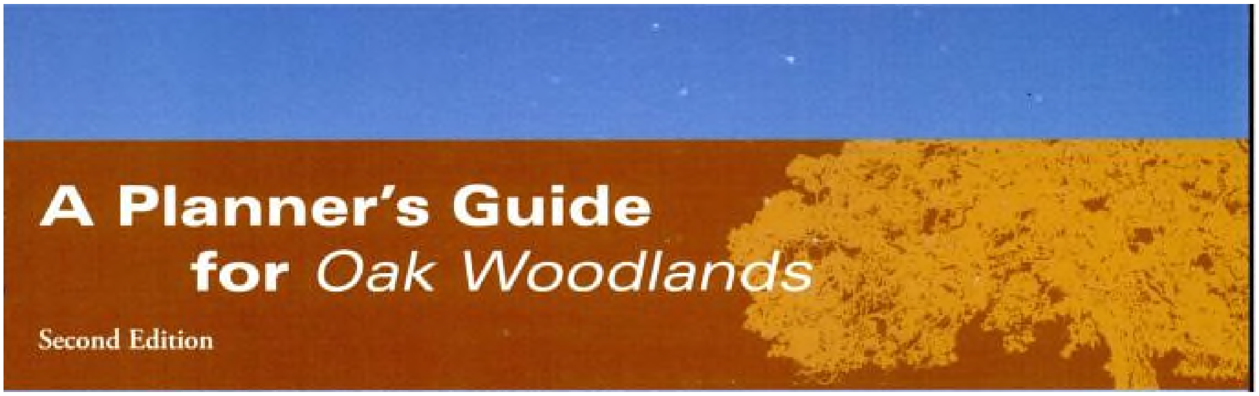

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Setback Recommendations to Conserve Riparian Areas and Streams in Western Placer County

Prepared for:

Placer County Planning Department

Prepared by

Jones & Stokes in cooperation with **PRBO Conservation Science**

February 2005

Setback Recommendations to Conserve Riparian Areas and Streams in Western Placer County

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February 2005

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Contents

Tables

Acronyms and Abbreviations

NCCP	Placer County Natural Communities Conservation Plan
HCP	Habitat Conservation Plan
RSPZs	Riparian and Stream Protection Zones
DFG	California Department of Fish and Game
USFWS	U.S. Fish and Wildlife Service
NOAA Fisheries	National Oceanic and Atmospheric Administration National Marine Fisheries Service
CEQA	California Environmental Quality Act
In	Inches
km	kilometers
Mi	mile
m	meters
Ft	Feet
PCWA	Placer County Water Authority
SOCs	synthetic organic compounds
DO	dissolved oxygen
CAFOs	concentrated animal feeding operations
N2	atmospheric nitrogen
NH4+	ammonia
NO2-	nitrite
NO3-	nitrate
O2	oxygen
SOCs	Synthetic organic compounds
PCBs	polychlorinated biphenyls

DDT	dichlorodiphenyltrichloroethane
Delta	San Joaquin Delta
C	Celsius
F	Farenheit
mg/l	milligrams per liter
M/sec	meter per second
Ft/sec	feet per second
SRA	Shaded riverine aquatic

Chapter 1
Introduction

Riparian areas provide important ecological functions (Table 1-1). They occupy the land between stream channel banks and adjacent uplands, and generally correspond to stream floodplains. These areas are transitional between terrestrial and aquatic ecosystems, and they contain gradients in hydrology, soils, ecological processes and biota (Brinson et al. 2002). Consequently, they perform ecological functions that are distinct from other components of the landscape. For example, riparian areas convey floodwaters and are important sites of denitrification, which returns nitrogen to the atmosphere. In western Placer County, they also provide essential habitat areas for a high diversity of aquatic and terrestrial wildlife species (Zeiner et al. 1988, 1990a,b; Moyle et al. 1996), including numerous threatened, endangered, and other special-status species that have been proposed for coverage under the Placer County Natural Community Conservation Plan (NCCP) and Habitat Conservation Plan (HCP) for the Phase I Planning Area (Jones & Stokes 2004a).

Because these areas provide such important ecological functions (including fish and wildlife habitat), a number of measures have been proposed to conserve riparian areas and aquatic ecosystems; these measures include establishing zones with land use restrictions (i.e., setbacks) around streams and riparian areas. Setbacks from streams and riparian areas have been widely recognized as necessary conservation measures. For example, the *Placer Legacy Open Space and Agricultural Conservation Program Implementation Report* (Placer County Planning Department 2000), which provided direction for development of a Placer County NCCP/HCP, identified Riparian and Stream Protection Zones (RSPZs) as an important component of the NCCP/HCP. Non-development setbacks encompassing and adjacent to riparian zones and streams are routinely recommended by local, state, and federal agencies including the Placer County Planning Department, the California Department of Fish and Game (DFG), the U.S. Fish and Wildlife Service (USFWS), and the National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries). These agencies have identified a need in western Placer County (and elsewhere in the Sacramento Valley) to develop a strong scientific foundation for recommending stream and riparian setbacks that include buffers to reduce effects from adjacent land uses.

The current study was designed to support efforts by the Placer County Planning Department to develop this scientific foundation for the establishment of stream and riparian setbacks. Its purpose was to review existing literature and make specific recommendations for riparian setbacks—particularly the width of such setbacks—that can be used in the California Environmental Quality Act (CEQA) or NCCP/HCP processes.

This report summarizes the results of the review. Each chapter addresses a set of related ecological functions performed by riparian areas and streams, as listed below.

- Hydrologic and geomorphic functions (e.g., groundwater recharge, sediment transport).
- Biogeochemical functions (e.g., nutrient cycling, degradation of contaminants).
- Provision of salmonid habitat.
- Provision of riparian plant habitat.
- Provision of wildlife habitat.

Each chapter describes the pertinent functions mechanistically, reviews the effects of human alterations on the functions, assesses the relationships between setback width and human activities, and concludes with recommendations for setback widths. The recommendations are intended to provide for long-term conservation of the relevant function by protecting the riparian area as well as a defined buffer that will reduce the effects of adjacent land uses on riparian and aquatic systems. In these recommendations, and throughout the report, all distances refer to only one side of streams.

The report concludes with an overall setback recommendation that includes setback widths and guidance regarding uses of setback land that may be compatible with resource conservation.

Table 1-1. Ecological Functions of Riparian Ecosystems[a]

Hydrologic and Geomorphic Functions	
	Recharge of groundwater
	Storage of surface water
	Conveyance of floodwaters and other overland flows
	Transport of sediment
	Storage of sediment
Biogeochemical Functions	
	Production of biomass (i.e., primary production)
	Storage of carbon in vegetation and soil
	Cycling of phosphorus
	Cycling of nitrogen
	Cycling of micronutrients
	Adsorbtion, storage, and transformation of non-nutrient metals (e.g., mercury)
	Adsorbtion, storage, and degradation of pesticides and hydrocarbons
Habitat Functions	
	Sustenance of characteristic plant associations
	Sustenance of aquatic animal habitats
	Sustenance of terrestrial animal habitats

[a] Based on lists of functions in Keddy 2000 and Brinson et al. 2002.

Chapter 2
Hydrologic and Geomorphic Functions

Overview

Hydrologic and geomorphic functions involve the transport and storage of water and sediment. Streams—comprising stream channels and floodplains—are integral to the provision of those functions. Riparian vegetation occupies floodplains; for the purposes of this report, riparian areas may be considered synonymous with floodplains. Sediment and water are transported to streams from throughout the watershed; upon reaching the stream, sediment and water move down the stream and occasionally outwards onto the floodplain. In response to these inputs of water and sediment, the form of stream channels and floodplains changes. These dynamic changes can in turn affect most ecological functions provided by riparian areas and aquatic ecosystems. This chapter describes these processes and the effects on them caused by human activities. The chapter concludes with an assessment of the relationship of setback width and human effects, and offers the project team's recommendation for setback widths to conserve hydrologic and geomorphic functions.

Effects of Human Alterations on Movement of Water and Sediment to Riparian Areas and Streams

Watershed Hydrology

In the absence of human alterations (e.g., interbasin water transfers), streamflows originate from the precipitation falling throughout a stream's watershed. Rainfall is the predominant form of precipitation in most of western Placer County. Before reaching a stream, precipitation may infiltrate to become groundwater or return to the atmosphere through evapotranspiration. Human alterations affect the proportion of precipitation following each of these pathways, and thus the quantity and timing of streamflows, which in turn influences geomorphic functions in the stream corridor.

Evapotranspiration

Evapotranspiration is the loss of water to the atmosphere due to the diffusion of water vapor from the interior of plant leaves (transpiration) and from soil and other surfaces (evaporation). It can dominate a watershed's water balance and can influence soil moisture content, groundwater recharge, and streamflow.

Air temperature and humidity determine the potential rate of evapotranspiration, whereas water availability determines its actual rate. Under cool or moist conditions, water availability does not limit evapotranspiration; actual and potential evapotranspiration are equal. Under drier and warmer conditions, as surfaces and soils dry, plants reduce their use of water by a combination of closing their leaf pores (i.e., stomata), changing leaf angles, losing leaves, becoming dormant, or dying (Barbour et al. 1998). Thus, under dry and warm conditions, actual evapotranspiration is limited by water availability.

Not all water is available for evapotranspiration. Only water stored at the earth's surface (i.e., surface water and water intercepted by surfaces) or in soils is available for evapotranspiration. Therefore, the timing of precipitation and the time water resides in a watershed strongly influence actual evapotranspiration.

Western Placer County has a Mediterranean-type climate, characterized by concentration of rainfall during the coldest months of the year. Consequently, only water stored in soils, streams, and other water bodies is available for evapotranspiration during summer months when the potential evapotranspiration is greatest. During these months, vegetation can remove a substantial fraction of the water within riparian areas and streams. For example, in July in the Sacramento Valley, potential evapotranspiration is about 0.8 centimeters (cm) (0.3 inches [in]) per unit area each day (California Department of Water Resources 2004). This corresponds to about 18 acre-feet of water being transpired by 1.6 kilometers (km) (1 mile [mi]) of a riparian corridor 30 meters (m) (98 feet [ft]) wide on each side of a stream.

Human alterations can increase or reduce evapotranspiration. Importing water from other watersheds or withdrawing groundwater from below the rooting zone to irrigate agricultural lands and landscaping can increase evapotranspiration by increasing the availability of water. Removing vegetation or increasing runoff can reduce evapotranspiration. Alterations that remove vegetation include both the temporary removal of biomass (e.g., timber harvesting, woodcutting) and the permanent conversion of natural vegetation to developed land uses with impervious surfaces (e.g., roofs, paved roads). Alterations affecting runoff are described in the next section.

Runoff

There are three basic types of runoff.

- Overland flow.
- Subsurface flow.
- Saturated overland flow.

Each of these runoff types can occur individually or in some combination in the same locale. Despite involving belowground flow, subsurface and saturated overland flow are considered components of runoff because they are closely linked to overland flow.

Overland flow occurs when the rate of rainfall or snowmelt exceeds the rate of water movement into the soil (i.e., infiltration rate). The infiltration rate is affected by soil structure and moisture content (infiltration diminishes as water saturates a soil). Areas with natural vegetative cover and leaf litter usually have high infiltration rates. These features protect the surface soil pore spaces from being plugged by fine soil particles as a consequence of raindrop splash.

Overland flows may subsequently enter the soil as rainfall diminishes in intensity or ceases, or they may reach a stream channel before entering the soil. Slope and vegetation affect the speed of overland flow, and thus the portion that discharges directly into stream channels.

Subsurface flow is a storm-generated pulse of groundwater. Once in the soil, water moves in response to differences in hydraulic head (i.e., the potential for flow resulting from a difference in hydrostatic pressure at different elevations). Before a storm, where the water table slopes toward a stream, water moves down and into the stream channel as baseflow. During a storm, as rainwater infiltrates the soil, the water table can rise more rapidly near the stream than it does further upslope. This can happen when the soil near the stream has greater moisture content and a shorter distance to the water table than does soil upslope. As the water table becomes locally steeper, this newly arrived groundwater moves relatively rapidly towards the stream channel, mixes with baseflow, and increases groundwater discharge to the channel.

Saturated overland flow is a combination of direct precipitation and subsurface flows. Where the water table reaches or emerges from the surface, soils are saturated. Consequently, all rain falling on these soils, as well as emerging groundwater, flows downslope as overland runoff.

Human alterations increase runoff by reducing the soil's infiltration capacity (i.e., maximum rate of infiltration). Conversion of natural vegetation to developed land cover causes the greatest reduction in infiltration. However, agricultural lands also exhibit reduced infiltration capacity compared to natural vegetation. Heavy machinery, livestock, and even humans can compact soils, reducing infiltration. Moreover, removal of vegetation can expose the soil surface to the impacts of raindrops, reducing soil pore spaces and infiltration. In western Placer County, these alterations have affected extensive portions of the landscape. For example, along the major streams of western Placer County, approximately a quarter of the land < 20 m (66 ft) from the centerline of a stream, is in developed or agricultural land-cover (Jones & Stokes 2004a, 2004b).

Groundwater

Gravity causes water to move downward through soil until it reaches an area already saturated with water. The top of this saturated zone defines the groundwater table. However, the movement of groundwater may be quite complex. The permeability of sediments and rock strongly influences the rate of groundwater movement. Water moves easily through larger pores and more slowly through smaller pores. In addition, layers of sediment or rock with low permeability (i.e., confining beds) may severely restrict groundwater movement. Thus, where the permeability of sediments and rock varies considerably, complex patterns of groundwater movement may occur. Riparian areas typically have considerable variability in the permeability of their sediments.

Human alterations can affect groundwater through several different mechanisms. First, activities that affect runoff or evapotranspiration affect the proportion of precipitation that becomes groundwater. Second, because streamflows can be an important source of groundwater, alterations that reduce streamflows can also reduce inputs to groundwater. Third, alterations that affect the quantity of groundwater (i.e., groundwater withdrawals) can change the elevation of the groundwater table. Drainage ditches and tiles also lower the water table's elevation.

Erosion

Gravity, wind, and water transport soil to riparian areas and streams. Soil is dislodged when the force of wind, water, or gravity exceeds the forces holding soil in place. Several factors affect the balance of these forces: the soil's physical properties; vegetation structure; topography; and the quantity, concentration, and speed of runoff. Soil characteristics, such as lithology (i.e., rock or mineral content), cohesion, and granulometry (i.e., grain size association), influence the erodibility of soils. Vegetation reduces erosion by binding soil particles and by slowing wind and water (Brinson et al. 2002); accordingly, greater cover of vegetation reduces the potential for erosion. Because both velocity and shear stress increase with slope, the potential for erosion increases with the angle and length of upland slopes. Also, as more runoff is generated and concentrated (i.e., greater runoff depth), the force exerted by flowing water on the soil surface—and hence erosion— increases.

Gravity can also induce the slow downhill movement of soil and rock (i.e., soil creep) and mass failures such as debris flows. In steep terrain, mass failures can transport enormous quantities of sediment into riparian areas and stream channels. Mass failures are often triggered by intense rainstorms falling on saturated soils (Swanston 1991). Under such conditions, soil is particularly heavy due to the added water, and subsurface flows can reduce the forces that offset gravity. Although western Placer County generally has gently sloping topography, that is not conducive to mass failures, slopes can be steep along stream channels, particularly near the area's eastern boundary in the Sierran foothills.

The magnitude and distribution of erosion in watersheds affect the yield of sediment to the stream corridor. Soil erosion can occur gradually over a long period or it can be cyclic or episodic, accelerating during certain seasons or during certain rainstorm events (Grove and Rackham 2001). Erosion does not proceed at a uniform rate, because rainstorms are episodic events of varied intensity and because the forces binding soils continually change with temperature, moisture content, and vegetation structure.

Human activities strongly alter patterns of erosion and thus the quantity of sediment entering riparian areas and streams. In the Sacramento Valley and adjacent foothills, human-induced fine sediment loading is primarily due to changes in land use that both alter the vegetative cover and increase runoff. The three main land uses generating sediment in the region are agriculture, in-channel mining, and construction activities. The effects of silvicultural activities, though discussed in this section, are concentrated at higher elevations in the central and eastern portions of the county.

Agriculture generally exposes friable topsoils to raindrop erosion, which has the potential to generate large amounts of sediment (Waters 1995). In the Sacramento Valley and adjacent foothills, additional land is still being converted from natural vegetation to agriculture. Much of this new agricultural land is of marginal quality and on relatively steep slopes, and is consequently likely to generate more sediment than agricultural land with gentler slopes (Charbonneau and Kondolf 1993).

Gravel mining can increase fine sediments in streams and streambeds. Gravel mines are often in the active floodplain or even the stream channel itself, and because processing of aggregate occurs on site, this activity can add fine sediment directly to the stream and streambed. Gravel mining is on-going in the historic floodplains of at least two streams in western Placer County (EDAW 2004; Jones & Stokes 1999).

Forestry practices, including clear-cutting, skidding, yarding, site preparation, and road construction and maintenance, can substantially increase sediment input to streams. Poorly designed logging roads and skid trails are persistent sources of sediment. Open slopes with soils exposed by yarding activities, scarification, or by associated mass failures or fires erode easily (Chamberlain et al. 1991).

Residential development, industrial construction, streets and utilities, and other urban infrastructure elements can increase sediment movement to streams

(Waters 1995). Excavation for infrastructure construction and maintenance is a primary source of sediment transported to streams. Development on steep hillsides further increases erosion and transport of sediment (Renard et al. 1997).

In addition to these effects of general types of land use activities, roads, graded and recontoured land, and the routing of stormwater drainage can all spatially concentrate runoff, and hence increase both surficial erosion and the likelihood of mass failures.

Effects of Human Alterations on Water and Sediment Movement along Streams

Flow Regime

Streamflows originate in runoff and groundwater entering the stream channel. As this water moves along the stream it may follow several different pathways. Some water will evaporate from the surface of the flow. Some will enter the sediments underlying the channel and floodplain, where it will intermix with groundwater in a zone (i.e., the hyporheic zone) that can extend from several to more than a hundred meters from the channel (Brunke and Gonser 1997). (This hyporheic zone is habitat for invertebrates and microbes that have important roles in nutrient cycling and the degradation of pollutants.) Stream water entering the hyporheic zone may reenter the channel downstream; alternatively, in reaches where the water table is lower than the stream channel, the water entering the hyporheic zone may continue to flow away from the stream toward the water table. During high streamflows, the channel may not be able to convey the entire flow, and streamflows spill over the channel banks onto the floodplain, and may or may not reenter the channel downstream.

Streamflows are typically highly variable across days, seasons, and years. Most aspects of a stream’s flow regime (i.e., the pattern of streamflow), including magnitude, frequency, timing, and duration, have consequences for sediment transport and channel form, and indirectly or directly affect organisms. For example, low flows can reduce the area of aquatic habitats. High flows can wash away eggs or, through sediment movement, can sustain or degrade habitats. Rapid declines in flow can strand fish.

Together with the pattern of water inputs from the watershed, channel form and vegetative structure determine a stream’s flow regime. The slope, area, form, and roughness (i.e., irregularity of the surface) of the channel and floodplain surface determine the depth and velocity of streamflows, as well as their magnitude and duration.

As a stream’s discharge (i.e., the volume of water discharged per unit time) increases, either flow velocity, flow area, or both must increase. Similarly, as water flows along a stream, the depth, velocity, and cross-sectional area of the flow change to maintain a constant discharge. This occurs because as more water enters than exits a section of channel, the volume of water in that section increases, changing the width and depth of the flowing water until the discharge entering the segment equals the exiting discharge. As width and depth change flow velocity changes.

Flow velocity is a product of slope (which causes water to accelerate as it moves downhill) and the surface over which the water flows (the character of which can impede or facilitate the water's passage through friction or the lack of it). At a given slope, water velocity decreases as the roughness of the inundated surface increases. Vegetation, coarse sediment, and larger obstacles all increase roughness. For example, the encroachment of woody plants into a stream channel reduces the velocity of water, and consequently the channel's capacity to convey floodwaters before inundating the floodplain; for this reason, woody plants are removed from many stream banks to maintain floodwater conveyance.

Flow regime is changed to some degree by all human activities that alter the quantity or timing of water inputs to streams or the movement of flows along streams. Surface water diversions, groundwater withdrawals, and inter-basin water transfers change the quantity of water entering streams. When these waters are used for irrigation during California's summer dry season (and subsequently drain back to streams), they change the seasonality as well as the levels of flows. Conversions of land cover throughout the watershed affect the rate at which water enters streams. As described in *Watershed Hydrology* above, replacement of natural vegetation with agricultural or developed lands increases runoff. This increased runoff results in higher peak streamflows because, after rainstorms, runoff enters streams much more rapidly than does groundwater. Decreased infiltration is also associated with increased runoff; such decreased inputs to groundwater can reduce low flows, and can even convert a perennial flow regime to a seasonal or intermittent one. These changes are most dramatic along urban streams where much of the watershed consists of developed lands with a high proportion of impervious surfaces (Hollis 1975; Macrae 1996; Booth and Jackson 1997; Paul and Meyer 2001).

Interbasin water transfers are a particularly significant human alteration of flow regimes in western Placer County (Jones & Stokes 2004b). Water is diverted from the Bear River's watershed into Coon Creek, Doty Ravine and Auburn Ravine. Water is also diverted from the American River's watershed into Auburn Ravine. Because large quantities of water (about 20,000 acre-feet) are transferred by the Placer County Water Authority (PCWA) from the American River watershed to the City of Roseville, it is likely that interbasin transfers augment flows in the Dry Creek watershed as well (ECORP 2003).

Modifications of channels and floodplains also alter flow regime. Vegetation removal that is conducted to clear channels or that results from grazing, logging, or conversion to agricultural and developed lands can reduce roughness, thereby increasing flow velocities. Physical alterations to the channel and floodplain (e.g., channelization, levees, berms) also changes flow regimes. For example, the straightening and deepening of the channel to improve conveyance (channelization) speeds velocities and increases peak flows downstream. Dams and reservoirs can affect all aspects of flow regimes, and in some instances replace the previous flow regime with a new regime determined by the schedule of releases from a reservoir. Common downstream effects of reservoirs include a reduction in overall flows, reduced peak flows, and rapid changes in discharge (Stanford et al. 1996; Brinson et al. 2002). Along some Sacramento Valley streams, reservoir releases in conjunction with drainage from irrigated lands have increased summer flows, converting seasonal flow regimes to perennial ones.

Sediment Transport

Sediment transport is directly related to stream power. A stream's power is a product of its discharge, the specific weight of water (which is essentially a constant), and slope. Stream power represents the quantity of work that a streamflow can perform (i.e., the rate of potential energy expenditure per unit length). Most of this energy is dissipated overcoming friction at the channel and floodplain surface, but a small portion moves sediment.

The portion of stream power that moves sediment depends on several stream attributes. The movement of sediment downstream only occurs when the force exerted by water along the surface of the channel (shear stress) exceeds the forces holding sediment in place. The magnitude of shear stress and the forces that offset it are affected by the following factors.

- Flow depth and velocity.
- Channel morphology.
- Sediment size.
- Adhesion of particles.
- Binding of particles by roots.

Sediment transport is increased by conditions that concentrate the force of flowing water (e.g., confining flow to a narrower channel) or reduce the resistance of particles to their displacement (e.g., loss of vegetation and hence of roots).

Sediment transport in any given stream is greatest during peak flows. Not only does shear stress increase with flow depth and velocity, but the relationship between shear stress and sediment transport is non-linear (Gordon et al. 1992). In other words, the increased force exerted by peak flows results in a disproportionate increase in the capacity to transport sediment.

Human alterations affect sediment transport by changing flow regime or sediment inputs to streams, and by blocking the continuity of sediment delivery along a stream. Human effects on flow regime and sediment inputs have already been described in the flow regime and erosion sections of this chapter. The movement of sediment along a stream may be blocked by dams or reduced by pits from gravel mining. Dams block the downstream movement of coarser sediment from the upper portions of watersheds of most rivers and streams in the Sacramento Valley. In-stream gravel mining produces pits that trap incoming sediment (Mount 1995).

Effects of Human Alterations on Channel and Floodplain Form

The form of stream channels and their floodplains affects the important stream and riparian functions listed below.

- Transport and storage of sediment.
- Conveyance of floodwaters.
- Provision of floodplain habitats.
- Provision of aquatic habitats.

For example, the shape and gradient of channels affects the location of areas of sediment deposition and removal. Similarly, fish spawning and rearing habitats are affected by the interplay of channel geometry with flow depth, velocity, and the scour and deposition of sediments.

The form of a stream's channel and floodplain is a product of water and sediment inputs from the watershed, geologic constraints, channel or floodplain vegetation, and historic events. Consequently, changes in sediment inputs, flow regime, or vegetation cause changes in channel and floodplain form. These geomorphic responses can be complex because of interactions among these important factors. Flow regime, sediment transport, and vegetation influence each other; changes in channel and floodplain form likewise affect the growth of plants and the movement of water and sediment. Consequently, changes in a watershed may cause channels and floodplains to undergo complex patterns of change across decades.

Channel Morphology

In the absence of human alterations, the form of stream channels is not static, unless constrained by geology. Channel and floodplain morphology changes slowly in response to long-term changes in climate; it can also change rapidly in response to periodic intense storms or to massive inputs of sediments from slope failures.

Human alterations often cause changes in flow regime and sediment input that lead to unstable channels with rapidly changing forms. Unstable channels result from rates of erosion and sedimentation that are much more rapid than in comparable, but relatively unaltered, streams (Doyle et al. 2000). This instability can affect riparian and stream biogeochemical and habitat functions (Paul and Meyer 2001; Brinson et al. 2002).

Channel instability has both horizontal (channel bed) and vertical (channel banks) components. A longitudinal section of streambed is stable when the size and quantity of sediment entering the section equals the size and quantity of sediment carried downstream. If the capacity of flows to transport sediment changes (e.g., change in peak flows) without a corresponding change in sediment inputs, or vice versa, then net erosion or deposition will occur and the channel may become unstable. The rising (i.e., aggradation) or lowering (i.e., incision or degradation) of channel beds generally alters flows of groundwater and surface water through riparian areas by changing the elevation or slope of the water table, and by changing the discharge necessary for overbank flows.

The stability of channel banks is affected not only by the shear stress of flowing water, but also by the force of gravity pulling bank sediments downward, which can lead to mass failure of sections of bank (i.e., bank failure). The binding of sediment particles by plant roots can substantially reduce bank erosion. A tree's roots typically extend up to twice the radial distance of the tree's crown; thus, in western Placer County, trees up to 20 m [66 ft] from the channel may contribute to bank stability. Therefore, bank retreat (i.e., net linear recession of the bank) is increased not only by changes in flow regime that increase shear stresses, but also by removal of vegetation along the banks (Lawler et al. 1997).

Human alterations affect channel stability through changes of flow regime, sediment transport, or channel vegetation, or by placing structures along or in the channel. Human activities altering flow regime, erosion, and sediment transport are described in the respective sections of this chapter. Their net affect on channel form is to alter the balance between erosion and deposition along the stream channel, causing a corresponding change in channel form.

Channel bank vegetation is directly altered by grazing, channel maintenance, wood cutting and timber harvesting, land-cover conversion, and even by the trampling associated with intensive recreational use. All these activities may lead to bank retreat. With the exception of timber harvesting, these activities occur locally along western Placer County's streams (Placer County 2002; Appendix A)

Channel vegetation is also altered by activities that change flow regime, water table elevation, or channel stability. If changes to flow regime or water table elevation reduce water availability during the growing season, vegetation will be altered and will probably exhibit reduced roughness or a lower density of roots to bind bank sediments. Conversely, reduced flows may allow riparian vegetation to establish on lower-elevation surfaces within the channel, where establishment and survival were previously not possible because of scouring or prolonged submergence (Pelzman 1973). The latter scenario has occurred along a number of Sacramento Valley streams below dams (Pelzman 1973; CALFED 2000b). This encroachment of vegetation on the channel stabilizes channel sediments.

The changes in erosion, runoff, and peak flows associated with conversion of natural vegetation to developed land cover generally cause channel instability (Paul and Meyer 2001). Though channels may transiently aggrade with sediment eroded from construction sites, the higher flow peak flows associated with runoff from developed lands are capable of eroding and transporting more sediment (Wolman 1964). This tends to cause channel incision, bank retreat, or both, and a resulting increase in the channel's cross-sectional area. The slope and meanders of stream channels also may change (Riley 1998). Other changes in vegetation or land cover may cause effects comparable to those from conversion to developed lands. Incision is widespread along western Placer County's streams, and has reduced the area of floodplain inundated by floodflows, and thus detrimentally affected most riparian functions (Placer County 2002; EDAW 2004; Jones & Stokes 2004c).

All structures constructed in the channel or active floodplain to some degree alter flows and sediment erosion and deposition, and thus have consequences for channel form. The most substantial effects result from bank protection, berms and levees, and dams. Bank protection (e.g., stone revetment, riprap) is installed for the purpose of reducing lateral movement of the channel. Berms and levees restrict floodwaters to a small portion of the floodplain, and thus may create deeper and faster peak flows capable of eroding and transporting more sediment, which in turn may expand channel cross-sectional area. Berms and bank protection exist occur along western Placer County's streams, particularly at lower elevations. Other structures include numerous road crossings and about thirty dams (County of Placer 2002; DWR 2002; Bailey Environmental 2003; Foothill Associates 2004; Jones & Stokes 2004b)

The construction of dams to form reservoirs contributes to accelerated channel erosion below the dams and to changes in the particle size on the riverbed (Kondolf 1997). Water released from dams is relatively free of sediment, particularly coarse sediment (i.e., larger than 2 mm in diameter). The relatively sediment-free flow results in net erosion of channel bed and banks, often leading to channel incision. Without the input of coarse sediment from upstream, the area of gravel beds in the channel is reduced, and the remaining gravel is often of larger sizes that are not mobilized by flows released from the dam (i.e., armoring of the channel). Dams also reduce peak flows, resulting in a reduction of channel size and accumulation of finer sediment along and within the river channel (Kondolf 1997). Flashboard dams, however, may have lesser effects if removed during peak flows. Most dams in western Placer County are flashboards dams, and many are removed during peak flows (DWR 2002; Placer County 2002; Bailey Environmental 2003)

Stream channel shape is directly altered by channelization and in-channel gravel mining. As mentioned earlier in this chapter, channelization converts streams into deeper, straighter, and often wider shapes to improve conveyance of floodwaters. It increases peak flows and can promote channel instability, which may lead to lowering of the water table (Gordon et al. 1992). In-channel gravel mining removes material from the channel bed and thus lowers its elevation (Bravard et al. 1997).

Floodplain Morphology

The active floodplain is the geomorphic surface adjacent to the stream channel that is typically inundated on a regular basis (i.e., a recurrence interval of about 2–10 years or less). It is the most extensive low depositional surface, typically covered with fine overbank deposits, although gravel bar deposits may occur along some streams. The floodplain surface often contains abandoned channels or secondary channels (i.e., chutes).

The stream migrates laterally across the floodplain as the outside of the meander bend erodes and the point bar builds with coarse-textured sediment. This naturally occurring process maintains the cross section needed to convey water and sediment from the watershed.

Floodplains are built by two stream processes: lateral and vertical accretion. Lateral accretion results from differential erosion and deposition along the channel. In unconstrained rivers, bank retreat is concentrated on the outside (concave side) of bends in the channel (i.e., meanders), forming cut banks; deposition occurs on the inside (convex side) of bends, forming point bars. This difference in erosion and deposition along channel bends causes channels to migrate across the floodplain. Other floodplain features also arise through channel migration. Where bends become cut off at their base (because erosion joins their upstream and downstream ends), oxbow lakes are formed. Where higher flows cross over point bars, chutes may form. Channel shifts to old or new courses (i.e., channel avulsion) can occur during floodflows, and may cut off meander bends and change the channel's form.

Vertical accretion is the deposition of sediment on flooded surfaces. It occurs when flows exceed the channel's conveyance capacity, inundate the floodplain, and deposit sediment. Though most floodplain sediment is deposited through lateral accretion (Leopold et al. 1964), overbank flows and the associated vertical accretion have a significant effect on aquatic and floodplain habitats that are described in subsequent chapters of this report.

Lateral and vertical accretion are affected by human alterations that modify flow regime, sediment supply, and channel stability or that construct structures within the floodplain. Human alterations affecting flow regime, sediment transport, and channel form alter the rate of channel movement and the frequency of overbank flows. These alterations, including the effects of dams, have been described in the preceding sections of this chapter. All structures within the channel or floodplain alter flows and accretion to some degree. However, the most substantial alterations are bank protection, which is installed specifically to reduce lateral channel migration, and berms and levees, which restrict floodwaters, and thus vertical accretion, to a small portion of the floodplain.

Relationships Between Human Effects and Riparian Setback Width

Riparian setbacks can reduce the effects of human alterations on water and sediment inputs to streams; if they extend beyond the active floodplain, setbacks can also reduce direct effects on flow regime, sediment transport, and channel and floodplain morphology. However, many effects of human alterations on hydrologic and geomorphic functions would be relatively unaltered by setbacks.

There has been considerable research on the effects of natural riparian vegetation or managed buffers on the movement of runoff and suspended sediment. (This literature has been reviewed by Castelle et al. 1992; Wenger 1999; Brinson et al. 2002; Lowrance et al. 2002; Correll 2003). This research indicates that setbacks have three beneficial effects: slightly reducing the area of sediment sources in a watershed, increasing the distance of runoff and erosion sources from streams, and interposing a zone of vegetation with high roughness and high infiltration capacity between streams and sources of runoff and erosion. The roughness of both natural and managed vegetation can slow runoff and cause the deposition of sediment before it reaches the stream. This deposition of sediment increases with vegetation width; at any given width, deposition is greatest when flows are evenly distributed (not locally concentrated) and when vegetation and topography are uniform (Herrone and Hairsine 1998; Wenger 1999; Brinson et al. 2002).

Numerous studies document the effectiveness of managed or natural vegetation in removing suspended sediment, particularly sands and silts, from runoff before it reaches stream channels (Castelle et al. 1992; Wenger 1999; Brinson et al. 2002; Lowrance et al. 2002). (Because clay particles are very small [less than 2 μm], they remain suspended even in still water for hours, and thus are much more likely to remain in runoff.) If this sediment is deposited on the active floodplain, it may be only temporarily stored there before entering the stream channel. However, if sediment is removed from runoff before it reaches the floodplain, it is much less likely to be remobilized into the stream channel. Setbacks may also reduce the likelihood of mass failures on adjacent slopes by including susceptible terrain inside the buffer, where human alterations are less likely to cause mass failures (Rhodes 1994; Tang and Montgomery 2004).

There is considerable variation among the results of studies assessing the relationship between the width of buffers and sediment removal from runoff. A number of studies document narrow buffers (less than 10 m [33 ft]) removing substantial amounts of sediment from runoff (Castelle et al. 1992; Wenger 1999; Lee et al. 2000; Hook 2003). However, many of these have been short-term studies or studies of managed buffers that were conducted under a narrow range of conditions. Short-term studies probably underestimate the distance sediment is able to be moved across buffers because erosion is a highly variable process, largely associated with intense storms and other unusual events (Grove and Rackham 2001). Similarly, small-scale studies of managed buffers probably underestimate the quantity of sediment that is able to cross unmanaged buffers because natural topography and vegetation are quite varied, and can concentrate flow, have less roughness than managed vegetation, or provide additional sources of runoff or sediment at some locations. These findings are supported by other studies that have indicated wider buffers (20–60 m [66–197 ft]) are necessary to remove most sediments (Cooper and Gilliam 1987; Castelle et al. 1992; Davies and Nelson 1994; Wenger 1999). These include longer-term studies that have shown most sediment moving considerable distances into riparian areas (Cooper et al. 1987), and studies that document effects of excessive sedimentation on aquatic organisms in streams bordered by wide buffers (Megahan 1987 *in* Rhodes 1994).

Setbacks of sufficient width to include the entire active floodplain prevent structures and developed land uses from impeding overbank flooding and channel migration. Setbacks including the entire active floodplain also reduce direct effects of human activities on bank stability.

Recommended Setback Width to Conserve Hydrologic and Geomorphic Functions

For the purpose of long-term conservation of hydrologic and geomorphic functions, the project team recommends that riparian setbacks include the entire active floodplain, regardless of the current extent of riparian vegetation on that surface, and that an additional 30 m (98 ft) buffer be included within the setback. This width should be sufficient to substantially slow or infiltrate much of the runoff from adjacent uplands, and to remove excessive sediment from that runoff prior to its entering the active floodplain.

It is important to note that setbacks do not ameliorate many effects of human alterations on hydrologic and geomorphic functions. Some effects are offset only if the activities causing them are excluded from the setback. Examples of these activities include riparian vegetation removal, grazing, and channel modifications. Other alterations are only partially offset, such as the effects of developed or agricultural land cover on runoff and groundwater. Finally, other effects are not addressed by riparian setbacks. These include the effects of surface water diversions, groundwater withdrawals, and dams. Therefore, to conserve hydrologic and geomorphic functions, other measures are necessary in addition to setbacks.

Chapter 3
Biogeochemical Functions

Introduction

Biogeochemical functions cycle elements among compounds and locations by biological and geological mechanisms. For example, in the carbon cycle, photosynthesizing plants remove carbon from the atmosphere; through respiration, plants, animals, and microbes return carbon to the atmosphere. A substantial quantity of carbon is stored in these organisms and in the organic matter derived from them. Nutrient cycles are essential to ecosystem functions; moreover, such cycles facilitate the transformation and degradation of contaminants entering these ecosystems.

All terrestrial habitats provide some biogeochemical functions. However, riparian areas are particularly important for nutrient and other element cycles because they are ecotones (transitional zones) between terrestrial, fluvial, and groundwater systems. Consequently, riparian areas have substantial effects on water quality because they help to regulate the transfer of sediment and water, and because they facilitate chemical transformations of contaminants (Naiman and Decamps 1997; Brinson et al. 2002).

This chapter reviews the transport, storage, and transformation of nutrients, metals, and synthetic organic compounds (SOCs; e.g., most pesticides) in riparian areas, and the consequences of human alterations for these ecosystem processes. The chapter concludes with a summary of the relationships between riparian setback widths and human influences on biogeochemical processes.

Effects of Human Alterations on Biogeochemical Functions

Macronutrients

Agricultural and developed lands are major sources of nitrogen and phosphorus entering streams and rivers (Jackson et al. 2001). In aquatic ecosystems, over-enrichment with phosphorus and nitrogen (i.e., eutrophication) causes a wide range of problems, including degradation of water quality for human uses (e.g., irrigation, drinking, recreation), toxic algal blooms, loss of biodiversity, and fish kills (Richter et al. 1997; Jackson et al. 2001). These detrimental effects are largely due to greatly increased growth of microbes, algae, and plants, accompanied by the decomposition of their biomass and the resulting depletion of dissolved oxygen (DO). DO is frequently the key substance in determining the extent and composition of life in water bodies (Manahan 1994). For instance, it was found to be one of the best environmental predictors of invertebrate community composition in flow-through constructed wetlands (Spieles and Mitsch 2000). Salmonids are particularly sensitive to low DO concentrations (Bjornn and Reiser 1991).

The cycles of phosphorus and nitrogen involve different mechanisms, and riparian areas affect these cycles differently. Accordingly, these cycles and the effects of human alteration are described in separate sections below.

Phosphorus

Ultimately, all phosphorus originates from the weathering of rock; it should be noted that different rock types may have substantially varied phosphate contents (Wetzel 2001). However, because it is a macronutrient, phosphorus concentrates in organisms; consequently, organic matter, fertilizer applications, wastes from concentrated animal feeding operations (CAFOs), and sewage are all important sources of the phosphorus entering streams (Jackson et al. 2001).

The availability of soluble phosphorus (i.e., phosphorus in a molecule dissolved in water) is strongly affected by pH (Wetzel 2001). Soluble phosphorus is most available at a pH of 6–7; consequently, it is most readily leached from soils of that pH range. At lower pH values, phosphorus combines readily with aluminum, iron, and manganese. At higher pH values, greater amounts of phosphate combine with calcium as calcium phosphates and apatites (i.e., minerals in which calcium and phosphorus combine with other elements). These reactions (that predominate above and below the pH 6–7 range) result in the formation of insoluble complexes and the adherence of phosphorus to the surfaces of clay particles.

In most environments (including waters with pH values of 6–7), insoluble forms of phosphorus predominate because they readily form and persist longer than soluble forms, which are rapidly taken up by microorganisms and plants or are sorbed to soil particles (Marschner 1995; Wetzel 2001). (Sorption includes absorption, adsorption, and physical interspersion or association.) Consequently, runoff is the primary means by which phosphorus enters waters, because most phosphorus is transported to streams adhered to soil particles or associated with particles of organic matter (Wenger 1999; Jackson et al. 2001; Wetzel 2001). Insoluble and sediment-bound forms of phosphorus may subsequently become soluble in streams.

Though phosphorus is readily bound to particles of clay and organic matter, soils cannot retain unlimited quantities of phosphorus. Therefore, high inputs of phosphorus could saturate binding sites in riparian soils. This saturation was suggested by the results of several studies (reviewed in Wenger 1999) where the percent of phosphorus inputs removed by newly established buffers declined over time.

Human alteration of ecosystems can affect the transport and storage of phosphorus in riparian areas through the effects of adjacent land uses, conversion of riparian areas to agricultural or developed land cover, hydrologic and geomorphic alterations, and alterations of riparian vegetation and soils. In addition to increasing phosphorus inputs, adjacent land uses can increase or concentrate overland flows, or even route them past riparian areas. For example, the Roseville Wastewater Treatment Plant adds effluent containing substantial quantities of phosphorus to Dry Creek (ECORP 2003), and this effluent enters the stream without ever passing through the soils of a riparian area. Such alterations limit opportunities for phosphorus to sorb to particles of clay and organic matter in the soil. Similarly, drainage tiles and ditches also reduce phosphorus retention by moving flows rapidly through riparian areas. Conversion of riparian areas to agricultural or developed land uses reduces the size of riparian areas, and thus reduces the residence time of flows and the capacity of the riparian area for retaining phosphorus. Direct alterations that reduce hydraulic roughness of the vegetation or soil infiltration (e.g., grazing, timber harvest) could reduce sediment deposition and the residence time of flows in the riparian area, which could in turn reduce phosphorus retention.

Nitrogen

Nitrogen cycling involves fixation of atmospheric nitrogen (N_2) into organic molecules, and the return of nitrogen to the atmosphere through denitrification (Jackson et al. 2001; Wetzel 2001). Microorganisms perform both these transformations. Nitrogen is also fixed by the high temperatures and pressures of internal combustion engines and, to a lesser extent, by lightning. The nitrogen fixed into organic molecules is stored in living organisms and the organic materials derived from them. It is a constituent of amino acids and nucleic acids, and is also a component of the animal waste products urea and uric acid, as well as other organic molecules. During decomposition, nitrogen is released to the environment in the small inorganic molecules ammonia (NH_4^+), nitrite (NO_2^-) and nitrate (NO_3^-). These molecules and small organic molecules (e.g., amino acids) are highly soluble, readily taken up by microbes and plants, and through denitrification are transformed to N_2 and returned to the atmosphere.

Agricultural and developed lands are major sources of the nitrogen entering streams (Jackson et al. 2001). Fertilizer applications and wastes from CAFOs are the primary sources on agricultural lands. On developed lands, nitrogen sources include septic systems, pet wastes, fertilizers applied to lawns and other landscaping, sewage systems, and some industrial sources. Erosion is also an important source of nitrogen from both agricultural and developed lands.

Unlike phosphorus, nitrogen is quite soluble and readily moves into shallow groundwater (Lowrance et al. 1984; Schnoor 1996); in many areas most nitrogen enters streams via subsurface flows (Fennessey and Cronk 1997). Denitrification is the major pathway for removal of nitrogen as this subsurface water crosses riparian areas. Plant uptake also removes nitrogen from groundwater and stores it in plant tissue (Marschner 1995; Fennessey and Cronk 1997). However, unless they are removed from riparian areas or deeply buried, plant tissues will decompose after death, releasing this stored nitrogen.

Most denitrification occurs in saturated soils (Fennessey and Cronk 1997; Jackson et al. 2001; Wetzel 2001). There, low oxygen (O_2) concentrations create a demand for NO_3^- as an electron acceptor. During aerobic respiration (the primary source of energy for the metabolic activities of animals, plants, and many microbes), oxygen is required as the terminal electron acceptor. Where limited oxygen availability hinders aerobic respiration (e.g.,, under anaerobic conditions), organisms can still derive energy from metabolic pathways that rely on other molecules as electron acceptors. In the case of denitrifying bacteria, energy is derived from organic compounds using NO_3^- instead of oxygen as the terminal electron acceptor.

Factors affecting removal of nitrates by riparian areas include the portion of flows crossing the riparian area as runoff, the rate of denitrification, and the time required for subsurface flows to cross the riparian area (Fennessey and Cronk 1997). Because surface flows cross riparian areas rapidly, little or no nitrate is removed from runoff. From subsurface flows, the amount of nitrate removed is a product of the rate of denitrification and time in the riparian area.

Rates of denitrification are governed by the following conditions.

- Nitrate concentration.
- Quantity of organic carbon.
- Degree of soil saturation.
- Activity of denitrifying bacteria.
- Temperature.
- pH.

Denitrification primarily removes nitrogen that enters riparian areas as nitrate, and low concentrations of nitrate, relative to other forms of nitrogen (e.g., organic nitrogen), can limit the rate of denitrification. For example, in one study, 76% of the nitrogen entering a riparian area was in nitrate, but only 18% of the nitrogen leaving that riparian area was in the form of nitrate (Fennessey and Cronk 1997). Compared to nitrate, a much larger fraction of nitrogen in organic compounds passes through riparian areas.

Organic matter is the substrate from which denitrifying bacteria obtain energy; consequently, the lack of a carbon source can limit denitrification. Exudates from plant roots, and the roots themselves, provide an important carbon source for soil microorganisms (Marschner 1995; Gurwick et al. 2004).

Saturated soils have higher denitrification rates than unsaturated soils because they have less oxygen availability than dry or unsaturated soils. Denitrification is a mechanism for extracting energy from organic molecules; in aerobic environments, many denitrifying bacteria will perform aerobic metabolism instead of denitrification, or will compete for carbon sources with microbes performing aerobic respiration. Aerobic respiration does not involve nitrate, and thus the rate of N_2 production decreases (Fennessey and Cronk 1997; Wetzel 2001).

The ability of denitrifying bacteria to perform denitrification depends on their abundance and the quantity of nitrate to which they have recently been exposed, which together determine the overall denitrifying activity of the microbes; temperature (which affects the rate of all reactions); and pH (Fennessey and Cronk 1997; Wetzel 2001).

The residence time of surface and subsurface water in a riparian area is as important as the rate of denitrification. Many factors affect the residence time of water in riparian areas; these include width of the riparian area, slope gradient, surface roughness, hydraulic head (i.e., the force moving water through the riparian area), and soil hydrologic connectivity (i.e., permeability) (Gordon et al. 1992; Brunke and Gonser 1997; Spruill 2000). Depending on the characteristics of the given riparian area, residence times can range from hours to months or even years. Within individual riparian areas, residence time also can vary considerably due to local concentration of flow before it enters the riparian area, heterogeneity in hydrology and topography, and the characteristic heterogeneity of the texture (and hence permeability) of riparian soils (Brunke and Gonser 1997; Fennessey and Cronk 1997).

Riparian areas typically support favorable conditions for denitrification (Fennessey and Cronk 1997; Naiman and Decamps 1997; Brinson et al. 2002). The rooting zone of riparian soils is typically saturated, and plant roots provide an organic carbon source. In addition, riparian soils support high levels of microbial activity (Fennessey and Cronk 1997; Naiman and Decamps 1997; Tufekcioglu et al. 2001; Brinson et al. 2002). Therefore, a substantial portion of the nitrates contained in subsurface flows are denitrified if they pass through the rooting zone (Pinay and Fabre 1993; Fennessey and Cronk 1997; Lee et al. 2000; Spruill 2000; Sabater et al. 2003; McKergow et al. 2004; Zegre et al. 2004).

However, not all water entering streams passes through riparian soils within the plant rooting zone, where conditions for denitrification are most favorable. For example, overland flows and deep groundwater do not pass through this zone; consequently, the riparian area may remove little nitrogen from these waters (Fennessey and Cronk 1997; Wenger 1999; Spruill 2000; Simpkins et al. 2002).

Human alterations affect the ability of riparian areas to remove nitrogen through the effects of adjacent land uses, conversion of riparian areas to agricultural and developed land cover, hydrologic and geomorphic alterations, and direct removal of riparian vegetation. Adjacent land uses can increase overland flows and nitrogen inputs, and can concentrate flows or route them past riparian areas. Increased overland flows and concentration of flows before they enter riparian areas reduces the time water spends there, and reduces their opportunity to remove nitrogen. Conversion of portions of riparian areas to developed or agricultural uses reduces the time water spends within the riparian area and hence the quantity of nitrogen removed. Artificial drainage (e.g., tile drains) also reduces the residence time of water. Flow diversions, groundwater withdrawals, and channel incision that lowers the water table below the rooting zone of riparian vegetation reduce the ability of riparian soils to remove nitrogen and the ability of plants to take up nitrogen. Riparian management that reduces infiltration, vegetation density, or the cover of woody plants can also reduce nitrogen removals by reducing flows through the plant rooting zone or by altering the density and depth of plant roots.

In western Placer County, incision of stream channels is widespread (Appendix A; Placer County 2002; ECORP 2003; EDAW 2004; Jones & Stokes 2004c), and riparian vegetation has often been reduced to a narrow discontinuous band (Appendix A; Placer County 2002). Consequently, human alterations have reduced the denitrifying capacity of these riparian areas.

Heavy Metals

Heavy metals include zinc, copper, cadmium, lead, nickel, iron, silver, chromium, and mercury. Due to their potential toxicity at low concentrations to organisms at all trophic levels, heavy metal contaminants, particularly mercury, have been identified as a problem in the Sacramento River Basin (including the Bear River in Placer County) and downstream in the Bay-Delta (CALFED 2000a). Downstream of Placer County in the Sacramento–San Joaquin Bay-Delta, relatively high (and potentially harmful) concentrations of copper, nickel, zinc, and mercury have been observed in water and in some cases in organisms (Cain and Louma 1999; Hornberger et al. 1999; CALFED 2000a). These metals can cause gill, kidney, liver, and nerve damage in fish and other aquatic organisms (Luoma et al. 1990; Schnoor 1996; Morel et al. 1998; CALFED 2000a). Because of differences in its cycling in the environment, as well as heightened concerns regarding bioaccumulation, mercury is discussed separately from the other heavy metals in this chapter.

Mercury

Mercury contamination is widespread in sediments and waters of the Sacramento Valley, including western Placer County, and downstream in the Sacramento–San Joaquin Bay-Delta. Although atmospheric deposition and inputs from developed land uses occur, mercury contamination is in large part a legacy of the

California gold mining era, when mercury was used in the gold refining process (Domagalski 1998).

The fate of mercury in the environment depends on its chemical form and the local environmental conditions (Beckvar et al. 1996). Elemental mercury, inorganic mercury, and methylmercury are the three most important forms of mercury in natural aquatic environments. Most mercury is released into the environment as inorganic mercury, which is primarily bound to sediment particles and organic substances; in this form, it may not be available for direct uptake by aquatic organisms. However, methylmercury, an extremely harmful form of mercury, is readily taken up by aquatic plants, fish, and wildlife; it has been demonstrated to bioaccumulate and transfer through the food web (Beckvar et al. 1996).

Methylmercury is formed by sulfate-reducing bacteria (Wetzel 2001). The methylation of mercury is influenced by the availability of inorganic mercury, oxygen concentration, pH, oxidation-reduction potential, presence of sulfate and sulfide, type and concentrations of complexing inorganic and organic agents, salinity, and organic carbon (Blum and Batrha 1980; Jackson 1989; Parks et al. 1989; Winfrey and Rudd 1990; Beckvar et al. 1996; Gill et al. 2002). These conditions and the biological productivity of methylating microbes are also affected by seasonal changes in temperature, nutrient supply, oxygen supply, and hydrodynamics (changes in suspended sediment concentrations and flow rates).

Methylmercury has been demonstrated to accumulate in plant and animal tissues and to transfer through the food web as contaminated food sources are consumed (Beckvar et al. 1996). Methylmercury and other associated forms of bioavailable mercury damage nervous and other tissues and cause mutations, leading to cancers and reduced survival of embryos (Birge et al. 1979; Sharp and Neff 1980; Gentile et al. 1983; Thain 1984; Morel et al. 1998; CALFED 2000a).

Sediment is the primary source of mercury entering aquatic environments in the Sacramento Valley (Beckvar et al. 1996). Correlating mercury concentrations in sediment with concentrations in biota is difficult, however, particularly for higher-trophic-level species. High concentrations of organic substances and reduced sulfur that complex with free inorganic mercury ions in sediment can reduce the availability of mercury to biota (Luoma 1977; Rubinstein et al. 1983). Many investigators report no correlation between sediment and tissue concentrations of mercury for higher-trophic-level species (Nishimura and Kumagi 1983; Jackson 1988; Rada et al. 1989b; Lindqvist 1991; Dukerschein et al. 1992). This difficulty in correlating mercury in sediment with mercury in organisms reflects the complexity of variables that affect both the methylation of mercury in surface sediments and its transfer between trophic levels (Beckvar et al. 1996).

The movement, transformation, and storage of mercury within riparian areas are particularly complex processes; the human effects on these processes are also complex. Consequently, the effects of riparian setbacks on methylmercury production are likely to vary among sites. Wide setbacks (e.g., more than 30 m

[98 ft]) would reduce inputs of mercury-laden sediments from adjacent uplands, and would reduce disturbance and remobilization of mercury-laden sediments in riparian areas. However, the saturated soils and high organic carbon content of many riparian soils provide favorable conditions for methylation of mercury; in western Placer County, such soils also likely contain some mining sediments with elevated concentrations of mercury. Therefore, riparian setbacks may reduce additional inputs of mercury to riparian areas and streams, but probably will not diminish the role of riparian areas as a source of methylmercury.

Other Heavy Metals

Heavy metals enter streams from natural and human sources. Natural sources are the dissolution of rocks and minerals in sediments. Human sources include brake pad debris (Woodward-Clyde Consultants 1994), roofing materials (U.S. Environmental Protection Agency 1978) and other urban and industrial inputs, agricultural chemicals (e.g., copper-based herbicides), historical mine tailings, and acidic mine drainage (CALFED 2000a; Paul and Meyer 2001).

Unlike SOCs, heavy metals are elements that cannot be degraded; unlike nitrate, relatively little metal is transformed into other chemical forms that volatilize into the atmosphere. Therefore, heavy metals removed from flows are merely stored in riparian areas. This storage may be transient, as when metals in overland flows rapidly cross the riparian area, or may be for prolonged periods of time, as when metals sorb to buried sediments in riparian areas.

In riparian areas and adjacent streams, metal ions may be dissolved in water (either hydrated or complexed with other ions), precipitated (i.e., in an insoluble complex), sorbed to sediment or suspended particles, or taken up by plants or microbes. With the exception of uptake by organisms, these states are reversible, and metals exist in equilibrium between them. (The concentration of metal in each state depends on its rate of conversion to other states, relative to the reverse transformation.) This equilibrium, and the concentration of metals in water, is strongly influenced by DO concentration, pH, and the abundance of organic matter (Wetzel 2001; Schnoor 1996). In anaerobic environments, metals tend to precipitate in complexes with sulfides that are generated by microbes under these conditions. Under aerobic conditions, at near neutral (i.e., pH 7) and high pH (i.e., pH greater than 7), metals tend to form precipitates (i.e., insoluble forms) with hydroxyl ions (OH^-). Therefore, solubility of metals is much greater in aerobic, acidic waters (i.e., pH less than 7). Because organic matter contains many components that complex with metals, increased concentrations of organic matter in soils and in suspended sediments reduces metal solubility.

The high biomass and organic matter content of many riparian soils contributes to the removal of metals from subsurface flows. (Riparian plants also take up metals, but they require only minute quantities of a few heavy metals as nutrients, and the root endodermis functions as a barrier that blocks most additional uptake [Marschner 1995]). Thus, riparian areas store metals that would otherwise enter streams. However, soils cannot retain unlimited quantities of heavy metals, and high inputs of metals could saturate binding sites in riparian soils. The clay and organic matter content, and pH, of riparian soils will substantially influence the quantity of metals they can retain.

The association of metals with the surfaces of sediments and suspended particles is particularly important for their transport and storage in riparian areas. Surfaces of particles, such as clays, are typically charged or polar, and these particles interact with a coating of ions and molecules removed from and reentering the surrounding water. In most environments, heavy metals tend to form surface complexes with particles, and this tendency has been described as “metals scavenging” by particles (Schnoor 1996).

Because of the insoluble precipitates and complexes with particles formed by metals, eroding sediments are the major delivery mechanism for metals into riparian areas. The high surface roughness and soil permeability of many riparian areas causes deposition of metal-containing sediments that would otherwise enter streams. However, this storage is not necessarily permanent. Metals may be subsequently leached from these transported sediments, and the sediments themselves may be subsequently eroded or moved by floodwaters. Riparian soils cannot retain an unlimited quantity of heavy metals (similar to soil limitations regarding phosphorus retention), and high inputs may saturate the available binding sites.

Human alterations can affect the transport and storage of heavy metals in riparian areas through the effects of adjacent land uses, conversion of riparian areas, direct hydrologic and geomorphic alterations, and direct alterations of riparian vegetation. In addition to increasing metal inputs, human alterations of adjacent lands (e.g., acid mine drainage) can increase the acidity of waters and the leaching of metals from riparian sediments. Adjacent land uses can also increase or concentrate overland flows, or even route them past riparian areas. These alterations limit opportunities for heavy metals to sorb to particles of clay and organic matter in the soil. Similarly, drainage tiles and ditches reduce metal retention by moving flows rapidly through riparian areas. Conversion of riparian areas to agricultural or developed land uses reduces the size of riparian areas, and consequently reduces the residence time of flows and the capacity of the riparian area for retaining heavy metals. Direct alterations that reduce hydraulic roughness of the vegetation or soil infiltration could reduce sediment deposition and the residence time of flows in the riparian area, also reducing metal retention.

Synthetic Organic Compounds

SOCs include most pesticides and herbicides and a wide variety of chemicals used in industry. Many of these artificial compounds persist in the environment for prolonged periods (in some cases for decades), and some (e.g., polychlorinated biphenyls [PCBs]) bioaccumulate in animal tissues (Schnoor 1996). (Use of some of the most persistent molecules has been banned, but the compounds have remained in the environment.)

Pesticides (including diazinon, carbofuran, and chlorpyrifos), herbicides, solvents, and other SOCs are frequently washed into the Sacramento Valley's river systems during irrigation, by winter storms, and through urban runoff (Kuivila and Foe 1995; MacCoy et al. 1995; Domagalski 1996). These compounds can have direct and indirect harmful effects on soils and aquatic organisms including microorganisms, invertebrates, and vertebrates (CALFED 2000a). For example, diazinon, an organophosphate insecticide used for many agricultural applications, and until recently for urban applications as well, is highly toxic to birds, terrestrial insects, aquatic invertebrates, soil microbes, and fish (Ingham and Coleman 1984; Stone and Gradoni 1985; Mackenzie and Winston 1989; Robertson and Mazzella 1989; Turner 2002). Application of this insecticide coincides with the rainy season in California, resulting in runoff discharges into streams and rivers. Consequently, in tributaries of the Sacramento River (including the Bear River in Placer County), peak values of diazinon can exceed state or federal water quality standards by an order of magnitude or more (Turner 2002).

The SOCs in streams and rivers may come from point and nonpoint sources, release of materials stored in sediments, illegal dumping, and accidental spills. Applications of pesticides and herbicides to plants and soils in agricultural and developed lands are particularly important sources of SOCs. When applied by field equipment, aerial drift may distribute them for several meters beyond the site of application (de Snoo and de Wit 1998); when these compounds are applied by airplanes, drift may extend much further (tens to hundreds of meters).

In the environment, SOCs can volatilize (i.e., disperse into the atmosphere), dissolve in and be transported by water, adsorb to soil, bioaccumulate in animals, and degrade. The fate of these compounds is determined by their chemical properties, especially their size and solubility in water. Synthetic organic compounds vary widely in size and polarity. Many SOCs contain highly polar alcohol, organic acid, and ionic groups that increase their polarity, and increase their solubility in water. However, other SOCs are essentially non-polar; these are generally insoluble. For example, the solubility in water of PCBs and dichlorodiphenyltrichloroethane (DDT) is low (approximately 10^{-2} $\mu moleL^{-1}$); that of chlorpyrifos is higher (about 1 $\mu moleL^{-1}$); whereas the solubility of industrial solvents such as toluene and tetrachloroethylene is very high (>10^{3} $\mu moleL^{-1}$).

The smallest SOCs (e.g., organic solvents) are those most prone to volatilize. However, larger molecules that are relatively insoluble in water also volatilize at moderate rates (Schnoor 1996).

SOCs also sorb to particles of soil and organic matter. This sorption occurs through electrostatic attractions, ionic bonding, or physical intermingling (e.g., the dissolution of a non-polar molecule among particles of organic matter). However, stronger and less reversible chemical bonds also may form. The tendency of an SOC to sorb to sediment is negatively related to its solubility in water (i.e., molecules with lower solubility in water have greater propensity to sorb to sediment). The sorbed molecules of SOCs attach primarily to clays and particles of organic matter, and the sorption of SOCs increases substantially with the concentration of organic matter in the sediment (Schnoor 1996; Neitsch et al. 2002).

The accumulation of SOCs in organisms (i.e., bioaccumulation) represents the net balance resulting from uptake across gill and skin, ingestion from food, metabolic degradation, and excretion. The SOCs most prone to bioaccumulate are the relatively non-polar, hydrophobic molecules (e.g., DDT, PCBs, chlordane) that tend to sorb into membranes and fatty tissues (Schnoor 1996). Typically, these are the same molecules that tend to sorb to sediment.

SOCs can be degraded (changed into other molecules) through the absorption of light energy (photodegradation), by reacting with water or chemicals in water or soil (chemical degradation), or by microorganisms (biodegradation). With the exception of photodegradation, these processes occur most rapidly in soil (Brinson et al. 2002; Neitsch et al. 2002). Biodegradation occurs because microorganisms use SOCs as food sources; they obtain energy stored in the chemical bonds of SOCs through a series of oxidation-reduction reactions, ultimately breaking the SOCs down to carbon dioxide and water. Microbes also mediate other transformations of SOCs (Schnoor 1996). Rates of degradation of SOCs vary over a wide range (Schnoor 1996). Chemical degradation of molecules dissolved in water can reduce the concentration of some SOCs by half within minutes, while other SOCs require years before concentrations are halved. Photodegradation can break down more than 99% of dissolved Carbaryl in a month, but does not eliminate 1% of DDT in a year. For any given SOC, biodegradation rates vary with the environmental conditions listed below.

- Temperature.
- Concentration of oxygen.
- Nutrient availability.
- Microbial population density or biomass concentration.
- Acclimation of the microbial flora to the SOC.

All these factors affect the activity of microbes that perform biodegradation. Riparian areas are considered to support high rates of biodegradation because they typically contain a range of oxygen and nutrient availability, and they support dense, active populations of microorganisms (Fennessey and Cronk 1997; Naiman and Decamps 1997; Tufekcioglu et al. 2001; Brinson et al. 2002).

Overall, the degradation of SOCs in riparian areas depends not only on degradation rates but also on the infiltration of water and associated SOCs into the soil and the time required for water to cross the riparian area. Because overland flow (i.e., runoff) crosses riparian areas rapidly, little or no degradation or storage occurs (Neitsch et al. 2002; Popov and Cornish 2004). Factors affecting the passage of subsurface flows through a riparian area include its width, hydraulic head, and hydrologic conductivity (Fetter 1994; Brunke and Gonser 1997).

The degradation and storage of SOCs in riparian areas is entirely dependent on human alterations because they are the sole source of SOCs. In addition to generating inputs, human alterations also affect the degradation and storage of SOCs in riparian areas by converting these areas to other land-cover types; reducing infiltration of water in riparian areas and adjacent uplands; and lowering groundwater levels through groundwater withdrawals, flow diversions, and stream channel incision. All these alterations reduce the quantity of SOCs passing through riparian soils and the time they remain there. Alterations that concentrate overland flows, or that reduce the hydraulic roughness of riparian vegetation, can also reduce the deposition of SOCs associated with suspended sediment. In western Placer County, incision of stream channels and loss of riparian vegetation have reduced the ability of riparian areas to degrade SOCs.

Relationships Between Effects and Setback Width

A substantial quantity of research has been conducted worldwide on the biogeochemical functions of riparian areas, the effects of human alterations on those functions, and the benefits of managed buffers between streams and areas of timber harvest, agricultural activities, and development (Correll 2003). This research strongly supports the conservation and management of riparian areas and adjacent uplands for water quality benefits, and it has identified the factors affecting riparian functions. Accordingly, this research provides justification for riparian setbacks and some information to guide their planning and design. Nonetheless, current understanding is not sufficient to reliably determine the exact effects that different width buffers will have on biogeochemical functions (and stream water quality). Several computer models have recently been developed that could be used to evaluate the consequences of different width setbacks (Lowrance et al. 2000; Dallo et al. 2001; Zhongwie and Wong 2004). However, these models have several deficiencies: they have not been tested under a range of conditions; they have several unresolved issues regarding their accuracy; and they are currently costly to apply (Inamdar 2004).

The most important factors affecting biogeochemical functions in riparian areas are listed below.

- Loadings from adjacent uplands.
- Partitioning of runoff between overland and subsurface flow.
- Distribution (i.e., spatial concentration) of overland flow.
- Depth of shallow groundwater.
- Time that water resides in the riparian area or buffer (i.e., residence time).
- Quantity of sediment eroded and transported to riparian areas.
- Redistribution of deposited sediment by subsequent floodwaters.

The width of riparian setbacks can affect several of these factors, and can consequently affect the biogeochemical functions of riparian areas. First, the width of a setback determines the distance between stream waters and sources of macronutrients, metals, and SOCs. A wide riparian zone increases infiltration (and subsurface flows), rates of sediment deposition, and the time required for materials to reach a stream. Thus, greater setback widths tend to increase the storage and removal of materials en route to streams. Second, the area of sources for macronutrients, metals, and SOCs is reduced by wider setbacks because more land is retained in natural vegetation. Third, if a riparian setback extends beyond the stream's active floodplain, then sediments and associated contaminants will be stored, at least in part, outside the active floodplain, where they are less likely to be carried into streams by floodwaters.

Researchers have documented substantial reductions in stream loadings of macronutrients, metals, and SOCs due to riparian areas or buffers ranging in width from several to more than a hundred meters. (Castelle et al. 1992; Fennessey and Cronk 1997; Wenger 1999; Brinson et al. 2002.) Reductions resulting from a very narrow riparian area (e.g., 6 m [20 ft]) in one study may be comparable to reductions in a much wider riparian area (e.g., 30 m [98 ft]) in another study. This variability reflects both differences in site attributes that affect movement, transformation, and storage of these materials, as well as variability in the methods of researchers.

Overall, the most significant factors causing variation in the biogeochemical functions of riparian areas are hydrologic conditions (e.g., the depth of subsurface flows); climate and vegetation attributes seem to cause lesser effects (Fennessey and Cronk 1997; Simpkins et al. 2002; Sabater et al. 2003). Nonetheless, California's Mediterranean climate may reduce a setback's effectiveness relative to a setback of similar width in other climates. In northern California, because rainfall is concentrated during the winter months and evapotranspiration is low at that time, rain frequently falls on saturated soils, and overland flows are consequently greater than they might be under a different climatic regime.

Variation in the results of relevant research is often due to differences in the types of sites and the range of conditions included in the study. For example, many studies are conducted in small-scale plots with simulated rainstorms. The results of such short-term studies under a narrow range of conditions often indicate greater effectiveness of narrow buffers or setbacks than do the results of longer-term, larger-scale studies (Castelle et al. 1992; Davies and Nelson 1994; Fennessey and Cronk 1997; Wenger 1999; Lee et al. 2000; McKergow et al. 2004; Zegre et al. 2004). Similarly, actively managed buffers, such as tilled and planted borders of agricultural fields, are generally more effective at narrower widths than are unmanaged setbacks; appropriately, many of the recommendations for narrower setbacks are intended for actively managed areas (Lowrance et al. 2002).

Recommended Setback Width to Conserve Biogeochemical Functions

For the purpose of long-term conservation of biogeochemical functions, the project team recommends that riparian setbacks include the entire active floodplain, regardless of the current extent of riparian vegetation on that surface, and that an additional 30-m (98-ft) buffer be included in the setback.

For effective long-term conservation of riparian functions, setback widths should be sufficient to retain macronutrients, metals, and SOCs from the concentrated flows and infrequent events (e.g., intense rain on saturated soils) that transport a substantial portion of the sediment and materials to riparian areas. This criterion requires a setback of moderate width. Consequently, for the purpose of long-term conservation, though widths from several to more than a hundred meters have been recommended, setbacks of 20–30 m (66–98 ft) have been recommended most frequently (Castelle et al. 1992; Johnson and Ryba 1992; McCauley and Single 1995; Fennessey and Cronk 1997; Herrone and Hairsine 1998; Wenger 1999; Lowrance et al. 2002; Environmental Law Institute 2003; Lee et al. 2004).

It is important to note that setbacks do not ameliorate many effects of human alterations on biogeochemical functions. Not all inputs (of macronutrients, metals, SOCs, and other contaminants) to streams will pass through riparian soils (e.g., deeper groundwater flows, stormwater, and agricultural drainage that crosses in pipes or ditches). Moreover, riparian setbacks will not retain all inputs of fertilizers, heavy metals, pesticides, and other contaminants that pass through them. In addition, high levels of inputs may cause the effectiveness of setbacks to may diminish over time. Therefore, other measures that address the upland sources of macronutrients, metals, SOCs, and other contaminants are necessary.

Chapter 4
Salmonid Habitat Functions

Overview

Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss irideus*) are anadromous fishes that spend a major portion of their lives in the Pacific Ocean. Maturing adult steelhead and Chinook salmon migrate from the ocean to spawn in Central Valley rivers and creeks, including those of western Placer County. After rearing in these rivers, the juveniles migrate back to the Pacific Ocean.

Salmonids occupy the freshwater systems from the Sacramento–San Joaquin Delta (Delta) to stream headwaters, depending on the streams' accessibility to migrating fish and the availability of spawning and rearing habitat within them. Not only are salmonid habitat functions valued directly, but they also provide an indicator of human effects on other components of these aquatic ecosystems. This chapter describes salmonid habitat functions and how human alterations affect those functions. It concludes with a summary of the relationships between riparian setback width and human effects, and offers the project team's recommendation for setback widths to conserve salmonid habitat functions.

Effects of Human Alterations on Migration

Shallow water depth, high water velocity, and physical barriers may impede salmonid passage through spawning streams. Human alterations affect each of these potential impediments to migration.

Water Depth

In general, water depth greater than 0.3 m (1 ft) is needed to allow passage of adult and juvenile Chinook salmon and steelhead (California Department of Fish and Game 2001; National Marine Fisheries Service 2001). However, this minimum depth may be a somewhat conservative estimate, because Chinook salmon and steelhead can pass through short sections of water that are less than 0.3 m (1 ft) deep (Thompson 1972 *in* Bjornn and Reiser 1991).

Low streamflows and shallow water depths may delay or block migrating salmonids' access to upstream spawning habitats, expose adult fish to water temperatures detrimental to individual survival, and reduce the fecundity of females (i.e., egg viability). Delayed passage of adults may also delay spawning and extend incubation of eggs and rearing of juveniles into months when warmer water temperatures predominate. The result may be reduced egg and juvenile survival and reduced productivity in that year (i.e., year class production).

Low streamflows can also affect juvenile migration. Like the requirements for adult salmonid passage, water depth greater than 0.3 m (1 ft) is necessary for passage of juvenile Chinook salmon and steelhead (California Department of Fish and Game 2001; National Marine Fisheries Service 2001). Delayed or blocked passage of juveniles may prevent access to downstream rearing habitat and increase their exposure to warm water temperatures, entrainment in diversions, and predation. The resulting decrease in survival and growth rates reduces year class production and potentially reduces adult abundance in subsequent years.

Relatively shallow flow in combination with physical barriers and high water temperatures can cause fish to fatigue as they migrate upstream; these cumulative effects may lower the survival and reproductive success of individual fish (Gallagher 1999). For these reasons, long stretches of river with maximum depths near 0.3 m (1 ft) may be barriers to migration. Other factors interacting with the effects of depth include cover and suitable resting areas (e.g., deep pools).

Flow rates may affect travel time for juvenile salmonids. Travel time for juvenile Chinook salmon and steelhead generally decreases with increasing flow and water velocities. Faster travel times may reduce exposure to predation and facilitate movement of smolts to the ocean (Berggren and Filardo 1993).

Vertical Drops

In addition to adequate depth and velocity, vertical drops should not exceed the leaping abilities of Chinook salmon and steelhead. The ability to jump vertical drops is greatly affected by staging pool depth, jump angle, and the horizontal distance of the leap (Powers and Orsborn 1985; Reiser and Peacock 1985). The ratio of staging pool depth to barrier height should be at least 1.5 (Stuart 1962; U.S. Forest Service 1977; Robison et al. 1999). Although the conservative vertical limit for adult fish is 1.4 m (4.5 ft) for steelhead and 0.9 m (3 ft) for Chinook salmon, passage is best facilitated by drops of 0.3 m (1 ft) or less. For juvenile salmonids, downstream migration is facilitated by drops of 0.15 m (0.5 ft) or less (National Marine Fisheries Service 2001).

Water Temperature

Warm temperatures and low DO concentrations may impede salmonid migration. Temperatures warmer than 13º Celsius (C) (55ºFarenheit [F]) have caused mortality of female adult Chinook salmon prior to spawning, and migration was blocked when water temperature reached 21ºC (69.8ºF) in the Delta (Andrew and Green 1960 *in* Raleigh et al. 1986; Hallock 1970 *in* McCullough 1999). In the Columbia River, a temperature of 21ºC (69.8ºF) was lethal to steelhead acclimated to a river temperature of 19ºC (66.2ºF). The response to warm temperatures may be complicated by low DO concentrations. In the Delta, adult Chinook salmon avoided temperatures warmer than 19ºC (66ºF) when DO was less than 5 milligrams per liter (mg/l) (Alabaster and Hallock 1988, 1970 *in* McCullough 1999).

Discussion of Effects

Construction of dams and other barriers, such as temporary diversion structures, are the most significant human alterations affecting migration and causing the loss of salmonid habitats (Yoshiyama et al. 2001). These barriers prevent Chinook salmon and steelhead migration to the higher foothill reaches of many streams in the Sacramento Valley. The alteration of flows, temperatures, and water quality below major reservoirs may also interfere with salmonid migration.

In western Placer County, dams are considerable impediments to fish passage. There are approximately thirty dams on western Placer County's streams (DWR 2002; Placer County 2002; Bailey Environmental 2003). While some of these allow fish passage under many flow conditions, others (e.g., Cottonwood Dam on Miners Ravine) are more substantial barriers.

Water control structures, road crossings, and culverts constrain flows and can create high water velocities. Culverts are characteristically uniform and designed to optimize flow efficiency, often resulting in high velocities. The velocity a fish can overcome in moving through a culvert depends on its length; as culvert length increases, flow velocities must decrease to permit fish passage. In general, water velocity should be less than 1 meter per second (m/sec) (3 feet per second [ft/sec]) for any culvert more than 30 m (98 ft) long and less than 1.5 m/sec (5 ft/sec) for culverts less than 30 m (98 ft) long (California Department of Fish and Game 2001). In western Placer County, roads cross streams at dozens of locations, and the culverts under a number of these roads are partial barriers, particularly at low flows (DWR 2002; Placer County 2002; Bailey Environmental 2003).

Surface water diversions and management of water releases from reservoirs can affect migration and increase mortality of juvenile salmonids by creating warm water temperatures. Diversions also can cause direct effects such as migration delay, injury, and mortality resulting from entrainment, impingement, and predation (National Marine Fisheries Service 1994). Entrainment occurs when fish move with the diverted flow into a canal or turbine; in most cases, entrained organisms do not survive. Impingement occurs when individual fish come in contact with a screen, a trashrack, or debris at the intake. Contact causes bruising, loss of scales, and other injuries. Fish mortality can result if impingement is prolonged, repeated, or occurs at high velocities. In addition, intakes increase predation by stressing or disorienting prey fish and by providing habitat for fish and bird predators (National Marine Fisheries Service 1994).

The proportion of a population that can become entrained or impinged in diversions depends on the location, timing, duration, and volume (relative to total flow) of the diversion relative to the distribution, abundance, and behavior of each species' life stage. Diversions in the Sacramento River Basin affect juvenile Chinook salmon and steelhead (U.S. Fish and Wildlife Service 1995). In addition to the possibility of entrainment at unscreened diversions, juvenile salmonids can be impinged against screens by fast-moving water, or they can pass through screens that are not designed to screen out salmonid fry and other small fish. Western Placer County's dams are associated with water diversions. Most of these diversions are unscreened, and thus entrainment can occur.

Effects of Human Alterations on Spawning Habitat

Salmonids lay their eggs in streambed gravels. The fish create depressions in the gravel, deposit and fertilize their eggs, and then bury the eggs with gravel. The resulting gravel nest is called a redd. The quality of spawning habitat is influenced by water temperature and depth, flow velocity, and substrate.

Water Temperature

Chinook salmon eggs and larvae require temperatures between 4ºC and 12ºC (39.2ºF and 53.6ºF) for maximum survival (Myrick and Cech 2001). Survival of eggs was less than 50% when temperature is warmer than 16ºC (60.8ºF) (Alderice and Velsen 1978). Optimal water temperatures for steelhead spawning and incubation are similar to those of Chinook salmon; they fall between 3.9ºC and 11.1ºC (39ºF and 52ºF) (Myrick and Cech 2001). Steelhead eggs subjected to temperatures warmer than 15ºC (59ºF) are prone to increased mortality.

Water Depth and Velocity

Water depth and flow velocity are factors that influence spawning habitat selection for Chinook salmon and steelhead. Minimum water depths at redd areas vary with fish size and water velocity, because these variables affect the depth necessary for successful digging; the water should be sufficiently deep to cover the fish (Healey 1991). In general, suitable spawning gravels are covered by flows at least 0.25 m (0.8 ft) deep and with velocities between 0.25 m and 1.2

m/sec (0.8 and 3.8 ft/sec) (Bjornn and Reiser 1991; Railegh et al. 1986). Reduced flows during incubation periods may cause mortality through desiccation of redds, or through reduced water circulation resulting in low DO, accumulation of metabolic waste, and increased incidence of disease.

Substrate

Although the suitability of gravel substrates for spawning depends largely on the species and individual fish size, a number of studies have determined substrate sizes that represent the most suitable conditions. Generally, Chinook salmon require substrates of approximately 0.3–15 cm (0.1–5.9 inches), whereas steelhead prefer substrates no larger than 10 centimeters (4 inches) (Bjornn and Reiser 1991).

The eggs depend on water flow through spawning gravels to supply oxygen for the developing embryos. Oxygen is supplied by the water flowing through the area of the gravel bed with the eggs (i.e., the redd). Flow rates and the concentration of oxygen in the flowing water effectively determine the DO available to eggs and fry in the redd.

The velocity of the water and the permeability of the surrounding gravels together determine the rate at which water flows through a redd. Gravel beds consisting of smaller-sized particles have lower permeability (greater resistance) to water flow than do gravel beds consisting of larger-sized particles. Therefore, the velocity of water through a redd slows as particle size decreases.

Discussion of Effects

Throughout the Central Valley, including Placer County, human alterations (i.e., changes in sediment supply and transport) have substantially reduced the extent of suitable spawning gravel for salmonids (Jones & Stokes 2004c). Along most Central Valley rivers and streams, sediment supply and transport have been altered by hydraulic mining, levees, land use changes, gravel mining, dam construction, and water diversions (CALFED 2000b). Currently, managed forest lands, roads, construction, and developed and agricultural lands contribute substantially more sediment than do areas of natural vegetation (Charbonneau and Kondolf 1993). In the lower portions of watersheds, most of this sediment is of fine materials (less than 2 mm [0.08 in] in diameter). On most rivers and streams, dams block the transport of coarser materials from the upper portions of watersheds, while gravel mining has removed coarse materials from downstream floodplains and channels. As a consequence of these changes, spawning habitats for Chinook salmon and steelhead have been reduced.

The addition of fine sediments into streams and streambeds can decrease the quality and quantity of spawning habitat by reducing the permeability of spawning gravels and thus reducing the flow of water and oxygen to eggs, which leads to direct mortality of eggs and fry, physiological stress, and impediments to the movement of fry from the redd (Gibbons and Salo 1973; Tappel and Bjornn 1983, Sigler et al. 1984; Raleigh et al. 1986; Lloyd et al. 1987; Reynolds et al. 1989; Waters 1995; Ligon et al. 2003). In western Placer County, gravel beds currently have high concentrations of fine sediments that reduce suitability for spawning (Jones & Stokes 2004b).

Spawning habitats are also affected by human alterations of riparian vegetation. The loss of riparian vegetation has contributed to increased water temperatures and reduced quality of spawning habitat along many Central Valley rivers and streams, including those in western Placer County (CALFED 2000b; Jones & Stokes 2004b). Reduced flows may allow riparian vegetation to establish on river bars and channels where establishment and survival were not previously possible because of scouring or prolonged submergence under unregulated flow regimes (Pelzman 1973). This encroachment of vegetation stabilizes sediments and confines the channel, contributing to a reduction in salmonid spawning habitat.

Effects of Human Alterations on Rearing Habitat

Multiple environmental conditions, food resources, and interactions among individuals, predators, and competitors all influence rearing habitat quantity and quality and the productivity of streams (Bjornn and Reiser 1991). Water temperature and velocity, cover, and inundation of floodplains are particularly important factors influencing salmonid rearing habitats.

Water Temperature

Water temperature has a strong affect on juvenile salmonids, and rearing success deteriorates at water temperatures above 20ºC (68ºF) (Raleigh et al. 1984; Myrick and Cech 2001). Myrick and Cech (2001) observed maximum juvenile growth rates at water temperatures between 17ºC and 20ºC (62.6ºF and 68ºF) and at 19ºC (66.2ºF), for steelhead and Chinook salmon, respectively. Rich (1987) found that juvenile Chinook salmon from the Nimbus State Fish Hatchery died before the end of the experiment when reared at 24ºC (75.2ºF). Steelhead juveniles can be expected to show significant mortality at temperatures exceeding 25ºC (77ºF) (Raleigh et al. 1984; Myrick and Cech 2001).

Water Velocity

Water velocity is of particular importance in determining where juvenile salmonids occur, because it determines the energetic requirements of fish for maintaining position and the amount of food delivered to a particular location. Juvenile salmonids tend to select positions that maximize access to food and minimize energy expenditures, but these positions can be altered by interaction with other fish and the presence of cover (Shirvell 1990). The water velocity preferred by salmonids varies with size of the fish; larger fish occupy areas of higher velocity and greater depth than small fish, potentially gaining access to abundant food and avoiding predatory birds (Bjornn and Reiser 1991; Jackson 1992). Griffith (1972 *in* Raleigh et al. 1984) found water velocities of 0.10–0.22 m/second (sec) (0.32–0.72 ft/sec) to be associated with occurrence of rainbow trout. Sheppard and Johnson (1985) found similar results for juvenile steelhead; they measured velocities of 0.12–0.24 m/sec (0.40–0.80 ft/sec). Bovee (1978 *in* California Department of Fish and Game 1991) reported water velocities of 0.18–0.37 m/sec (0.6–1.2 ft/sec) as the preferred range for juvenile rainbow trout and steelhead.

Cover

Instream cover (e.g., undercut banks, downed trees, other woody debris) is important for juvenile rearing. The addition of cover increases spatial complexity and may reduce predation of juvenile fish. The abundance of food, suitable physical conditions, and the presence of competitors and predators determine cover value. Fine-textured instream woody material provides the hydraulic diversity necessary for selection of suitable velocities, access to drifting food, and escape refugia from predatory fish. An area of cover less than 15% of the total habitat area is likely inadequate for juvenile salmonids (Raleigh et al. 1984).

Shaded riverine aquatic (SRA) cover is important to juvenile Chinook salmon and steelhead because it provides high-value resting and feeding areas and protection from predators. Riparian vegetation not only provides woody debris for instream cover, but also filters sediments, inputs organic matter, modifies channel pattern and geometry, creates SRA cover, and provides habitat for aquatic invertebrates eaten by salmonids. For these reasons, stream sections shaded by riparian vegetation (in contrast to sections characterized by denuded banks) provide important rearing and resting areas for adult Chinook salmon and steelhead migrating upstream (Raleigh et al. 1984, 1986; Slaney and Zaldokas 1997; Haberstock 1999; CALFED 2000b). Woody material is important not only because it provides instream cover, but also because it affects geomorphology and facilitates the creation of pools for holding juvenile salmon during high flow events (Larson 1999; Macklin and Plumb 1999). Shade reduces daily temperature variability and maximum temperature, maintains DO, and may help maintain base flows during dry seasons (Slaney and Zaldokas 1997; Whitting 1998; Haberstock 1999; CALFED 2000).

Floodplain Habitat

Seasonally inundated floodplains, though they provide habitat for both native and nonnative fish species, are particularly important to native species (Moyle et al.

2000). Many native fish species, including salmonids, are dependent on or benefit from inundated floodplains. Floodplains function as nursery areas, refuges from low water temperatures in early spring and winter, and refuges from high water velocities during high flow periods (Turner et al. 1994). Inundated floodplains also provide high food abundance, a range of water temperature conditions, and increased water clarity that may increase growth and survival rates (Sommer et al. 2001a, 2001b). Inundated floodplains of the Sacramento River and its tributaries may also provide high-quality organic nutrients to the Bay-Delta, benefiting estuarine species.

Discussion of Effects

Human alterations have affected rearing habitat by reducing water quality, removing riparian vegetation, hydraulically isolating floodplains, and altering flows. The introduction of nonnative predatory fish species has also detrimentally affected juvenile rearing. These alterations have all contributed to the loss of rearing habitat in western Placer County.

Adjacent agricultural and developed land uses are sources of contaminants and sediment (e.g., macronutrients, pesticides, and heavy metals) that reduce water quality. These effects on water quality are described in the chapter dealing with biogeochemical functions.

In addition to physically affecting salmonids, contaminants and sediments can cause changes in macroinvertebrate communities. These changes in turn can affect food available to foraging fish (Waters 1995). Such changes may have occurred in the streams of western Placer County, because in all six streams for which data are available, macroinvertebrate communities are dominated by species moderately to highly tolerant of pollution (Bailey 2003).

Researchers have found that elevated concentrations of suspended sediment can cause direct mortality of fry, fingerlings, and juvenile salmonids (Sigler et al. 1984; Lloyd et al. 1987; Reynolds et al. 1989). Sublethal effects include avoidance of sediment-laden areas, reduced feeding and growth, respiratory impairment, reduced tolerance to disease and toxicants, and physiological stress (Waters 1995).

The loss of riparian vegetation and SRA cover results from conversion of riparian areas to other land uses, adjacent gravel mining, placement of bank protection (e.g., riprap), grazing, and other direct removals (e.g., due to levee maintenance). It also is a consequence of hydrologic and geomorphic alterations, such as flow reductions and incision. Because riparian vegetation affects not only stream water temperature, but also cover, food resources, habitat complexity, and geomorphic processes (e.g., pool formation, bank stability), its loss substantially degrades rearing habitat. In western Placer County, conversion to developed or agricultural land-cover has removed extensive areas of riparian vegetation (Jones & Stokes 2004a, 2004b), and remaining vegetation is often in narrow bands with a discontinuous cover of trees (Appendix A).

Water diversions cause broad effects on stream ecosystems that can reduce the quality of rearing habitat. Water diversions affect fish, aquatic organisms, sediments, salinity, streamflows, habitat, foodweb productivity, and species abundance and distribution (National Marine Fisheries Service 1994). Some diversions have screens that exclude larger organisms such as most adult fish, but eggs, larvae, invertebrates, plankton, organic debris, and dissolved nutrients are important components of the lower trophic levels that may be lost to diversions. Reductions at the lower trophic levels can result in reduced food supplies and have secondary impacts on all higher trophic levels, affecting the overall foodweb. In western Placer County, there are over two dozen water diversions, and most of these are unscreened (DWR 2002; Placer County 2002; Bailey Environmental 2003; Jones & Stokes 2004b).

Human alterations affecting hydrologic and geomorphic processes can reduce rearing habitat on floodplains. (The effects of human alterations on hydrologic and geomorphic processes are described in detail in the chapter on hydrologic and geomorphic functions.) These alterations include water diversions, groundwater withdrawals, dams, levees, bank protection, and changes in land cover. Due to human alterations, in western Placer County, stream channel incision has reduced the area of rearing habitat on floodplains.

In addition to inundating floodplains, streamflow has several effects on the rearing capacity of streams. Predation may increase during low flows, particularly during downstream migration of juveniles. Higher flows result in faster outmigration, reduced water clarity, and cooler water temperature, all contributing to reduced predation (U.S. Fish and Wildlife Service 1996). Both flow and depth affect travel time for juvenile salmonids. Faster travel time may reduce exposure to predation and facilitate movement of smolts to the ocean (Berggren and Filardo 1993).

Flow alterations have a major effect on the water temperatures of Sacramento Valley streams. For rivers and larger streams, reservoir operations (i.e., the timing, temperature, and magnitude of reservoir releases, as well as total reservoir storage) are among the most important influences on water temperatures. Agricultural and municipal diversions reduce river flow and potentially increase temperatures during summer months (Myers et al. 1998; Myrick and Cech 2001), and the elevated temperatures of irrigation return flows can also affect instream water temperatures (U.S. Fish and Wildlife Service 1995). Water temperatures that are marginal or unsuitable for rearing of juvenile salmonids frequently occur along most streams in western Placer County (Bailey 2003; Jones & Stokes 2004b).

Streamflow also affects the concentration, and consequently the detrimental effects, of contaminants. For example, experimental studies indicated that contaminants in agricultural return flow from the west side of the San Joaquin Valley had no detrimental effects on the growth and survival of juvenile Chinook salmon when the return flows were diluted by 50% or more with San Joaquin River water (Saiki et al. 1992).

High pesticide concentrations may affect aquatic invertebrates (Brown et al. 2000). Adult and larval aquatic macroinvertebrates are a major food source for juvenile Chinook salmon, and a loss of invertebrate production could have an effect on juvenile salmonid production (Brown and May 2000); however, the extent of this effect has not been quantified.

Rapid fluctuations in flows can cause the stranding of juvenile and adult anadromous fish and the dewatering of redds. Fish can become stranded in borrow areas, the floodplain, shallow nearshore areas, side channels, and deep areas in the active stream channel when water levels change quickly.

Although adult fish do become stranded, juvenile fish are more vulnerable to stranding. Fry are poor swimmers and tend to stay in shallower water along the edges of streams and rivers or in side channels (Phinney 1974; Woodin 1984; Hunter 1992). Juvenile fish are not as able to follow receding waters back to the river (U.S. Fish and Wildlife Service 1995b). Also, redd dewatering can occur when flows decline while eggs are incubating.

Factors such as the total drop in stage, the lowest water level attained, the frequency of flow reductions, and the rate of change in flow affect fish stranding rates. In an episode of flow reduction, the greater the total drop in stage, and the lower the lowest flow attained, the more likely it is that side channels and shallow ponds in the floodplain will be isolated from flow and that gravel bars where redds may be located could be exposed (Hunter 1992). Frequent flow fluctuations result in cumulative stranding (U.S. Fish and Wildlife Service 1995; Bauersfeld 1978), and the faster the rate of change in flow, the more likely fish are to become stranded. Olsen (1990) found that ramping rates of less than 2.5 cm per hour (1 inch per hour) were needed to protect steelhead fry on the Sultan River in Washington State.

Relationships Between Setback Width and Effects of Human Alterations

The width of riparian setbacks directly affects the integrity of geomorphic processes that sustain salmonid habitats, the area of floodplain rearing habitat, and the extent of riparian vegetation providing SRA cover and inputs to the aquatic ecosystem. Setback width also influences inputs of sediment and contaminants from adjacent uplands; these inputs are described in other chapters (Chapters 2, 3, and 5) of this report.

Structures, developed land uses, and most agricultural land uses within the active floodplain detrimentally affect salmonid habitat functions. Thus, to conserve salmonid habitat functions, setback widths should be sufficient to include the active floodplain and to buffer the active floodplain from detrimental effects that may result from adjacent land uses.

All riparian vegetation within the active floodplain contributes inputs to the aquatic ecosystem. These inputs are greatest from vegetation immediately adjacent to the stream channel, and shade is only provided by vegetation within a distance determined by stream orientation, tree height, and topography. In some cases (e.g., topographically confined or incised reaches), the vegetation affecting streams is outside the active floodplain. One tree height (i.e., potential maximum tree height on that site) has often been used as an approximation of the width of the zone alongside streams that provides effective shading and inputs (e.g., large woody debris) to the channel (Rhodes et al. 1994), although vegetation further from streams can still, in the proper circumstances, provide some shade. This distance (i.e., potential maximum tree height) is roughly 20 m (66 ft) to as much as 30 m (98 ft) in western Placer County, based on the observed and potential heights of mature Fremont's cottonwoods, valley oaks, and other tree species (Hickman 1993; Stuart and Sawyer 2001).

Recommended Setback Width to Conserve Salmonid Habitat Functions

For the purpose of long-term conservation of salmonid habitat functions, the project team recommends that riparian setbacks include the entire active floodplain, regardless of the current extent of riparian vegetation on that surface, and that an additional 30 m (98 ft) buffer be included within the setback. Conversion of the active floodplain to developed or agricultural land uses would substantially affect the hydrologic and geomorphic processes that sustain salmonid habitat functions. Land adjacent to the active floodplain also may affect shade, inputs of woody debris, and water quality; consequently, the 30 m (98 ft) buffer would reduce the effects of adjacent land uses.

It is important to recognize that riparian setbacks are not sufficient to ensure conservation of salmonid habitat functions. Many effects on salmonid habitat functions result from human alterations that are unrelated to setback width, but that are rather associated with flow alterations, water quality, vegetation management, and land uses within the watershed. Therefore, conservation of salmonid habitat functions requires the implementation of a coordinated set of measures involving land use, flow management, and vegetation management in these watersheds and within these defined setbacks.

Chapter 5
Plant Habitat Functions

Introduction

More than 15 native tree and shrub species occur in the riparian forests, woodlands, and scrublands of the Sacramento Valley and adjacent foothills (Conard et al. 1980). These species are all deciduous, and all require high or very high levels of water availability. They differ in their dispersal mechanisms, seed size, shade tolerance, size, growth rates, and longevity (Table 5-1). These attributes, in concert with site conditions and flow and disturbance regimes, determine the species composition and structure of riparian vegetation.

In the Sacramento Valley, early successional vegetation typically is dominated by Fremont's cottonwood (*Populus fremonti*) and willow species (*Salix* spp.). Both taxa produce large numbers of widely dispersed seeds and are rapidly growing, shade intolerant, and relatively short-lived (Sudworth 1908; Strahan 1984; Burns and Honkala 1990). Shrubby thickets of these species can reach heights of 3–12 m (10–40 ft) over a period of 10–20 years. Other species, such as Oregon ash (*Fraxinus latifolia*) and valley oak (*Quercus lobata*), establish either concurrently with or subsequent to the willows and cottonwood and grow more slowly, but they are more tolerant of shade and are longer lived (Burns and Honkala 1990; Tu 2000). In the absence of frequent disturbance, individuals of these species enter the canopy, particularly after 50 years since stand initiation, as mortality of willows and cottonwoods create openings in the forest canopy. Conversely, frequent disturbance prevents the transition to mature mixed riparian or valley oak forests. Currently, in western Placer County, oak species are abundant in the riparian vegetation, white alder (*Alnus rhombifolia*) is widespread, and cottonwoods and willows are less abundant than along many other Central Valley rivers and streams (Appendix A; Placer County 2002).

Human alterations of riparian areas change site conditions, including flow and disturbance regimes, and consequently affect the dispersal, establishment, growth, reproduction, and mortality of riparian species. These changes alter the species composition and structure of riparian vegetation, thereby modifying habitat for aquatic fish and terrestrial wildlife habitat, as well as biogeochemical functions.

Effects of Human Alterations on Life Cycle of Riparian Species

Effects on Dispersal

Air, water and animals disperse riparian plant species. However, flow regime strongly affects the dispersal of all plant species. Surfaces that remain submerged throughout the period of seed release are largely inaccessible to most dispersing seed, and surfaces that remain above water during this period are inaccessible to water-dispersed seed. Seeds are commonly dispersed through the air or by floating on water; large numbers of seeds wash onto shorelines and bars as water levels recede. The river stage during the dispersal period must be at a level high enough to distribute seeds to a surface where scouring by subsequent flows does not occur, and low enough to prevent desiccation of seedlings once the river stage recedes.

Accordingly, hydrologic or geomorphic alterations affect the dispersal of riparian plant species. Levees and berms isolate surfaces from stream flows and preclude the deposition of water-dispersed seed. Flow alterations modify the river's stage, raising or lowering the elevation at which seeds are deposited. Similarly, incision of the stream channel lowers the river's stage, and thus lowers the elevation at which seeds are deposited. Such incision is widespread in western Placer County (Appendix A; Placer County 2002; ECORP 2003; EDAW 2004; Jones & Stokes 2004 c).

Similarly, conversion of active floodplain to agricultural or developed land uses can isolate seed sources and potentially create barriers to flows or animal movements and thus to seed dispersal. However, the extent of these effects is not well known.

Effects on Establishment

Establishment of riparian plants requires suitable conditions for germination and subsequent growth. Hydrology and hydraulics, soil properties, competing vegetation, disease-causing organisms, herbivorous animals, and vegetation management by humans all affect the transition from seed to established plant.

For successful recruitment, cottonwood and willows are particularly dependent on specific hydrologic events before, during, and immediately following their seed release periods. These shade-intolerant species have very small and short-lived seeds (Table 5-1); accordingly, they require establishment sites that are largely free of competition from existing vegetation. The erosion and deposition of sediment along stream channels and on floodplains creates such surfaces. A moist substrate must be maintained for approximately a week following seed dispersal to allow seeds to germinate (Scott et al. 1999, 2000). Following germination, the river stage must decline gradually to enable seedling

Table 5-1. Selected Attributes of Sacramento Valley and Foothill Riparian Tree Species

Species	Seed Size[a]	Seedling Shade Tolerance[b]	Height[c]	Longevity[d] (years)
Box-elder *Acer negundo*	0.1 g (0.001 oz.)	Tolerant	15-25 m (49-82 ft)	50-100
White Alder *Alnus rhombifolia*	0.001 g (0.0001 oz.)	Intolerant	15-25 m (49-82 ft)	50-100
Oregon ash *Fraxinus latifolia*	0.1 g (0.001 oz.)	Tolerant	10-25 m (33-82 ft)	150-250
Walnut *Juglans hindsii*	10.0 g (0.1oz.)	Intermediate	10-20 m (33-66 ft)	50-150
Sycamore *Platanus racemosa*	0.01 g (0.0001 oz.)	Intolerant	10-30 m (33-98 ft)	150-200
Fremont's cottonwood *Populus fremontii*	0.001 g (0.0001 oz.)	Intolerant	15-30 m (49-98 ft)	50-100
Valley oak *Quercus lobata*	1.0 g (0.1 oz.)	Intermediate	10-35 m (33-115 ft)	300-400
Interior Live-oak *Quercus wislizenii*	1.0 g (0.1 oz.)	Intermediate	5-20 m (16-66 ft)	100-200
Goodding's black willow *Salix gooddingii*	0.0001 g (0.00001 oz.)	Intolerant	10-30 m (33-98 ft)	50-100
Narrow-leaved willow *Salix exigua*	0.0001 g (0.00001 oz.)	Intolerant	5 m (16 ft)	20-30
Red willow *Salix laevigata*	0.0001 g (0.00001 oz.)	Intolerant	10-15 m (33-49 ft)	40-60
Arroyo willow *Salix lasiolepis*	0.0001 g (0.00001 oz.)	Intolerant	5-10 m (16-33 ft)	30-50
Shining willow *Salix lucida*	0.0001 g (0.00001 oz.)	Intolerant	5-10 m (16-33 ft)	30-50

[a] = Based on information in Schopmeyer 1974, and rounded to nearest order of magnitude
[b] = Based on information in Sudworth 1908, Burns and Honkala 1990
[c] = Based on information in Hickman 1993, Stuart and Sawyer 2001
[d] = Based on information in Burns and Honkala 1990, Sudworth 1908 and J. Hunter unpublished data
g = grams
oz = ounces
m = meters
ft = feet

establishment. If the river stage declines too quickly, seedlings are prone to mortality by desiccation. To supply seedlings with adequate water as their roots elongate toward the water table, the decline in river stage should not exceed 2.5-3.8 cm (1–1.5 inches) per day (Mahoney and Rood 1998; Shafroth et al. 1998; Scott et al. 1999, 2000).

After germination, seedlings grow on surfaces ranging from immediately below peak-flow to immediately above low-flow elevations. Most seedlings do not survive their first year on these surfaces. Because high levels of soil moisture within several feet of the surface are required for these seedlings to survive through the first summer, seedlings may desiccate on higher elevation surfaces. Moreover, prolonged inundation during the growing season can kill seedlings (Sprenger et al. 2001). Under unaltered conditions, high summer flows typically do not occur; however, where streams are downstream of dams or are used to convey irrigation waters, high summer flows may frequently occur. Finally, flows during the following winter and spring may inundate all surfaces supporting seedlings; seedlings may be scoured from those surfaces inundated with sufficient depth and velocity of water to mobilize the surface (Friedman and Auble 1999). Such scouring is most likely on lower-elevation surfaces.

Historically, flows suitable for cottonwood and willow establishment did not occur in most years. Historical records and tree-aging studies have shown that in numerous riverine environments in the western United States, the combination of factors leading to a large-scale establishment event typically occurs once every 5–10 years (Stromberg et al. 1991; Scott et al. 1997; Mahoney and Rood 1998). Scott et al. (1997) determined that establishment of cottonwoods on the upper Missouri River in an area with little channel movement was most likely on surfaces inundated by floods with a recurrence interval of more than 9 years. Hughes (1994) concluded that long-term cottonwood establishment was associated with even longer flood return intervals (30–50 years) along some non-meandering rivers.

Because other species of riparian trees and shrubs are characterized by larger seed sizes and greater shade tolerance than willows and cottonwoods (Table 5-1), the establishment of such species is less dependent on stream flows. All riparian plants are affected by water availability and competition from existing vegetation, and are consequently affected to some degree by hydrology and the creation of new surfaces by the erosion and deposition of sediment. Some species, such as Oregon ash and valley oak, are able to establish in the shade of other plants; others, such as elderberry and valley oak, can survive drier conditions than can cottonwoods and willows. Thus, in the absence of suitable conditions for willow and cottonwood establishment, other riparian species establish, but the resulting stands differ from cottonwood and willow–dominated stands in species composition, structure, and wildlife habitat value.

Vegetation management activities also affect the establishment of all riparian species. Such activities entail removal of vegetation by means of grazing, herbicide application, and mechanical operations for rangeland and agricultural management; firewood cutting; and levee, floodway, road, and right-of-way maintenance. (Silviculture is not a widespread practice in the Sacramento Valley and foothill riparian areas.) While vegetation removal kills seedlings, it also removes established plants, creating greater opportunities for establishment in subsequent years.

Vegetation management activities occur in western Placer County and may be detrimentally affecting the regeneration of riparian vegetation. Despite stands having a sparse layer of trees and a narrow width, small saplings (i.e., < 2 m [6.6 ft]), particularly those of cottonwoods or willows, often are rare or absent (Appendix A; Placer County 2002). However, hydrologic alterations also may account for these conditions.

Effects on Growth and Reproduction

Growth and reproduction of riparian plants are affected by changes in resource availability and interactions with other species. The effects of human alterations on reproduction have not been documented, except to the extent that reproduction is dependent on growth, and effects on growth have been documented. Human alterations affect the growth of riparian species through surface water diversions and groundwater removals, nutrient inputs, the introduction of nonnative species, and inundation of riparian habitats by dams and reservoirs.

Beyond providing suitable conditions for establishment, flows must be sufficient to maintain existing riparian vegetation year-round. Cottonwoods and willows, in particular, are very susceptible to drought-induced stress. In California, the lack of summer moisture limits these and other riparian tree species to areas with readily available shallow groundwater. Accordingly, groundwater and flows following seedling establishment must be sufficient to maintain the elevation of the riparian groundwater zone or capillary fringe within 10–20 feet of the surface (Jones & Stokes 2000a). Diversions of surface water and groundwater removals that cause groundwater levels to fall could reduce growth and contribute to mortality (Stromberg and Patten 1992). Human alterations increase nutrient inputs to riparian areas thorough atmospheric deposition of nitrogen; additionally, irrigation and stormwater runoff conveys fertilizers from agricultural and developed lands into riparian areas and stream channels. Though the addition of nutrients tends to increase plant growth and biomass, it also affects the cycling of other elements and does not benefit all species equally (Vitousek et al. 1997). Typically, a few species are able to acquire most of the added nutrients, and consequently to outcompete species they would otherwise have been unable to displace. In grasslands, shrublands, and wetlands, nutrient additions have been found to reduce plant species diversity (Vitousek et al. 1997; Keddy 2000). Effects on woody riparian vegetation are undocumented, but are likely to be similar to those reported for other vegetation types.

A number of nonnative species have been introduced and become abundant in the riparian areas of the Sacramento Valley and adjacent foothills (Hunter et al. 2003). These nonnative species create new competitive interactions, and they alter growth by changing resource availability for native species. For example, several introduced species, including black locust (*Robinia pseudoacacia*) and red sesbania (*Sesbania punicea*), fix nitrogen from the atmosphere into biologically available forms via symbioses with soil microorganisms (Hunter 2000; Hunter and Platenkamp 2003). These introduced species may increase nutrient availability for other species. In contrast, tamarisk (*Tamarix* spp.) may reduce water availability for other species (Sala et al. 1996). Several invasive nonnatives, including red sesbania, Himalayan blackberry (*Rubus discolor*), giant reed (*Arundo donax*), and perennial pepperweed (*Lepidium latifolium*), form dense, monotypic stands that preclude the establishment of native species (Bossard et al. 2000).

In western Placer County, many of these invasives are widespread and abundant. For example, Himalayan blackberry is the most abundant species in the shrub layer along western Placer County's streams, and red sesbania grows widely along Dry Creek (Appendix A; ECORP 2003). This non-native vegetation has displaced native species and altered several riparian functions (e.g., conveyance of floodwaters, nitrogen cycling and wildlife habitat).

Effects on Mortality

The mortality resulting from disturbance is integral to the dynamics of riparian vegetation; it affects the proportions of different successional stages and vegetation types within riparian corridors (Stromberg et al. 1991; Malanson 1993; Johnson 1994; Freidman and Auble 1999; Taylor et al. 1999). Along Sacramento Valley and foothill rivers and streams, trees are killed by a number of mechanisms including scour, undercutting by channel migration, uprooting and inundation by flood flows, drought, fire, windthrow, and the removal of vegetation for agricultural or flood control purposes. These disturbances clear spaces for the establishment of early successional vegetation, such as willow thickets and forests dominated by young Fremont's cottonwoods. They also can remove forest vegetation before growth and succession has resulted in the complex canopy structures of mature forests and later successional stages, such as mixed riparian forests and stands of valley oaks. Thus, disturbance regimes determine the proportions of early and late successional vegetation within riparian landscapes.

To maintain both early successional vegetation and mature forests within a riparian landscape, the rate of disturbance must be sufficient to create space for the establishment of new patches of riparian forest, yet not so frequent that it prevents any forest from reaching maturity. Of course, disturbances are not randomly distributed spatially or by type (Conard et al. 1980; Hunter and Parker 1993; Malanson 1993; Freidman and Auble 1999). Disturbance by scour, channel migration, flood flows, and inundation are more frequent and intense at lower elevations (i.e., nearer the stream channel) than at higher elevations (Conard et al. 1980; Malanson 1993; Mitsch and Gosselink 1993; Freidman and Auble 1999; Keddy 2000). In contrast, along Central Valley riparian systems, disturbance by drought and fire is more frequent and intense at higher elevations further from the channel. Thus, across a single cross-section of a riparian corridor, clear gradients exist in disturbance frequency and magnitude. These disturbance gradients, together with interspecific differences in physiological tolerances and establishment requirements, lead to the well-documented zonation of riparian vegetation (Conard et al. 1980; Warner and Hendrix 1985; Mitsch and Gosselink 1993). Accordingly, the persistence of substantial areas of both early successional and mature vegetation within riparian areas is not dependent upon a specific overall average rate of disturbance; rather, it requires only zones of higher and lower rates of disturbance. The combination of flood flows, an actively meandering river channel, and a range of elevations provide such zonation.

Human alterations not only change mortality rates by directly removing vegetation but also by altering hydrology and geomorphic processes. Dams, levees, and surface water diversions isolate riparian areas from the stream channel and floodflows, and thus from associated disturbances. Similarly, bank protection and channelization reduce mortality that can result from channel migration. In addition, groundwater removals can reduce water availability and exacerbate drought-induced mortality of riparian plants.

In western Placer County, substantial areas of riparian vegetation have been converted to developed and agricultural land-cover (Jones & Stokes 2004a, 2004b). For example, along the major streams of western Placer County, approximately a quarter of the land < 20 m (66 ft) from the centerline of a stream, is in developed or agricultural land-cover (Jones & Stokes 2004a, 2004b). The remaining riparian vegetation frequently consists of a narrow band (< 20 m [66 ft]) with a discontinuous layer of trees (Appendix A).

Relationships Between Effects and Setback Width

Human alterations primarily affect riparian plant habitats by vegetation management (e.g., grazing, removal of vegetation to increase conveyance of floodwaters) or by altering hydrology and geomorphic processes. Vegetation management is not necessarily related to setback width, but alterations of hydrologic and geomorphic processes are related to setback width. Infrastructure and other developed land uses within the active floodplain, as well as associated levees, berms, and bank protection, affect hydrology and geomorphic processes; such uses consequently alter the structure and species composition of riparian vegetation. Thus, riparian setbacks narrower than the active floodplain facilitate much more extensive alteration of riparian vegetation than setbacks that extend beyond the active floodplain.

Recommended Setback Width to Conserve Plant Habitat Functions

For the purpose of long-term conservation of plant habitat functions, the project team recommends that riparian setbacks include the entire active floodplain, regardless of the current extent of riparian vegetation on that surface. The distribution of riparian vegetation is not static within the active floodplain, and the diversity of vegetative structure and species composition is strongly related to the hydrologic and geomorphic processes within the active floodplain. Therefore, conversion of any portion of the active floodplain to developed or agricultural land-cover types would not only affect hydrologic and geomorphic functions but would affect plant habitat functions as well.

It is important to note that many human effects on riparian plant habitat functions are not necessarily reduced by establishing setbacks. These effects include the consequences of hydrologic and geomorphic alterations and of vegetation management. Additional measures are necessary to address these effects.

Chapter 6
Terrestrial Animal Habitat Functions

Introduction

The contribution of riparian habitats to biodiversity greatly exceeds the proportional extent of landscape areas they occupy. Scientific documentation of the importance of these habitats for plants and animals has been published in studies conducted across the continent (Sands 1977, Warner and Hendrix 1984, Naiman et al. 1993, 2000; Crow et al. 2000; Brinson et al. 2002).

In western Placer County, Valley Foothill Riparian Woodlands (riparian woodlands) (Mayer and Laudenslayer 1988) and their associated upland habitats provide food, water; cover and migration and dispersal corridors for a higher diversity of wildlife species than any other habitat. Riparian woodlands may support up to 193 vertebrate species, including 133 breeding species and 60 visitors, in western Placer County (Jones & Stokes 2004a). Some animals reside primarily in riparian woodlands year-round, while others occupy these habitats as part of their breeding home range or territories. Many species visit riparian woodlands seasonally or for short periods (e.g., migrating birds).

A number of special-status animals are known to be associated with riparian woodlands in western Placer County: valley elderberry longhorn beetle, foothill yellow-legged frog, western pond turtle, giant garter snake, double-crested cormorant, great egret (rookery), great blue heron (rookery), black-crowned night-heron (rookery), bald eagle, Swainson's hawk, osprey, white-tailed kite, Cooper's hawk, yellow-billed cuckoo (one historical record), long-eared owl, willow flycatcher, purple martin, yellow warbler, yellow-breasted chat, Modesto song sparrow, river otter, ringtail, and an unknown number of bat species (e.g., Townsend's big-eared bat, long-eared myotis, long-legged myotis, and Yuma myotis).

Riparian-associated species vary considerably in their area requirements; many special-status and declining species have large home ranges, and thus require wide riparian areas to maintain viable populations. The habitat and area requirements of riparian-associated birds, mammals, reptiles, and amphibians in western Placer County are summarized in Table 6-1. This list includes only species that depend on riparian woodlands for successful reproduction and survival. Plant and animal population size is often the best predictor of future extinctions or local extirpations; accordingly, habitat patches should be large enough to maintain viable populations of the most area-sensitive species, including special-status and economically important species (Environmental Law Institute 2003).

The primary goal of this chapter is to examine the possible relationships between terrestrial vertebrate diversity (i.e., species' occurrence and abundance) and the extent, width, and condition of riparian woodlands in western Placer County and nearby foothill counties. For each vertebrate group discussed below, the project team evaluated riparian and upland habitat requirements, patch size requirements (area and width), and effects of human activities on those vertebrate groups. The chapter concludes with a summary of the relationships between the width of riparian setbacks and the effects on wildlife habitat due to human alterations, and setback recommendations for conservation of wildlife habitat functions.

Birds

Habitat Relationships

Riparian habitats have been identified as the most important habitat for landbirds in California (Manley and Davidson 1993, Riparian Habitat Joint Venture 2004). Birds of numerous species are abundant in riparian woodlands of western Placer County. Up to 70 species breed in these habitats; an additional 55 species use them for shelter, foraging, or as migratory stopover areas (Jones & Stokes 2004a). Several riparian-associated birds may be covered under the HCP/NCCP for the Phase I Planning Area: Swainson's hawk, yellow-billed cuckoo (one historical record), yellow warbler, yellow-breasted chat, and Modesto song sparrow. Two potentially covered species (bald eagle and bank swallow) may use these habitats for foraging, shelter, or cover but do not breed there (Jones & Stokes 2004a).

Many species of riparian-associated birds are known to breed in western Placer County. These include Cooper's hawk, red-shouldered hawk, Swainson's hawk, black-chinned hummingbird, downy woodpecker, western wood-pewee, Pacific-slope flycatcher, warbling vireo, tree swallow, house wren, yellow warbler (no recent breeding records), yellow-breasted chat, common yellowthroat, Modesto song sparrow, black-headed grosbeak, blue grosbeak, and American goldfinch (Table 6-1).

Riparian Habitat Requirements

Riparian-associated bird species occupy a wide variety of ecological niches; accordingly, they require a complex vegetative structure for breeding, foraging, and shelter/cover (Riparian Habitat Joint Venture 2004). Riparian woodlands provide many niches for breeding birds because they typically support diverse plant communities, are varied in their vertical and horizontal structures, and

			Riparian		Upland	
Species	Home Range Size	Territory Size	Habitat Use	Habitat Requirements	Habitat Use	Habitat Requirements
Pacific treefrog* *Hyla regilla*	Most move < 10 m; capable of moving up to 400 m (Schaub and Larsen 1978)	Circles with radii of 50 cm (Whitney 1980)	Breeding, cover, foraging	Breeds in water; takes cover under logs and vegetation. Uses all riparian stages and temporary water sources (Zeiner et al. 1988)	Cover, foraging	Requires upland sites for cover during nonbreeding season, takes cover in moist niches under logs and vegetation (Zeiner et al. 1988)
Common garter snake* *Thammophis sirtalis*	Probable overlap between pairs during the spring-fall activity period (Zeiner et al. 1988)	Not thought to be territorial; they often remain aggregated from fall until spring (Zeiner et al. 1988)	Cover, foraging, breeding	Permanent and semi-permanent water bodies. Seeks cover in holes and small mammal burrows, often basks on flat rocks and rotting logs near cover (Zeiner et al. 1988)	Cover, foraging, but only in cold northern climates	May migrate to inland localities during winter in cold northern climates (Zeiner et al. 1988)
Western terrestrial garter snake* *Thamnophis elegans*	Probable overlap between pairs during the summer activity period (Zeiner et al. 1988)	Not thought to be territorial (Zeiner et al. 1988)	Cover, foraging, breeding	Permanent and semi-permanent water bodies. Seeks cover in holes and small mammal burrows, often basks on flat rocks and rotting logs near cover (Zeiner et al. 1988)	Cover, foraging	In mild climates, mammal burrows and surface objects (rocks and rotting logs) serve as winter refuges (Zeiner et al. 1988)
Giant garter snake* *Thamnophis couchi gigas*	Probable overlap between pairs during summer activity period; may migrate between wetland habitats and upland sites that provide winter hibernacula (Zeiner et al. 1988)	Not thought to be territorial (Zeiner et al. 1988)	Cover, foraging, breeding	Highly aquatic; seeks cover in holes and small mammal burrows, crevices, and surface objects. Often basks in streamside vegetation. Rocks and rotting logs serve as winter refuges	Cover, foraging	In mild climates, mammal burrows and surface objects (rocks and rotting logs) serve as winter refuges (Zeiner et al. 1988)
Cooper's hawk *Accipiter cooperii*	*Michigan* – four home ranges averaged 311 ha, range 96–401 ha; 17 others averaged 207 ha, range 18–531 ha *Wyoming* – One home range of 205 ha (Craighead and Craighead 1956).	Males defend ~100 m around potential nest sites prior to pair formation (Brown and Amadon 1968). *Oregon* – nests were 3.2–4.2 km apart (Jackman and Scott 1975). Elsewhere, nests were 1.6–2.4 km apart (Meng 1951, Brown and Amadon 1968). *California* – In oak stands, mean distance between nests was 2.6 km (Zeiner et al. 1990a)	Breeding, foraging, perching	Needs dense stands of live oak, riparian deciduous, coniferous, or other forest habitats near water; nests in crotches 3–23 m high (Zeiner et al. 1990a)	Breeding, foraging, perching	Hunts in patchy wooded areas and edges; needs snags or dense tree stands for perching and waiting for prey (Beebe 1974). Dense stands with moderate crown-depths used for nesting (Zeiner et al. 1990a)

			Riparian		Upland	
Species	Home Range Size	Territory Size	Habitat Use	Habitat Requirements	Habitat Use	Habitat Requirements
Red-shouldered hawk* *Buteo lineatus*	*Michigan* – averaged 63 ha, range 19–384 ha (Craighead and Craighead 1956)	Same as home range	Breeding, perching, foraging	Extensive stands of forest with tall trees and variable amounts of understory required for breeding (Crocoll 1994)	Cover, foraging	Does not require upland sites, but will use them for foraging and roosting; mostly forages in oak woodlands and adjacent annual grasslands (Zeiner et al. 1990a)
Swainson's hawk+ *Buteo swainsoni*	*Wyoming* – five pairs averaged 2.5 km^2 (Craighead and Craighead 1956) *California* – 12 pairs, 2,760–2,553 ha (Estep 1989); 5 pairs ranged 4,038–2,663 ha (Babcock 1995) *Washington* – eight pairs, 621–214 ha (Fitzner 1978); five pairs, 886–243 ha (Bechard 1982) *Colorado* – eight pairs, 2,429–1,050 ha (Andersen 1995) Nest sites in riparian forest close to alfalfa or recently harvested row crops corresponded to smaller home ranges (Estep 1989)	No specific information on territory size (England et al. 1997); three territories were found within a 1.1-km length of riparian forest in the Central Valley (Bloom 1980)	Breeding and perching	Requires large trees to support nests, but will nest in open habitats with scattered trees and small groves near water (Bloom 1980); nests 1.3–30 m above ground (Zeiner et al. 1990a)	Breeding, foraging, perching	Not an obligate riparian species; needs proximity to good foraging habitat such as grassland, pasture, or grainfields; primarily needs large trees for nesting (Woodbridge 1998; Zeiner et al. 1990a); may nest in open grassland or cropland habitats with scattered trees (England et al. 1997)
Yellow-billed cuckoo+ *Coccyzus americanus*	Large home ranges averaging 17 ha (Laymon and Halterman 1987)	10 ha is an appropriate minimum patch size (Halterman pers. comm.)	Nesting, foraging, perching	Optimal stands defined as more than 80 ha in extent and more than 600 m wide, marginal stands as 20–40 ha and 100–200 m wide, and unsuitable stands as less than 15 ha and less than 100 m wide (Laymon and Halterman 1989)	Foraging	May forage in uplands adjacent to riparian woodlands, especially early successional stands of cottonwoods and willows (Laymon and Halterman 1989). 10 ha is an appropriate minimum patch size for this species (Halterman pers. comm.)

			Riparian		Upland	
Species	Home Range Size	Territory Size	Habitat Use	Habitat Requirements	Habitat Use	Habitat Requirements
Black-chinned hummingbird+ *Archilochus alexandri*	No data	*S. California* – male breeding territory averaged 0.1 ha (Stiles 1973); 41–130 nests per 40 ha (Pitelka 1951) *Arizona* – eight nests per 40 ha in oak woodland; 21 per 40 ha in oak juniper woodland (Balda 1970)	Nesting, foraging, perching	Sparse to open riparian woodland preferred for breeding; uses trees and shrubs for cover; places open cup nest in understory (0.9–9.1 m above ground) near water source (Grinnell and Miller 1944; Zeiner et al. 1990a)	Occasional breeding, mostly foraging	Woodland and scrub habitats adjacent to riparian areas used for feeding during breeding season. Occasionally nests in orchards (Zeiner et al. 1990a)
Downy woodpecker* *Picoides pubescens*	Territory and home range are the same (Zeiner et al. 1990a)	*Ontario* – two breeding territories of 2.0 and 3.2 ha (Lawrence 1967)	Breeding, foraging, cover	Associated with riparian deciduous softwoods; uses tree and shrub foliage for cover; requires abundant snags and tree/shrub, tree/herbaceous, and shrub/herbaceous ecotones (Zeiner et al. 1990a). Excavates nest cavity in snag (preferably aspen) or dead branch 1.3–15 m high (Bent 1939; Lawrence 1967)	Foraging, cover	Frequents hardwoods, conifer habitats, and orchards adjacent to riparian areas (Zeiner et al. 1990a)
Western wood-pewee+ *Contopus sordidulus*	No information found, but probably equal to territory. Density estimates range from 1–10 pairs per 40 ha in Colorado aspen-conifer habitat (Beaver and Baldwin 1975) to 18–33 pairs per 40 ha in Sacramento Valley riparian habitats (Gaines 1974)	*Colorado* – territory averaged 1.2–1.6 ha over 3 yrs (Eckhardt 1976). Territory size probably varies widely depending on habitat and foraging conditions (Zeiner et al. 1990a)	Breeding, perching, foraging	Uses trees of almost any size, especially with dead lower branches, for nesting, singing, and foraging perches. Places open cup nest 4–25 m above ground. Nests in woodlands edging riparian areas and in valley foothill riparian habitats (Zeiner et al. 1990a)	Breeding, roosting, foraging	Nests in open woodlands with sparse to moderate canopy, most commonly in ponderosa pine, montane hardwood-conifer, mixed conifer, Jeffrey pine, lodgepole pine, eastside pine, red fir, and aspen (Grinnell and Miller 1944; Garrett and Dunn 1981; Zeiner et al. 1990a)

			Riparian		Upland	
Species	Home Range Size	Territory Size	Habitat Use	Habitat Requirements	Habitat Use	Habitat Requirements
Willow flycatcher+ *Empidonax traillii*	In breeding season, probably equal to territory. *Washington* – 9.2 pairs per 40 ha in scrub habitat (King 1955) *Michigan* – 60.7 individuals per 40 ha in scrub habitat (Berger 1957)	*California* - six paired males ranged 0.09–0.38 ha and averaged 0.18 ha in Fresno County (KRCD 1985); 22 territories ranged 0.06–0.89 ha and averaged 0.34 ha in Sierra County (Sanders and Flett 1989); monogamous males averaged 0.6 ha (SD = 0.35, n = 24, range 0.1–1.3) and polygynous males averaged 1.1 ha (SD = 0.68, n = 24, range 0.2–2.8) at the South Fork Kern River (Whitfield and Strong 1995; Whitfield and Enos 1996; Whitfield et al. 1997). *Arizona* – range 0.06–1.5 ha (Sogge et al. 1997). *Michigan* – avg. size was 0.7 ha (Walkinshaw 1966)	Nesting, foraging, perching	Broad river valleys or moist mountain meadows where lush thickets of dense willows, alders, and cottonwoods edge on wet meadows, ponds, or backwaters (Zeiner et al. 1990a; Serena 1982; Harris et al. 1988; Whitfield et al. 1997; Sanders and Flett 1989). In mountain meadows prefers willow thickets interspersed with open space; in lowland riverine habitats prefers contiguous willow thickets (Harris 1991). Does not occur in areas of dense tree cover (King 1955; Walkinshaw 1966)	Migration	May migrate into higher elevations after breeding and during fall migration (Grinnell and Miller 1944). No specific data un upland habitat use
Pacific-slope flycatcher+ *Empidonax difficilis*	*Colorado* – 5–28 individuals/40 ha in conifer forest (Beaver and Baldwin 1975) *California* – 11 males/40 ha in broadleaf evergreen forest in Alameda County (Cogswell 1973), 35 males/40 ha in buckeye/California bay mixed forest in Marin County (Stewart 1973)	No data	Breeding, foraging, perching	Breeds in shady alder and willow thickets and similar riparian growth in oak woodlands, redwood, and ponderosa pine forests (Zeiner et al. 1990a)	Foraging, perching, migration	Frequents shaded woodlands and forests with dense canopy adjacent to riparian habitat during breeding season. Occurs in more open habitats in migration (Zeiner et al. 1990a)

			Riparian		Upland	
Species	Home Range Size	Territory Size	Habitat Use	Habitat Requirements	Habitat Use	Habitat Requirements
Warbling vireo+ *Vireo gilvus*	*Idaho* – one pair had a 37-m radius around the nest (Rust 1920); five pairs/40 ha in a cut-over Douglas-fir forest (Johnston 1949) *Arizona* – 42 pairs/40 ha in fir-pine-aspen forest (Haldeman et al. 1973) *California* – 40 pairs/40 ha in an oak/bay mixed forest (Stewart 1973); 21 pairs/40 ha in a lodgepole-aspen forest (Winkler and Dana 1977); eight pairs/40 ha in a broadleaf evergreen forest (Cogswell 1973)	*California* – nine pairs in coastal riparian forest averaged 1.45 ha; 19 territories in eastern California averaged 1.2 ha (Gardali and Ballard 2000) *Arizona* – 2 pairs were both 1.2 ha (Barlow 1977). *Illinois* – One pair was ~1.2 ha (Gardali 2003). *Ontario* – Three pairs ~1.2-1.5 ha (Gardali 2003). *Alberta* – Two pairs were both 1.5 ha (Gardali 2003)	Breeding, foraging, perching	Nests in mature mixed deciduous woodlands along riparian corridors (Gardali 1998). Likes edges and openings, large trees, and semi-open canopy (James 1971; MacKenzie et al. 1982; Marzluff and Lyon 1983; Verner and Boss 1980) According to Grinnell and Miller (1944), may be more attracted to riparian trees than to moisture	Occasional breeding, perching, and migration	Commonly uses deciduous trees, shrubs and conifers for cover. Occasionally breeds in conifer habitats and forest interiors near edges and openings (Zeiner et al. 1990a; Gardali 1998). Also occurs in desert riparian, orchards, vineyards, and urban habitats during migration (Zeiner et al. 1990a; Gardali 1998)
Tree swallow+ *Tachycineta bicolor*	Kuerzi (1941) stated home range is "large"	*California* – 4–18 pairs/40 ha in riparian habitat (N = 3) and 2–10 pairs/40 ha in mixed conifer forest (N = 4) in the Sierra Nevada (Raphael and White 1978)	Breeding, foraging, cover	Requires trees and snags with cavities in forest and riparian woodland for nesting and cover (Zeiner et al. 1990a)	Breeding, foraging, perching, migration	Will nest in lodgepole pine belts. Common to occasional transient throughout the state in virtually all non-desert habitats (Zeiner et al. 1990a)
House wren* *Troglodytes aedon*	No data	*Oregon* – 14 breeding territories averaged 0.9 ha, range 0.5–1.8 ha (Kroodsma 1973) *Ohio* – 178 breeding territories averaged 0.4 ha, range 0.03–1.5 ha (Kendeigh 1941b)	Breeding, foraging, cover	Brushy understory beneath oaks and other riparian deciduous trees. Requires cavities in trees and snags with thickets nearby for foraging (Zeiner et al. 1990a)	Dispersal	Moves upslope after breeding in the Cascades and Sierra Nevada (Zeiner et al. 1990a)

			Riparian		Upland	
Species	Home Range Size	Territory Size	Habitat Use	Habitat Requirements	Habitat Use	Habitat Requirements
Yellow warbler+ *Dendroica petechia*	*New York* – less than 0.2 ha (Ficken and Ficken 1966) *Iowa* – 0.16 ha (Kendeigh 1941a)	*California* – 0.40–.74/ha (mean 1.64 SE + 0.12) in early successional habitats of eastern Sierra Nevada (PRBO unpublished data) *Iowa* – 0.16/ha in prairie community *Minnesota* – range 0.03–1.62 ha (Beer et al. 1956) *Michigan* – polygynous male territories (0.78 ha) significantly larger than those of monogamous males (0.21 ± 0.05 ha) (DellaSala 1986) Territory size variable depending on availability of foraging area (Kendeigh 1941)	Breeding, foraging, perching	Nests in early successional riparian habitat or remnant or regenerating canopy with good shrub cover. Prefers deciduous trees such as willows, alders, sycamore, maples, and cottonwoods; in the eastern Sierra breeds locally in wild rose and more xeric plant species and habitats (Heath 1998)	Breeding, foraging, perching	Breeds in montane shrubs in open conifer forests (Gaines 1977). In migration, visits woodland, forest, and shrub habitats (Zeiner et al. 1990a). Kendeigh observed individuals regularly moving up to 488 m to a willow-marsh edge to feed. (Zeiner et al. 1990a). *D.p. brewsteri* was found to breed in locations away from water in the Modoc Bioregion (Grinnell et al. 1930).
Common yellowthroat *, + *Geothlypis trichas*	*Michigan* – 1.4 ha for polygynous male; 10 pairs ranged 0.3–0.7 ha in marsh and riparian habitats (Stewart 1953) *New York* – seven pairs spaced uniformly over 2.0–2.4 ha in a brush field (Kendeigh 1945)	*California* – 1.04 territories/ha in Marin County (Evens et al. 1997); spacing of 0.2–2.0 ha reported by Foster (1977) in the SF Bay *Michigan* – 0.3–0.7 ha (Stewart 1953) *New York* – spacing of 2.0–2.4 ha	Breeding, foraging, perching	Needs tall, emergent herbaceous wetlands and low, dense vegetation near water (Timossi 1990; Zeiner et al. 1990)	Occasional breeding, migration	Occasionally breeds in dense shrubs and annual/perennial grasslands (Garrett and Dunn 1981; Zeiner et al. 1990). Brushy habitats used in migration (Zeiner et al. 1990a)

Species	Home Range Size	Territory Size	Riparian		Upland	
			Habitat Use	Habitat Requirements	Habitat Use	Habitat Requirements
Yellow-breasted chat + *Icteria virens*	*California* – 10pairs/40 ha reported in the Sacramento Valley (Gaines 1974)	*Indiana* – avg. 1.24 ha (range 1.12–1.58 ha). Males that arrived early established large territories that shrunk as more males arrived; males expanded their territories if neighboring territories were abandoned (Thompson and Nolan 1973)	Breeding, foraging, perching	Requires dense riparian thickets of willows, vine tangles, and dense brush associated with streams, swampy ground, and borders of small ponds (Small 1994). Uses taller trees as song perches (Dunn and Garrett 1997). Nest substrate in California consists of blackberry, wild rose, and pipevine (Ricketts and Kus 2000; Burnett and DeStaebler 2002)	Dispersal	May wander upslope post-breeding (Gaines 1977)
Song sparrow * *Melospiza melodia*	*New York* – 0.6 ha (Butts 1927) *Kansas* – 3.6 ha winter home range; 29 home ranges averaged ~2.8 ha (Fitch 1958) *British Columbia* – averaged 0.05 ha in an island population (Tompa 1962)	*California* Modoc Bioregion: 1.94 territories/ha (n=14) (King and King 2000). Sierra Bioregion: 0.2–1.2 territories per creek km (Heath and Ballard 1999) Bay/Delta Bioregion: 4.4–8.1 territories/ha (Gardali et al. 1998) *British Columbia* – 1.7–5.6 pairs/ha (Rogers et al. 1997)	Breeding, foraging, perching	Breeds in early successional riparian habitat, emergent wetlands, and coastal scrub (Burridge 1995; Roberson and Tenney 1993). Requires water, dense vegetation, light, and exposed ground for foraging (Marshall 1948) Abundance is negatively correlated with tree cover and closed canopy cover ($p<0.05$) (Holmes et al. 1999)	Breeding, foraging, perching	Regularly breeds in coastal scrub habitat, which provides enough water in the form of fog (Humple and Geupel 2004). In winter may be found far from water, in open habitats with thickets of shrubs or tall herbs. Usually avoids densely wooded habitats, except along forest edges (Zeiner et al. 1990a)
Black-headed grosbeak+ *Pheucticus melanocephalus*	*California* – 31–66 singing males/40 ha (Gaines 1974)	*New Mexico* – 0.79 ha (n=28, range=0.43-1.63ha) (Hill 1988; Hill 1995) *Utah* – 2.7 ha (n=12, range=1.9–3.0 ha) (Ritchisson 1983) No information available for California	Breeding, foraging, perching	Requires vegetation density and vertical complexity (Hill 1988); trees and shrubs as low as 1 m to support nests (Zeiner et al. 1990a); favors cottonwood/ willow associations (Grinnell and Miller 1944) with a primary and secondary canopy, variety in shrub height, and patches of herbaceous cover (Gaines 1977)	Occasional nesting, foraging, perching	Sometimes nests in open woodlands, orchards, or edges of dense woodlands (Zeiner et al. 1990a, Lynes 1998)

			Riparian		Upland	
Species	Home Range Size	Territory Size	Habitat Use	Habitat Requirements	Habitat Use	Habitat Requirements
Blue grosbeak+ *Guiraca caerulea*	No data	*South Carolina* – 5.2–6.12 ha (Odum and Kuensler 1955) *Georgia* – 1.2 ha in tung-oil groves (White 1998)	Breeding, foraging, perching	Prefers riparian edges, forest/field edges, or forest/gravel-bar interfaces (Gaines 1974) with herbaceous annuals and young, shrubby willows/cottonwoods (Grinnell and Miller 1944). Prefers upright growing herbs for nest placement, and tall shrubs and trees for singing perches and shade for nest sites (White 1998)	Foraging, dispersal, migration	Forages in openings, grasslands, and croplands adjacent to riparian areas. Not limited to riparian habitats post breeding or in migration (Zeiner et al. 1990a)
American goldfinch* *Carduelis tristis*	*Michigan* – nesters fed up to 274 m from nest (Nickell 1951) and at least 0.8 km from nest (Coutlee 1967); 53–205 pairs/40 ha (Berger 1957) *California* – 10–33 males/40 ha (Gaines 1974)	*Michigan* – males defended 30 m around nest and built nests at least 35 m apart (Coutlee 1967) *Wisconsin* – 9.1–27 m around nest in marshland (Stokes 1950)	Breeding, foraging, perching	Nests in riparian deciduous woodland near feeding areas in brushy or herbaceous habitats (Coutlee 1967). Must be near water and may require trees for roosting (Zeiner et al. 1990a). Uses willow, cottonwood, or other riparian deciduous tree as nesting substrate (Grinnell and Miller 1944)	Breeding, foraging, perching	Will move upslope after breeding (Zeiner et al. 1990a). May nest in oaks, orchards, other upland shrubs, or thistles (Grinnell and Miller 1944)
Ornate shrew* *Sorex ornatus*	Occurrence and abundance of shrews varied significantly between sites and years but the size of the landscape or the study site had no effect on their abundance; peak densities usually occurred during the spring (Laakkonen et al. 2001).	No data found.	Breeding, foraging, cover	Optimum habitats are foothill and montane riparian (Zeiner et al. 1990b). The amount of urban edge had no significant effect on the captures of shrews but increased edge allows invasion of the Argentine ants, which had a highly significant negative impact on shrew abundance (Laakkonen et al. 2001)	Breeding, foraging, cover	Occurs in a variety of woodland, scrub, and grassland habitats and occupies dry, upland sites more commonly than most other shrews (Zeiner et al. 1990b)

			Riparian		Upland	
Species	Home Range Size	Territory Size	Habitat Use	Habitat Requirements	Habitat Use	Habitat Requirements
Yuma myotis *Myotis yumanensis*	Radio telemetry studies showed that direct line distances between capture sites and first day roosts averaged 2,007 m, and 1,130 m for roost sites on consecutive days (Evelyn et al. 2004)	Territoriality has not been reported; probably not territorial at foraging or roosting sites; roosts in large groups numbering from about 200 to thousands of individuals (Zeiner et al. 1990b)	Breeding, foraging, cover	Usually forages over water, and seems to be more closely associated with water than any other North American bat species (Barbour and Davis 1969). Riparian habitats offer optimal habitats for this species since they provide suitable roosting and breeding habitat a nearby source of water for foraging (Zeiner et al. 1990b). Large maternity colonies may be found in buildings, caves, under bridges (Zeiner et al. 1990b), and in large trees (Evelyn et al. 2004). Prefers to roost in large trees (mean diameter 115 cm) that provide suitable cracks, crevices, and cavities; roost sites are usually near water (mean 133 m from water) (Evelyn et al. 2004)	Breeding, foraging, cover	Found in a wide variety of habitats from the coast to mid-elevations, and preferred habitats include open forests and woodlands near sources of water for foraging (Zeiner et al. 1990b).
Beaver* *Castor canadensis*	*Canada*—colonies had home range of 0.8 km radius from lodge, or about 201 ha (Aleksiuk 1968) *California*—colony home range was about 15 ha (Light 1969)	*Canada*--territory boundaries maintained by scent mounds, averaged 0.4 km radius, or about 50 ha (Aleksiuk 1968); colonies closer together formed more scent mounds than did more isolated colonies (Butler and Butler 1979)	Breeding, foraging, cover	In winter forages almost entirely on the bark and cambium of riparian trees including aspen, willow, alder, and cottonwood; forages mostly on streambanks, felling trees and harvesting branches for winter food. Builds lodges out of branches and mud, usually on streamside banks or on islands. Takes cover in lodge or by diving in water; makes dams to form deeper ponds for foraging and taking cover (Zeiner et al. 1990b)	Foraging	Forages us to 200 m from water; cuts a variety of trees but tends to take smaller trees far from water (Jenkins 1980)

			Riparian		Upland	
Species	Home Range Size	Territory Size	Habitat Use	Habitat Requirements	Habitat Use	Habitat Requirements
Ringtail* *Bassariscus astutus*	No information available	*California* – estimated to vary from 44–515 ha (Grinnell et al. 1937) *Texas* – average size estimated at 20–43 ha (Toweill and Teer 1981)	Breeding, foraging, cover	Breeds and takes cover in hollow logs, trees, and cavities in talus and other rocky areas, usually near water (Zeiner et al. 1990b). Primarily carnivorous; prefers rodents and rabbits. Also consumes birds and eggs, reptiles, invertebrates, fruits, nuts, and some carrion (Trapp 1978)	Foraging	Forages primarily in riverine and riparian areas, but may also use nearby uplands if suitable prey is available (Zeiner et al. 1990b)
Raccoon* *Procyon lotor*	*Michigan*—home ranges of males averaged 204 ha and varied from 18 to 814 ha (Stuewer 1943) *North Dakota*—home ranges of males varied from 396 ha to 1,468 ha, and females varied from 532 to 743 ha for females (Fritzell 1977)	Radiotelemetry studies suggest that males may be territorial, but females probably are not; no information on territory size available (Zeiner et al. 1990b)	Breeding, foraging, cover	Found in greatest abundance in low and mid-elevation riparian habitats; takes cover and breeds in tree cavities, snags, and downed logs. Usually forages for both animal and plant material in shallow water (Zeiner et al. 1990b)	Breeding, foraging, cover	Frequents a high diversity of habitats including upland areas such as forested, shrub, and herbaceous areas; may use rocky areas for dens or cover; a source of water is required for foraging and washing (Zeiner et al. 1990b)
River otter* *Lutra canadensis*	Home ranges may extend an average of 24 km along rivers and streams (Haley 1975); travel distance is highly variable and depends on food supplies and habitat quality; may travel 80 to 96 km along streams during a year (Liers 1951)	Males known to establish scent posts using urine, feces, and musk but no information on territory size available ((Zeiner et al. 1990b)	Breeding, foraging, cover	Uncommon residents of riparian habitats and associated streams and rivers; takes cover and nests in burrows and cavities in river banks; also uses hollow logs, stumps, snags, abandoned beaver lodges, and natural cavities in riparian habitats (Zeiner et al. 1990b)	Foraging	Seldom moves away from water but may pursue prey short distances from water courses into upland habitats (Sheldon and Toll 1964)

* Resident (at least partially) in riparian habitats of western Placer County.

+ Neotropical migrant species that breed in riparian habitats of western Placer County or in nearby counties.

provide a source of surface water (MacArthur 1964; James 1971; Rice et al. 1983, 1984; Brinson et al. 2002). Many riparian areas offer a range of successional habitats due to the dynamic nature of their hydrology. Riparian woodlands are also critical to a diversity of migratory birds (e.g., raptors, flycatchers, vireos, warblers, tanagers, sparrows, and grosbeaks) that depend on trees and shrubs near streams for shelter/cover and for the rich food supplies (e.g., insects, seeds, and fruits) associated with these areas (Jones & Stokes 2004a). Moreover, riparian areas can also provide perching, nesting, and foraging habitat, as well as water, for bird species that primarily nest in upland areas (Heath and Ballard 2003).

Because habitat heterogeneity promotes animal diversity, the highest bird abundance and species richness are usually found in riparian woodlands with a variety of different successional stages (i.e., young and old trees) and a lush understory of shrubs and/or herbaceous plants. Many breeding bird species prefer specific successional stages of riparian woodlands. For example, song sparrows, blue grosbeaks, yellow-breasted chats, yellow warblers, and common yellowthroats are often most abundant in early successional habitats (e.g., stands approximately 2 to 4 m [6.5 to 13 ft] tall) with dense vegetation near the ground. Other species, such as Cooper's hawks, red-shouldered hawks, yellow-billed cuckoos, tree swallows, and black-headed grosbeaks, prefer late-successional stands with taller trees and snags (e.g., more than 10 m [33 ft] tall) that are required for nesting substrates and/or song or foraging perches. Some bird species (most woodpeckers, owls, and some swallows and flycatchers) require large snags for nesting (Zeiner et al. 1990a; Riparian Habitat Joint Venture 2004).

Riparian areas also provide essential habitat for migratory birds and wintering species. For example, willow flycatchers (state listed as endangered) require these habitats during spring and fall migration, but they do not remain to nest in western Placer County (Table 6-1). Many other species of Neotropical birds such as vireos, warblers, thrushes, and grosbeaks also depend on riparian habitats for cover and foraging during migration (Riparian Habitat Joint Venture 2004).

Upland Habitat Requirements

Upland habitats provide migratory stopover grounds, foraging habitat, and dispersal corridors for non-breeding adults and juveniles of many riparian-associated species. For this reason, the adjacent land cover is a strong determinant of the species composition of a specific habitat area (Appendices A and B). Yellow-billed cuckoos, yellow warblers, common yellowthroats, and song sparrows are among the many riparian-associated species that may forage in upland habitats adjacent to riparian nesting sites (Zeiner et al. 1990a). Upland areas serve both as refugia during floods and as supplemental or primary foraging areas at other times of year. Riparian areas also can support primarily upland nesting bird species for perching, nesting, foraging, and water (Heath and Ballard 2003). Uplands can also be important for juvenile dispersal. For example, in coastal California, juvenile Swainson's thrushes use uplands regularly during the post-fledgling period (PRBO unpublished data). Swainson's hawk is an example of a species that frequently nests in riparian woodlands in the Central Valley but forages in upland habitats consisting of large, flat, open, undeveloped landscapes with suitable grassland or agricultural foraging habitat. Swainson's hawks usually nest in large native trees such as valley oaks, cottonwoods, and willows, although nonnative trees, such as eucalyptus, are also used (England et al. 1997). Other primarily riparian-associated birds that often forage in adjacent, upland habitats include Cooper's hawks, red-shouldered hawks, tree swallows, blue grosbeaks, and American goldfinches (Table 6-1).

Patch Size and Riparian Width Requirements

Numerous studies in North America have demonstrated that breeding bird species richness and abundance are positively correlated with riparian width and patch size—at least for riparian-associated and forest interior species. The following studies from California, other states, and Canada provide examples of the relationships between riparian width and patch size and bird species richness and abundance.

California

- In the California Central Valley, riparian bird species richness increased with the width of the riparian zone (Stralberg et al. 2004 [Appendix B of this report]). Species richness was positively associated with riparian width along mainstem rivers, but not along smaller, tributary streams, with a significant increase in species richness occurring beyond 100 m (Appendix B).
- Also in the Central Valley, the occurrence of three riparian-associated species (i.e., black-headed grosbeak, common yellowthroat, and yellow warbler) also was positively associated with riparian zone width (Appendix B). Black-headed grosbeak presence was positively associated with riparian width at mainstem, but not tributary sites, while the reverse was true for the yellow warbler and common yellowthroat. For all three species, significant increases in abundance occurred when the riparian zone was greater than 100 m in width (Appendix B).
- In the San Francisco Bay Area, bird species richness and density decreased as the number of artificial structures (i.e., bridges) increased and as the volume of native vegetation decreased due to urbanization (Rottenborn 1999).
- In coastal Marin County, the abundance of warbling vireos, Swainson's thrushes, and common yellowthroats increased with the width of the riparian corridor. There was no association between riparian width and bird species diversity or richness (Holmes et al. 1999).
- In the eastern Sierra, bird species diversity was positively correlated with riparian width and tree species diversity (Heath and Ballard 2003).

- In California, Song Sparrows and Spotted Towhees have been observed in strips as narrow as 1 m, and other species have been observed in strips 10 m wide (Soulé 1988, PRBO unpubl. data).

Other States

- Along Oregon's headwater streams, riparian buffers are likely to provide the most benefit to riparian- and forest-associated birds if they are more than 40 m (131 ft) wide (Hagar 1999).
- In eastern Oregon, total abundance of riparian birds was greater in continuous shrub associations than in discontinuous shrub associations (Sanders and Edge 1998).
- In Texas, bird abundance was positively correlated to forest width, and streamside forests more than 50 m (164 ft) wide supported the greatest number of total species; area-sensitive bird species increased in abundance in these forests as widths increased from 25 to 100 m (82 to 328 ft); and narrow riparian strips were usually inhabited only by species associated with early successional vegetation and habitat edges (Dickson et al. 1995).
- In South Carolina, species richness of all birds (including Neotropical migrant birds) increased with the width of riparian stands. Narrow riparian strips (less than 50 m [164 ft] wide) supported an abundant and diverse avifauna, but conservation of wide strips (more than 500 m [1,640 ft] wide) was required to support the complete avian community characteristic of that region (Kilgo et al. 1998).
- In Iowa, bird species richness increased with the width of wooded riparian habitats (from 10 to 200 m [33 to 656 ft]), and area-sensitive species were only present on the widest plots (Stauffer and Best 1980).
- In Pennsylvania, most area-sensitive bird species did not occur in riparian zones less than 25 m (82 ft) wide. However, the presence of very narrow (e.g., 2 m [7 ft]) bands of woody vegetation along streams was found to be important for some bird species in disturbed areas (Croonquist and Brooks 1993).
- In Maryland and Delaware, the species richness of area-sensitive riparian birds increased in width zones between 25 m (82 ft) and 100 m (328 ft), and several Neotropical migrant species were only found in riparian forests more than 100 m (328 ft) wide (Keller et al. 1993).

Canada

- In Alberta, forest-dependent bird species declined as buffer width narrowed from 200 m (656 ft) to less than 100 m (328 ft) (Hannon et al. 2002).
- In Quebec, riparian strips less than 40 m (131 ft) wide had the highest mean bird densities (Darveau et al. 1995).

- In Newfoundland, total numbers of interior forest birds may increase in wider buffers, but these species were rare even in the widest strips sampled (40–50 m [131–164 ft]) (Whitaker and Montevecchi 1999).

Overall, the species richness (i.e., total number of species) and abundance (i.e., number of individuals within a species) of riparian-associated species are highest in wide and continuous riparian corridors; this pattern is especially true for area-sensitive species. The effect of riparian width depends on each species' needs, the riparian habitat type and its historic conditions, and attributes of the surrounding landscape. Fragmentation of riparian woodlands could be especially detrimental to nonmigratory species such as song sparrows and spotted towhees that generally do not disperse over large distances. Even thin strips of connecting habitat, while usually not suitable for nesting, can benefit sedentary species that will not disperse through open habitats (e.g., grasslands or barren areas) (Croonquist and Brooks 1993).

Patch size requirements for each species depend on territory and home range sizes and relative sensitivity to fragmentation (Tewksbury et al. 1998; Riparian Habitat Joint Venture 2004). In planning the conservation of an assemblage of species, those species with greatest sensitivity to habitat fragmentation should be used to set patch size requirements (Tewksbury et al. 1998). In western Placer County, some of the most area-sensitive bird species are raptors (home ranges often larger than 100 ha [247 ac]), yellow-billed cuckoos (home ranges larger than 10 ha [25 ac]), downy woodpeckers, and yellow-breasted chats (home ranges greater than 1 ha [2.5 ac]). These species require relatively large areas of riparian habitat to breed and forage successfully (Table 6-1).

Yellow-billed cuckoo is an example of a species that requires large tracts of late-successional riparian forest for breeding habitat. This species was a rare historical visitor to western Placer County, but it has not been recorded there in many decades (Jones & Stokes 2004a). However, yellow-billed cuckoos are regular breeders in wide riparian forests along the Sutter Bypass, about 12 km (7.5 mi) from the Placer and Sutter county line. Using radio-telemetry, Laymon and Halterman (1987) determined that yellow-billed cuckoos have large home ranges, averaging 17 ha (42 ac). Optimal stands were defined as more than 80 ha (198 ac) in extent and wider than 600 m (1,970 ft), marginal stands as 20–40 ha (49–99 ac) in extent and 100–200 m (328–656 ft) wide, and unsuitable stands as less than 15 ha (37 ac) in extent and less than 100 m (328 ft) wide Laymon and Halterman (1989).

Effects of Human Alterations on Riparian Birds

Habitat Loss and Degradation

In the western United States, approximately 95% of riparian habitats have been lost or degraded due to human activities during the past 100 years (Smith 1977, Ohmart 1994). These habitats represent less than 1% of most western landscapes, yet they provide breeding habitat for more than 50% of bird species in this region (Ohmart and Anderson 1982; Rice et al. 1983; Ohmart 1994; Tewksbury et al. 2002). Throughout the Central Valley and Sierra Nevada foothills, riparian habitats have been reduced to a small fraction of their original extent (Hunter et al. 1997, Riparian Habitat Joint Venture 2004), and those habitats that remain have been fragmented and degraded by a variety of human activities. The primary factors include historical gold mining; heavy livestock use of some riparian corridors; vegetation removal on the floodplain; introduction and spread of noxious weeds; road and home development; alterations in the hydrologic regime caused by hydroelectric and water storage reservoirs; gravel mining; and groundwater extraction (Kondolf et al. 1996).

In western Placer County, riparian woodlands occur as well-developed and continuous stands along depositional reaches of Coon Creek and portions of the Bear River and the American River. Along most other creeks, however, this habitat occurs as narrow and generally discontinuous bands of trees (Appendix A). Riparian woodlands rarely occur on intermittent streams and almost never on ephemeral streams that only flow during storm events. Riparian vegetation occupies about 2,456 ha (6,069 ac), or roughly 2% of the land area, in western Placer County (Jones & Stokes 2004a). Accordingly, it is clear that available riparian habitat has been greatly reduced and fragmented, causing a decline in locally nesting populations and an increased potential for local extirpation.

Riparian areas in western Placer County are increasingly surrounded by urban, rural-residential, and agricultural development. Increased noise levels associated with human activity can cause nest abandonment, flushing from the nest, and consequent nest failure (Delaney et al. 1999). Agricultural activities such as mowing, disking, grazing, pesticide use, and artificial flooding can also reduce the habitat quality if they encroach into riparian woodlands (Ohmart 1994). Fragmentation and degradation resulting from urban, residential, and agricultural land uses has probably reduced the wildlife habitat functions of most riparian areas in western Placer County (Appendix A; Jones & Stokes 2004a, 2004b). Urban development can also result in increased mammalian and avian predator populations and greater exposure to predation pressures, as discussed below.

The species richness and densities of certain riparian-associated birds have been demonstrated to decrease with increasing urban development in the surrounding landscape (Rottenborn 1999; Miller et al., 2003). In the uplands of Placer County's foothill oak woodland zone, several riparian-associated bird species (including black-headed grosbeak) were found at lower relative abundance in fragmented compared to unfragmented oak woodland landscapes (Stralberg and Williams 2002).

Livestock Grazing

Livestock grazing in riparian areas is particularly widespread in the western U.S., especially in dry areas where cattle are attracted to riparian zones for water, shade, and shelter (Bryant 1979). Many native bird species have experienced population declines in grazed or heavily settled riparian areas (Tewksbury et al. 2002). Cattle browse and trample riparian vegetation, compact the soil, promote stream bank erosion and loss of water quality, and they attract brown-headed cowbirds (see below). Intensive grazing often increases the fragmentation and degradation riparian habitats, and this leads to a reduction of bird species richness and abundance. During the breeding season, grazing can be particularly detrimental to bird species that nest on or near the ground because cattle disturb understory vegetation and may directly trample nests and/or fledglings (Bock et al. 1993).

Brown-Headed Cowbird Brood Parasitism

The brown-headed cowbird is a native North American species that expanded its range into California in the early 1900s (Grinnell and Miller 1944). Brown-headed cowbirds parasitize the nests of other native songbirds and reduce their reproductive success (Rothstein 1975, Beedy and Granholm 1985, Zeiner et al. 1990a, Gaines 1992, Lowther 1993). Cowbird parasitism contributes to lowered productivity in host species through direct destruction of host eggs and competition between cowbird and host chicks. Brown-headed cowbirds usually parasitize songbird nests that are situated near forest edges (Rothstein et al. 1984, Gates and Evans 1998). However, more recent studies suggest proximity to (within 3.2 km [2 mi]) and occurrence of host species is much more important than the presence of habitat edges, especially in western riparian habitats (Tewkbury et al.1999).

Cattle grazing and other livestock operations attract brown-headed cowbirds. Human habitation, agriculture, and livestock facilities adjacent to riparian zones provide brown-headed cowbirds with ample foraging habitat close to songbird breeding grounds (Tewksbury et al. 1998, Riparian Habitat Joint Venture 2004). In riparian woodlands of western Placer County, brown-headed cowbirds are most common in disturbed areas and in early successional stands, especially where livestock are present nearby (Appendix A). Radio telemetry studies have demonstrated that brown-headed cowbirds may move more than 6.7 km (4.2 mi) between foraging and breeding areas (Rothstein et al. 1984). Daily commute distances of 14 k or more have been reported cowbird abundance has also been shown to decline with increasing distance from human food sources over distances as short as 2 to 4 km (1.2 to 2.5 mi) (Curson et al. 2000).

Predation

The number of young fledged is probably the most important factor influencing the occurrence and persistence of many songbird species. For most species, nest success rates of 20% or less indicate unsustainable or *sink* populations (Donovan et al. 1995).

Proximity to urban and agricultural areas typically leads to higher densities of predators subsidized by human activity, such as raccoons, skunks, feral and domestic cats, jays, crows, and magpies, all of which are well-documented avian nest predators (Zeiner et al. 1990a). Nest predation rates are higher in narrow riparian buffer strips than in intact riparian forests (Vander Haegen and Degraff 1996 but see Haff 2003). Nest predation is higher in smaller woodlots and woodlots near suburban areas than in woodlots in rural areas, and survivorship of most bird species is higher in large forested habitats (larger than 35 ha [86 ac]) than in smaller habitat areas (Doherty and Grubb 2002). Open-cup nests more than 2 m (7 ft) above ground are most vulnerable to predation (Wilcove 1985). A dense and diverse herbaceous or shrub understory provides both nesting sites and protection from predators; this vegetative layer is especially important for species such as spotted towhees, song sparrows, and common yellowthroats that nest on or near the ground (Riparian Habitat Joint Venture 2004).

In general, “soft” edges (e.g., wetland or herbaceous cover grading to shrubs or scrubby willow grading to riparian woodland) are preferable to “hard” edges (e.g., abrupt changes in vegetation type such as agricultural or urban development adjacent to stream corridors), because predation levels along hard edges are higher (Suarez et al. 1997). Manicured parks, rural homes, dairies, and urban areas adjacent to riparian habitat can attract predators and be detrimental to riparian bird populations (Miller et al. 2003). Feeding of wildlife, either inadvertently or intentionally, encourages and elevates populations of nest predators such as domestic and feral cats that are estimated to kill many millions of songbirds annually (Stallcup 1991) and have a major impact on local bird populations (Churcher and Lawton 1987, Coleman et al. 1997).

Introduction of Non-native Species

Introduction of Himalayan blackberry in riparian corridors has reduced the extent of native herbaceous and shrub vegetation in riparian woodlands of western Placer County (Appendix A). This species is the dominant understory plant along many riparian corridors. Although it is not native, Himalayan blackberry is used for nesting, food, and cover by many birds (e.g., California quail, song sparrows, spotted towhees, California towhees, common yellowthroats, and tricolored blackbirds) (Jones & Stokes 2004a), and it may have beneficial effects on some species. Other nonnative plants, such as yellow star-thistle, acacia, black locust, and eucalyptus (blue gum), can outcompete native trees and understory plants that are favored by most bird species (Jones & Stokes 2004a).

Introduced birds such as European starlings, house sparrows, and wild turkeys are widespread in riparian areas of western Placer County. Starling populations are thought to be increasing in the Sierra Nevada foothills (Purcell et al. 2002) and occur throughout the oak woodland landscape in Placer County (Stralberg and Williams 2002). Starlings and house sparrows often outcompete native cavity nesters for nest sites, and turkeys consume foods that might otherwise be used by California quail and other native species (Zeiner et al. 1990a; Purcell et al. 2002).

Black rats and Norway rats occur in riparian woodlands of western Placer County; they are common along urbanized streams that are dominated by Himalayan blackberry thickets (Appendix A). Introduced rats may have detrimental effects on nesting songbirds because they prey on eggs and young, and because they often carry and transmit diseases (Zeiner et al. 1990b).

Mammals

Habitat Relationships

Numerous mammal species are abundant in the riparian woodlands of western Placer County. Up to 41 species breed in these habitats; two other species use them for shelter or foraging. No mammal species are proposed for coverage under the HCP/NCCP for the Phase I Planning Area (Jones & Stokes 2004a).

Mammal species that are often associated with riparian woodlands of western Placer County include vagrant shrew, ornate shrew, Trowbridge's shrew, broad-footed mole, Yuma myotis, California myotis, western pipistrelle, big brown bat, hoary bat, Townsend's big-eared bat, and pallid bat, brush rabbit, black-tailed jackrabbit, western gray squirrel, beaver, western harvest mouse, brush mouse, deer mouse, dusky-footed woodrat, California vole, muskrat, western jumping mouse, porcupine, coyote, gray fox, long-tailed weasel, mink, ringtail, raccoon, American badger, western spotted skunk, striped skunk, river otter, mountain lion (visitor), bobcat (visitor), mule deer, and wild pig (introduced). All these species also occur in a variety of upland habitats in western Placer County (Jones & Stokes 2004a).

Riparian Habitat Requirements

Mammals use riparian woodlands for all scales of movement—as part of their territories or home ranges; as dispersal corridors; or for short-distance movements between breeding, resting, and foraging areas. Conservation biologists often recommend preserving riparian areas for mammals with large home ranges in part because such areas can also function as corridors for dispersal of species with smaller home ranges in fragmented landscapes (Brinson et al. 2002). However, if a riparian woodland does not meet a species' habitat requirements, it may not be used for dispersal and hence will not provide a suitable corridor connecting habitat patches for many large mammals (Noss et al. 1996; Rosenberg et al. 1997; Brinson et al. 2002).

Like territories and home ranges, dispersal capabilities differ among vertebrate groups and species. Large mammals move over large distances, while most species of small mammals (except bats) are relatively sedentary and make only short-distance movements.

Some mammals, such as the ornate shrew, Yuma myotis, beaver, ringtail, raccoon, and river otter are strongly associated with riparian corridors in western Placer County (Table 6-1). Riparian woodlands are also important for migratory mule deer that forage, breed, and take cover there. A source of surface water (e.g., creek or river) is especially important to deer (Zeiner et al. 1990b).

Upland Habitat Requirements

As is true of many bird species, many riparian-associated mammals also frequent nearby upland habitats; most use these areas for breeding, foraging, and cover (Table 6-1). Thus, the adjacent land cover is a strong determinant of the species composition of a specific habitat area. In general, riparian areas that are adjacent to agricultural or urban development have fewer native mammals and an increased density of introduced species such as house mouse, Norway rat, and black rat (Jones & Stokes 2004a).

Patch Size and Riparian Width Requirements

Darveau et al. (2001) found that some large mammal species using riparian strips in Quebec seemed to prefer narrower riparian buffers, while other small mammals preferred wider strips.

Thin (e.g., 20 m [66 ft] wide) strips that connect larger patches can be used as refugia by small and larger mammals. However, narrow strips do not provide sufficient habitat to support mammal species with large territories and home ranges, because such strips exhibit high edge-to-interior ratios (Darveau et al. 2001). Riparian strips at least 100 m (328 ft) wide have been recommended to maintain riparian-associated small mammals, because the presence of these species has been observed to change little with increased width (Hannon et al. 2002).

In western Placer County, most small mammals (e.g., shrews, rabbits, ground squirrels, tree squirrels, mice, woodrats) have relatively small territories and home ranges (less than 1 ha [2.5 ac]) (Zeiner et al. 1990b). However, a few species of larger mammals (coyotes, gray foxes, mountain lions, bobcats, mule deer) occupy large areas, and their home ranges may cover many square kilometers, encompassing riparian woodlands and adjacent oak woodlands, annual grasslands, foothill chaparral, and other upland habitats. For this reason, the extent and quality of upland habitats surrounding riparian habitats is especially important in maintaining breeding populations of these species.

Effects of Human Alterations on Riparian Mammals

Habitat Loss and Degradation

The effects of human-induced habitat loss and degradation on riparian mammals are similar to those described above for riparian-associated birds.

Livestock Grazing

Intensive grazing often increases the fragmentation and degradation riparian habitats, and this leads to a reduction of mammal species richness and abundance. Livestock grazing in streams and their associated riparian corridors affect small mammal populations through direct disturbance and alteration of habitat conditions such as loss of cover and reduced food materials (Ehrhart and Hansen 1997).

Predation

Predation resulting from fragmentation (edge and patch effects) causes effects similar to those described above for birds.

Introduction of Nonnative Species

Nonnative mammals (e.g., house mouse, black rat, Norway rat, Virginia opossum) occur in riparian woodlands in western Placer County (Jones & Stokes 2004a), and they often outcompete native small mammals for food, breeding sites, and cover. In general, riparian woodlands that are situated near urbanized or agricultural areas support the highest densities of these species. Feral cats are widespread in riparian woodlands of western Placer County (Jones & Stokes 2004a, Appendix A), and they prey extensively on small native mammals (Zeiner et al. 1990b). Nonnative plants such as Himalayan blackberry provide habitat for black rats and Norway rats that that may compete with or prey upon small mammals in riparian woodlands.

Reptiles and Amphibians

Habitat Relationships

Up to 18 species of reptiles and four amphibians breed in riparian woodlands of western Placer County. Three other amphibian species (California newt, Pacific treefrog, and foothill yellow-legged frog) visit these habitats during some portions of their life cycles. Two riparian-associated reptiles (western pond turtle and giant garter snake) and one amphibian (foothill yellow-legged frog) may be covered under the HCP/NCCP for the Phase I Planning Area.

Amphibian species that occur in riparian woodlands of western Placer County include: ensatina, California slender salamander, Pacific treefrog, foothill yellow-legged frog, and western toad. Reptiles that may occur in these habitats include racer, common garter snake, western terrestrial garter snake, western aquatic garter snake, common kingsnake, night snake, ringneck snake, California whipsnake, gopher snake, western rattlesnake, western and Gilbert's skinks, southern alligator lizard, and western fence lizard (Jones & Stokes 2004a).

Riparian Habitat Requirements

Most amphibians and some reptiles are closely associated with riparian areas and their associated water bodies. Few terrestrial vertebrates are as dependent on water as are amphibians, since these species require surface water to complete their life cycles. Frogs, toads, and salamanders occur in riparian areas year-round, and intact riparian areas, upland habitats, and aquatic breeding habitats are essential for their survival (Brinson et al. 2002). Reptiles use riparian corridors for cover, shade, and a source of water. Microhabitats in riparian areas are important in meeting the habitat requirements of amphibians and reptiles, and dense, shaded forest canopies and leaf litter are positively correlated with the abundance of these species in narrow riparian corridors (Rudolf and Dickson 1990).

Upland Habitat Requirements

Similar to birds and mammals discussed above, many riparian-associated amphibians and reptiles frequent nearby upland habitats, and can use these areas for breeding, foraging, and cover (Table 6-1). Accordingly, the adjacent land cover is a strong determinant of the species composition of a specific habitat area. Upland habitats can serve as important refugia for reptile and amphibian species during times of flooding. Aquatic turtles will use upland habitats, including forests and flooded agricultural areas, during the warm months (Bodie and Semlitsch 2000). Several species of lizards associated with the vegetative cover and organic material of riparian forests bask and forage in uplands (Brinson et al. 2002). Many snake species hunt in upland habitats, but they rest in cooler microclimates under dense riparian forests (Zeiner et al. 1988).

Patch Size and Riparian Width Requirements

Most reptiles and amphibians in western Placer County have relatively small home ranges and territories (less than 1 ha [2.5 ac]) (Table 6-1). For example, Pacific treefrogs often move only about 10 m (33 ft), and western skinks have average home ranges of only about 0.09 ha (0.22 ac) (Zeiner et al. 1988). In contrast, western pond turtles breed along slow-moving, permanent streams, and they deposit eggs in nests in sandy soils up to 100 m (328 ft) from the streams (Zeiner et al. 1988). Similarly, giant garter snakes may migrate long distances (more than 100 m [328 ft]) from wetland habitats to upland sites that serve as winter hibernacula (Zeiner et al. 1988). Semlitsch and Bodie (2003) recommended a three-tiered approach to conserving habitat for riparian-associated amphibians and reptiles: aquatic buffer (30–60 m [98–197 ft]), core habitat (142–289 m [466–948 ft] including aquatic buffer), and terrestrial buffer (additional 50 m [164 ft] beyond the core habitat to account for the needs of most reptile and amphibian species).

Effects of Human Alterations on Riparian Reptiles and Amphibians

Changes in Flows

Flow diversions or increased streamflows in summer due to water supply and/or releases of treated sewage water could possibly affect amphibians by stranding of tadpoles, washing away or desiccating egg masses, or increasing predation. These effects have been documented for salmonids and foothill yellow-legged frogs (Bauersfeld 1978; National Marine Fisheries Service 1994; U.S. Fish and Wildlife Service 1995, 1996; Kupferberg 1996a; Lind et al. 1996). Water diversions for agriculture also have the potential to entrain tadpoles and other amphibian larvae into irrigation ditches, causing direct mortality. In general, flow and depth affect habitat suitability for riparian-associated amphibians, and reduced flows may confine larvae in remaining pools where they are more susceptible to predation (Hayes and Jennings 1986, 1988).

Habitat Loss and Degradation

In general, the effects of anthropogenic habitat loss and degradation on riparian reptiles and amphibians are similar to those described above for riparian-associated birds. However, inputs of fine sediment from adjacent land uses may also detrimentally alter the aquatic habitats of amphibians (Ashton et al. 2003).

Livestock Grazing

Livestock grazing in riparian corridors affects reptile populations through direct disturbance and alteration of habitat conditions. However, these effects may not result in differences in reptile and amphibian species richness or abundance between grazed and ungrazed sites (Homyack and Giuliano 2002).

Predation

Predation as a result of fragmentation (edge and patch effects) probably is greater in agricultural and urbanized areas than in riparian forests surrounded by oak woodlands or other upland habitats. The introduced bullfrog is a major predator of adult and larval amphibians (see discussion below).

Introduction of Nonnative Species

Bullfrogs are the only introduced, nonnative amphibian species in western Placer County. They were observed on about 25% of the riparian plots that were surveyed in the course of this study (Appendix A). Bullfrogs frequently prey on the larvae and adults of native amphibians, and they compete with native amphibians for space and food (Zeiner et al. 1988). Bullfrogs may be responsible for the elimination of California red-legged frogs and foothill yellow-legged frogs from the floor of the Central Valley and much of the Sierra Nevada foothills (Moyle 1973; Kupferberg 1996b). There are no introduced reptiles in western Placer County (Jones & Stokes 2004a).

Relationships Between Setback Width and Effects of Human Alterations

Some effects of human-induced alterations (e.g., abrupt flow changes) do not vary with riparian width, and their effects on terrestrial vertebrates are not well understood. However, many other relationships between riparian area width and animal diversity have been well documented. The effects that are most strongly related to setback width and the total area of riparian plots are direct habitat losses and fragmentation of riparian corridors. Many riparian species require a minimum area of contiguous habitat that must contain specific habitat attributes (e.g., interior forest microclimate, upland refugia, large trees, snags). In order to conserve wildlife habitat functions, the width of riparian areas must be sufficient to contain these habitat attributes for area-sensitive species.

Habitat requirements vary considerably among various riparian-associated vertebrate taxa. However, the following general conclusions can be made regarding the relationship of habitat values to width and size of riparian areas in western Placer County.

- Large (more than 10 ha [25 ac]) and wide (more than 500 m [1,640 ft]) riparian corridors provide the highest habitat values for riparian-dependent wildlife with large home ranges and territories.
- Moderately large (5–10 ha [12–25 ac]) and wide (more than 100 m [328 ft]) corridors provide sufficient habitat values to support most native species that are strongly associated with these habitats.

- Small (less than 5 ha [12 ac]) and narrow (less than 30 m [98 ft]) riparian corridors provide habitat values for many species, but most area-sensitive species will probably not be present.
- Highly fragmented and narrow riparian corridors (< 5 m [16 ft]) provide habitat for only a few generalist species, but they may still provide some values for cover and as movement corridors in urbanized and agricultural areas.

Recommendations for Setbacks to Conserve Terrestrial Animal Functions

In view of the foregoing, the project team recommends the following management strategies to conserve wildlife habitat functions.

- Low order streams (i.e., first and second order stream segments), which typically have narrow riparian corridors, should be managed to maintain and enhance riparian corridors at least 30 m wide. Where only very narrow (e.g., < 5 m [16 ft] wide) riparian corridors are feasible, these narrow areas should still be conserved because they may function as dispersal corridors.
- Higher order stream segments (i.e., third order and higher), which often have broader riparian corridors, should be managed to maintain and enhance riparian corridors at least 100 m (294 ft) on both sides of the channel (Semlitsch and Bodie 2003, Appendix B). Riparian woodlands should be restored and enhanced within this zone. Restoration and enhancement measures should include:
  - Re-creation of regular disturbance events (e.g., high water) on the floodplain will enhance vegetation and breeding bird populations in most systems (Riparian Habitat Joint Venture 2004).
  - Management activities such as mowing, grazing and burning within riparian zones should be limited to the non-breeding season to minimize impacts on nesting birds (Riparian Habitat Joint Venture 2004).
  - Other recommendations listed in (Riparian Habitat Joint Venture 2004).
- Where feasible, contiguous areas larger than 5 ha (12 ac) should be maintained, enhanced and linked to provide habitat refuge areas for area-sensitive species. These areas should be connected by riparian corridors more than 30 m (98 ft) wide on both sides of the channel wherever possible, in order to provide movement and dispersal corridors for wildlife.
- Where large, wide riparian corridors are not feasible in urbanized and/or agricultural settings, a minimum riparian buffer width of 10 m (33 ft) should be maintained to provide movement corridors for generalist species (Riparian Habitat Joint Venture 2004).

- Riparian woodland edges should be minimized (e.g., patches rather than linear strips) and buffered by shrubs and forbs (to reduce predation pressure on open-cup nesting species (RHJV 2004, Small et al. 1999).
- Streams should be prioritized for preservation and/or enhancement based on the information summarized herein. Some streams currently have higher wildlife value than others (e.g., Coon Creek) and should be the conservation priority.
- Non-native plants and animals, especially nest predators (e.g. rats, raccoons, domestic and feral cats), should be reduced and controlled on riparian-adjacent properties (Riparian Habitat Joint Venture 2004).
- The preservation, restoration and linkage of large parcels of undeveloped and uncultivated lands adjacent to riparian areas will provide significant benefits to riparian songbird species. Thus, large contiguous areas of riparian vegetation surrounded by "natural" uplands should be conserved to the greatest extent possible.
- Potential effects of adjacent land uses on riparian areas should be thoroughly evaluated during regional land use planning, and during the environmental review and permitting processes for specific projects, and these effects should be avoided to the maximum extent practicable.

It is important to recognize that riparian setbacks are not sufficient to ensure habitat functions for all wildlife species. Many factors affecting wildlife habitats are unrelated, or only indirectly related, to setbacks; such factors include the condition of the riparian vegetation and the abundance of nonnative plants and animals. Landscape factors can have significant effects on riparian areas (Allan 2004, Appendices A and B of this report). For example, adjacent land uses, such as intensive grazing, human habitation, golf courses, and agriculture, can significantly subsidize predator populations that can then turn to the riparian zone for sustenance (Riparian Habitat Joint Venture 2004).

Currently, most riparian areas in western Placer County have been affected by human alterations. Even where moderately wide sections (i.e., more than 100 m [328 ft]) of riparian vegetation remain, wildlife habitat functions and species richness and abundance may be reduced compared to large and wide riparian corridors that are surrounded by native vegetation (Appendices A and B). Therefore, conservation of wildlife habitat functions in western Placer County's riparian areas will require the implementation of measures involving the management of adjacent land uses as well as streams and riparian vegetation within defined setbacks.

Chapter 7
Overall Recommendations for Riparian Setbacks

Riparian setbacks should be adequate to provide long-term conservation of riparian and stream functions in western Placer County. However, while width criteria for setbacks are particularly important, other criteria should address the compatibility of existing and future land uses within these setbacks with the conservation of riparian and stream functions. Setbacks are essential for the conservation of riparian and stream functions, but they are not in themselves sufficient to ensure successful conservation of these functions. For this reason, additional measures also will be necessary to conserve these functions.

Conclusions Regarding Riparian and Stream Functions

Based on the review and analysis of riparian and stream functions, the effects of human alterations on such functions, and the relationships between these effects and setback widths, the project team identified the following 10 conclusions that are particularly relevant for setback criteria.

- Stream channels move within their active floodplains.
- Changes in runoff and erosion from uplands affect hydrologic and biogeochemical functions of streams.
- Patterns of groundwater flow affect biogeochemical functions (e.g., nitrate and phosphorus removal, degradation of SOCs); these patterns can be complex in both active and historic floodplains.
- Erosion of sediment is a major pathway by which contaminants enter streams.
- Sediments stored on active floodplains may remain there temporarily until floodwaters carry them into stream channels.
- Periodic floodplain inundation is important for salmonid and riparian plant habitat functions.
- Riparian vegetation is dynamic: it is frequently removed by disturbances, grows rapidly, and is sensitive to water availability.

- All riparian and stream functions are affected by artificial structures, impervious surfaces, ground disturbance, and removal of natural vegetation within stream channels or active floodplains.
- Riparian-associated wildlife species differ in the specific habitat attributes they require in riparian systems. Consequently, structurally diverse vegetation, as well as the full range of naturally occurring physical conditions and disturbance regimes, are necessary to provide suitable riparian habitat for the entire community of associated wildlife species.
- Many riparian-associated wildlife species use, and often require, both riparian and adjacent upland habitats for reproduction, cover, and/or foraging.

Rationale for Including Active Floodplains in Setbacks

These conclusions regarding riparian and stream functions, considered collectively, indicate that most human uses of the active floodplain are not compatible with conservation of riparian functions, because the stream and its floodplain represent an integrated system that, when intact, produces riparian functions. Accordingly, development and encroachment setbacks should include the entire active floodplain of a creek or river. (The active floodplain is the geomorphic surface adjacent to the stream channel that is typically inundated every 2-10 years or less.)

These conclusions also indicate that active floodplain boundaries are more stable and measurable than stream banks or the boundaries of riparian vegetation that are dynamic and change with time. Therefore, the boundary of the active floodplain, which can be readily delineated, is a preferable basis for determining setback widths than are the edges of stream banks, stream centerlines (or thalwegs), or any boundaries based exclusively on channel widths or vegetation.

Rationale for Including Lands Adjacent to Active Floodplains in Setbacks

The conclusions regarding riparian and stream functions indicate that lands adjacent to active floodplains provide physical and habitat functions, and they help to buffer streams from excessive inputs of sediment and contaminants. In general, conservation of most terrestrial wildlife functions depends on the inclusion of land beyond the active floodplain to provide adjacent upland habitats that benefit many riparian-associated wildlife species, and to buffer riparian habitats from the effects of adjacent land uses.

In western Placer County, riparian vegetation currently provides wildlife habitat outside the active floodplains of rivers and creeks. Such vegetation can occur on historic floodplains that have become isolated from streams due to changes in flows and channel form. Construction of levees or berms also causes isolation of riparian vegetation. Some of this adjacent vegetation would be within setbacks that include land outside the active floodplain. Adjacent lands would also buffer riparian and stream ecosystems from inputs of sediments and contaminants through infiltration of runoff and retention of sediment. Along the smallest channels, whose floodplains are very narrow (or essentially absent), this additional buffer is necessary to prevent inputs from entering the stream channel directly.

There is no single, abrupt, well-documented threshold width setback that would provide maximum benefits for all riparian functions. Rather, because riparian functions have different mechanistic bases, they are affected by different site attributes, and the relationship between setback widths and reduction of human effects differs among riparian functions. These relationships are described in detail in Chapters 2-6.

Nevertheless, several defensible arguments can be constructed regarding the appropriate width for a buffer to include within riparian setbacks. First, most riparian functions would be affected if setbacks included a buffer of less than 20 m (66 ft) beyond the active floodplain; consequently, narrower widths are not adequate for long-term conservation of riparian functions. This conclusion is based largely on our review of the scientific literature (summarized in Chapters 2-6). In addition, in western Placer County, stream incision and a discontinuous cover of woody plants reduces the benefits of narrow buffers. Recent incision now restricts the active floodplain to a narrow band along many of the higher order stream segments in western Placer County (Jones & Stokes 2004c, Placer County Planning Department 2002). Thus, a narrow setback would not include large areas of riparian vegetation on the historical floodplain. Also, the riparian vegetation of western Placer County has a lower and more discontinuous cover of trees and shrubs than do many of the sites where research has been conducted (Appendix A). For many functions (e.g., cover for terrestrial wildlife), this variability in vegetation extent and structure reduces the effectiveness of narrow setbacks.

Second, while there is evidence that even buffers wider than 30 m (98 ft) are not sufficient to eliminate detrimental effects altogether, the benefits provided by additional width beyond 30 m (98 ft) are either small or represent diminishing returns for most functions. For example, in western Placer County, riparian (and most upland) trees reach only 20-30 m (66-98 ft) in height. Thus, at distances > 30 m (98 ft) trees provide very little woody debris to stream ecosystems, and cast little shade on streams.

Third, unlike most other functions, the conservation of wildlife habitat functions for some area-sensitive species requires buffer areas substantially wider than 30 m (98 ft) beyond the active floodplain. This is illustrated by the summary in Table 6-1 of the habitat requirements and area requirements of riparian-associated wildlife in western Placer County. Significantly, wildlife habitat functions also differ from most other functions because the setbacks necessary to conserve them do not necessarily have to be applied along the entire stream network in order to be beneficial. Most wildlife habitat functions probably could be conserved in western Placer County by means of extensive sites with wider setbacks (> 100 m [328 ft]) connected by stream corridors with narrower setbacks (e.g., 30 m [98 ft]).

Recommendations for Riparian Setback Widths in Western Placer County

The project team's overall recommendations for riparian setbacks are presented below.

- Apply to first and second order stream segments a minimum riparian setback that includes the entire active floodplain plus a buffer of 30 m (98 ft) of adjacent land (on each side of the active floodplain), or the distance to the nearest ridgeline or watershed boundary, whichever is less. (First order stream segments are upstream segments that have no tributaries, and second order segments are formed by the junction of first order segments.) Though the purpose of this setback would be to conserve stream and riparian functions; it would not be sufficient for the conservation of many wildlife species with large area requirements.
- Along higher order stream segments (i.e., third order and greater), and along lower order segments at selected sites (e.g., those in or adjacent to conservation lands), apply a setback of at least 100 m (328 ft), and preferably 150 m (656 ft), from the active floodplain for the purpose of conserving and enhancing stream and riparian ecosystem functions including most wildlife habitat functions. Along these larger stream segments, floodplains and riparian areas are more extensive, continuous, and structurally diverse than for lower order stream segments (e.g., first and second order). These areas constitute corridors connecting a watershed's lower order stream segments, and, at a watershed scale, the riparian areas of these higher order segments contain particularly important habitats for most riparian-associated species. The conservation of wildlife habitat functions within these areas may be necessary for the persistence of their populations within western Placer County. For this reason, a wider setback, sufficient for the retention of wildlife habitat functions, is recommended along these stream segments.

The team estimates that these recommendations would result in a total setback width ranging from slightly more than 30 m (98 ft) on most first- and second-order stream segments to over 150-200 m (492-656 ft) on higher-order streams near Placer County's western boundary. (Widths > 150 m (656 ft) would be associated with the 150 m setback suggested for higher order stream segments in the overall recommendation above.) This estimate is based on a preliminary examination of riparian vegetation as shown on aerial photographs and of mapped alluvial soils; such soils indicate the extent of the historic floodplain, which in many cases is wider than the current active floodplain. The project team did not measure active floodplains in the field. However, widespread incision limits active floodplains to a fraction of the historical floodplain of along several of the larger streams (Jones & Stokes 2004c, Placer County Planning Department 2002).

By basing these recommendations, in part, on the width of active floodplains, the project team has created a variable, site-specific setback width that accounts for stream size. The width of the active floodplain provides a clear, functional basis for a variable width criterion that accomplishes the same purpose more directly than criteria based on stream order, slope, and other attributes of streams and their settings.

Management Recommendations for Riparian Setbacks

Within these setbacks, most developed land uses would be incompatible with the conservation of stream and riparian functions. Within the active floodplain, developed land uses should be restricted to unavoidable crossings by roads and other infrastructure, because any structures or alterations of topography, vegetation or the soil surface are likely to affect both stream and riparian functions, and could result in substantial effects both on-site and downstream.

Within the portion of a setback that is outside of the active floodplain, some uses could be compatible with conservation of riparian functions, particularly along first- and second-order streams where conservation of salmonid and wildlife habitat are not necessarily the primary objectives. Along first- and perhaps second-order streams, compatible agricultural uses include filter strips and riparian buffers managed according to standards established by the National Resources Conservation Service. Such practices would improve the buffers' effectiveness for conserving some functions; additionally, there are programs that subsidize the establishment and maintenance of such practices. Along first- and perhaps second-order streams, compatible developed land uses could include public open space, landscaping, and low-density residential development, provided that no impervious surfaces, infrastructure, or irrigation are placed within the setback.

Within the wider setbacks for wildlife conservation, some additional development > 30 m (98 ft) from the active floodplain could be incorporated at sites with limited conservation value. Though development within these setbacks generally is not compatible with the conservation of wildlife habitats, extensive areas of developed and agricultural lands already exist along streams in western Placer County. Thus, effective conservation of some sites may be very problematic, and it may be more appropriate to mitigate offsite for the loss of habitat caused by development of these sites, than to preclude this development (and thus potentially cause the loss of habitats elsewhere). Such mitigation could contribute to the conservation of more extensive areas along relatively unaltered stream reaches.

In the absence of additional site-specific information, effects on riparian wildlife habitats due to adjacent development could be considered to diminish with distance from the active floodplain or existing riparian area. Effects would be greatest due to development of immediately adjacent land and would drop to minimal levels at 100-200 m (328-656 ft) away. There are several reasons for considering effects to be related to distance. First, the magnitude of effects on the processes sustaining riparian habitats diminishes with distance. Second, most riparian-associated wildlife species also use upland habitats and the area of adjacent uplands is greater when development is more distant. Third, harm and harassment due to pets and people probably diminishes with distance. Fourth, roads and structures are less likely to affect animal movements along the riparian corridor if at a greater distance from it. These and other relevant mechanisms are described in detail in Chapters 2-6 of this report.

Currently, agricultural and developed land uses exist within the recommended setbacks, and they preclude the effectiveness of the recommended setbacks in these areas. For example, along the major streams of western Placer County, approximately a quarter of the land < 20 m (66 ft) from the centerline of a stream, already is in developed or agricultural land-cover (Jones & Stokes 2004a, 2004b). For some functions (e.g., biogeochemical and hydrologic functions), this limitation cannot be offset by establishing wider setbacks in other areas (Weller et al. 1998).

In addition, there are other, more fundamental limitations on the effectiveness of setbacks for conserving riparian and stream functions. Examples of these limitations include the effects of dams and flow diversions, currently abundant nonnative species, mercury from the Gold Rush era already in riparian and stream sediments, and runoff that bypasses riparian areas by passing through the stormwater system directly into streams. Also, conversion of large portions of a watershed or region to developed and agricultural land uses is associated with broad negative effects on riparian and stream ecosystems (Findlay and Houlahan 1996, Roth et al 1996, Booth and Jackson 1997, Magee et al. 1999, Doyle et al. 2000, Paul and Meyer 2001, Allan 2004, Hatt et al. 2004, Pellet et al. 2004, Wissmar et al 2004, and Appendices A and B of this report).

Addressing these and other effects on riparian and stream functions will require additional conservation measures. These additional measures include measures for the:

- design and operation of stormwater and water supply systems to minimize impacts on hydrologic and geomorphic functions;
- implementation of construction and agricultural Best Management Practices (i.e., BMPs) to prevent excessive erosion and high inputs of fine sediments to floodplains and streams.

- maintenance and enhancement of riparian vegetation and it's habitat values (as described in Chapter 6); and
- preservation of extensive areas of natural vegetation, particularly in and adjacent to riparian corridors.

The implementation of such measures would both complement, and greatly enhance, the benefits provided by riparian setbacks for the conservation of stream and riparian functions.

Chapter 8
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Appendix A

Relationships Among Animal Species and Site Attributes in Riparian Ecosystems of the Sacramento Valley, California

Relationships Among Animal Species and Site Attributes in Riparian Ecosystems of the Sacramento Valley, California

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Tables and Figures

Summary

This report summarizes the relationships between riparian site attributes and biodiversity in the data sets collected in Tasks 2.8 (Evaluation of Habitat Assessment) and 2.10 (Validate RAP and Habitat Assessment) for the Placer County Riparian Ecosystem Assessment. More specifically, for one-hectare (2.5 acres) plots located in riparian corridors of the Sacramento Valley and adjacent foothills, we describe the relationships between species richness (i.e., number of species) of selected taxonomic groups (i.e., birds, mammals, reptiles, amphibians, butterflies, dragonflies, and damselflies) and measured vegetation and land cover attributes. The primary goals for collecting and analyzing these data were to support the development of a functional assessment model (FAM) for riparian habitats in Placer County, and to provide setback guidance for riparian corridors in western Placer County. The key results of the study were:

- vertebrate data from multiple site surveys provide a much stronger basis for assessing a riparian site than do data from a single site visit;
- non-destructive area searches for mammals, amphibians, and reptiles were not effective rapid assessment survey techniques, even with the placement of cover boards to provide artificial shelter for these species;
- for the 50 riparian sites surveyed, species richness was not strongly correlated among the different taxonomic groups, nor was the width or structure of the riparian vegetation strongly correlated with richness for any taxonomic group; however
- land cover in the vicinity (i.e., within 250 meters to 5 kilometers) of plots was related to the species richness of several taxonomic groups we examined, and in some cases, these relationships were strong.

These results have implications for the development of a riparian FAM and for guidance regarding riparian setbacks. However, they should be interpreted with caution since they were based on a small sample size (e.g., only 12 plots were visited for multiple surveys), a large geographic area was covered, and only presence data were collected for species in each taxonomic group. (In addition, several published studies are not consistent with some of our conclusions.) Assessment of overall riparian habitat functions should not be based on a single taxonomic group because none indicates the overall habitat functions provided by a site and responses vary within each taxonomic group. Also, assessments of habitat values should consider, attributes of surrounding land cover, in addition to attributes of the riparian vegetation itself. Similarly, the basis for setback widths should consider the upland habitat requirements of riparian species and the effects of adjacent upland land uses on riparian habitat, as these factors have

significant relationships with species richness of riparian-associated species for at least several taxonomic groups (e.g., birds, dragonflies, and butterflies). Separate technical reports will propose a draft FAM and will provide guidance regarding riparian setbacks. The implications of this study will be considered more fully in these reports.

Relationships Among Animal Species and Site Attributes in Riparian Ecosystems of the Sacramento Valley, California

Introduction

This report summarizes the results of Tasks 2.8 (Evaluation of Habitat Assessment) and 2.10 (Validate RAP and Habitat Assessment) of the Riparian Ecosystem Assessment that Jones & Stokes is conducting for the Placer County Planning Department, with assistance from the Point Reyes Bird Observatory (PRBO). These tasks were intended to support development of assessment techniques, preparation of a functional assessment model (FAM) and summarizing setback guidance for the riparian corridors of western Placer County. These tasks involved collection of data on species presence and site attributes at a random sample of riparian sites in Placer County and throughout the Sacramento Valley. Task 2.8 consisted of a field and geographic information systems (GIS) assessment of 47 sites. Task 2.10 consisted of additional, more intensive, data collection (including multiple surveys) at 12 of these sites.

Our analyses of these data focused on the relationships typically serving as the basis for setbacks and indicator-based assessments. Some FAMs base their measures of terrestrial habitat functions on the presence of selected taxa (e.g., bird species) that are presumed to indicate habitat suitability for other taxonomic groups. However, most FAMs are based on a combination of site attributes that are predicted to influence habitat area or quality for most species. The widths of riparian setbacks that are intended to conserve habitat functions are based on the relationships between species presence and the area of habitat types and the potential influence of adjacent land uses. Therefore, we examined criteria for assessments and setbacks by comparing the relationships among the species richness of taxonomic groups and their relationships to measured site attributes. Our general hypotheses were:

1. The number of riparian–associated bird species (riparian bird species richness) is positively associated with the species richness of other vertebrates and of invertebrates (i.e., bird species richness is a valid indicator of overall biodiversity);

For all taxonomic groups:

2. Species richness increases with the width of riparian vegetation;

3. Species richness increases with the cover of woody plants (i.e., trees and shrubs) in the riparian vegetation;
4. Species richness increases with the total area of riparian vegetation in a plot and its surrounding landscape;
5. Species richness increases with the proportion of surrounding land area in natural vegetation; and
6. Species richness is negatively associated with the proportion of developed and agricultural land uses in the surrounding landscape.

For our analysis of birds and butterflies, we included only riparian-associated species, which are presumably more responsive to riparian site attributes than other species that may use a range of habitat types, including riparian. We considered riparian-associated birds and butterflies to be those species that in the Sacramento Valley and adjacent foothills are primarily associated with riparian vegetation (Tables 1 and 2). These lists were determined prior to field work on the basis of relevant literature (Pool and Gill 1990–2003) and our professional judgments; the draft bird list also was revised in response to comments by PRBO ornithologists.

Methods

In addition to the following summary, our sample design and data collection methods were described (in more detail) in the sample design memo and field protocols provided to the Placer County Planning Department in 2003 (Appendix A).

Sample Design

Study site locations (plots) were a stratified random sample of existing PRBO point count survey sites along tributary streams in the Sacramento Valley where information regarding riparian corridor width was available and site access was know to be possible. Additional plots in Placer County were also included in cases where permission to enter private lands had been granted. Although not along a tributary stream, PRBO sites along the Cosumnes River were included in the list of potential plots because this area was considered reasonably similar to many of the included tributary streams in its riparian attributes. This set of potential plots was stratified on the basis of riparian corridor width. Data from PRBO records, digital aerial photographs, and a draft land cover map of Placer County were used to assign each plot to a width category. These categories were: 0–20 meters (m), >20–40 m, >40–60 m, >60–100 m, and >100–200 m. From each width category, ten plots were randomly selected, each at least 500 m from all other selected plots.

Sample size was limited by access to suitable survey sites and the available budget. On this basis, we estimated the maximum sample size would be 50 plots.

The power associated with this sample was sufficient to identify correlations between variables (power > 0.8 for even small values of *r*); however, it was of more marginal size for the application of multivariate analyses, such as multiple regression analyses. Statistical power is the ability of a statistical test to the identify relationships and differences that exist (i.e., it is the ability to reject the null hypothesis of no difference or association when it is incorrect).

From those plots located on Placer County, public or Nature Conservancy properties, 12 were randomly selected as more intensive data collection plots, each at least 5 kilometers (km) apart. At these plots, in addition to the data collection taking place at other plots, the following surveys were performed: small mammal trapping; placement of cover boards that might be used as artificial shelters for amphibians and reptiles; and multiple surveys for butterflies and vertebrate groups. These data collection plots were included in the study, despite their cost, to allow the value of this additional data to be evaluated. However, for these additional data, the small sample size substantially limits the analyses that can be applied, the power of these analyses, and thus the conclusions that can be drawn from the data. For example, the power associated with data from these 12 plots was only sufficient for the identification of strong correlations (i.e., *r* values > 0.7), and important combinations of site attributes had few or no replicates.

During our study, access or scheduling difficulties prevented most data collection at three plots, and seven plots were not surveyed for odonates. Thus, sample sizes were reduced to $n = 47$ and to $n = 43$ for odonates.

Field Data Collection

A 1-ha plot (100 m by 100 m) was located along the bank of the stream channel at all of the study sites. These plots contained riparian vegetation, and most also contained other natural, or agricultural or developed land-cover. For each plot, information on site attributes was recorded and area searches were conducted for vertebrate and invertebrate species.

The site attributes recorded in the field included: onsite infrastructure, disturbance, vegetation, surrounding land use, and evidence of overbank flows (Appendix A). Presence of infrastructure (roads, bridges, levees, or bank protection) and evidence of disturbance (grazing, trash dumping, cutting of trees and shrubs, etc.) were recorded for the riparian and non-riparian portions of the plot and for lands within 250 m of the plot. (The riparian portion of the plot was defined as the zone covered by riparian trees and shrubs.) For the riparian vegetation within the plot, we recorded its width along the stream (at the plot's edges and center), cover of the tree, shrub and herb layers, and the cover of each woody species, as well as snag density, and predominant tree size class. We also recorded the length and continuity of riparian vegetation along the stream corridor, and estimated the percent of adjacent land (within 250 m) that was in natural vegetation, agricultural, and developed land cover types.

Standardized, time-constrained area searches (Ralph et al. 1993) were conducted separately for vertebrate and invertebrate species (see Appendix A for protocols). For vertebrates, searches of the entire plot were conducted for one hour (between 6 and 11 a.m.) on one day between mid-May and mid-June, 2003. However, at 12 intensive data collection plots we conducted area searches four times at approximately one-week intervals from mid-May to July 1. During the area searches, we recorded all species observed, and species for which scat or tracks were observed, and noted whether the species was observed in the riparian or non-riparian portions of the plot. Woody debris and rocks were not disturbed to avoid degrading habitat. For birds, we also recorded total numbers of individuals and observed behaviors (e.g., territorial displays, carrying food or nesting material, or observation of nests). Observed behaviors (and presence of nests or fledglings) were used to identify potential residents, and the number of potential resident species among riparian-associated birds was included in the analysis. Point counts (Point Reyes Bird Observatory 2003) also were conducted at plots in Placer County because no PRBO point count data existed for those locations.

Each plot was also surveyed twice for butterfly species, once during May 15–30 and again during June 2–14, 2003 and most plots (43 of 47) were surveyed once for odonates (i.e., dragonflies and damselflies) during August 19-29, 2003. These searches were conducted between 9 a.m. and 4 p.m. because of the daily flight activity patterns of these animals. As with the vertebrate area searches, the odonate and first butterfly surveys at each site were one hour long and each observed species was recorded. For butterflies, the number of observed individuals also was recorded. Based on the results of the first butterfly survey and to reduce costs, the second survey at each site was shortened to 50 minutes. (This caused no complications for the testing of our hypotheses because each site received equal survey effort.)

Small mammal live-trapping was also conducted at the 12 intensive data collection sites. Along the length of the plot's streambank side, 15 Sherman live traps were evenly spaced. An additional 15 traps were placed along a second line 10 m away and parallel to the first trap line. Each trap was baited with peanut butter and rolled oats, and a wad of cotton was placed at the back of each trap for bedding. These traps were set within 2 hours of sunset and checked within 3 hours of sunrise on three consecutive nights between June 10 and July 3, 2003.

At the 12 intensive data collection sites, cover boards also were placed within plots (Fellers and Drost 1994). These cover boards were approximately 0.9-m by 0.6 m pieces of 1.9 centimeters (cm) thick plywood. Along the length of the plot's streambank side, 10 cover boards were evenly spaced. An additional 10 boards were placed along a second line 10 m away and parallel to the first. These boards were lifted during each area search to determine the presence of amphibians and reptiles.

Geographic Information Systems Data Collection

In addition to site attributes recorded in the field, GIS data layers were used to estimate the area of four land cover types within 250 m, 1 km, and 5 km of each plot center including: riparian vegetation, natural vegetation (including riparian), developed, and agricultural land cover types. For this analysis, we used the best available data for each plot's location in the Sacramento Valley. These land cover data were from the California Department of Fish and Game's Wetland and Riparian GIS Mapping Layers (Ducks Unlimited 1997), Sacramento River riparian vegetation (California Sate University Chico 1998), U.S. Forest Service existing vegetation (U.S. Forest Service 1999–2000), California Department of Water Resources' land use layer (California Department of Water Resources various years), and the Draft Land Cover Map of Western Placer County (Jones & Stokes 2004). The process by which a single coverage was produced from these data sources involved converting each data source from its vector format to a 31 m grid. For tabulating the area of riparian vegetation within 250 m, 1 km and 5 km, cells attributed as riparian in any of the data layers were counted as riparian. Surrounding land use information was calculated from the California Department of Water Resources land use layer. This layer was a composite of counties that were photographed and mapped in different years. The land use categories in this layer were aggregated into three broad categories: natural vegetation, and agricultural and developed lands.

Data Analysis

Our data analysis consisted of summarizing the data sets and testing our six general research hypotheses. In evaluating these hypotheses, we used scatter plots, correlation coefficients, and simple or multiple stepwise regression models (Sokal and Rolf 1994). All statistical analyses were performed with the S-Plus statistical software package (MathSoft, Inc. 1999).

We evaluated our hypotheses with respect to eight species groups: 1) All bird species; 2) Riparian-associated bird species; 3) All mammals; 4) Small mammals; 5) All amphibians and reptiles; 6) All butterflies; 7) Riparian-associated butterflies; and 8) all odonates. For all of these groups (except small mammals), species richness (i.e., number of species) was used as the measure of the habitat provided for that group at an individual site. In other words, species richness was analyzed with respect to the amount, quality and diversity of habitat. Density of trapped individuals was the metric used for small mammals.

Our conclusions were based on the results of these analyses, consideration of the data's limitations (due to methodology and sample size) and a review of applicable scientific literature.

Table 1. Riparian-Associated Birds of Western Placer County

Common Name	Scientific Name
Cooper's Hawk	*Accipiter cooperii*
Red-shouldered Hawk	*Buteo lineatus*
Swainson's Hawk	*Buteo swainsoni*
Black-chinned Hummingbird	*Archilochus alexandri*
Downy Woodpecker	*Picoides pubescens*
Western Wood Pewee	*Contopus sordidulus*
Willow Flycatcher	*Empidonax traillii*
Pacific-slope Flycatcher	*Empidonax difficilis*
Warbling Vireo	*Vireo gilvus*
Tree Swallow	*Tachycineta bicolor*
House Wren	*Troglodytes aedon*
Yellow Warbler	*Dendroica petechia*
Common Yellowthroat	*Geothlypis trichas*
Yellow-breasted Chat	*Icteria virens*
Song Sparrow	*Melospiza melodia*
Black-headed Grosbeak	*Pheucticus melanocephalus*
Blue Grosbeak	*Guiraca caerulea*
American Goldfinch	*Carduelis tristis*

Table 2. Riparian-Associated Butterfly Species

Common Name	Scientific Name
Sara Orange-tip	*Anthocaris sara*
Pipevine Swallowtail	*Battus philenor*
Lorquin's Admiral	*Limentis lorquini*
Mourning Cloak	*Nymphalis antiopa*
Two-tailed Swallowtail	*Papilio multicaudatus*
Western Tiger	*Papilio rutulus*
Umber Skipper	*Paratrytone melane*
Green-veined White	*Pieris napi*
Satyr Comma	*Polygonia satyrus*
Sylvan Hairstreak	*Satyrium sylvinus*
Red Admiral	*Vanessa atalanta*
California Dogface	*Zerene eurydice*

Prior to calculating correlation coefficients or constructing regression models, variables were transformed to improve normality and homogeneity of variances. Percents were arcsine transformed, areas and widths were log transformed, and count data were square root transformed (Sokal and Rolf 1994; Zar 1999). Correlation coefficients were used to evaluate the magnitude and significance of relationships between pairs of variables. (Magnitude is the degree that two variables co-vary, while significance indicates that the correspondence is unlikely to have occurred by chance.) We used these coefficients to evaluate relationships among plot attributes, the different species groups, and between species groups and plot attributes.

Regression models were also used to evaluate the strengths of relationships between plot attributes and the measured species richness of taxonomic groups. A least-squares regression model is the equation for the straight line that best "fits" the data. This is the line that comes as close to passing through the data points as is possible. Unlike correlation coefficients, regression models can be used to quantify the degree to which combinations of readily observed plot attributes could be considered predictors of species richness. The interpretation of each regression model was based on its R^2 value and the partitioning of the sum of squares among variables (i.e., the sum of the squared deviations from the mean). In developing a regression model for each species group, species richness was the dependent variable and 1–4 plot attributes were the independent variables considered. Only variables significantly correlated with a group's species richness ($\alpha = 0.05$) were considered for initial inclusion in a model. When two or three variables representing an adjacent land cover type (e.g., percent natural vegetation within 250 m and within 1 km) were correlated with a species group, only the variable with the highest correlation was included. This was done to avoid including strongly correlated independent variables that could complicate interpretation of the results. Stepwise multiple regression analysis was used to define the final regression model if two or more variables were included in the initial model.

In interpreting the statistical significance of relationships, we adjusted the threshold for significance to account for making multiple statistical comparisons to evaluate one research hypothesis. Traditionally, a P value < 0.05 is used to indicate statistical significance. However, as more statistical tests are performed the odds of encountering a low P value due to chance increase. Therefore, we adjusted the P value considered significant through a Bonferroni correction (Sokal and Rolf 1994) so that the probability of erroneously considering a result significant (i.e., when the pattern was due to random variation in the absence of an actual relationship) was < 0.05 for the entire set of statistical tests addressing one of our general research hypotheses. Each of our hypotheses was addressed by 8–24 statistical comparisons, therefore, P values of 0.0063–0.0021, respectively, were considered the thresholds for significant relationships. Since Bonferroni adjustments are sometimes criticized as being overly strict, especially when the consequences of false negatives (β error) are worse that the consequences of false positives (α error), P values above these thresholds but < 0.01 were considered suggestive of possible relationships among the variables.

Although more than one dependent variable (i.e., richness based on one or four site surveys) was analyzed for several of the species groups, not every variable was used to evaluate any one of our research hypotheses. Because few mammal, amphibian or reptile species were detected over the course of a single area search, we only used richness based on four visits for these species groups.

Results

Most of the plots were situated in moderately to substantially altered riparian corridors, including Placer County plots (Table 3, Appendix B). At only 2 of the 47 plots (4%) was riparian vegetation > 100 m wide. Only 6 of the 47 plots (13%) were completely surrounded by natural vegetation and did not contain any infrastructure. In contrast, for 16 plots (34%) agricultural or developed land accounted for over half the adjacent land cover within 250 m, and 44% contained a road or other infrastructure (Table 3). On average, agricultural or developed lands accounted for 43% of the lands within 1 km of the plots (Table 4).

The riparian vegetation within most survey plots also was somewhat altered in its composition and structure. In general, the tree layer was discontinuous and averaged only 46% cover, and the shrub layer also had a comparable cover (Table 4). Willows and Fremont’s cottonwood accounted for just 16% of tree cover, and oak species (primarily interior live oak and valley oak) accounted for 26%. Non-native species occupied little of this tree layer (5%), but Northern California black walnut, a species absent from this region 150 years ago, accounted for an additional 4% of total tree cover. In the shrub layer, the non-native Himalayan blackberry accounted for over half of all shrub cover.

Table 3. Presence of Infrastructure and Evidence of Disturbance in Plots[1]

Attribute	Total *N = 47*	Placer County Plots *N = 23*	Plots Outside Placer Co. *N = 24*
Presence of Bank Protection	4	5	4
Levee or Berm	15	4	25
Road in Plot	46	50	42
Stream Incision	61	55	67
Evidence of Overbank Flow	57	41	71
Evidence of Grazing	21	17	25
Evidence of Tree Cutting	0	0	0
Evidence of Brush Clearing	4	4	4
Evidence of Dumping	21	22	21
Evidence of Other Disturbance	13	17	8

Note:
[1] Values in table are percents.

Table 4. Summary of Plot Vegetation and Surrounding Land Cover[1,2]

Attribute	Total Mean (Range)	Placer County Mean (Range)	Outside Placer County Mean (Range)
Riparian Width (meters [m])[3]	37 (2–200)	25 (2–80)	49 (10–200)
Tree Cover (%)	46 (3–95)	48 (3–95)	44 (10–80)
Shrub Cover (%)	41 (1–90)	38 (1–80)	44 (2–90)
Herb Cover (%)	76 (10–100)	84 (10–98)	69 (10–100)
Riparian Vegetation 250 m (hectares [ha])	5 (0–13)	4 (0–9)	6 (0–13)
Riparian Vegetation 1 kilometers (km) (ha)	36 (0–147)	26 (0–74)	45 (0–147)
Riparian Vegetation 5 km (ha)	365 (33–1,001)	261 (132–554)	465 (33–1,001)
Natural Vegetation 250 m (%)	66 (0–100)	69 (0–100)	64 (18–100)
Natural Vegetation 1 km (%)	58 (6–100)	59 (6–23)	56 (10–100)
Natural Vegetation 5 km (%)	60 (8–100)	63 (25–91)	57 (8–100)
Agricultural Land Cover 250 m (%)	20 (0–81)	10 (0–68)	28 (0–81)
Agricultural Land Cover 1 km (%)	29 (0–87)	18 (0–62)	39 (0–87)
Agricultural Land Cover 5 km (%)	26 (0–88)	15 (0–49)	37 (0–88)
Developed Land Cover 250 m (%)	14 (0–100)	20 (0–100)	8 (0–81)
Developed Land Cover 1 km (%)	14 (0–49)	23 (0–94)	5 (0–26)
Developed Land Cover 5 km (%)	14 (0–73)	22 (0–73)	5 (0–26)

Notes:

[1] *N* = 47.

[2] Riparian width, and tree, shrub and herb covers are ground-based measurements and land-cover variables are geographic information systems (GIS)–based.

[3] SD = standard deviation.

[4] Sample was stratified by anticipated riparian width, thus these width statistics are not representative of riparian vegetation width in the Sacramento Valley (e.g., the Valley's mean width is narrower).

The six relatively unaltered plots (i.e., no infrastructure in plot and no agricultural or developed land within 250 m) varied widely in their vegetation structure and species composition. The width of their riparian vegetation ranged from 8 m to 200 m. In the tree layer, the cover of oak species ranged from 0 to 78% and the cover of willows and cottonwood from 0 to 30%. The shrub layer varied from over 80% Himalayan blackberry (*Rubus discolor*) to a sparse cover (5%) of shrubs and tree saplings. With the exception of tree cover, these relatively unaltered plots bracketed the range of conditions observed in other plots that were more altered. None of the unaltered plots had low tree covers (range 40-80%); in contrast, 49% of other plots had tree covers below 40%.

There were relatively few strong relationships among site attributes (Table 5); however, suggestive positive relationships existed among riparian vegetation width with tree and shrub cover. Otherwise, most negative relationships were between variables that are inversely related by definition (e.g., land cover proportion) and most positive relationships were between variables that represented the same land cover category at different scales (e.g., developed land within 250 m, 1 km and 5 km).

Data collected at the 12 intensive data collection sites varied in their value for assessing riparian habitats. At these sties, almost no amphibians or reptiles were found beneath the cover boards. The results of the small mammal trapping varied substantially among sites (Table 6, Appendix B), and they did not correspond closely to the results of surveys for other taxonomic groups. However, conducting area searches for vertebrates on multiple dates resulted in more complete species lists (i.e., greater species richness) compared to lists based on a single area search, and species richness estimates based on multiple surveys had stronger relationships to site attributes than single survey estimates (Tables 7 and 8, Figure 1).

Three of the relatively unaltered plots were intensive data collection sites, and at these plots, results were similar to those at more altered sites, with the exception of small mammal density and the number of potential nesting bird species. The total number of small mammals trapped at the unaltered sites averaged 32 ± 4 (mean ± standard error) versus 3 ± 1 at the more altered plots. The number of potential nesting bird species at the unaltered sites averaged 3.3 ± 0.3 versus 1.1 ± 0.4 at the other plots (Table 6).

Table 5. Correlations Among Plot Attributes[1,2]

	Riparian Width	Tree Cover	Shrub Cover	Riparian (250 m)	Riparian (1 km)	Riparian (5 km)	Natural (250 m)	Natural (1 km)	Natural (5 km)	Agricultural (250 m)	Agricultural (1 km)	Agricultural (5 km)	Developed (250 m)	Developed (1 km)	Developed (5 km)
Riparian Width	1.00	**0.48**	**0.44**	0.30	-0.01	-0.04	0.04	**0.43**	0.01	0.13	-0.28	-0.17	-0.14	-0.16	0.19
Tree Cover	–	1.00	**0.44**	0.03	0.03	-0.04	-0.07	-0.06	-0.05	0.05	-0.01	-0.06	0.05	0.13	0.18
Shrub Cover	–	–	1.00	-0.18	-0.12	-0.04	-0.13	-0.01	0.16	-0.07	-0.08	-0.02	0.26	0.17	-0.10
Riparian (250 m)	–	–	–	1.00	**0.91**	**0.63**	-0.21	-0.21	-0.04	0.24	0.28	0.15	0.01	-0.03	-0.08
Riparian (1 km)	–	–	–	–	1.00	**0.73**	-0.29	-0.26	-0.06	0.28	0.27	0.13	0.06	0.04	-0.05
Riparian (5 km)	–	–	–	–	–	1.00	-0.29	-0.27	-0.03	0.28	0.20	0.02	0.07	0.13	0.04
Natural (250 m)	–	–	–	–	–	–	1.00	**0.84**	**0.59**	**-0.55**	**-0.44**	**-0.37**	**-0.59**	**-0.49**	-0.20
Natural (1 km)	–	–	–	–	–	–	–	1.00	**0.74**	**-0.53**	**-0.65**	**-0.55**	**-0.44**	**-0.42**	-0.11
Natural (5 km)	–	–	–	–	–	–	–	–	1.00	**-0.48**	**-0.54**	**-0.61**	-0.21	-0.23	-0.30
Agricultural (250 m)	–	–	–	–	–	–	–	–	–	1.00	**0.83**	**0.68**	**-0.34**	**-0.35**	-0.30
Agricultural (1 km)	–	–	–	–	–	–	–	–	–	–	1.00	**0.88**	-0.28	**-0.40**	**-0.49**
Agricultural (5 km)	–	–	–	–	–	–	–	–	–	–	–	1.00	-0.22	**-0.38**	**-0.57**
Developed (250 m)	–	–	–	–	–	–	–	–	–	–	–	–	1.00	**0.89**	**0.49**
Developed (1 km)	–	–	–	–	–	–	–	–	–	–	–	–	–	1.00	**0.71**
Developed (5 km)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.00

Notes:

m = meters, km = kilometers

[1] $n = 47$

[2] Numbers in table are correlation coefficients (r) between the site attributes, and those with a p value <0.01 are in bold; P values are based on the r value and number of observations (n), and in this analysis values <0.01 are considered to indicate suggestive relationships among variables. Variables were transformed as described in methods prior to calculation of correlation coefficients.

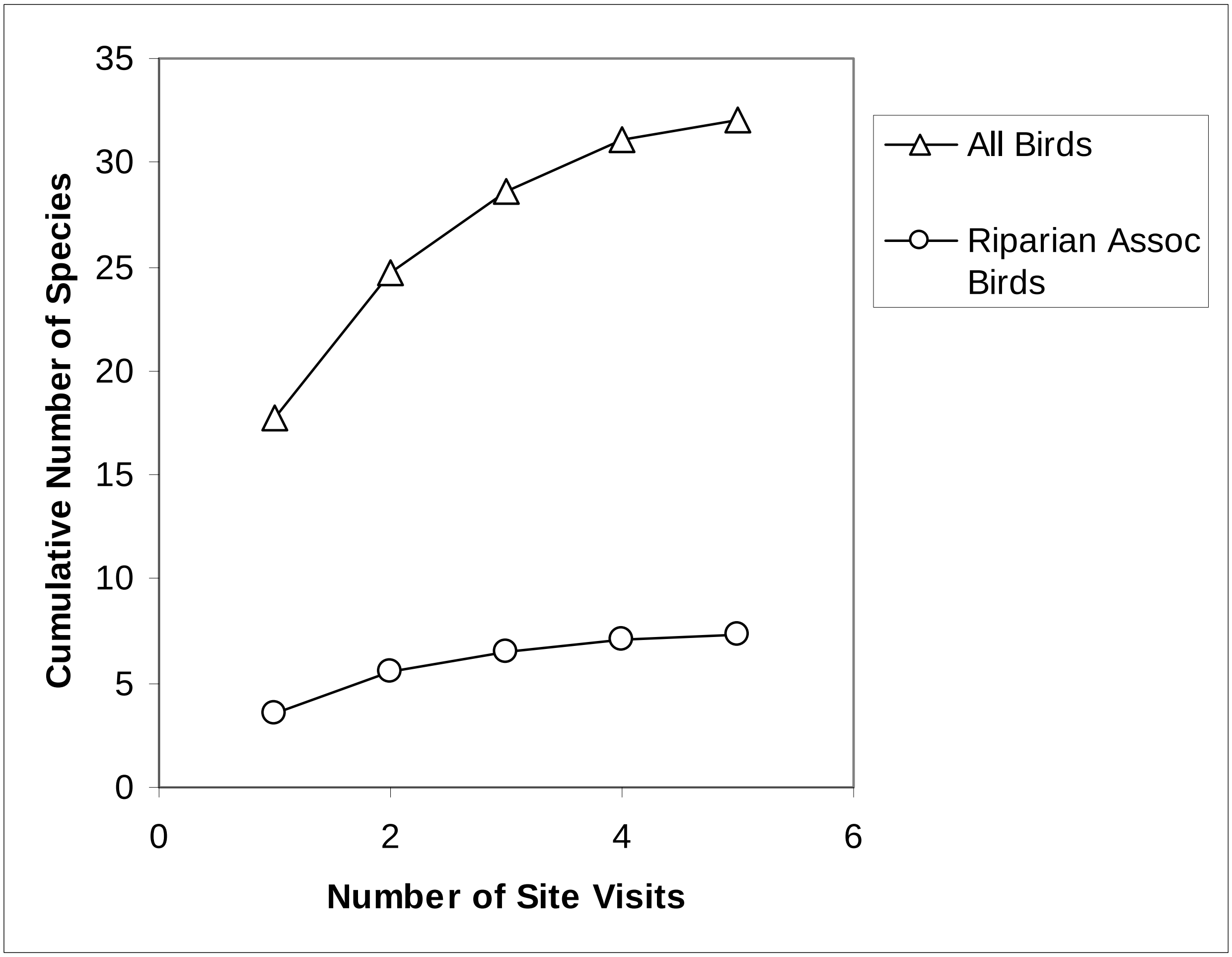


Figure 1. Cumulative Number of Bird Species Observed During Area Searches

Table 6. Summary of Species Observations[1,2]

Species Group	*N*	Mean	SD	Range
Butterfly Spp (2 Surveys)	47	8.6	2.6	4–14
Riparian-Associated Butterfly Spp (2 Surveys)	47	2.4	1.2	0–5
Odonate Spp (1 Survey)	43	7.8	2.3	3–12
Bird Spp (1 Survey)	47	16.3	4.3	6–29
Riparian-Associated Bird Spp (1 Survey)	47	4.3	2.0	0–8
Riparian Associated Bird Spp (4 Surveys)	12	7.4	2.0	4–14
Small Mammal Density (3 nights trapping)[3]	10	12	15	0–39
Mammal Spp (1 Survey)	47	1.5	1.3	0–4
Mammal Spp (4 Surveys)	12	2.3	1.2	1–4
Amphibian and Reptile Spp (1 Survey)	47	0.8	1.0	0–3
Amphibian and Reptile Spp (4 Surveys)	12	2.7	1.1	1–4

Notes:

1 Numbers in table are numbers of species observed per plot, except for small mammal density, which is number of individuals per plot.

2 Abbreviations: N = number of plots, SD = standard deviation, Spp = species.

3 Number of individuals per unit area (not number of species).

With the exception of relationships between surrounding land cover types and vertebrate species richness, our results did not strongly support our initial research hypotheses. In most cases, the species richness of riparian-associated birds was not strongly related to the species richness of other animal groups, though two relationships were significant (Table 7, Figure 2). There was a significant relationship between riparian-associated birds and mammal species (4 surveys, $df = 10$, $r = 0.71$, $p < 0.05$ and < 0.01 without Bonferroni adjustment). There were also significant relationships between potentially resident riparian-associated birds and amphibians and reptiles (based on 4 surveys, $df = 10$, $r = 0.76$, $p < 0.01$, without Bonferroni adjustment $p < 0.005$).

Species richness did not increase significantly with the width of riparian vegetation for any animal group. Correlation coefficients between species groups and riparian width generally were all below 0.40 (Table 8). Results for riparian-associated birds (based on 1 survey) suggested a positive relationship with riparian width ($df = 45$, $r = 0.35$, $p < 0.07$ and < 0.009 without Bonferroni adjustment; Table 8, Figure 3). This could be considered evidence of a significant relationship. However, for the multiple survey plots, there was not a relationship between the number of riparian-associated bird species and riparian width ($df = 10$, $r = 0.16$, $p > 0.25$ without Bonferroni adjustment; Figure 3). Similarly, the species richness of other animal groups had no significant or suggestive positive relationships with riparian width. Riparian width was initially included in four regression models (Table 9), although, in one case (riparian-associated birds based on 1 survey), width was not included in the final model.

In general, species richness of the animal groups had no significant or suggestive relationships with the area of riparian vegetation, and only weak relationships with tree or shrub cover (Table 8). However, riparian-associated birds,, based on 1 survey, had a highly significant relationship with tree cover ($df = 45$, $r = 0.49$, $p < 0.004$ and $p < 0.0005$ without Bonferroni adjustment; Figure 3). The species richness of other animal groups did not have significant or suggestive relationships with riparian woody plant cover.

For the plots receiving multiple surveys, significant correlations existed between vertebrate species richness and surrounding land cover. For these data, nearly half the correlation coefficients were between 0.50 and 0.87, and 14 of these were significant or suggestive (Table 8).

The species richness of riparian-associated birds was significantly related to the extent of surrounding natural and agricultural lands. Riparian-associated birds (based on 4 surveys) had suggestive relationships with percent of surrounding land in natural vegetation within 250 m, 1 km and 5 km ($r = 0.67$–0.73, $p < 0.22$-0.09 and $p < 0.009$–0.004 without Bonferroni adjustment). If the count of riparian-associated bird species at each plot were restricted to just potential nesting species, the relationships to adjacent land cover were stronger. For this set of observed riparian-associated bird species, correlations with agricultural and natural land cover within 250 m had coefficients of -0.84 and 0.82, respectively, indicating strong relationships with surrounding land cover (p values < 0.01-0.02 and < 0.0005 without Bonferroni adjustment). This group also had suggestive relationships to natural and agricultural land cover at other scales (Table 8). Furthermore, no breeding or nesting behaviors were observed for riparian-associated birds at the sites with higher portions of the surrounding area in agricultural land at 250 m (Figure 4).

Similarly, in the multiple survey data sets, the species richness of amphibians, reptiles and mammals was related to surrounding land-cover within 250 m to 5 km. Species richness of amphibians and reptiles had a significant relationship with the portion of the surrounding area in agricultural land for the areas within 1 km and 5 km ($r = -0.78$ and -0.85, respectively, $p < 0.04$ and 0.01, respectively, and p values < 0.002 and < 0.0005 without Bonferroni adjustment). Similarly, species richness of mammals had a significant negative correlation with developed land cover within 250 m and 1 km ($r = -0.82$ and -0.87, respectively, $p < 0.02$ and 0.01, and p values < 0.001 and 0.0005 without Bonferroni adjustment), and suggestive correlations to natural land cover (Table 8).

Although some of the relationships between vertebrate species richness and surrounding land cover were considered just suggestive in the context of this analysis's numerous hypothesis tests, each of these relationships accounted for a moderate portion of the variability among the multiple survey plots in the species richness of a vertebrate group.

Combinations of variables did not produce substantially stronger models for predicting species richness than did single variables. For the individual

Table 7. Correlations Among Species Groups[1,2]

	All Bird Spp	R-A Bird Spp (1 Survey)	R-A Bird Spp (4 Surveys)	R-A, PN Bird Spp (4 Surveys)	Mammal Spp (1 Survey)	Mammal Spp (4 Surveys)	Small Mammal Density	Amphibian & Reptile Spp (1 Survey)	Amphibian & Reptile Spp (4 Surveys)	All Butterfly Spp	R-A Butterfly Spp	Odonate Spp
All Bird Spp (*n* = 47)	1.00	–	–	–	–	–	–	–	–	–	–	–
R-A Bird Spp 1 survey (*n* = 47)	**0.75**[3]	1.00	–	–	–	–	–	–	–	–	–	–
R-A Bird Spp 4 Surveys (*n* = 12)	**0.50**	**0.78**[3]	1.00	–	–	–	–	–	–	–	–	–
R-A, PN Bird Spp 4 Surveys (*n* = 12)	0.53	0.20	0.54	1.00	–	–	–	–	–	–	–	–
Mammal Spp 1 survey (*n* = 47)	0.18	0.06	0.12	0.16	1.00	–	–	–	–	–	–	–
Mammal Spp 4 surveys (*n* = 12)	0.11	0.43	**0.71**[3]	0.32	0.42	1.00	–	–	–	–	–	–
Small Mammal Density (*n* = 10)	0.12	-0.12	0.00	0.58	0.16	0.25	1.00	–	–	–	–	–
Amphibian & Reptile Spp 1 Survey (*n* = 47)	0.32	0.18	0.28	**0.87**[3]	0.29	0.31	-0.13	1.00	–	–	–	–
Amphibian & Reptile Spp 4 Surveys (*n* = 12)	0.20	0.06	0.29	**0.76**[3]	-0.04	-0.13	0.59	**0.62**	1.00	–	–	–
All Butterfly Spp 2 Surveys (*n* = 47)	0.10	0.14	-0.08	-0.06	-0.09	-0.09	-0.26	0.13	-0.02	1.00	–	–
R-A Butterfly Spp 2 Surveys (*n* = 47)	0.14	0.33	-0.30	-0.23	-0.10	-0.15	-0.07	-0.01	0.43	**0.57**	1.00	-
Odonate Spp 1 Survey (*n* = 43)	0.19	-0.01	**0.58**	0.52	-0.24	0.09	-0.07	0.23	0.45	0.04	-0.13	1.00

Notes:

1 Numbers in table are correlation coefficients (*r*) between the number of species observed and the value of a site attribute, and those with a *p* value <0.01 are in bold; *P* values are based on the *r* value and number of observations (*n*), and in this analysis values <0.01 are considered to indicate suggestive or significant relationships among variables. Variables were transformed as described in methods prior to calculation of correlation coefficients.

2 Abbreviations are: R-A = riparian-associated, PN = potentially nesting, and Spp = Species.

3 Correlation significant at $\propto = 0.05$ with Bonferroni adjustment.

Table 8. Correlations of Species Observations with Plot Attributes[1]

Species Group[2]	Riparian Width	Tree Cover	Shrub Cover	Riparian (250 m)	Riparian (1 km)	Riparian (5 km)	Natural (250 m)	Natural (1 km)	Natural (5 km)	Agricultural (250 m)	Agricultural (1 km)	Agricultural (5 km)	Developed (250 m)	Developed (1 km)	Developed (5 km)
All Bird Spp (*n* = 47)	0.18	0.27	0.12	-0.05	-0.08	-0.03	0.18	0.15	0.05	-0.03	-0.16	-0.18	-0.22	-0.07	0.13
R-A Bird Spp 1 survey (*n* = 47)	**0.35**	**0.49**[3]	0.18	0.07	0.07	0.16	0.21	0.20	0.20	0.03	-0.10	-0.14	-0.28	-0.16	-0.04
R-A Bird Spp 4 Surveys (*n* = 12)	0.16	0.33	0.04	-0.15	-0.33	-0.40	**0.67**	**0.70**	**0.73**	-0.38	-0.31	-0.23	-0.43	-0.61	-0.50
R-A, PN Bird Spp 4 Surveys (*n* = 12)	-0.01	-0.07	0.34	-0.45	-0.46	-0.52	**0.82**[3]	**0.73**	0.52	**-0.84**[3]	**-0.70**	**-0.67**	-0.15	-0.29	-0.05
Mammal Spp 1 survey (*n* = 47)	0.14	-0.17	0.06	0.32	**0.36**	0.21	0.01	-0.11	-0.10	0.19	0.28	0.27	-0.19	-0.20	-0.21
Mammal Spp 4 surveys (*n* = 12)	0.32	0.33	0.20	-0.12	-0.18	-0.36	**0.70**	**0.76**	0.42	0.05	-0.01	0.12	**-0.82**[3]	**-0.87**[3]	-0.47
Trapped Mammal Density (*n* = 10)	0.39	0.02	0.50	-0.31	-0.37	-0.42	0.62	0.67	0.29	-0.40	-0.47	-0.29	-0.29	-0.30	-0.03
Amphibian & Reptile Spp 1 Survey (*n* = 47)	-0.24	-0.19	-0.17	0.27	0.25	0.30	0.21	0.22	0.28	-0.04	-0.14	-0.25	-0.20	-0.12	-0.04
Amphibian & Reptile Spp 4 Surveys (*n* = 12)	-0.18	-0.19	0.62	-0.44	-0.45	-0.34	0.02	0.35	0.46	-0.46	**-0.78**[3]	**-0.85**[3]	0.37	0.31	0.38
All Butterfly Spp 2 surveys (*n* = 47)	**-0.39**	0.07	-0.11	0.16	0.16	0.05	0.33	0.20	0.25	-0.18	-0.15	-0.29	-0.22	-0.10	0.07
R-A Butterfly Spp 2 surveys (*n* = 47)	0.05	0.30	0.23	0.15	0.18	0.07	0.10	0.13	0.27	-0.06	-0.10	-0.17	-0.08	-0.04	-0.06
Odonate Spp 1 survey (*n* = 43)	-0.24	-0.11	-0.08	-0.19	-0.27	-0.25	0.03	0.04	-0.02	0.11	0.13	0.06	-0.15	-0.26	-0.15

Notes:

1 Numbers in table are correlation coefficients (r) between the number of species observed and the value of a site attribute, and those with a p value <0.01 are in bold; P values are based on the r value and number of observations (n), and in this analysis values <0.01 are considered to indicate suggestive or significant relationships among variables. Variables were transformed as described in methods prior to calculation of correlation coefficients.

2 Abbreviations are: R-A = riparian-associated, PN = potentially nesting, and Spp = Species.

3 Correlation significant at ∝ = 0.05 with Bonferroni adjustment.

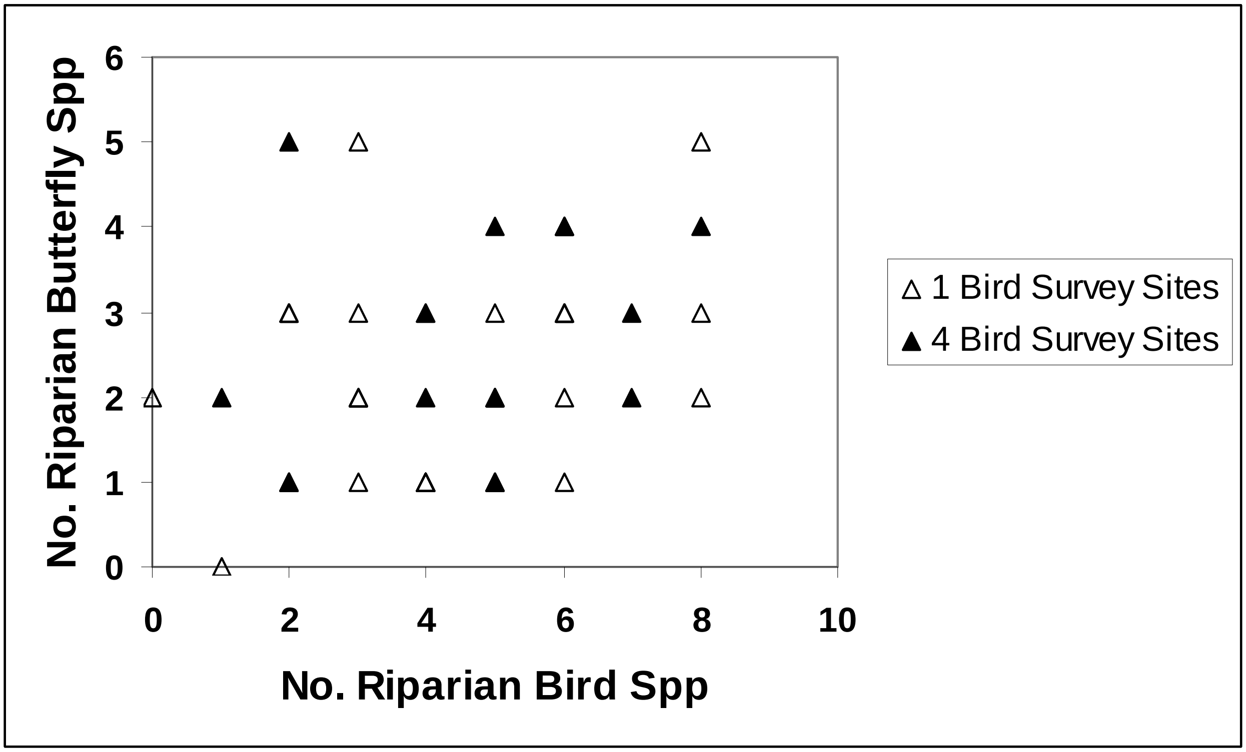
Table 9. Contribution of Variables to Multiple Regression Models for Relationship of Species Groups to Site Attributes[1]

Species Group[2]	R^2	Total SS	Sum of Squares (SS) Associated with Variables												
			Riparian Width	Tree Cover	Shrub Cover	Riparian (1 km)	Riparian (5 km)	Natural (250 m)	Natural (1 km)	Natural (5 km)	Agricultural (250 m)	Agricultural (1 km)	Agricultural (5 km)	Developed (250 m)	Developed (1 km)
All Bird Spp (*n* = 47, p = 0.0426)	0.09	13.59 (100%)	–	1.20 (9%)	–	–	–	–	–	–	–	–	–	–	–
R-A Bird Spp 1 Survey (*n* = 47, p = 0.0003)	0.31	11.63 (100%)	0 (0%)	2.89 (25%)	–	–	–	–	–	–	–	–	–	0.71 (6%)	–
R-A Bird Spp 4 Survey (*n* = 12, p = 0.0115)	0.63	1.53 (100%)	–	–	–	–	–	–	–	0.67 (44%)	–	–	–	–	0.29 (19%)
R-A, PN Bird Spp (*n* = 12, p < 0.0001)	0.90	3.41 (100%)	–	–	–	–	0 (0%)	2.63 (77%)	–	–	0.44 (13%)	–	–	–	–
Mammal Spp 1 Survey (*n* = 47, p = 0.0132)	0.13	9.99 (100%)	–	–	–	1.29 (13%)	–	–	–	–	–	0 (0%)	–	–	–
Mammal Spp 4 Survey (*n* = 12, p = .0175)	0.45	1.37 (100%)	–	–	–	–	–	–	0 (0%)	–	–	–	–	–	0.61 (45%)
Sm. Mammal Density (*n* = 10, p = 0.0641)	0.37	40.16 (100%)	–	–	–	–	–	–	14.68 (37%)	–	–	–	–	–	–
A & R Spp 1 Survey (n = 47, p = 0.0505)	0.13	7.74 (100%)	0.62 (8%)	–	–	–	0 (0%)	–	–	0.36 (5%)	0 (0%)	–	–	–	–
A & R Spp 4 Survey (*n* = 12, p = 0.0017)	0.64	1.01 (100%)	–	–	0 (0%)	–	–	–	–	–	–	–	0.65 (64%)	–	–
All Butterfly Spp (*n* = 47, p = 0.0006)	0.29	8.75 (100%)	1.43 (16%)	–	–	–	–	1.08 (12%)	–	–	–	–	0 (0%)	–	–
R-A Butterfly Spp (*n* = 47, p = 0.0453)	0.09	6.49 (100%)	–	–	–	–	–	–	–	0.56 (9%)	–	–	–	–	–
Odonate Spp (*n* = 43, p = 0.0405)	0.19	7.47 (100%)	0.44 (6%)	–	–	0.44 (6%)	–	–	–	–	–	–	–	–	0.54 (7%)

Notes:

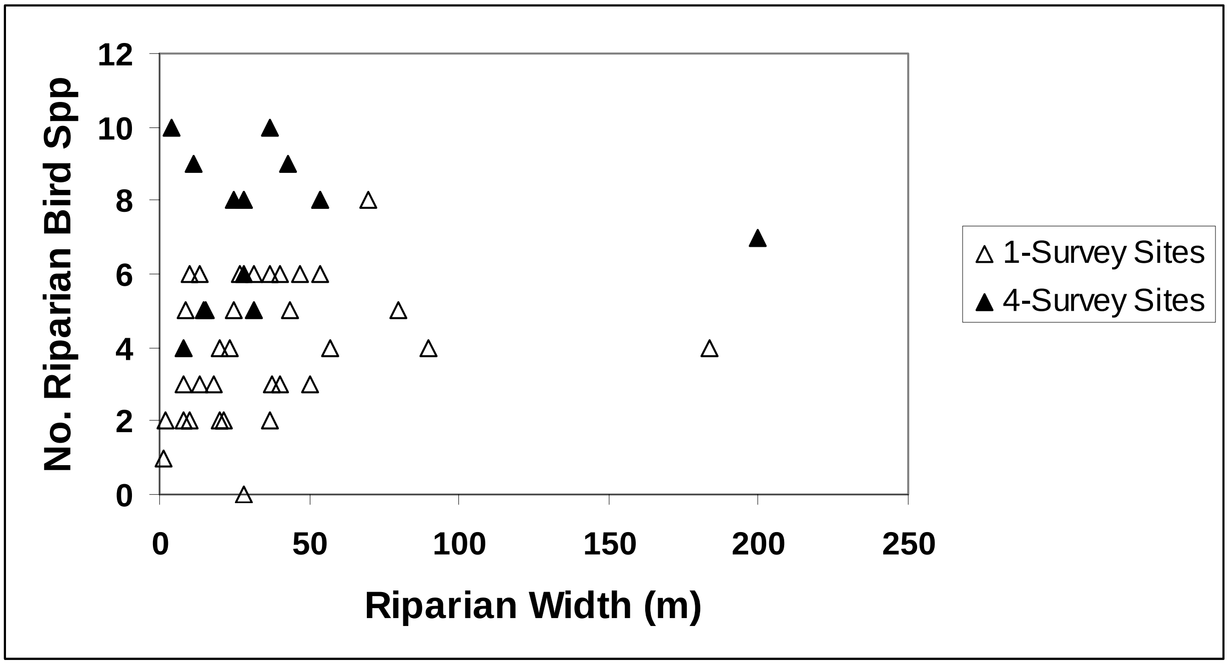
[1] Variables were transformed as described in methods prior to calculation of regression models.

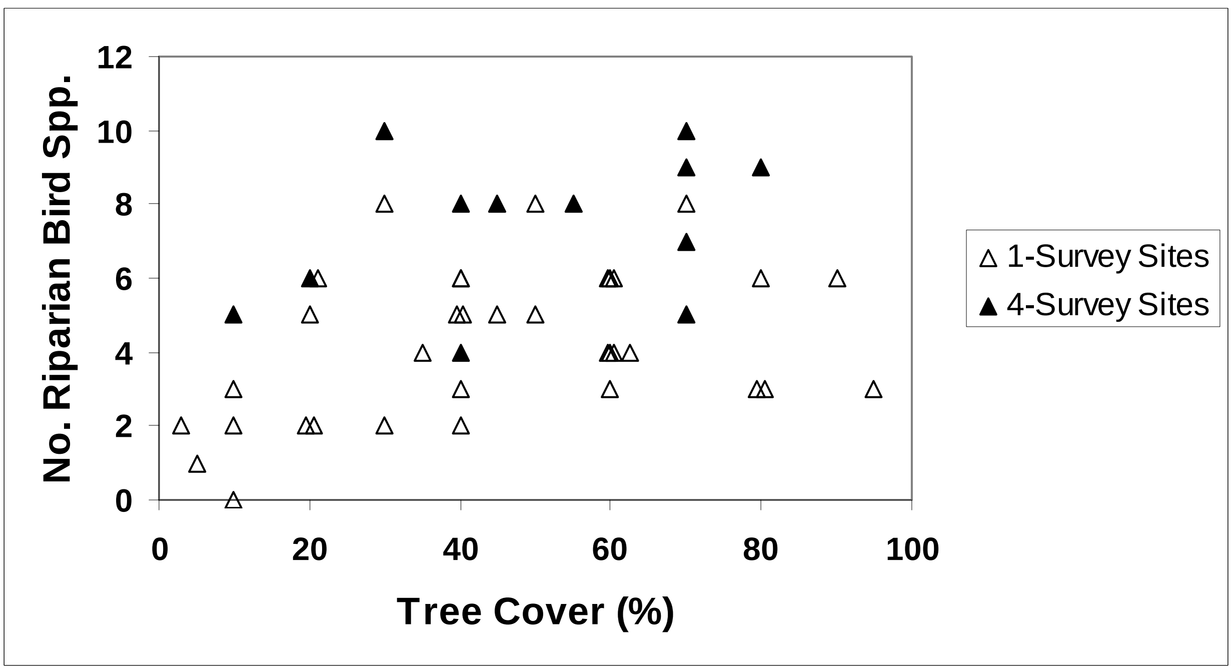
[2] Abbreviations are: R-A = riparian-associated, PN = potentially nesting, A & R = Amphibian and Reptile, and Spp = Species.



Note:
[1] *n* = 47

Figure 2. Correspondence of Species Richness among Riparian-Associated Birds and Riparian-Associated Butterflies[1]





Note:

1 $n = 47$

Figure 3. Relationship of Species Richness of Riparian-Associated Birds and Selected Site Attributes[1]

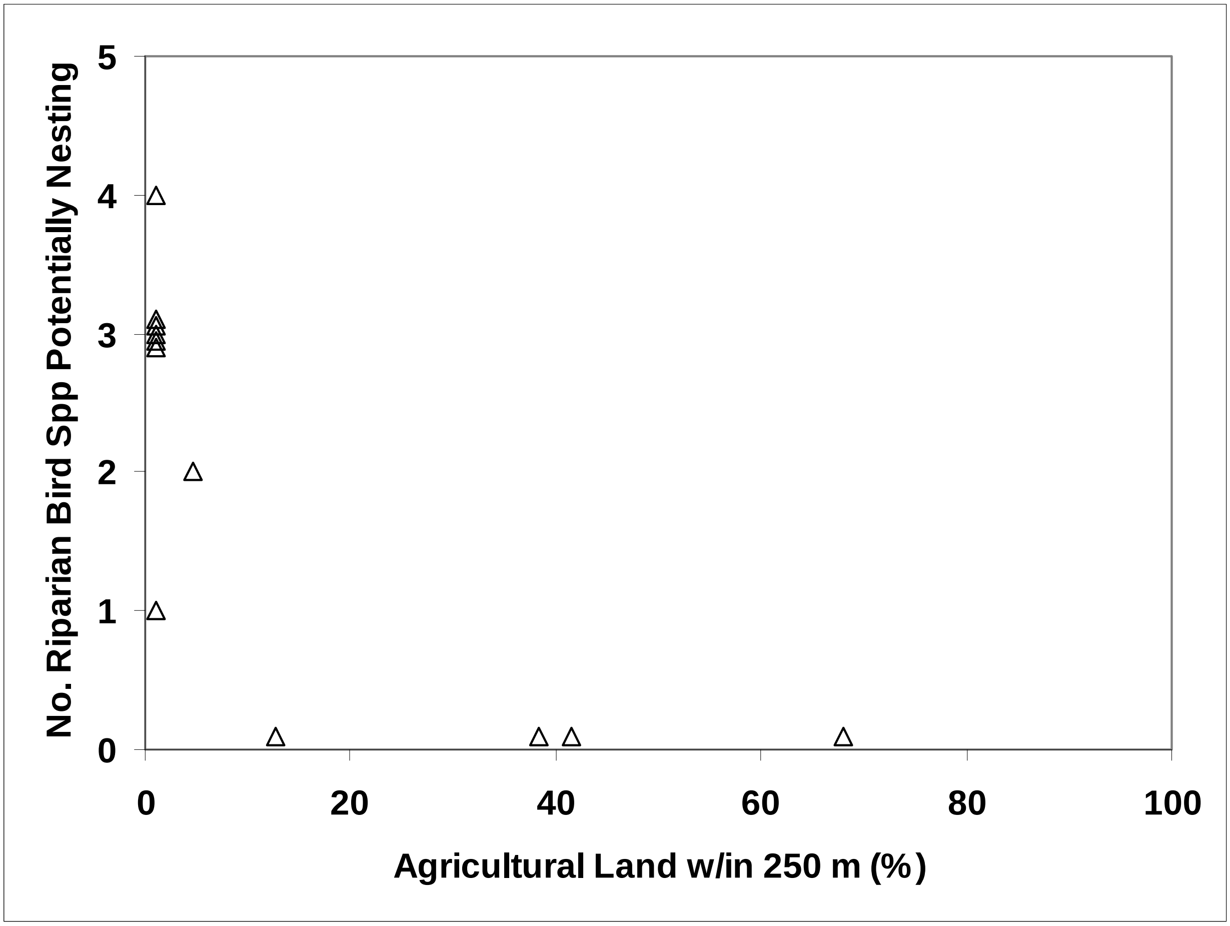


Figure 4. Relationship Between Number of Riparian-Associated Bird Species Potentially Nesting at a Site and Adjacent Agricultural Land

taxonomic groups, simple linear and stepwise multiple regression produced models with p values between < 0.0001 and 0.064 (Table 9). For all vertebrate species, the models consisted of one or two variables and almost all independent variables represented surrounding land cover. Only three of these models had R^2 values > 0.5: riparian-associated birds (4-surveys), riparian-associated birds potentially nesting (4 surveys) and amphibians and reptiles (4 surveys). The amphibian and reptile model was based only on the percent of area within 5 km that was in agricultural land. The model for potential nesting riparian-associated birds was based on two land cover variables, but just one of these (natural vegetation within 250 m) accounted for 86 % of the variability explained by the model. For riparian-associated birds (all observed during 4 surveys regardless of behavior), the regression model based on two variables was substantially stronger than for any one variable ($R^2 = 0.63$).

Discussion

The results of this study must be interpreted cautiously due to limitations of the study's overall sample size, attributes of available sites and chosen methodologies. Nonetheless, the results have implications for assessment methodologies, development of a FAM, and for riparian setbacks. These implications are discussed in the following sections.

Implications for Biological Site Surveys to Assess Riparian Biodiversity

These results indicated that data from multiple site surveys for vertebrates provide a much stronger basis for assessing a riparian area than data from a single site visit. Not only did data from four site surveys document more species than a single survey of those sites, but the results of single and multiple surveys were not highly correlated with each other. Overall, multiple site surveys provide a much more consistent basis for evaluating the habitat value of riparian sites.

These results also indicate that non-destructive area searches for mammals, amphibians, and reptiles were not an effective survey technique, even with the placement of cover boards. Overall, few species were observed during these area searches, usually less than one amphibian or reptile species during a single survey. Though few amphibian or reptile species may have been present, the results still demonstrate that a single non-destructive area search is not an effective means of inventorying the mammal, amphibian, and reptile species using a site. In most plots surveyed multiple times, additional species were observed, indicating that during a single survey most species using a site were not detected. No amphibian or reptiles species was observed beneath any of the 240 cover boards set out and checked 4–6 times during this study. However, cover boards may be more effective is used during late winter-early spring rainy season, when conditions beneath them would be more favorable for amphibians and reptiles, and possibly if constructed using thicker materials that provided better insulation from higher temperatures.

Implications for a FAM

Overall, our results indicate that, for the smaller streams and rivers of the Sacramento Valley, developing a single model that *precisely* quantifies *overall* habitat functions on the basis of readily measured site attributes is not possible, particularly on the basis of available information. However, the results do show that some readily measured site attributes are related to the species richness of particular taxonomic groups. For particular species, guilds, or taxonomic groups, this indicates that useful assessment criteria based on readily measured site attributes could be developed as shown in the examples in Table 10.

In this study, the species richness of different groups (particularly between vertebrates and invertebrates) was not related, and species groups often differed in their relationships to plot attributes. In general, species differ in their biology and thus their habitat requirements, particularly across major taxonomic groups such as vascular plants, butterflies and mammals. Therefore, numerous specific site attributes such as disturbance history, vegetation structure, and presence of host plants, refugia, or rock outcrops affect these species groups differently, and many of these attributes are themselves only loosely related to the landscape variables that are most useful for a cost-effective FAM (e.g., surrounding land use, area and width of riparian vegetation). Thus, models, or assessment criteria, that focus on individual species or guilds will likely provide more useful assessments of a site's habitat value than a model that attempts to quantify habitat value for all species combined (Stein et al. 2000; Smith 2000; Bryce et al. 2002).

In this study, the vertebrate groups had relationships to site attributes, and thus for particular vertebrate taxonomic groups, guilds or species effective assessment criteria based on readily measured site attributes probably could be developed through additional studies. In data from multiple site visits, which were most effective at documenting species' presence, relationships between species richness and surrounding land use were important.

Unfortunately, due to their sample size and the types of data collected, these data sets have substantial limitations. They consist of only twelve plots, and they contain few or no replicates of some important types of sites (e.g., wide riparian corridors in urban areas). They also were scattered over a wide and heterogeneous geographic area. Furthermore, they contain little information on abundance and no information on rates of growth, survival or reproduction. Thus, while these data indicate the importance of surrounding land uses, and other readily measured site attributes, additional studies with larger sample sizes, and collecting other types of ecological data (e.g., density, survival or reproduction), are necessary for defining assessment criteria that precisely quantify habitat values under different combinations of site attributes. We consider such studies important next steps for the conservation planning process.

Table 10. Evaluation of Habitat Functions by Representative Functional Assessment Methods

Assessment	Terrestrial Habitat Functions	Variables used to Assess Habitat Function	Tested[1]
Spatial Wetland Assessment for Management and Planning, SWAMP (Sutter 2001)	Terrestrial wildlife habitat	Area of interior habitat Heterogeneity of vegetation Presence of surface water	No
Assessment of riverine wetlands in Washington State (Hruby et al. 1999)	Bird, Mammal, Amphibian Habitat	Density and condition of snags Presence of special features Evidence of disturbance on adjacent land Interspersion of vegetation types	No
Hydrogeomorphic assessment (HGM) of riverine floodplains in the Northern Rocky Mountains (Hauer et al. 2002)	Characteristic vertebrate habitats	Cover in herb and shrub layers and of native species Tree density Inundation frequency Connectivity of vegetation types	No
Suggested revisions to BLM's Proper Functioning Condition assessment procedure (Stevens et al. 2002)	Fish and wildlife habitat	Canopy connectivity Vegetation patch density Fluvial landform diversity	No
Southern California Riparian Model (Stein et al. 2000)[2]	Condition units[2]	Cover of native plants Percent invasive species Vegetation structural diversity Riparian vegetation continuity Adjacent land cover	No
Bird Integrity Index (Bryce et al. 2002)	Overall riparian integrity including overall habitat integrity	Number or proportion of bird species (or of individuals) in selected guilds	Yes
Tidal freshwater wetlands along Hudson River (Findley et al. 2002)	Breeding Bird, Muskrat and Waterfowl Habitat[3]	Cover or stem density of plant species Soil texture	No[3]
Wetland Assessment, WEA, for San Francisco Bay Region (Breaux and Martindale 2003)	Wildlife Utilization Rating	Guidelines for professional judgment	No
San Diego Creek Assessment (Smith 2000)	Riparian habitat integrity	Native riparian vegetation area Riparian corridor continuity Adjacent land use/land cover	No
Indicator Value Assessment, IVA (Hruby et al. 1995)	General waterfowl, General wildlife	Numerous (>60 indicators)	No
Wetland Habitat Assessment Technique, HAT (Cable et al. 1989)	Habitat quality	Bird species presence Wetland area	No

Notes:

[1] Tested by comparison to direct measurements of species presence, abundance or demography. For assessments that used direct measures of animal species group (e.g., birds) presence to assess overall site condition or habitat quality, testing requires comparison to direct measurements of other animal groups.

[2] Habitat function incorporated into overall rating (i.e., condition units), and only habitat variables are listed in this table.

[3] This study also included fish and aquatic invertebrate habitat functions that were tested by comparison to direct measurements.

As one of these next steps, PRBO's point count dataset provides an excellent opportunity to evaluate relationships between the abundance (i.e., number of individuals) of riparian-associated bird species and riparian width and surrounding land cover. Point count surveys are designed to record the relative abundance of individual species, and PRBO has conducted these surveys for over a thousand locations over multiple years. Their analysis would require the calculation of GIS-based landscape metrics (comparable to the surrounding land cover variables used in this study) and an aerial photo-based interpretation of riparian width. Nonetheless, the analysis of existing PRBO point count data would be a cost-effective means to rigorously analyze relationships between the abundance of species and riparian width and surrounding land cover.

Because of the differences among species groups, and the limitations of current knowledge, a FAM for western Placer County that calculates a single score for a riparian area's habitat functions should be considered only a very general indicator of the overall provision of habitat functions. Such a score should be based on a limited number of variables, preferably just one or two variables that are broadly related to most habitat values and the processes sustaining them (e.g., proportion of surroundings in natural vegetation, hydraulic connectivity). This would limit inaccuracies caused by the operations and coefficients selected to combine variables, and would maintain a mechanistic basis for the assessment.

Implications for Riparian Setbacks

Though width of riparian vegetation was not strongly related to species richness, as measured by these measures, this result should not be interpreted as evidence that the width of a riparian setback is not an important consideration for habitat conservation. This study's sample size, particularly for the multiple survey sites, was small and spread over a large geographic area. Thus, it is likely that only effects of larger magnitude would have been identified and locally important effects would not have been detected without a larger sample size. Width may be important for some species, but these species might be few in number or absent from our data sets. Because all but a few plots represented landscapes substantially altered by human use, most species sensitive to these alterations (including a reduction in riparian width) may no longer be present at any of the study sites. For example, Western Yellow-billed Cuckoo is such a species (Greco et al. 2002) and was not detected at any of the 47 plots during our surveys.

Riparian setbacks would include both riparian and other natural vegetation, and their width would be directly related to the extent of adjacent natural, agricultural and developed land cover; and the proportions of surrounding land-cover types were related to species richness in this study's results. Furthermore, other studies, have shown relationships between the width of riparian vegetation and the presence of riparian-associated animals (Greco et al. 2002).

This study's results indicated that there are important relationships between adjacent land use within 250 m–5 km and the biodiversity of riparian corridors in the Sacramento Valley. These relationships are consistent with studies of riparian habitat elsewhere (Findlay and Houlahan 1996; Forman and Alexander 1998; Bryce et al. 2002; Miller et al. 2003; Semlitsch and Bodie 2003) and with our understanding of factors known to affect riparian species in the Sacramento Valley, such as the availability of upland habitats also used by many of these species. Thus, riparian setbacks should consider both the condition and management of riparian vegetation and the buffer between this vegetation and adjacent developed and agricultural lands. Also, the results suggest that riparian setbacks may not be able to prevent all adverse effects of surrounding land uses on riparian biodiversity, and thus that other conservation measures may be necessary as well. These conservations measures will be discussed in the report providing guidance for riparian setbacks.

However, the results of this study are not by themselves a sufficient basis for recommending setback or buffer widths. For this reason, our report providing guidance for riparian setbacks (Task 5 of the Riparian Ecosystem Assessment), will consider these results together with other available data, and a review of the scientific literature regarding the use of adjacent land by riparian species and the influences of adjacent land uses on those species.

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Appendix A

RAP Forms

Protocol for Description of Riparian Ecosystem Assessment Plots

INTRODUCTION

These protocols provide a guide to assist the survey team in obtaining the required information as efficiently as possible. Minor modifications to these protocols may be necessary depending on access constraints and time available to complete the surveys. All RAP surveys will be done at riparian sites that PRBO has surveyed previously and at Placer County riparian sites where permission is granted from the landowners. Assume that all land is private and do not trespass if you are uncertain about the land ownership. Also, avoid stopping in front of residences and generally be discrete about displaying maps, cameras, and clipboards. Be careful about pulling off roads and do not violate any traffic laws to sample a riparian plot or observe a species. Always leave gates exactly as you found them. Also, for Placer County sites, it is important that all requirements specified by the landowner are followed. These requirements are attached to the directions, map, and photograph for each plot in Placer County.

PREFIELD TASKS

Prior to performing the field surveys, please review the following materials that will be provided in the field packets:

- Road maps and maps of the individual streams showing roads and access points so that survey routes can be planned and surveyed efficiently;
- PRBO field notes giving directions to individual sites, vegetation descriptions, and bird species lists for survey plots;
- Aerial photographs of individual creeks and rivers (as available).

Plan your route to the riparian sites and consult the field checklist to ensure that you have gathered all the necessary equipment to complete the site description and any other RAP survey work you will be conducting (an equipment and contact list is included as Attachment 1).

LOCATING THE PLOT

Proceed to the pre-determined coordinates for the plot center point. Centered on this point, the plot edge ds 100 m along the stream bank edge of the riparian zone (50 m up and 50 m down stream), and then extends 100 m inland (away from the stream bank). In most cases, the actual center of the located plot will differ from the pre-determined coordinates used to locate the plot. Therefore, once the plot boundaries have been determined, the actual coordinates for the plot center point are determined and recorded on the data form (see below).

RIPARIAN RAP DATA FORM

The intent of the RAP data form is to facilitate the collection of field data at selected plots rapidly and accurately. At each plot record the required data in each of the following data fields:

Location

- Provide the River/Creek name and number the plot (e.g., Deer Creek #1).
- Provide the survey date(s) and names of surveyors.
- Use the GPS unit to determine coordinates for the center point of each plot; and record the lat/long on the form. (Elevation will be determined from USGS topographic map and recorded on the form afterwards.)

- Take photographs facing North, East, South, and West, and of a representative view of the riparian corridor. Record their numbers on the form.

Environmental Description

This provides a brief description of the general slope exposure and steepness of the riparian plot that is sampled. If slope varies within the plot, record the slope across the plot as a whole (i.e., from the stream-side to the inland side of the plot).

ADJACENT LAND USES AND IMPACTS

***Developed Non-industrial Land Uses* -** Record the extent of adjacent residential and suburban development with 250 m of the center of the survey plot both by noting the percentage of area covered by these land uses and recording the number of development units (du) observed, including barns and other out buildings.

Agricultural Land Uses – Record agricultural development within 250 m of the center of the plot both by recording the percentage of area covered by agricultural land uses, and by noting the general agricultural type(s) observed.

Industrial Land Uses – Record industrial development within 250 m of the center of the plot both by recording the percentage of area covered by industrial land uses and by noting the general type of industrial uses observed.

Impact Types – In the table provided, for both the riparian and non-riparian portions of the plot, record the presence of the following impacts: brush removal, tree cutting, roadedness, grazing, and trash dumping. The adjacent area extends 250 m from the center of the plot. If the adjacent area is not in natural vegetation, do not record brush cutting, tree cutting, or trash dumping as occurring in the adjacent area. In documenting roadedness, all roads, including dirt and gravel, and other impervious or heavily compacted surfaces are included in this type of impact. For the other category, specify the impact type.

Channel Condition – Indicate whether bank protection has been used in the channel adjacent to the plot, and whether the channel shows evidence of incision. Note whether levees are present at or near the site that may confine the extent of potential riparian habitat areas, and indicate whether there is evidence of overland flow on the plot. Also, indicate the distance to the nearest road (paved, gravel or dirt).

ADDITIONAL COMMENTS

Add any additional comments on site access or interpretation, including management of creeks (e.g., recent revegetation or clearing, channelization, herbicide use, etc.). Also, if aerial photos are available and vegetation has changed since the photograph was taken, this should be noted. Add these additional comments, as necessary, at the bottom of the form.

VEGETATION DESCRIPTION

- In the box provided, enter the Habitat Type(s) using the appropriate Placer County WHR codes (Attachment 2).
- Estimated width of the riparian vegetation. Estimate the width of the riparian stand using a range finder at the center and both ends of each plot and record these widths on the data form.
- Record the surrounding habitat types using the Placer County WHR codes.
- Estimate the total size of the stand from aerial photos and ground inspection, and record its approximate length and continuity, as indicated on the form.
- Record estimates of total absolute cover (expressed as a percentage) of the tree, shrub, and herbaceous layers, and estimate the total extent of unvegetated ground (i.e., bare ground).

- Estimate the total snag density as high (> 20 per hectare), moderate (10-19 ha^{-1}), low (< 10 ha^{-1}), or absent.
- Check the appropriate habitat stage category for that represents the size of the trees dominating the tree layer.
- In the table provided, based on a visual estimate, record the scientific name and check the appropriate category for absolute cover for each woody species in the tree layer (> 3 m), and in the shrub layer (0.5-3 m).

POST-FIELD CHECKLIST

- Check over the field data forms and make sure everything is completed and clear.
- Surveyors should review each other's completed forms for completeness and accuracy in the field.
- From topographic maps, add plot elevations to the RAP data form.
- Photocopy all your field forms. File the copes in the file cabinet in Ted's office and the originals in the Placer Legacy office.
- Download the digital photographs into the P drive folder and rename with the site, point number and orientation (e.g., Thomes 7-1 N, Thomes 7-1 E etc.).
- Download the site coordinates from the GPS into the P drive folder.
- Cross off, date, and initial your completed site on the master list to ensure that field work is not repeated.
- Report progress to the project manager and obtain additional survey packages.

RIPARIAN ECOSYSTEM ASSESSMENT SURVEY PLOTS
RAPID BIOLOGICAL ASSESSMENT FIELD FORM

(J&S--Revised May 7, 2003)

LOCATION

RIVER/CREEK NAME ____ Plot #____________

Surveyors ____**Date** ___________________

Photo #s: ____

GPS Coordinates: Lat. ____°_____'_______" **Long.** _____°_____'_______" **Elevation** (ft/m) ________________
(WGS 84)

ENVIRONMENTAL DESCRIPTION

General Slope Exposure: ___________

General Slope Steepness: 0 degrees_____ 1-5 degrees _____ 5-25 degrees _____ > 25 degrees

ADJACENT LAND USES AND IMPACTS:

Developed Non-industrial Land Uses ___% of adjacent area**;**
Number of development units per acre: < 1du/ha ___1-2 du/ha _____ > 2 du/ha
Agricultural Land Uses: ___% of adjacent area; Types**:** _____**Orchard** _____ **Vineyard** _____ **Row Crops** ____ **Grain** ___ **Pasture** ___ **Other**
Industrial Land Uses: ___% of adjacent area; Types: ___**Gravel Mining** ____**Other**

Comments ____

Impact Types in Riparian Plot and Adjacent Areas (within 250 m)

IMPACT TYPE	Riparian portion of plot	Non-riparian part of plot	Adjacent Area
Brush removal[1]			
Tree-cutting[1]			
Roadedness[2]			
Grazing[1,3]			
Trash dumping[1]			
Other – specify			

[1] – For adjacent areas not in natural vegetation, do not consider this impact type to be present.
[2] – As roads, include dirt, gravel and paved roads, and other paved surfaces.
[3] – Evidence of grazing includes cows, cow excrement, and tracks.

Bank Protection (e.g. riprap): __% of plot length Channel Incised? Yes No (circle one)

Levee (circle one): [None along stream] [In plot] [Between plot & channel] [Plot between channel & levee]

Evidence of overland flow within plot? Yes No (circle one)

Nearest road : In Plot: Yes No (circle one) If No Road in Plot: Nearest road within ___meters of plot center point.

ADDITIONAL COMMENTS

____

____

____

____

____

VEGETATION DESCRIPTION

Habitat Type (CWHR)	**Stand Width (Plot Edge)**	**Stand Width (Plot Center)**	**Stand Width (Plot Edge)**	**Surrounding Habitat Types**

Estimated size of total stand: ___< 0.5 ha ___ >0.5-1 ha ___>1-5 ha ___>5-10 ha ___ >10-25 ha ____ >25 ha

Stand Length and Continuity: > 1 km, continuous_____ > 1 km, not continuous _____ 0.5-1 km, continuous _____
0.5-1 km , not continuous _____ < 0.5 km, continuous ______ <0.5 km, not continuous _____

Total Cover (absolute): Tree Layer: __% Shrub Layer: ___% Herbaceous Layer: __% Bare:___%

Snag Density: High (> 20/ha)_____ **Moderate** (< 20 to 10/ha) _____ **Low** (< 10/ha) _____ **Absent ______**

Predominant Tree Size Class (refer to WHR Habitat Stages for visual examples of each)

Size Class (circle one)	**1**	**2**	**3**	**4**	**5**	**6**
Stage	Seedling	Sapling	Pole	Small	Medium-Large	Multi-storied
DBH	< 1”	1”-6”	6”-11”	11”-24”	>24”	Size 5 over 4 or 3

Woody Plant Absolute Cover in Riparian Portion of Plots

(Check 1 category for each species present)

Species	**0-1 %**	**>1-5 %**	**>5-25%**	**>25-50%**	**>50-75%**	**>75-95%**	**>95%**
Tree layer (> 3 m)							
Shrub layer (< 3 m)							

Attachment 1. Riparian Assessment Field Equipment

Equipment List

Road maps, area maps, and aerial photographs (as available).
Compass
Clipboard
Rangefinder
Thermometer
Digital Camera
GPS
Cell phone
Fine Sharpies, pencils
J&S equipment bag
Cover boards (if 1st visit to a site where amphibian & reptile data will be collected)

Data Forms

Plot Description Fomr RAP Data Form and Attachments 1, 2, 3
PRBO Area Search Form
Amphibian and Reptile Search Form
Mammal Area Search Form
PRBO Pont Count Form
Small Mammal Trapping data Collection Form
Continuation Pages

Reference Package
RAP Protocols (Plot Description, Area Search and Small Mammal trapping)
Attachment 1. Field Equipment
Attachment 2. CWHR Land Cover and Habitat Types and Codes
Attachment 3. Key to Woody Plants of Central Valley Riparian Zones
Attachment 4. Beaufort Wind Scale
Road map(s)
USGS Quad map

Contacts List

Becky N.	916.752.0973
Ted	530.274.7232
Eric	530.292.0100
Brad	916.752.0923
Margaret	916.752.0941
Kate	916.752.0930
John S.	916.752.0899
Bud	916.752.0938
Jen H.	916.752.0985
Doug	916.835.3197

Placer Wildlife Habitat Relationship Classification
Placer Legacy Phase 1 Area - Land Cover & Habitat Types
2-20-03

Aquatic – Open Water

WL Lacustrine (Lakes/Reservoirs) (generally these features are greater than 1 acre in size)
WR Riverine (Rivers and Creeks) (only mapped if large enough to be mapped accurately on the photographs)

Barren

BR Barren (Cliffs, rock outcrops)
BD Disturbed Lands (Landfills, Graded lands-Non agricultural)

Herbaceous

HA Annual Grassland
HP Pasture - Irrigated
HW Fresh Emergent Wetland
VP Vernal Pool (individual vernal pool >0.5 acre in size) (only mapped if not included in previous mapping and not within a complex)
VC Vernal Pool Complex
- VCh—(High) vernal pool density >7%
- VCm—(Medium) vernal pool density 4-7%
- VCl—(Low) vernal pool density <3%

HS Seasonal Wetland

Shrub

SC Foothill Chaparral

Forested

FR Riparian
FH Foothill Hardwood - includes where signatures are distinguishable:
- FHV Valley Oak Woodland
- FHB Blue Oak Woodland
- FHL Interior Live Oak Woodland

FS Oak Woodland-Savanna (low density oak woodland/savanna mix where density is <= 5 'large' trees per acre)
FOP Oak-Foothill Pine
FP Ponderosa Pine
FE Eucalyptus

Agricultural

AR Rice
AC Row Crops
AA Alfalfa
AP Pasture
AV Vineyards
AO Orchards
AU Unidentified Croplands (including plowed, idle)

Urban

US Urban/Suburban (>1 unit / acre)

UR Rural-residential (0.1 – 1.0 unit / acre) (less than 70% canopy cover of large trees)

URF Rural-residential Forested (0.1-1.0 unit/acre plus 70-90% canopy cover of large trees)

UP Urban Parks (includes isolated city parks: playgrounds, grass fields, etc)

UG Golf Courses

UT Urban riparian (includes internal riparian areas such as greenbelts, most often surrounded by residential/urban development)

UF Urban woodland (includes city parks with predominate woodland type vegetation and windbreaks with mostly non-native trees)

UW Urban wetland (includes vernal pools, seasonal wetlands, and emergent marshes surrounded by urban uses)

Small-Patch Ecosystems

XW Springs and Seeps

XP Stock Ponds (less than 1 acre)

XL Landscape and Golf Course Ponds (less than 1 acre)

Special Geologic Formations and Soils

XG Gabbrodiorite Soils

XS Serpentine Soils

MR Mehrten Formation Soils

BIRD AREA SEARCH PROTOCOL

INTRODUCTION

These protocols provide a guide to assist the survey team in obtaining the required information as efficiently as possible. Minor modifications to these protocols may be necessary depending on access constraints and time available to complete the surveys. All RAP surveys will be done at riparian sites that PRBO has surveyed previously and at Placer County riparian sites where permission is granted from the landowners. Assume that all land is private and do not trespass if you are uncertain about the land ownership. Also, avoid stopping in front of residences and generally be discrete about displaying maps, cameras, and clipboards. Be careful about pulling off roads and do not violate any traffic laws to sample a riparian plot or observe a species. Always leave gates exactly as you found them. Also, for Placer County sites, it is important that all requirements specified by the landowner are followed. These requirements are attached to the directions, map, and photograph for each plot in Placer County.

PREFIELD TASKS

Prior to performing the field surveys, please review the following materials that will be provided in the field packets:

- Road maps and maps of the individual streams showing roads and access points so that survey routes can be planned and surveyed efficiently;
- PRBO field notes giving directions to individual sites, vegetation descriptions, and bird species lists for survey plots;
- Aerial photographs of individual creeks and rivers (as available).

Plan your route to the riparian sites and consult the field checklist to ensure that you have gathered all the necessary equipment to complete the RAP survey work you will be conducting (an equipment and contact list is included as Attachment 1).

LOCATING THE PLOT

Proceed to the coordinates for the center point of the 100 m by 100 m plot. Centered on this point, the plot edge is 100 m along the stream bank edge of the riparian zone (50 m up and 50 m down stream), and then extends 100 m inland (away from the stream bank).

CONDUCTING THE AREA SEARCH

The area search involves conducting a census of the entire1 ha plot (100 m X 100 m) and recording all bird species detected there. Please use the PRBO area search form to record data. Each area search plot is covered in approximately 1 hour to provide comparable search time at each plot. Typically, at least 3 plots should be covered in a single morning.

Begin the area search by filling out the observer and census information at the top of the PRBO AREA SEARCH FORM. Complete the weather information, and record the air temperature, % cloud cover (% of sky covered in clouds), and approximate wind speed using the attached Beaufort wind scale.

During the census, carefully record the name of each species seen, heard, or for which tracks or scat was observed. Please use the species' common name (not 4-letter codes) to avoid later confusion. For each individual of each species, record a single letter (S=song, V=visual, C=call), in the order of priority explained in the code key. You should change the data (i.e. from a call to a song) if a higher priority observation later occurs for that individual. Also, record breeding and nesting behavior. Recording other special behaviors (such as food carries, flocking, displaying), is strongly recommended but not required; there are respective columns on the form for these observations, following breeding bird atlas methodology. Other species observed off the plot or flying over may be recorded under Notes and Flyovers or on a separate sheet of paper.

In recording species on the data form, note whether the species was observed in the riparian or non-riparian portions of the plot.

POST-FIELD CHECKLIST

- Check over the field data forms and make sure everything is completed and clear.
- Surveyors should review each other's completed forms for completeness and accuracy in the field.
- Photocopy all your field forms. File the copes in the file cabinet in Ted's office and the originals in the Placer Legacy office.
- Cross off, date, and initial your completed site on the master list to ensure that field work is not repeated.
- Report progress to the project manager and obtain additional survey packages.

Beaufort Wind Scale

Used to guage wind speed using observations of the winds effects on trees and other objects. Often used in monitoring projects because it doesn't require fancy equipment.

Format: Beaufort Number * Wind Speed in Miles/hour(Km/hour) *** Description**

0 *** <1 (<1.6)*****Calm:** Still: Smoke will rise vertically.

1***1-3(1.6-4.8)*** **Light Air:** Rising smoke drifts, weather vane is inactive.

2***4-7(6.4-11.3)*****Light Breeze:** Leaves rustle, can feel wind on your face, weather vane is inactive.

3***8-12(12.9-19.3)*****Gentle Breeze:** Leaves and twigs move around. Light weight flags extend.

4***13-18 (20.9-29.0)*****Moderate Breeze:** Moves thin branches, raises dust and paper.

5***19-24 (30.6-38.6)*****Fresh Breeze:** Moves trees sway.

6***25-31(40.2-50.0) *****Strong Breeze:** Large tree branches move, open wires (such as telegraph wires) begin to "whistle", umbrellas are difficult to keep under control.

7***32-38 (51.5-61.2)*****Moderate Gale:** Large trees begin to sway, noticeably difficult to walk.

8***39-46(62.8-74.0)*****Fresh Gale:** Twigs and small branches are broken from trees, walking into the wind is very difficult.

9***47-54(75.6-86.9)*****Strong Gale:** Slight damage occurs to buildings, shingles are blown off of roofs.

10***55-63 (88.5-101.4)*****Whole Gale:** Large trees are uprooted, building damage is considerable.

11***64-72 (103.0-115.9)*****Storm:** Extensive widespread damage. These typically occur only at sea, and rarely inland.

12***>73 (>115.9)*****Hurricane:** Extreme destruction.

NOTE: The Beaufort number is also referred to as a "Force" number, for example, "Force 10 Gale".

* To calculate knots, divide miles/hour by 1.15.

PRBO AREA SEARCH FORM

Observer Information	Census Information	
Observers	River/Creek	Plot #
Date	Location (County)	

__________°F or °C (circle one) __________% __________ mph , knots, or kmph (circle one)
Temperature Cloud Cover Wind Speed

Number of Observers: ______ **Start Time:** ________________ **End Time:** ______________

Species	Tally of Individuals (Song, Visual, Call, one letter per individual)	Total	Behavior (check if applicable)* Forage.	Flock	Copul.	Displ.	Pair	Mater. carry	Food carry	Nest	Fledge.

*Forag. = foraging, Copl. = copulation, Displ. = courtship or territorial display, Food carry includes fecal sack, Fledg. = fledgling.

Notes and flyovers:____

____

____

____

____

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Be sure you have the following:

- binoculars
- watch which indicates seconds
- at least 2 pens
- field notebook
- sufficient blank data forms
- clipboard
- rubber bands (for holding forms on clipboard)

Depending on the route, census type, and your experience level, you may also need:

- directions and maps
- GPS unit & extra batteries
- cell phone or radio
- range finder
- field guide
- water and snacks

Counts begin approximately 15 minutes after local sunrise and should be completed within 3-4 hours, generally by 10AM.

We recommend 2-3 visits per season (e.g., twice in May and once in June). Visits should be at least 10-15 days apart. Timing of the field season will vary by location, but should cover the local breeding season with as little overlap with migration or dispersal as possible.

When possible, the order in which points are surveyed should vary between visits. Ideally, observers should also vary among visits.

Do not conduct surveys during weather conditions that likely reduce detectability (e.g., high winds or rain). If conditions change for the worse while doing a count, remaining points can be completed <7 days from the first day, but this should be avoided as much as possible.

Approach the point with as little disturbance to the birds as possible, and begin your count as soon as you are oriented and are confident you can estimate distances accurately (less than 1 minute).

PRBO point counts are 5 minutes duration at each point. Record the time the survey begins at each point using the 24-hour clock. If something interferes with your ability to detect birds during the 5-minute count, stop the count until

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the disturbance has passed and start over. Cross out the interrupted data and note what happened on your form.

Every species detected at a point is recorded, regardless of how far from the observer. Use the standardized banding lab 4-letter abbreviation for species codes (http://www.pwrc.usgs.gov/bbl/manual/bandsize.htm) and follow the naming conventions maintained by the American Ornithologists Union (http://www.aou.org/aou/birdlist.html). For unknown species, record "XXXX." For unknown members of various families, use "XX" plus two letters to signify the family – "XXHU" for unidentified hummingbird, for example. You can follow birds after the completion of a point in order to verify identification. If no birds are detected at a point, write "No birds detected" on your form. We recommend keeping a list of all species detected between points (i.e., not during the 5 minute counts) on the back of your form.

For each individual detected we record the distance to the detection and the behavior that alerted us to the individuals' presence. Also, for each species we record any indications of breeding status. Make every effort to avoid double counting individuals detected at a single point. However, if an individual is known or thought to have been counted at a previous point, make a note of it, but record its presence at the current point anyway. No attracting devices, recordings, or "pishing" should be used.

Distance: All point counts involve recording distance to detections at some level of resolution. Depending on project, we use either 50m fixed-radius counts, or Variable Circular Plots (VCP), in which the distance to each detection is recorded to the nearest 10m (though this distance may vary by project and habitat type – consult project leader). Both methods also specify whether or not detections were beyond 100m.

Note: Fifty m radius counts may not provide sufficient data for calculating population density or trends for some species or habitats where the use of VCP's may improve estimates. We recommend the use of range finders and extensive training for either method, but especially for VCP. VCP data should always be taken in a way that is transferable to 50m format.

The distance recorded is the distance from the point to the first location an individual was observed, regardless of its behavior. If the bird subsequently moves, *do not change the original distance recorded*. If a bird is flying (but not "flying over" – see below), or perched high in a tree, the distance recorded is to the point at which a plumb line would hit the ground if hung from the point at which the bird was first observed. This distance should be measured as

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though a tape were laid across the ground, that is, including any intervening topographic features.

A bird flushed from within 10m of the point when you arrive should be included in the count. Birds that are flushed from farther away should be noted on the back of the form if they are species that didn't occur during the count.

We record the behavioral cue that alerted us to the presence of the individual - generally "S" for song, "V" for visual, or "C" for call (“D” for drumming woodpecker, “H” for humming hummingbird). If a bird sings after it has been detected via a different cue, this is indicated in the data, but the initial detection cue is preserved. Circle the original detection cue ("V" or "C") to note that a bird was singing subsequent to its initial detection, but otherwise, no changes in behavior are noted. Juvenile birds are recorded as “J”s regardless of their behavior, and are not included in most analyses.

Birds that are flying over but not using the habitat on the study area are recorded in the fly-over column. Birds flying below canopy level, flying from one perch to another, or actively foraging on or above the study area are recorded as described in the previous paragraphs.

Breeding status: We record any potential indications of breeding if noted for species at each point as follows:

- CO – copulation
- DI – territorial display.
- DD – distraction display
- FC – food carry
- FL – fledglings
- FS – fecal sac carry
- MC – material carry
- NF – nest found
- PA – pair

Riparian Ecosystem Assessment Mammal Area Search Protocol

INTRODUCTION

These protocols provide a guide to assist the survey team in obtaining the required information as efficiently as possible. Minor modifications to these protocols may be necessary depending on access constraints and time available to complete the surveys. All RAP surveys will be done at riparian sites that PRBO has surveyed previously and at Placer County riparian sites where permission is granted from the landowners. Assume that all land is private and do not trespass if you are uncertain about the land ownership. Also, avoid stopping in front of residences and generally be discrete about displaying maps, cameras, and clipboards. Be careful about pulling off roads and do not violate any traffic laws to sample a riparian plot or observe a species. Always leave gates exactly as you found them. Also, for Placer County sites, it is important that all requirements specified by the landowner are followed. These requirements are attached to the directions, map, and photograph for each plot in Placer County.

PREFIELD TASKS

Prior to performing the field surveys, please review the following materials that will be provided in the field packets:

- Road maps and maps of the individual streams showing roads and access points so that survey routes can be planned and surveyed efficiently;
- PRBO field notes giving directions to individual sites, vegetation descriptions, and bird species lists for survey plots;
- Aerial photographs of individual creeks and rivers (as available).

Plan your route to the riparian sites and consult the field checklist to ensure that you have gathered all the necessary equipment to complete the RAP survey work you will be conducting (an equipment and contact list is included as Attachment 1).

LOCATING THE PLOT

Proceed to the coordinates for the center point of the 100 m by 100 m plot. Centered on this point, the plot edge is 100 m along the stream bank edge of the riparian zone (50 m up and 50 m down stream), and then extends 100 m inland (away from the stream bank).

SEARCHING FOR MAMMALS

Area searches are conducted for approximately 1 hour to ensure comparable search effort on each plot. Begin the area search by entering the observer, date, time and site information at the top of the *Mammal Area Search* form. During the census, carefully record the name of each species seen or heard. Please use the species' common name (not 4-letter codes) to avoid later confusion. The area search involves walking throughout the entire (100 m by 100 m) plot.

POST-FIELD CHECKLIST

- Check over the field data forms and make sure everything is completed and clear.
- Surveyors should review each other's completed forms for completeness and accuracy in the field.

- Photocopy all your field forms. File the copes in the file cabinet in Ted's office and the originals in the Placer Legacy office.
- Cross off, date, and initial your completed site on the master list to ensure that field work is not repeated.
- Report progress to the project manager and obtain additional survey packages.

Mammal Area Search Form

Site: ______________________________________ **Plot**: ______________

Date: ______________ **Start Time**: _______ **Stop Time:** _____

Observer: ________________________________

Temperature: ________ **Cloud Cover**: _________

Species	Visual Observation	Vocalization	Scat	Tracks	Prey Remains	Notes

Additional Comments:

Riparian Ecosystem Assessment Amphibian & Reptile Search Protocol

INTRODUCTION

These protocols provide a guide to assist the survey team in obtaining the required information as efficiently as possible. Minor modifications to these protocols may be necessary depending on access constraints and time available to complete the surveys. All RAP surveys will be done at riparian sites that PRBO has surveyed previously and at Placer County riparian sites where permission is granted from the landowners. Assume that all land is private and do not trespass if you are uncertain about the land ownership. Also, avoid stopping in front of residences and generally be discrete about displaying maps, cameras, and clipboards. Be careful about pulling off roads and do not violate any traffic laws to sample a riparian plot or observe a species. Always leave gates exactly as you found them. Also, for Placer County sites, it is important that all requirements specified by the landowner are followed. These requirements are attached to the directions, map, and photograph for each plot in Placer County.

PREFIELD TASKS

Prior to performing the field surveys, please review the following materials that will be provided in the field packets:

- Road maps and maps of the individual streams showing roads and access points so that survey routes can be planned and surveyed efficiently;
- PRBO field notes giving directions to individual sites, vegetation descriptions, and bird species lists for survey plots;
- Aerial photographs of individual creeks and rivers (as available).

Plan your route to the riparian sites and consult the field checklist to ensure that you have gathered all the necessary equipment to complete the RAP survey work you will be conducting (an equipment and contact list is included as Attachment 1).

Where data on amphibians and reptiles will be collected, cover boards will be placed out during the first visit to the site, and will be checked during the next visit (at least a week later).

LOCATING COVER BOARDS WITHIN THE PLOT

Proceed to the coordinates for the center point of the 100 m by 100 m plot. Centered on this point, the plot edge is 100 m along the stream bank edge of the riparian zone (50 m up and 50 m down stream), and then extends 100 m inland (away from the stream bank). Locate the first 100 m line of cover boards along the length of the stream bank side of the plot. Place 10 cover boards, evenly spaced apart, along this first line. Place an additional 10 cover boards along a second 100 m line 10 m in from the stream bank side of the plot and parallel to the first line of cover boards.

SEARCHING FOR AMPHIBIANS AND REPTILES

Area searches are conducted for approximately 1 hour to ensure comparable search effort on each plot. (If area searches deviate from the 1 hour duration, note this in the “Additional Comments” section of the data form.) Begin the area search by entering the observer, date, time and site information at the top of the *Amphibian and Reptile Data Collection* form. During the census, carefully record the name of each species seen or heard. Please use the species' common name (not 4-letter codes) to avoid later confusion. The area search involves walking throughout the entire (100 m by 100 m) plot and also checking under all cover boards. In checking cover boards, quickly lift each cover board and identify species present. Only handle amphibians and reptiles if you have a DFG permit and you cannot identify them. Most species should be identifiable without handling them. After it has been checked, replace each board in its original position. Please collect all cover boards and remove any flagging after the final plot survey.

POST-FIELD CHECKLIST

- Check over the field data forms and make sure everything is completed and clear.
- Surveyors should review each other's completed forms for completeness and accuracy in the field.
- Photocopy all your field forms. File the copes in the file cabinet in Ted's office and the originals in the Placer Legacy office.
- Cross off, date, and initial your completed site on the master list to ensure that field work is not repeated.
- Report progress to the project manager and obtain additional survey packages.

Amphibian and Reptile Data Collection Form

Site: ______________________________________ **Plot**: ______________

Date: ______________ **Start Time**: _______ **Stop Time:** _____

Observer: _________________________

Temperature: ________ **Cloud Cover**: _________

Species	Visual Observation	Vocalization	Under Cover	Notes

Additional Comments:

Riparian Ecosystem Assessment Butterfly Search Protocol

INTRODUCTION

These protocols provide a guide to assist the survey team in obtaining the required information as efficiently as possible. Minor modifications to these protocols may be necessary depending on access constraints and time available to complete the surveys. All RAP surveys will be done at riparian sites that PRBO has surveyed previously and at Placer County riparian sites where permission is granted from the landowners. Assume that all land is private and do not trespass if you are uncertain about the land ownership. Also, avoid stopping in front of residences and generally be discrete about displaying maps, cameras, and clipboards. Be careful about pulling off roads and do not violate any traffic laws to sample a riparian plot or observe a species. Always leave gates exactly as you found them. Also, for Placer County sites, it is important that all requirements specified by the landowner are followed. These requirements are attached to the directions, map, and photograph for each plot in Placer County.

PREFIELD TASKS

Prior to performing the field surveys, please review the following materials that will be provided in the field packets:

- Road maps and maps of the individual streams showing roads and access points so that survey routes can be planned and surveyed efficiently;
- PRBO field notes giving directions to individual sites, vegetation descriptions, and bird species lists for survey plots;
- Aerial photographs of individual creeks and rivers (as available).

Plan your route to the riparian sites and consult the field checklist to ensure that you have gathered all the necessary equipment to complete the RAP survey work you will be conducting (an equipment and contact list is included as Attachment 1).

Where data on amphibians and reptiles will be collected, cover boards will be placed out during the first visit to the site, and will be checked during the next visit (at least a week later).

SEARCHING FOR BUTERFLIES

All butterfly area searches must take place between 9 AM and 4 PM because of the daily flight patterns of butterflies. Area searches are conducted for approximately 1 hour to ensure comparable search effort on each plot. (If area searches deviate from the 1 hour duration, note why in the “Additional Comments” section of the data form.) Begin the area search by entering the observer and site information at the top of the *Butterfly Area Search* form. The area search involves walking throughout the entire (100 m by 100 m) plot. During the census, carefully record the name of each species seen. Please use the species’ scientific name (not 4-letter codes) to avoid later confusion. Indicate the relative abundance of each species in the *General Abundance* column of the data form using the following scale: Rare (1 individual), Uncommon (2-5 individuals), Common (5-10 individuals), Abundant (> 10 individuals).

POST-FIELD CHECKLIST

- Check over the field data forms and make sure everything is completed and clear.

- Surveyors should review each other's completed forms for completeness and accuracy in the field.
- Photocopy all your field forms. File the copes in the file cabinet in Ted's office and the originals in the Placer Legacy office.
- Cross off, date, and initial your completed site on the master list to ensure that field work is not repeated.
- Report progress to the project manager and obtain additional survey packages.

Area Search for Butterfly Species

Site: ______________________________________ **Plot**: ______________

Date: ______________ **Start Time**: ______ **Stop Time**: ____

Observer: _________________________

Notes on Weather: ____

____

Species	In Riparian	Out of Riparian	General Abundance	Notes

Additional Comments:

Riparian Ecosystem Assessment Small Mammal Trapping Protocol

INTRODUCTION

These protocols provide a guide to assist the survey team in obtaining the required information as efficiently as possible. Minor modifications to these protocols may be necessary depending on access constraints and time available to complete the surveys. All RAP surveys will be done at riparian sites that PRBO has surveyed previously and at Placer County riparian sites where permission is granted from the landowners. Assume that all land is private and do not trespass if you are uncertain about the land ownership. Also, avoid stopping in front of residences and generally be discrete about displaying maps, cameras, and clipboards. Be careful about pulling off roads and do not violate any traffic laws to sample a riparian plot or observe a species. Always leave gates exactly as you found them. Also, for Placer County sites, it is important that all requirements specified by the landowner are followed. These requirements are attached to the directions, map, and photograph for each plot in Placer County.

PREFIELD TASKS

Prior to performing the field surveys, please review the following materials that will be provided in the field packets:

- Road maps and maps of the individual streams showing roads and access points so that survey routes can be planned and surveyed efficiently;
- PRBO field notes giving directions to individual sites, vegetation descriptions, and bird species lists for survey plots;
- Aerial photographs of individual creeks and rivers (as available).

Plan your route to the riparian sites and consult the field checklist to ensure that you have gathered all the necessary equipment to complete the RAP survey work you will be conducting (an equipment and contact list is included as Attachment 1).

LOCATING TRAPS WITHIN THE PLOT

Proceed to the coordinates for the center point of the 100 m by 100 m plot. Centered on this point, the plot edge is 100 m along the stream bank edge of the riparian zone (50 m up and 50 m down stream), and then extends 100 m inland (away from the stream bank). Locate the first 100 m line of traps along the length of the stream bank side of the plot. Place 15 traps, evenly spaced apart, along this first line. Place an additional 15 traps along a second 100 m line 10 m in from the stream bank side of the plot and parallel to the first line of traps.

CONDUCTING THE SMALL MAMMAL TRAPPING

Trapping will be conducted for three consecutive nights at each plot All traps will be set within 2 hours of sunset and checked within 3 hours after sunrise the following morning. Each trap will be baited with peanut butter and rolled oats, and a wad of cotton was placed at the back of each trap for bedding.

Each animal captured will be identified to species, and its age, sex, reproductive condition, and general health will be evaluated and noted. The time, location of capture, and general weather and habitat conditions also will be recorded. Photographs will be taken of each study plot and each new species captured. All data will be recorded on standardized Jones & Stokes field forms

(Attached). Each captured animal will be marked with a permanent nontoxic felt pen so it could be identified as a recapture if trapped on subsequent trap-nights. All animals will be released at the site of capture.

All Jones & Stokes biologists conducting the small mammal surveys will wear appropriate protective clothing and respirators during the handling of the animals to avoid potential exposure to Hantivirus. Standard precautionary measures identified in Mills et al. (1995) *Guidelines for Working with Rodents Potentially Infected with Hantivirus* will be observed during this work.

Once tapping has been completed all traps and flagging will be removed from the site.

POST-FIELD CHECKLIST

- Check over the field data forms and make sure everything is completed and clear.
- Surveyors should review each other's completed forms for completeness and accuracy in the field.
- Photocopy all your field forms. File the copes in the file cabinet in Ted's office and the originals in the Placer Legacy office.
- Cross off, date, and initial your completed site on the master list to ensure that field work is not repeated.
- Report progress to the project manager and obtain additional survey packages.

Project: Placer Riparian Ecosystem Assessment Page _______ of _______

Site:________________ **Plot:** ____________

Date:_____/_____/03 **Start Survey Time:**___________ **End Survey Time:**___________

Team Members: ____
____

Weather: Temp:______F; **Wind:** _______mph from_______; **Clouds:** __________; **Precip:**________
Other Site Conditions: ____
____

Photos: ____

Trap Survey Results

Time	Site	Location	Cl	Species	Sex	Age	Condition	Recapture?	Marked?	

Trap check-off

Trap #	Trap Line		
	1	2	3
1			
2			
3			
4			
5			
6			
7			
7			
8			
10			
11			
12			
13			
14			
15			

Enter species code for each capture.
If trap is empty, put "x" in box

Notes:

Project Manager sign-off:

A KEY TO THE WOODY PLANTS OF RIPARIAN ZONES IN CALIFORNIA"S CENTRAL VALLEY

By John C. Hunter, Jones & Stokes, 2600 V Street, Sacramento CA 95818 jhunter@jsanet.com

1. Plant a large (up to several m high), densely clumped grass, with thick (> 2 cm) woody stems … *Arundo donax* (Giant reed)
1. Plant not a grass … 2
    2. Leaves compound (the thin flat portion of the leaf discontinuous) … 3
        3. Leaves opposite (> 1 leaf attached to stem in same plane) … 4
            4. Leaflets palmately arranged (radiating from a central point), flowers > 1 cm long, fruit with a husk that separates from the large (> 3 cm in diameter) round seed … *Aesculus californica* (California buckeye)
            4. Leaflets pinnately arranged (feather-like, arranged like ribs off a backbone), flowers < 1 cm long and fruits either flat and winged or small (<5 mm across) round and fleshy … 5
                5. Fruits dry and winged (with a thin flat extension), flowers inconspicuous, pith (in center of stem) not particularly large … 6
                    6. Fruit two-parted, each part with a wing; Leaves with 3-7 leaflets; Leaflet margins coarsely toothed … *Acer negundo* (box elder)
                    6. Fruit one-parted with one wing; Leaves with 5-7 leaflets; Leaflet margins smooth or with fine (small) teeth … *Fraxinus latifolia* (Oregon ash)
                5. Fruits fleshy without a wing, pith conspicuously large and spongy, flowers small and white (or cream) but showy in a dense inflorescence (cluster) … 7
                    7. Flowers in a broad flat clusters, Fruits black (sometimes white) with a white waxy coating that causes them to appear blue … *Sambucus mexicana* (Blue elderberry)
                    7. Flowers in rounded to cylindrical clusters, Fruits red, or black, without a waxy covering … *Sambucus racemosa* (Red elderberry)
        3. Leaves alternate (just 1 leaf attached to stem at any perpendicular plane) … 8
            8. Plant a legume (Our woody species in the Central Valley have pea-like flowers in drooping clusters, fruit a dry pod with multiple seeds) … 9
                9. A tree with white flowers, spines at the base of leaves, and a flat pod … *Robinia pseudoacacia* (black locust)
                9. A shrub or small tree with red flowers, no spines, and a pod with four "wings" … *Sesbania punecia*
            8. Plant not a legume … 10
                10. Plant w/ prickles … 11
                    11. Fruits dry, enclosed in a fruit-like fleshy to leathery sac (a rose hip); Leaflets pinnately arranged (feather-like, arranged like ribs off a backbone) … *Rosa californica* (California rose)
                    11. Fruits fleshy, blackberry-like; Leaflets palmately arranged (radiating from a central point) … 12
                        12. Leaves white on underside; Prickles broad-based; Stems often stout and ribbed (ridged); Leaflets 3-5; Flowers/fruits > 10 in each inflorescence (cluster) … *Rubus procerus* (Himilayan blackberry)
                        12. Leaves light green on underside; Prickles slender; Stems round; Leaflets 3; Flowers/fruits 2-15 in an inflorescence … *Rubus ursinus* (California blackberry)
                10. Plant w/o prickles … 13
                    13. Leaflets with a round gland (a thickened dot) near the base, fruit flat, dry with a wing … Ailanthus (Tree-of-Heaven)
                    13. Leaflets without a basal gland, fruit round, fleshy or leathery and without a wing … 14
                        14. Plant a vine or shrub; Leaflets 3-5; Leaflet margins lobed, coarsely toothed or smooth; Fruits small (< 1 cm) … *Toxicodendron diversilobum* (Poison oak)
                        14. Plant a tree, Leaflets 11-19; Leaflet margins sharply toothed but not lobed; Fruits large (> 2.5 cm across) … *Juglans californica* var. *hindsii* (Northern California black walnut)

2. Leaves simple (the thin flat portion of the leaf continuous)
   15. Plant a willow: Fruit a capsule with seeds embedded in cottony fluff; Leaves alternate, deciduous and narrow (ranging from linear (almost not taper) to lance-shaped); Buds covered by a single scale; Bark bitter tasting and astringent with an aspirin-like flavor … 16
      16. Scale covering bud in axil of leaf (where leaf meets stem) has free and overlapping margins (you can see this by pressing down on the tip of the bud and rocking it from side to side); Axillary bud small (< 3 mm), conical and pointed … 17
         17. Leaf dull green on both sides; stipules (a pair of small leafy or dry and papery bracts where the leaf joins the stem) absent; Twigs of the current year tend to be yellow to olive, Plant a tree to 30 m high … *Salix gooddingii* (Gooding's black willow)
         17. Leaf glossy green above and glaucous (waxy white) below; stipules generally present; Current year twigs typically red to yellowish brown; Plant a tree to 14 m … *Salix laevigata* (Red willow)
      16. Scale covering bud in axil has margins fused together so that the scale forms a cap; Axillary bud small to large, with a rounded tip and shape elliptic to conical … 18
         18. Leaves narrow (linear and generally < 1 cm wide) with upper and lower surfaces similar, both covered (thickly or thinly) in silky hairs; Plant a clonal, multi-stemmed shrub to 6 m … *Salix exigua* (Sandbar or Narrow leaf willow)
         18. Leaves broader (elliptic to lance-shaped and generally > 1 cm wide) with upper surfaces shiny green and lower surfaces pale green or glaucous (waxy white), hairs generally restricted to young leaves; Plant a shrub or small tree to 18 m … 19
            19. Petiole (stalk of leaf) with glands at base of blade (these glands appear as small warty, irregular protrusions); Leaves 5-17 cm long, lance-shaped and gradually tapering towards the tip with concave sides (long acuminate)… *Salix lucida* var. *lasiandra*, (Shining willow)
            19. Petiole without glands; Leaves 3-12 cm long, narrowly lance-shaped to elliptic, tapers to tip with convex sides … *Salix lasiolepi*s, (Arroyo willow)
   15. Plant not a willow and the complete set of attributes not as above; Fremont's cottonwood is in the willow family and shares some of the traits described above except that its leaves are broad and triangular to heart-shaped and its buds have > 1 scale; For other species: Fruit not a capsule and seeds not embedded in cottony fluff; Leaves alternate or opposite, deciduous or evergreen and narrow or broad; Buds covered by more than one scale; Bark taste varied but without an aspirin-like flavor;
      20. Plant an oak: Fruit an acorn; Buds clustered near the branch tips; Plant a tree … 21
         21. Leaves with bristles *Quercus wislizenii* (Interior live oak) – However, at higher elevations, if underside of leaf has a pale bluish cast and it covered in powdery dust, the plant could be could be *Quercus chrysolepis* (Canyon live oak)
         21. Leaves w/o bristles … 22
            22. Leaves deeply lobed (often > ½ distance to midrib); Acorn 3-5 cm long; Leaves upper surface with a greenish cast … *Quercus lobata* (Valley oak)
            22. Leaves shallowly lobed (< ½ distance to midrib) or wavy margined; Acorn 2-3.5 cm long; Leaves upper surface often with a bluish cast … *Quercus douglasii* (Blue oak)
      20. Plant not an oak: Fruit not an acorn; Buds generally not clustered near branch tips; Plant a tree, shrub or vine … 23
         23. Plant a woody vine … 24
            24. Plant evergreen, lacking tendrils … *Hedera helix* (Ivy)
            24. Plant deciduous and with tendrils opposite leaves … *Vitis californica* (California wild grape)
         23. Plant a shrub or tree … 25
            25. Plant evergreen … 26
               26. Plant a shrub, often sticky; Flowers in dense clusters (surrounded by bracts so that they almost appear to be a single flower) developing into dry fruits with a tuft of bristles (pappus) at the top … 27
                  27. Leaves up to 15 cm long, narrow with a gradual taper, widest near middle; Leaf stalks (petioles) winged (i.e., having a thin, flat extension running along them) … *Baccharis salicifolia* (mule fat)

27. Leaves up to 5 cm long, broad and strongly tapering to base, often widest above middle; Leaf stalks very short … *Baccharis pilularis* (coyote brush)

26. Plant a shrub or tree, not sticky; Flowers not as above, clearly on separate stalks (pedicels), and fruits fleshy … 28

28. Leaf margin entire (smooth); Fruits 1-3 cm long, green or black when mature … 29

29. Leaves alternate, green on both sides, aromatic … *Umbellularia californica* (California bay laurel)

29. Leaves opposite, green above, silvery below, not particularly aromatic … *Olea europea* (olive)

28. Leaf margin toothed; Fruits about 0.6 cm long, red when mature … *Heteromeles arbutifolia* (toyon)

25. Plant deciduous … 30

30. Leaves opposite or whorled … 31

31. Leaf margins jagged (toothed); Fruit 2-parted, each part with a wing (a thin flat extension), and not splitting open, seeds not hairy … *Acer saccharinum* (Silver maple)

31. Leaf margins smooth; Fruit lacking a wing, seeds with or without a fringe of hairs …

32. Fruits arranged in a dense ball at or near tips of branches, and each fruit composed of two hard, dry pieces; Seeds without a fringe of hairs; Plant a shrub or small tree; Leaves with a dry scale (interpetiolar stipule) between adjacent leaf bases … *Cephalanthus occidentalis* (Button-willow)

32. Fruit a long woody pod; Seeds with fringes of hairs at their ends; Plant a tree; Leaves without scales (stipules) at the base of their stalks … *Catalpa* species (common name also Catalpa)

30. Leaves alternate … 33

33. Leaves small (< 3mm), triangular and close against the stem; Petioles (leaf stalks) absent … *Tamarix parviflora* (Smallflower tamarisk)

33. Leaves larger (> 1 cm), shapes various but not triangular, and spreading away from stem; Petioles present … 34

34. Leaves lobed … 35

35. Leaves 2-5 cm wide and hairless, base of leaf stalk does not completely enclose bud; Plant a shrub … *Ribes aureum* (Golden currant)

35. Leaves 10-20 cm wide and pubescent, base of leaf stalk either encircles stem or completely encloses bud; Plant a large shrub to large tree … 36

36. Leaves and stems exude milky sap when broken; Fruit fleshy; Bark relatively smooth and not flaking … *Ficus carica* (Fig)

36. Leaves and stem do not exude milky sap when broken; Fruit hard and dry with a tuft of hairs, arranged in dense round heads; Bark flakes in thin sheets to reveal smooth pale surface … *Platanus racemosa* (Western sycamore)

34. Leaves toothed but not lobed; Bark varied but not as above; Fruits various but not as above ... 37

37. Leaves triangular to heart-shaped; Petiole (leaf stalk) flattened near leaf blade; Fruit a capsule opening to release small seeds in cottony fluff; Plant a large tree to 30 m … *Populus fremontii* (Fremont's cottonwood)

37. Leaves elliptic to lance-shaped; petiole more or less round, not conspicuously flattened; Fruit not a capsule and seeds not embedded in cottony fluff; Plant a small to large tree … 38

38. Plant with two types of shoots – long and short shoots, the short shoots with closely spaced leaves and also bearing the flowers and fruits; Leaves with lateral veins that fork and bend before reaching the leaf margin (the edge of the leaf) … *Prunus* species (the stone fruits including cherries and almond)

38. Plant with one type of shoot, though these may vary in orientation and spacing of leaves; Leaves with straight lateral veins only some of which fork before reaching the leaf margin … 39
    39. Fruits produced on woody scales arranged in a cone-like structure; Buds on a small stalk, not offset from leaf stalk … *Alnus rhombifolia* (White alder)
    39. Fruits not produced in a cone-like structure; Buds not stalked, offset from leaf stalk … *Ulmus* species (Elm species)

Appendix B
Summary of Species Observations

Table B-1. Frequency of Observed Odonate Species

Common Name	Scientific Name	Total (%) *N = 43*	Placer County Plots (%) *N = 20*	Other Plots (%) *N = 23*
Damselflies	**Zygoptera**			
American Rubyspot	*Hetaerina americana*	47	50	43
Spotted Spreadwing	*Lestes congener*	2	0	4
California Spreadwing	*Archilestes californica*	7	0	13
California Dancer	*Argia agrioides*	19	20	17
Emma's Dancer	*Argia emma*	28	25	30
Sooty Dancer	*Argia lugens*	14	5	22
Aztec Dancer	*Argia nahuana*	2	0	4
Vivid Dancer	*Argia vivida*	40	45	35
Unknown sp. teneral dancer	*Argia* sp.	5	10	0
Boreal Bluet	*Enallagma boreale*	5	5	4
Familiar Bluet	*Enallagma civile*	44	40	48
Unknown sp. female bluet	*Enallagma* sp.	5	5	4
Pacific Forktail	*Ischnura cervula*	42	35	48
Western Forktail	*Ischnura perparva*	5	10	0
Desert Firetail	*Telebasis salva*	2	5	0
Dragonflies	**Anisoptera**			
Blue-eyed Darner	*Aeshna multicolor*	65	75	57
Common Green Darner	*Anax junius*	93	90	96
Pale-faced Clubskimmer	*Brechmorhoga mendax*	42	50	35
Western Pondhawk	*Erythemis collocata*	26	20	30
Eight-spotted Skimmer	*Libellula forensis*	0	0	0
Widow Skimmer	*Libellula luctuosa*	9	10	9
Common Whitetail	*Plathemis lydia*	7	10	4
Twelve-spotted Skimmer	*Libellula pulchella*	9	5	13
Flame Skimmer	*Libellula saturata*	21	0	39
Blue Dasher	*Pachydiplax longipennis*	30	35	26
Red Rock Skimmer	*Paltothemis lineatipes*	5	0	9
Wandering Glider	*Pantala flavescens*	44	40	48
Spot-winged Glider	*Pantala hymenaea*	26	25	26
Variegated Meadowhawk	*Sympetrum corruptum*	51	40	61
Striped Meadowhawk	*Sympetrum pallipes*	5	0	9
Black Saddlebags	*Tramea lacerata*	84	85	83

Table B-2. Observed Butterfly Species

Common Name	Scientific Name	Total (%) *N = 43*	Placer County Plots (%) *N = 23*	Other Plots (%) *N = 24*
California Sister	*Adelpha bredowii*	11	13	8
Sara Orange-tip	*Anthocharis sara*	6	9	4
Field Skipper	*Atlopedes campestris*	23	35	13
Pipevine Swallowtail	*Battus philenor*	72	70	75
Persius Duskywing	*Erynnis persius*	2	0	4
Northern Checkerspot	*Charidryas palla*	4	4	4
California Ringlet	*Coenonympha tullia*	45	70	21
Orange Sulphur	*Colias eurytheme*	77	74	79
Monarch	*Danaus plexipus*	0	0	0
Propertius Duskywing	*Erynnis propertius*	6	4	8
Mournful Duskywing	*Erynnis tristis*	2	4	0
Common Checkerspot	*Euphydryas chalcedona*	4	0	8
Eastern Tailed Blue	*Everes comyntas*	51	57	46
Gorgon Copper	*Gaeides gorgon*	2	0	4
Fiery Skipper	*Hylephila phyleus*	6	13	0
Buckeye	*Junonia coenia*	96	96	96
Lorquin's Admiral	*Limentis lorquini*	15	30	0
Purplish Copper	*Lycaena helloides*	4	9	0
Mourning Cloak	*Nymphalis antiopa*	11	17	4
The Farmer	*Ochlodes agricola*	4	9	0
Pale Swallowtail	*Papilio eurymedon*	2	4	0
Western Tiger	*Papilio rutulus*	70	78	63
Anise Swallowtail	*Paplio zelicaon*	13	17	8
Umber Skipper	*Paratrytone melane*	13	22	4
Common sSoty-wing	*Pholisora catullus*	2	0	4
Mylitta Crescent	*Phyciodes mylitta*	34	52	17
Cabbage Butterfly	*Pieris rapae*	89	91	88
Acmon Blue	*Plebejus acmon*	30	17	42
Sandhill Skipper	*Polites sabuleti*	2	4	0
Satyr Comma	*Polygonia satyrus*	4	0	8
Checkered White	*Pontia protodice*	2	4	0
Common Checkered	*Pyrgus communis*	4	0	8
California Hairstreak	*Satyrium californicum*	17	17	17
Hedge-row Hairstreak	*Satyrium saepium*	0	0	0
Sylvan Hairstreak	*Satyrium sylvinus*	11	9	13
Common Hairstreak	*Strymon melinus*	28	48	8
West Coast Lady	*Vanessa annabella*	4	0	8
Red Admiral	*Vanessa atalanta*	34	43	25
Painted Lady	*Vanessa cardui*	55	61	50
American Lady	*Vanessa virginiensis*	6	13	0

Table B-3. Amphibian and Reptile Species Observed During One Survey of Plots

Common Name	Scientific Name	Total (%) *N = 47*	Placer County Plots (%) *N = 23*	Other Plots (%) *N = 24*
Pacific Treefrog	*Pseudacris regilla*	2	4	0
Foothill Yellow-legged Frog	*Rana boylii*	0	0	0
Bullfrog	*Rana catesbeiana*	32	26	38
Western Pond Turtle	*Emys marmorata*	0	0	0
Western Fence Lizard	*Sceloporus occidentalis*	28	26	29
Western Skink	*Eumeces skiltonianus*	0	0	0
Aligator Lizard	*Elgaria* sp.	13	4	21
Gopher Snake	*Pituophis catenifer*	2	0	4
Garter Snake	*Thamnophis* sp.	2	0	4
Western Rattlesnake	*Crotalis viridis*	6	4	8

Table B-4. Amphibian and Reptile Species Observed During Four Surveys of Plots

Common Name	Scientific Name	Total (%) *N = 12*	Placer County Plots (%) *N = 8*	Other Plots (%) *N = 4*
Pacific Treefrog	*Pseudacris regilla*	8	0	25
Foothill Yellow-legged Frog	*Rana boylii*	8	13	0
Bullfrog	*Rana catesbeiana*	42	38	50
Western Pond Turtle	*Emys marmorata*	8	0	25
Western Fence Lizard	*Sceloporus occidentalis*	83	88	75
Western Skink	*Eumeces skiltonianus*	0	0	0
Aligator Lizard	*Elgaria* sp.	33	50	0
Gopher Snake	*Pituophis catenifer*	8	13	0
Garter Snake	*Thamnophis* sp.	0	0	0
Western Rattlesnake	*Crotalis viridis*	8	0	25

Table B-5. Mammal Species Observed During One Survey of Plots

Common Name	Scientific Name	Total (%) *N = 47*	Placer County Plots (%) *N = 23*	Other Plots (%) *N = 24*
Virginian Opossum	*Didelphis virginiana*	2	0	4
Desert Cottontail	*Sylivlagus audubonii*	4	4	4
Black-tailed Jackrabbit	*Lepus californicus*	11	13	8
Western Gray Squirrel	*Sciurus griseus*	19	22	17
Botta's Pocket Gopher	*Thomomys bottae*	9	4	13
American Beaver	*Castor canadensis*	6	0	12.5
Coyote	*Canis latrans*	6	9	4
Racoon	*Procyon lotor*	40	35	46
Northern River Otter	*Lontra canadensis*	2	0	4
Bobcat	*Lynx rufus*	9	9	8
Mule Deer	*Odocoileus hemionus*	34	26	42

Table B-6. Mammal Species Observed During Four Surveys of Plots

Common Name	Scientific Name	Total (%) *N = 12*	Placer County Plots (%) *N = 8*	Other Plots (%) *N = 4*
Virginian Opossum	*Didelphis virginiana*	8	13	0
Desert Cottontail	*Sylivlagus audubonii*	8	0	25
Black-tailed Jackrabbit	*Lepus californicus*	17	13	25
Western Gray Squirrel	*Sciurus griseus*	33	38	25
Botta's Pocket Gopher	*Thomomys bottae*	8	0	25
Deer Mouse	*Peromyscus maniculatus*	8	0	25
California Meadow Mouse	*Microtus californicus*	17	13	25
Feral Dog	*Canis familiaris*	8	0	25
Coyote	*Canis latrans*	17	25	0
Gray Fox	*Urocyon cinereoargenteus*	8	0	25
Raccoon	*Procyon lotor*	75	75	75
Feral Cat	*Felis catus*	17	25	0
Bobcat	*Lynx rufus*	17	13	25
Mule Deer	*Odocoileus hemionus*	67	63	75
Muskrat	*Ondatra zibethicus*	8	0	25

Table B-7. Mean Abundance of Small Mammals Trapped at Plots[1]

Common Name	Scientific Name	Total *N = 10*	Placer County Plots *N = 6*	Other Plots *N = 4*
Opossum	*Didelphis virginiana*	0.1 ± 0.1	0.2 ± 0.2	–
Brush Mouse	*Peromyscus boylii*	3.5 ± 2.3	–	8.8 ± 5.1
Deer Mouse	*Peromyscus maniculatus*	5.1 ± 1.8	2.0 ± 1.6	9.8 ± 2.5
California Meadow Mouse	*Microtus californicus*	3.2 ± 2.5	1.2 ± 0.7	6.3 ± 6.3
House Mouse	*Mus musculus*	1.3 ± 0.9	0.8 ± 0.8	2.0 ± 2.0
Black Rat	*Rattus rattus*	0.6 ± 0.2	0.7 ± 0.3	0.5 ± 0.3

[1] Values are means ± 1 standard error.

Table B-8. Bird Species Observed During One Survey of Plots

Common Name	Scientific Name	Summer Resident	Migrant	Total (%) *N = 47*	Placer County Plots (%) *N = 23*	Other Plots (%) *N = 24*
Pied-billed Grebe	*Podilymbus podiceps*	X		2	4	0
Great Blue Heron	*Ardea herodias*	X		2	4	0
Green Heron	*Butorides virescens*	X		2	0	4
Wood Duck	*Aix sponsa*	X		2	4	0
Mallard	*Anas platyrhynchos*	X		11	17	4
Cinnamon Teal	*Anas cyanoptera*	X		2	4	0
Common Merganser	*Mergus merganser*	X		0	0	0
Turkey Vulture	*Cathartes aura*	X		4	4	4
White-tailed Kite	*Elanus leucurus*	X		2	0	4
Cooper's Hawk	*Accipiter cooperii*	X		2	4	0
Red-shouldered Hawk	*Buteo lineatus*	X		11	13	8
Swainson's Hawk	*Buteo swainsoni*	X		2	4	0
Red-tailed Hawk	*Buteo jamaicensis*	X		6	0	13
American Kestrel	*Falco sparverius*	X		0	0	0
Ring-necked Pheasant	*Phasianus colchicus*	X		2	4	0
Wild Turkey	*Meleagris gallopavo*	X		4	9	0
California Quail	*Callipepla californica*	X		17	13	21
Common Moorhen	*Gallinula chloropus*	X		2	4	0
American Coot	*Fulica americana*	X		2	4	0
Killdeer	*Charadrius vociferus*	X		9	4	13
Spotted Sandpiper	*Tringa macularia*	X		0	0	0
Mourning Dove	*Zenaida macroura*	X		28	26	29
Barn Owl	*Tyto alba*	X		0	0	0

Common Name	Scientific Name	Summer Resident	Migrant	Total (%) *N = 47*	Placer County Plots (%) *N = 23*	Other Plots (%) *N = 24*
Great Horned Owl	*Bubo virginianus*	X		0	0	0
Black-chinned Hummingbird	*Archilochus alexandri*	X		17	17	17
Anna's Hummingbird	*Calypte anna*	X		32	30	33
Belted Kingfisher	*Megaceryle alcyon*	X		11	9	13
Acorn Woodpecker	*Melanerpes formicivorus*	X		30	48	13
Nuttall's Woodpecker	*Picoides nuttallii*	X		60	52	67
Downy Woodpecker	*Picoides pubescens*	X		40	39	42
Hairy Woodpecker	*Picoides villosus*	X		2	0	4
Northern Flicker	*Colaptes auratus*	X		11	4	17
Western Wood-Pewee	*Contopus sordidulus*	X		32	26	38
Willow Flycatcher	*Empidonax traillii*		X	13	22	4
Dusky Flycatcher	*Empidonax oberholseri*		X	2	4	0
Pacific-slope Flycatcher	*Empidonax difficilis*	X		19	22	17
Black Phoebe	*Sayornis nigricans*	X		51	61	42
Ash-throated Flycatcher	*Myiarchus cinerascens*	X		68	70	67
Western Kingbird	*Tyrannus verticalis*	X		30	26	33
Hutton's Vireo	*Vireo huttoni*	X		9	13	4
Warbling Vireo	*Vireo gilvus*	?		28	30	25
Western Scrub-Jay	*Aphelocoma californica*	X		57	65	50
Yellow-billed Magpie	*Pica nuttalli*	X		19	26	13
American Crow	*Corvus brachyrhynchos*	X		2	4	0
Common Raven	*Corvus corax*	X		0	0	0
Tree Swallow	*Tachycineta bicolor*	X		38	26	50
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	X		15	4	25
Cliff Swallow	*Hirundo pyrrhonota*	X		4	0	8

Common Name	Scientific Name	Summer Resident	Migrant	Total (%) *N = 47*	Placer County Plots (%) *N = 23*	Other Plots (%) *N = 24*
Barn Swallow	*Hirundo rustica*	X		2	4	0
Oak Titmouse	*Parus inornatus*	X		53	61	46
Bushtit	*Psaltriparus minimus*	X		57	61	54
White-breasted Nuthatch	*Sitta carolinensis*	X		51	65	38
Bewick's Wren	*Thryomanes bewickii*	X		40	26	54
House Wren	*Troglodytes aedon*	X		55	74	38
Western Bluebird	*Sialia mexicana*	X		9	4	13
Swainson's Thrush	*Catharus ustulatus*		X	9	0	17
American Robin	*Turdus migratorius*	X		30	30	29
Wrentit	*Chamaea fasciata*	X		15	26	4
Northern Mockingbird	*Mimus polyglottos*	X		13	17	8
European Starling	*Sturnus vulgaris*	X		40	48	33
Cedar Waxwing	*Bombycilla cedrorum*		X	2	0	4
Phainopepla	*Phainopepla nitens*	X		0	0	0
Orange-crowned Warbler	*Vermivora celata*	X		19	22	17
Nashville Warbler	*Vermivora ruficapilla*		X	2	0	4
Yellow Warbler	*Dendroica petechia*		X	21	13	29
Common Yellowthroat	*Geothlypis trichas*	X		11	9	13
Wilson's Warbler	*Wilsonia pusilla*	?		30	17	42
Yellow-breasted Chat	*Icteria virens*	X		30	22	38
Western Tanager	*Piranga ludoviciana*		X	26	22	29
Black-headed Grosbeak	*Pheucticus melanocephalus*	X		45	35	54
Blue Grosbeak	*Guiraca caerulea*	X		4	0	8
Lazuli Bunting	*Passerina amoena*	X		19	22	17
Spotted Towhee	*Pipilo maculatus*	X		28	30	25

Common Name	Scientific Name	Summer Resident	Migrant	Total (%) *N = 47*	Placer County Plots (%) *N = 23*	Other Plots (%) *N = 24*
California Towhee	*Pipilo crissalis*	X		19	9	29
Lark Sparrow	*Chondestes grammacus*	X		2	0	4
Savannah Sparrow	*Passerculus sandwichensis*	X		2	0	4
Song Sparrow	*Melospiza melodia*	X		26	26	25
Red-winged Blackbird	*Agelaius phoeniceus*	X		13	17	8
Western Meadowlark	*Sturnella neglecta*	X		13	13	13
Brewer's Blackbird	*Euphagus cyanocephalus*	X		11	0	21
Brown-headed Cowbird	*Molothrus ater*	X		51	30	71
Bullock's Oriole	*Icterus bullockii*	X		32	13	50
House Finch	*Carpodacus mexicanus*	X		49	43	54
Lesser Goldfinch	*Carduelis psaltria*	X		45	57	33
American Goldfinch	*Carduelis tristis*	X		45	48	42
House Sparrow	*Passer domesticus*	X		9	9	8

Table B-9. Bird Species Observed During Four Site Visits

Common Name	Scientific Name	Summer Resident	Migrant	Total (%) *N = 12*	Placer County Plots (%) *N = 8*	Other Plots (%) *N = 4*
Pied-billed Grebe	*Podilymbus podiceps*	X		0	0	0
Great Blue Heron	*Ardea herodias*	X		0	0	0
Green Heron	*Butorides virescens*	X		8	13	0
Wood Duck	*Aix sponsa*	X		17	25	0
Mallard	*Anas platyrhynchos*	X		25	38	0
Cinnamon Teal	*Anas cyanoptera*	X		0	0	0
Common Merganser	*Mergus merganser*	X		8	0	25
Turkey Vulture	*Cathartes aura*	X		17	13	25
White-tailed Kite	*Elanus leucurus*	X		8	0	25
Cooper's Hawk	*Accipiter cooperii*	X		8	13	0
Red-shouldered Hawk	*Buteo lineatus*	X		42	63	0
Swainson's Hawk	*Buteo swainsoni*	X		8	0	25
Red-tailed Hawk	*Buteo jamaicensis*	X		25	13	50
American Kestrel	*Falco sparverius*	X		8	13	0
Ring-necked Pheasant	*Phasianus colchicus*	X		8	13	0
Wild Turkey	*Meleagris gallopavo*	X		0	0	0
California Quail	*Callipepla californica*	X		42	25	75
Common Moorhen	*Gallinula chloropus*	X		0	0	0
American Coot	*Fulica americana*	X		0	0	0
Killdeer	*Charadrius vociferus*	X		17	13	25
Spotted Sandpiper	*Tringa macularia*	X		8	0	25
Mourning Dove	*Zenaida macroura*	X		58	38	100
Barn Owl	*Tyto alba*	X		0	0	0

Common Name	Scientific Name	Summer Resident	Migrant	Total (%) *N = 12*	Placer County Plots (%) *N = 8*	Other Plots (%) *N = 4*
Great Horned Owl	*Bubo virginianus*	X		8	13	0
Black-chinned Hummingbird	*Archilochus alexandri*	X		58	50	75
Anna's Hummingbird	*Calypte anna*	X		67	88	25
Belted Kingfisher	*Megaceryle alcyon*	X		42	38	50
Acorn Woodpecker	*Melanerpes formicivorus*	X		83	88	75
Nuttall's Woodpecker	*Picoides nuttallii*	X		92	88	100
Downy Woodpecker	*Picoides pubescens*	X		75	88	50
Hairy Woodpecker	*Picoides villosus*	X		0	0	0
Northern Flicker	*Colaptes auratus*	X		17	25	0
Western Wood-Pewee	*Contopus sordidulus*	X		58	50	75
Willow Flycatcher	*Empidonax traillii*		X	33	38	25
Dusky Flycatcher	*Empidonax oberholseri*		X	8	13	0
Pacific-slope Flycatcher	*Empidonax difficilis*	X		33	50	0
Black Phoebe	*Sayornis nigricans*	X		92	88	100
Ash-throated Flycatcher	*Myiarchus cinerascens*	X		100	100	100
Western Kingbird	*Tyrannus verticalis*	X		33	13	75
Hutton's Vireo	*Vireo huttoni*	X		17	25	0
Warbling Vireo	*Vireo gilvus*	?		33	38	25
Western Scrub-Jay	*Aphelocoma californica*	X		75	75	75
Yellow-billed Magpie	*Pica nuttalli*	X		25	25	25
American Crow	*Corvus brachyrhynchos*	X		17	25	0
Common Raven	*Corvus corax*	X		8	0	25
Tree Swallow	*Tachycineta bicolor*	X		58	38	100
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	X		50	50	50
Cliff Swallow	*Hirundo pyrrhonota*	X		17	25	0

Common Name	Scientific Name	Summer Resident	Migrant	Total (%) *N = 12*	Placer County Plots (%) *N = 8*	Other Plots (%) *N = 4*
Barn Swallow	*Hirundo rustica*	X		0	0	0
Oak Titmouse	*Parus inornatus*	X		92	100	75
Bushtit	*Psaltriparus minimus*	X		100	100	100
White-breasted Nuthatch	*Sitta carolinensis*	X		92	100	75
Bewick's Wren	*Thryomanes bewickii*	X		83	88	75
House Wren	*Troglodytes aedon*	X		92	88	100
Western Bluebird	*Sialia mexicana*	X		17	13	25
Swainson's Thrush	*Catharus ustulatus*		X	8	0	25
American Robin	*Turdus migratorius*	X		67	75	50
Wrentit	*Chamaea fasciata*	X		33	38	25
Northern Mockingbird	*Mimus polyglottos*	X		25	13	50
European Starling	*Sturnus vulgaris*	X		92	100	75
Cedar Waxwing	*Bombycilla cedrorum*		X	8	13	0
Phainopepla	*Phainopepla nitens*	X		17	13	25
Orange-crowned Warbler	*Vermivora celata*	X		42	50	25
Nashville Warbler	*Vermivora ruficapilla*		X	8	0	25
Yellow Warbler	*Dendroica petechia*		X	25	25	25
Common Yellowthroat	*Geothlypis trichas*	X		17	0	50
Wilson's Warbler	*Wilsonia pusilla*	?		58	50	75
Yellow-breasted Chat	*Icteria virens*	X		42	38	50
Western Tanager	*Piranga ludoviciana*		X	58	50	75
Black-headed Grosbeak	*Pheucticus melanocephalus*	X		83	88	75
Blue Grosbeak	*Guiraca caerulea*	X		0	0	0
Lazuli Bunting	*Passerina amoena*	X		25	25	25
Spotted Towhee	*Pipilo maculatus*	X		67	63	75

Common Name	Scientific Name	Summer Resident	Migrant	Total (%) *N = 12*	Placer County Plots (%) *N = 8*	Other Plots (%) *N = 4*
California Towhee	*Pipilo crissalis*	X		25	25	25
Lark Sparrow	*Chondestes grammacus*	X		0	0	0
Savannah Sparrow	*Passerculus sandwichensis*	X		0	0	0
Song Sparrow	*Melospiza melodia*	X		42	38	50
Red-winged Blackbird	*Agelaius phoeniceus*	X		0	0	0
Western Meadowlark	*Sturnella neglecta*	X		0	0	0
Brewer's Blackbird	*Euphagus cyanocephalus*	X		8	0	25
Brown-headed Cowbird	*Molothrus ater*	X		75	63	100
Bullock's Oriole	*Icterus bullockii*	X		58	50	75
House Finch	*Carpodacus mexicanus*	X		83	75	100
Lesser Goldfinch	*Carduelis psaltria*	X		92	100	75
American Goldfinch	*Carduelis tristis*	X		75	88	50
House Sparrow	*Passer domesticus*	X		25	25	25

Appendix B

Central Valley Songbird Responses to Riparian Width and Other Site- and Landscape-Scale Habitat Characteristics

Appendix B
Central Valley Songbird Responses to Riparian Width and Other Site- and Landscape-Scale Habitat Characteristics

Introduction

To address Placer County's interest in developing riparian setback guidelines for conservation purposes, we analyzed six years of riparian bird count data with respect to width of the riparian zone. Using a subset of PRBO bird survey sites, supplemented by new sites in Placer County, Jones & Stokes (2004) detected a positive relationship between riparian bird species richness and riparian zone width. Thus we wanted to investigate whether additional relationships could be detected using our comprehensive Central Valley riparian point count dataset. In our analysis, we also examined local vegetation and GIS-generated habitat types and surrounding landscape characteristics. Our primary goal was to characterize songbird relationships with riparian zone width, and to identify appropriate widths for riparian buffer zones (development setbacks), given a range of habitat and landscape characteristics.

Methods

Data used for analysis were obtained from bird point count surveys (Ralph et al. 1993) conducted between 1998 and 2003. Sites included long-term monitoring sites along the Sacramento, Cosumnes and San Joaquin Rivers, as well as sites that were surveyed for shorter periods of time, primarily for inventory purposes (Figure B-1). We used a total of 596 riparian point count stations along 117 streamside transects (Table B-1). Within each transect, points were spaced at least 200 meters apart, and the first point count survey station was selected using a random starting point. Point counts were conducted for five minutes, with 1-3 visits per season. (See http://www.prbo.org/tools/pc/pcprot.doc for detailed methods.)

For each of the 596 survey points, we calculated riparian species richness (as defined in Jones & Stokes 2004) as a cumulative value across all surveys. We also obtained a mean abundance across all surveys for each of these riparian-associated species, as well as presence/absence. A variable representing the number of surveys upon which the species richness and presence/absence values were based was retained in all models, to account for the fact that species richness increases with the number of surveys.

Using standard GIS data layers, point count stations were classified into two general categories, tributary or mainstem, as well as identified by drainage basin (DWR CalWater 2.2), elevation, and dominant vegetation cover type (WHR category based on best available GIS data layer) (Tables B-2 to B-5).

For each point we also calculated surrounding landscape characteristics within a 1-km radius, as well as the dominant surrounding land use—urban, agricultural, or "natural" (everything else). Land use and vegetation types were aggregated into more meaningful categories for analysis (Table B-5). We used three different GIS layers for these calculations:

1. Land use (DWR multi-year composite) (Figure B-2)
2. Vegetation (CDFG/DU 1993 wetlands where available; USFS existing vegetation multi-year composite elsewhere) (Figure B-3)
3. Riparian vegetation (union of available datasets: Chico State Sacramento River, San Joaquin River, CDFG/DU wetlands, DWR land use, Placer County vegetation)

Vegetation data were collected for each point count location using a modified relevé protocol (Ralph et al. 1993, Ralph et al. 1995) within a 50-m radius (see http://www.prbo.org/tools/pc/relevepr.html for detailed methods). A subset of variables representing major structural characteristics was used for this analysis (Table B-5). To reduce the number of variables considered, and because riparian zone width was of primary interest in our analysis, floristic composition variables were not analyzed.

Regression models were developed for riparian-associated bird species richness (as defined by Jones & Stokes 2004), as well as presence/absence of each of these species. We used multiple linear regression for species richness, and logistic regression (Hosmer and Lemeshow 1989) for each individual species' occurrence. Three classes of regression models were developed and compared with respect to the relative importance of riparian width as a predictor of bird species richness / occurrence. The dependent variables for each of these model classes were:

- Riparian width category only
- Riparian width category + potentially significant vegetation and landscape variables (from Pearson correlation analysis, $\alpha = 0.10$)
- Riparian width category + basin, vegetation type (WHR) and stream type

Models were first constructed using a numerical riparian width value (1 = 0-50 m, 2 = 50-100 m, 3 = >100 m), treated as a continuous variable, to test for linear relationships between riparian width and bird species richness and individual species' probability of occurrence. To evaluate differences between each of our three width categories (<50 m, 50-100 m, >100 m), we reran the models treating

Transect Code	Transect Name	County	Basin Name	Number of Points	Number of Visits	Number of Years
ANRP	Anderson River Park	Shasta	Redding	3	1	1
BACR	Battle Creek Parking	Tehama	Redding	15	6	3
BASL	Babel Slough	Yolo	Sacramento Delta	6	1	1
BEHI	Beehive	Glenn	Colusa Basin	6	4	2
BISO	Bloody Island South	Tehama	Redding	4	2	1
BIVI	Bianchi Vineyards	Fresno	South Valley Floor	3	1	1
BRSP	Bidwell-Sacramento River Park	Butte	Tehama	15	4	2
BUCR	Butte Creek	Shasta	Colusa Basin	4	1	1
BUPA	Bussett Park	Kings	South Valley Floor	1	1	1
BUSI	Butte Sink	Shasta	Colusa Basin	2	1	1
CAPA	Camp Pashayan	Fresno	South Valley Floor	2	2	1
CARO	Carpenter Road	Stanislaus	San Joaquin Valley Floor	2	2	1
CCRD	Coal Canyon Road		Colusa Basin	1	1	1
CHCA	Chowchilla Canal	Madera	San Joaquin Valley Floor	10	2	1
CMAT	Cal Mat Cement	Kings	South Valley Floor	9	2	1
CMIN	Calveras Material, Inc.	Merced	San Joaquin Valley Floor	6	2	1
CMSP	Caswell Memorial State Park	San Joaquin	San Joaquin Valley Floor	15	2	1
CNWR	Colusa National Wildlife Refuge	Colusa	Colusa Basin	1	1	1
CODO	Codora	Glenn	Colusa Basin	6	21	7
COLU	Colusa	Colusa	Colusa Basin	7	5	2
COTT	Cottonwood Creek	Shasta	Redding	4	1	1
DCER	Deer Creek at Elliot Road	Sacramento	North Valley Floor	1	1	1

Transect Code	Transect Name	County	Basin Name	Number of Points	Number of Visits	Number of Years
DECR	Deer Creek	Tehama	Tehama	23	6	3
DNWR	Delevan National Wildlife Refuge	Colusa	Colusa Basin	1	1	1
DUFE	Durham Ferry	San Joaquin	San Joaquin Delta	11	2	1
DWRE	Dept. Water Resources	Sacramento	North Valley Floor / San Joaquin Delta	9	23	8
DYCR	Dye Creek	Tehama	Tehama	15	7	3
EFYE	Effie Yeaw County Park	Sacramento	Valley-American	5	2	1
ELAV	Elkhorn Avenue	Kings	South Valley Floor	3	1	1
ELKH	Elkhorn Regional Park	Yolo	Valley Putah-Cache	3	1	1
ENCI	Encinal	Sutter / Yolo	Marysville	3	1	1
ERRO	Evans Reimer Road	Butte	Marysville	1	1	1
FGLS	Fish and Game Llano Seco		Colusa Basin	1	1	1
FIRE	Firebaugh	Madera	San Joaquin Valley Floor	2	2	1
FLYN	Flynn	Tehama	Tehama	14	24	8
FMRO	Four Mile Road		Colusa Basin	1	1	1
FOCO	Four Corners	Merced	San Joaquin Valley Floor	3	2	1
GJHA	Grayson	Stanislaus	San Joaquin Valley Floor	6	2	1
GRAY	Green Field	Stanislaus	Delta-Mendota Canal	5	2	1
GRKL	Grimes to Knights Landing	Colusa / Sutter / Yolo	Colusa Basin / Valley-American	4	1	1
GRLO	Gray Lodge	Butte	Colusa Basin	2	1	1
GVGA	Great Valley Grasslands A	Merced	San Joaquin Valley Floor	3	2	1
GVGB	Great Valley Grasslands B	Merced	Delta-Mendota Canal	3	2	1

Transect Code	Transect Name	County	Basin Name	Number of Points	Number of Visits	Number of Years
HALE	Haleakala	Tehama	Tehama	6	23	8
HAPA	Halgaman Park	Stanislaus	San Joaquin Valley Floor	1	1	1
HAYE	Hayes Avenue	Kings	South Valley Floor	5	1	1
HBRA	Honolulu Bar Recreation Area	Stanislaus	San Joaquin Valley Floor	1	2	1
HOSL	Howard Slough (F&G)		Colusa Basin	3	1	1
HW41	Highway 41	Fresno	South Valley Floor	3	1	1
JACI	Jacinto	Glenn	Colusa Basin	9	3	2
JFBR	Jelly's Ferry Bridge	Tehama	Redding	2	2	1
KAIS	Kaiser	Glenn	Tehama	8	9	3
KCCD	Kings County Conservation District	Kings	South Valley Floor	1	2	1
KOSL	Kopta Slough	Tehama	Tehama	6	17	6
LABA	La Baranca	Tehama	Tehama	15	23	8
LASL	Laird's Slough	Stanislaus	Delta-Mendota Canal	6	2	1
LBCR	Little Butte Creek	Butte	Colusa Basin	1	2	2
LIAV	Lincoln Avenue	Kings	South Valley Floor	1	1	1
LKRP	Layton-Kingston Regional Park	Fresno	South Valley Floor	2	1	1
LLSE	Llano Seco	Butte	Colusa Basin	5	5	3
LODI		Sacramento	North Valley Floor	3	1	1
LOLA	Lost Lake Park	Fresno	San Joaquin Valley Floor	13	2	1
LWWT	Livingston Waste Water Treatment	Merced	San Joaquin Valley Floor	1	1	1
MARO	Maple Road	Fresno	South Valley Floor	1	1	1
MEND	Mendota	Fresno	Delta-Mendota Canal / San Joaquin	4	2	1

Transect Code	Transect Name	County	Basin Name	Number of Points	Number of Visits	Number of Years
			Valley Floor			
MHRA	McHenry Recreation Area	San Joaquin	San Joaquin Valley Floor	4	2	1
MICR	Mill Creek	Tehama	Tehama	17	8	4
MOKE		Sacramento	North Valley Floor	1	1	1
MOON	Mooney	Tehama	Tehama	9	2	1
MORI	Mokelumne River	San Joaquin	North Valley Floor	6	1	1
MRBR	Meiss Road Bridge	Sacramento	North Valley Floor	1	1	1
MSRA	McConnel State Recreation Area	Merced	San Joaquin Valley Floor	5	2	1
OABR	Oakdale Avenue Bridge	Merced	San Joaquin Valley Floor	1	2	1
OBRA	Orange Blossom Recreation Area	Stanislaus	San Joaquin Valley Floor	2	2	1
OFBN	Ord Ferry Bridge North	Glenn	Colusa Basin	4	2	1
OLMI	Old Mill	Shasta	Redding	8	3	1
OSFA		Shasta	Redding	2	1	1
OWAR	Oroville Wildlife Area	Butte / Tehama	Marysville	10	2	2
PACR	Paine's Creek	Tehama	Redding	9	2	1
PAIS	Packer Island	Tehama	Colusa Basin	6	6	2
PARO	Parallel Road	San Joaquin	San Joaquin Valley Floor	3	2	1
PICR	Pine Creek	Butte	Tehama	7	11	4
PRAR	Project Area	Shasta	Redding	13	11	4
PRIN	Princeton	Colusa	Colusa Basin	7	3	2
PUCR	Putah Creek	Tehama	Valley Putah-Cache	3	1	1
PURO	Putnam Road	Colusa	Colusa Basin	2	1	1

Transect Code	Transect Name	County	Basin Name	Number of Points	Number of Visits	Number of Years
QSTR	Q Street	Fresno	Delta-Mendota Canal	1	2	1
RAMI	Ramirez	Fresno	Delta-Mendota Canal	1	1	1
RANK	Rank Island	Fresno	San Joaquin Valley Floor	3	1	1
REBA	Reading Bar	Shasta	Redding	4	11	4
REIS		Shasta	Redding	4	1	1
RIVI	River Vista	Tehama	Tehama	1	25	9
RSPO	Ripon Sewage Ponds	San Joaquin	San Joaquin Valley Floor	6	2	1
RYAN	Ryan	Tehama	Tehama	4	24	8
SACC	Sacramento River	Shasta	Redding	7	9	3
SFBR	Sante Fe Bridge	Stanislaus	San Joaquin Valley Floor	1	1	1
SHFA	Shiloh Fishing Access	Stanislaus	San Joaquin Valley Floor	1	1	1
SHGA	Shooting Gallery	Shasta	Redding	5	12	4
SRCL	Sacramento Refuge Car Loop		Colusa Basin	1	1	1
SRSL	Santa Rita Slough	Merced	Delta-Mendota Canal	1	2	1
STCR	Stony Creek	Glenn	Colusa Basin	6	23	8
STIL	Stillwater Creek	Shasta	Redding	1	1	1
SUNO	Sul Norte	Glenn	Colusa Basin	10	24	8
TAFO	Tall Forest	Sacramento	San Joaquin Delta	13	25	9
TAMO	Table Mountain	Tehama	Redding	7	1	1
THCR	Thomes Creek	Shasta / Tehama	Tehama	11	1	1
THOM	Thomas	Glenn	Colusa Basin	5	6	3
TLSR	Turlock Lake State Rec Area	Stanislaus	San Joaquin Valley Floor	4	2	1

Table B-1. Site Summary

Transect Code	Transect Name	County	Basin Name	Number of Points	Number of Visits	Number of Years
TURL	Turlock Road	Merced	San Joaquin Valley Floor	1	2	1
VALE	Valensin	Sacramento	North Valley Floor	5	20	7
VORA	Valley Oak Recreation Area	Stanislaus	San Joaquin Valley Floor	2	2	1
WELE	Wendell's Levee	Sacramento	San Joaquin Delta	3	25	9
WERO	Wendell's Road	Sacramento	North Valley Floor / San Joaquin Delta	3	23	9
WILA	Wilson's Landing	Butte	Tehama	3	1	1
WISL	Willow Slough	Sacramento	San Joaquin Delta	9	24	9
WIUN	Willow Unit	Fresno	San Joaquin Valley Floor	2	2	1
WOBR	Woodson Bridge State Park	Tehama	Tehama	13	5	3

Table B-2. Summary of Point Count Types -- Stream Type by Hydrologic Unit / Basin

Hydrologic Unit Name	Mainstem	Tributary	Total
Colusa Basin / Marysville	89	13	102
North Valley Floor / San Joaquin Delta	58	7	65
Redding	27	61	88
San Joaquin Valley Floor / Delta-Mendota Canal	117	2	119
South Valley Floor	31	0	31
Tehama	95	72	167
Valley-American / Valley Putah-Cache / Sacramento Delta	15	3	18
Total	432	158	590

Table B-3. Summary of Point Count Types -- Land Use Type by Hydrologic Unit / Basin

Hydrologic Unit Name	Agricultural	Natural	Urban	Total
Colusa Basin / Marysville	57	44	1	102
North Valley Floor / San Joaquin Delta	19	45	3	65
Redding	6	75	7	88
San Joaquin Valley Floor / Delta-Mendota Canal	77	39	3	119
South Valley Floor	20	11	0	31
Tehama	118	49	0	167
Valley-American / Valley Putah-Cache / Sacramento Delta	13	0	5	18
Total	310	263	19	590

Table B-4. Summary of Point Count Types -- WHR Habitat Type by Hydrologic Unit / Basin

Hydrologic Unit Name	AGR	AGS	BOW	CHP
Colusa Basin / Marysville	22	7	0	1
North Valley Floor / San Joaquin Delta	3	14	0	0
Redding	3	10	11	0
San Joaquin Valley Floor / Delta-Mendota Canal	14	18	1	0
South Valley Floor	2	8	0	1
Tehama	34	27	0	0
Valley-American / Valley Putah-Cache / Sacramento Delta	7	3	0	1
Total	85	87	12	3

Hydrologic Unit Name	FEW	URB	VOW	VRI	Total
Colusa Basin / Marysville	3	1	0	67	102
North Valley Floor / San Joaquin Delta	22	3	0	23	65
Redding	6	1	5	52	88
San Joaquin Valley Floor / Delta-Mendota Canal	9	3	0	75	119
South Valley Floor	1	2	0	17	31
Tehama	1	1	3	101	167
Valley-American / Valley Putah-Cache / Sacramento Delta	0	2	0	5	18
Total	42	13	8	340	590

Notes:

AGR = Agriculture

AGS = Annual Grassland

BOW = Blue Oak Woodland

CHP = Chaparral Scrub

FEW = Fresh Emergent Wetland

URB = Urban

VOW = Valley Oak Woodland

VRI = Valley / Foothill Riparian

Table B-5. Definition of Independent Variables Used in Regression Analysis

Variable name	Definition
Riparian width (field-collected)	
width2	riparian width category: 1 is 0-50 m, 2 is 50-100 m, 3 is >100 m)
Geography / habitat variables	
elevation	elevation (m)
huname / huname2	basin name (see Tables 2-4)
whr_new	WHR habitat type (see Table 4)
strm_type	stream type (mainstem or tributary)
Landscape-level vegetation variables	
rip_cov	proportion of riparian cover within a 1 km radius
agric_veg	proportion of agricultural vegetation within a 1 km radius
herb_veg	proportion of grassland vegetation within a 1 km radius
shrub_veg	proportion of shrub vegetation within a 1 km radius
wtlnd_veg	proportion of wetland vegetation within a 1 km radius
forest_veg	proportion of forest vegetation within a 1 km radius
Lanscape-level landuse variables	
agric_use	proportion of agricultural landuse within a 1 km radius
natur_use	proportion of natural landuse within a 1 km radius
urban_use	proportion of urban landuse within a 1 km radius
Site-level (field-collected) vegetation variables	
canopycov	canopy cover
treecov_new	absolute percent cover of the tree layer (>5 m in height); may contain vegetation that is not strictly a tree, such as vines hanging from trees, so long as its within the height range
shrubcov_new	absolute percent cover of the shrub layer (0.5-5 m in height); may contain non-woody plants within the height range
herbcov_new	absolute percent cover of the hebraceous layer (<0.5 m in height); may contain small shrubs and other woody plants less than .5 meters high
hitreeht	*average* height of the upper bounds of the tree layer
hishrubht	*average* height of the upper bounds of the shrub layer
maxtrdbh	maximum diameter at breast height to the nearest 0.1 centimeters, for the tree layer

width as a categorical variable and tested for equality of means within each width category.

This process was repeated for just the subset of point counts representing tributary streams, as well as for the subsets of data representing each dominant land use type within 1 km (agriculture, natural or urban).

Because we were interested in the effect of riparian width, with and without controlling for environmental conditions, we compared the model coefficient for riparian width across the three model classes. We recognized that riparian width could be affected by surrounding landscape characteristics, which may in turn affect local vegetation characteristics. Thus the apparent effect of riparian width could increase or decrease when controlling for other variables that are more strongly associated with a given bird metric. Our approach was intended to identify additional environmental variables associated with the bird metrics in question, and perhaps help explain the importance of riparian width. But we also wished to detect the responses to riparian width that may be obscured by other variables in a more complex model.

Results

Without controlling for any other environmental variables, riparian width was a significant positive predictor of riparian-associated bird species richness, as well as the presence of Black-headed Grosbeak (BHGR) and Common Yellowthroat (COYE) (Table B-6). Blue Grosbeak (BLGR) presence was negatively associated with riparian width. Controlling for the effect of geography (basin, elevation) and habitat type (WHR type and stream type), all of these species except COYE had a reduced, but still significant response to riparian width category, as did species richness. Only BHGR was positively associated with riparian width, and BLGR was negatively associated with riparian width, after also controlling for vegetation and surrounding land use characteristics (Table B-6).

Species richness and BHGR presence were positively associated with riparian width at mainstem, but not tributary sites, while the reverse was true for Yellow Warbler (YWAR) and COYE (Table B-7). For the Song Sparrow (SOSP), there was a significant positive relationship with riparian width at tributary sites, but a negative relationship at mainstem sites (Table B-7). BLGR presence was negatively associated with riparian width only at mainstem sites (Table B-7).

Comparing dominant surrounding land use categories (agricultural or natural), the relative importance of riparian width varied across species. For species richness, the effect was greater in natural than agricultural landscapes (Table B-8). For BHGR and BLGR probability of occurrence, the positive/negative effect of riparian width was greatest in natural landscapes. Warbling Vireo (WAVI) displayed a negative association with riparian width only in natural landscapes, while COYE and SOSP showed significant associations with riparian width only within agricultural landscapes (Table B-8).

Controlling for riparian width and site vegetation, we found a positive association between species richness and the proportion of riparian and wetland vegetation within a 1 km radius (Table B-10). With respect to individual species, we found that (Table B-10):

- YWAR was negatively associated with surrounding agricultural proportion within 1 km;
- BHGR and YWAR were negatively associated with surrounding grassland proportion;
- BLGR was positively associated with surrounding grassland proportion;
- SOSP and YBCH were positively associated with the proportion of surrounding natural land uses;
- YBCH was negatively associated with surrounding wetland proportion; and
- WIFL was positively associated with the proportion of surrounding forest.

Although we found a positive, linear effect of riparian width on species richness, tests for equality of means revealed a significant difference between widths greater than 100 m and those less than 100 m, but could not discriminate between widths less than 100 m (i.e., <50 m vs. 50-100 m) (Table B-6, Figure B-4). The same was true for YWAR and COYE probability of occurrence (Table B-7). However, for BHGR probability of occurrence, there was a threshold at 50 m, with a significant difference between width categories 1 (<50 m) and 2 (50-100 m), as well as between category 3 (>100 m) and category 1 (<50 m).

Summary and Recommendations

Our results indicated that, in California's Central Valley, the number of riparian songbird species was significantly lower where the riparian woodland zone was less than 100 m in width, at least along mainstem river corridors. Four species were also less likely to occur in riparian areas less than 100 m wide: the Black-headed Grosbeak, Common Yellowthroat, Yellow Warbler (a California Bird Species of Special Concern), and Song Sparrow. For the latter three species, this positive response to riparian width was only detected along tributary creeks, while for the Black-headed Grosbeak, it was only along mainstem rivers.

In addition, we found a strong influence of surrounding land use (within a 1-km radius) on which and how many riparian songbird species occurred at a site. The number of species increased with the amount of riparian and wetland habitat found within a 1-km radius. With respect to species composition, we found that the Yellow Warbler was negatively associated with the amount of agricultural land use within 1 km, and that the Song Sparrow and Yellow-breasted Chat were positively associated with the amount of “natural” (i.e., non-agricultural and non-urban) land use. Because few of our study sites were in urban areas, we were not able to evaluate the effect of urban development directly.

Table B-6. Comparison of Riparian Width Effect -- Univariate Models vs. Basin/Habitat Models vs. Vegetation/Landscape Models

		Univariate Model						Basin/Habitat Model						Veg/Landscape Model					
Bird Metric	Total Detections	Coeff	SE	Width test (1)	R2	P-value	n	Coeff	SE	Width test (1)	R2	P-value	n	Coeff	SE	Width test (1)	R2	P-value	n
Species Richness	N/A	0.40	0.08 ***	3>1*	0.67	<0.001	590	0.17	0.00 *	3>1*	0.72	0.01	590	0.13	0.09		0.71	0.15	556
BHGR presence	1499	0.70	0.12 ***	2>1*, 3>1**	0.24	<0.001	590	0.45	0.13 ***	2>1**, 3>1***	0.34	<0.001	587	0.37	0.14 *	2>1*, 3>1**	0.36	<0.001	560
BLGR presence	133	-0.60	0.17 ***		0.14	0.23	590	-0.59	0.19 **	3<1**	0.23	0.05	547	-0.37	0.19 *	3<1*	0.17	0.54	560
COYE presence	603	0.28	0.16 *	3>1*	0.04	<0.001	590	0.24	0.19		0.39	0.01	550	0.15	0.18		0.35	0.00	579
SOSP presence	957	-0.07	0.11		0.00	0.50	590	0.04	0.16 *		0.33	0.06	403	-0.22	0.12 *	3<1*	0.08	0.05	578
SWHA presence	15	0.11	0.60		0.17	0.33	590												
WIFL presence	43	0.07	0.22		0.08	0.42	590							-0.09	0.23		0.09		560
WAVI presence	124	-0.04	0.19		0.23	0.02	590	-0.21	0.22		0.31	0.67	548	-0.03	0.20		0.28	0.27	560
YBCH presence	227	0.08	0.15		0.04	0.14	590	-0.02	0.19		0.21	0.36	415	-0.13	0.17		0.24	0.54	560
YWAR presence	212	0.21	0.16		0.13	0.00	590	0.10	0.19		0.27	0.02	532	-0.04	0.20		0.24	0.27	558

* = P<0.10
** = P<0.01
*** = P<0.001

(1) 1 = 0-50 m
2 = 50-100 m
3 = > 100 m

Table B-7. Effect of Riparian Width -- Comparison Between Tributary and Mainstem Streams

		Univariate Model							Basin/Habitat Model						
Bird Metric		Coeff	SE		P-value	Width test	R2	n	Coeff	SE		P-value	Width test	R2	n
Species Richness	Mainstem	0.47	0.09	***		3>1***	0.71	432	0.14	0.09			3>1*	0.77	432
	Tributaries	0.23	0.15		0.13		0.50	158	0.16	0.15		0.28		0.59	158
BHGR presence	Mainstem	0.88	0.15	***		2>1*, 3>1***	0.12	432	0.56	0.18	**		2>1*, 3>1**	0.42	425
	Tributaries	-0.44	0.33		0.02		0.03	158	0.25	0.22		0.05		0.26	154
BLGR presence	Mainstem	-0.69	0.21	***		3<1***	0.18	432	-0.64	0.24	**		3<1**	0.28	376
	Tributaries	-0.44	0.33		0.27		0.03	158	-0.23	0.35		0.51		0.12	136
COYE presence	Mainstem	0.12	0.20		0.01		0.35	432	-0.17	0.25				0.41	385
	Tributaries	0.64	0.33	*		3>1*	0.21	158	0.98	0.39	*	0.01	3>1*	0.34	130
SOSP presence	Mainstem	-0.57	0.14	***		3<2*, 3<1***	0.06	432	-0.05	0.18				0.35	321
	Tributaries	0.84	0.32	**	0.00	3<1*	0.13	158	0.25	0.55		0.13		0.43	75
WAVI presence	Mainstem	0.16	0.24				0.28	432	0.12	0.29				0.35	388
	Tributaries	-0.63	0.37	*	0.16	3<2**	0.06	158	-0.60	0.42		0.32		0.15	115
YBCH presence	Mainstem	0.27	0.27				0.07	432	-0.38	0.32				0.15	258
	Tributaries	0.20	0.21		0.12		0.06	158	0.17	0.27		0.24		0.30	143
YWAR presence	Mainstem	-0.01	0.30				0.19	432	0.07	0.24				0.25	371
	Tributaries	0.68	0.29	*	0.01	3>1*	0.11	158	0.23	0.37		0.37		0.39	140

* = P<0.10
** = P<0.01
*** = P<0.001
(1) 1 = 0-50 m; 2 = 50-100 m; 3 = > 100 m

Table B-8. Riparian Width Effect -- Comparison between Predominantly Agricultural and Predominantly Natural Surrounding Land Uses

Bird Metric		Univariate Model Coeff	SE		Width tests (1)	R^2	n
Species Richness	Natural	0.50	0.10	***	3>1***, 3>2*	0.72	263
	Agricultural	0.31	0.12	**	3>1**	0.64	310
Black-headed Grosbeak presence	Natural	0.92	0.19	***	3>1***, 3>2*	0.22	263
	Agricultural	0.55	0.16	***	3>1**	0.28	310
Blue Grosbeak presence	Natural	-0.77	0.28	**	3<1**	0.21	263
	Agricultural	-0.48	0.22	*	3<1*	0.09	310
Common Yellowthroat presence	Natural	0.19	0.33			0.48	263
	Agricultural	0.38	0.19	*	3>1*	0.24	310
Song Sparrow presence	Natural	-0.02	0.19			0.16	263
	Agricultural	-0.52	0.17	**	3<2*, 3<1**	0.04	310
Warbling Vireo presence	Natural	-0.20	0.26			0.20	263
	Agricultural	0.08	0.31			0.33	310
Yellow-breated Chat presence	Natural	0.01	0.18			0.00	263
	Agricultural	0.16	0.34			0.23	310
Yellow Warbler presence	Natural	0.14	0.23			0.15	263
	Agricultural	0.15	0.27			0.15	310

Notes:

* = P<0.10
** = P<0.01
*** = P<0.001

(1)
1 = 0-50 m
2 = 50-100 m
3 = > 100 m

Table B-9. Significant Variables in Basin/Habitat Models

Bird Metric	n	R2 / Pseudo R2	Number of visits	Riparian width	Basin (1)	WHR Type (2)	Tributary	Elevation
Species Richness	590	0.72	+++		3(+++), 4(---), 6(+++), 7(--)	5(+++), 8(+++)	-	---
Black-headed Grosbeak presence	587	0.34	+++	+++	2(---), 4(---), 5(---), 7(-)		---	
Blue Grosbeak presence	547	0.23	+++	--	2(++), 5(+), 6(+)			
Common Yellowthroat presence	550	0.39	+++		3(+), 6(+)	6(+)		---
Song Sparrow presence	403	0.33	+++		2(+++), 3(+++), 4(+++), 5(+++)	3(-), 7(-), 8(---)		
Warbling Vireo presence	548	0.31	+++		6(+), 7(+)	3(++), 4(+), 8(+)	-	
Yellow-Breasted Chat presence	415	0.21	+++		2(--), 6(-)	2(+)	+	
Yellow Warbler presence	532	0.27	+++		6(-)	5(+++)		+

Notes:

+/- : P<0.10; ++/-- : P<0.01; +++/--- : P<0.001

(1) 1 = Colusa Basin / Marysville, 2 = North Valley Floor / San Joaquin Delta, 3 = Redding, 4 = San Joaquin Valley Floor / Delta-Mendota Canal, 5 = South Valley Floor, 6 = Tehama, 7 = Valley-American / Valley Putah-Cache / Sacramento Delta

(2) 1 = Agriculture (AGR), 2 = Annual Grassland (AGS), 3 = Blue Oak Woodland (BOW), 4 = Chaparral (CHP), 5 = Fresh Emergent Wetland (FEW), 6 = Urban (URB), 7 = Valley Oak Woodland (VOW), 8 = Valley/Foothill Riparian

Table B-10. Significant Independent Variables in Vegetation/Landscape Models

Bird Metric	n	R2 / Pseudo R2	Number of visits	Riparian width	Vegetation variables (2)	Landscape variables (2)
Species Richness	550	0.71	+++		maxtrdbh (+++), shrubcov_new (+++), herbcov_new (--)	rip_cov (+++), wtlnd_veg (+++)
Black-headed Grosbeak presence	560	0.36	+++	++	rip_cov (+++)	herb_veg (---)
Blue Grosbeak presence	560	0.17	+++	-	rip_cov (-)	herb_veg (+)
Common Yellowthroat presence	587	0.35	+++		shrubcov_new (+++)	
Song Sparrow presence	578	0.08	+++	-	treecov_new (-)	natur_use (+)
Swainson's Hawk presence	-					
Willow Flycather presence	560	0.09	++			forest_veg (+++)
Warbling Vireo presence	560	0.28	+++			shrub_veg (-), forest_veg (+), agric_use (-)
Yellow-breasted Chat presence	560	0.24	+++			shrub_veg (++), wtlnd_veg (---), natur_use (+++)
Yellow Warbler presence	558	0.25	+++		herbcov_new (-)	herb_veg (--), agric_use (---)

+/- = P<0.10
++/-- = P<0.01
+++/--- = P<0.001

(1) 1 = 0-50 m
2 = 50-100 m
3 = > 100 m

(2) See Table 5 for definitions of vegetation and landscape variables.

These findings suggest that, in order to maintain current populations of riparian-associated bird species, riparian woodlands and other natural vegetation should be maintained within at least 100 m on either side of all streams. To restore populations of species that are in decline (e.g., Yellow Warbler) or locally extirpated (e.g., Song Sparrow), the condition of riparian woodlands should be actively enhanced and restored within this zone. The Riparian Bird Conservation Plan (RHJV 2004) lists several recommendations for enhancing riparian habitat for birds and wildlife, which include managing for a diverse understory, increasing the diversity of woody plants, control of invasive plant and animals, and timing of management activities, such as mowing and grazing, to avoid the breeding season. To conserve greater riparian bird diversity, riparian setbacks and activity restrictions should be implemented not only in rural residential and urban areas, but also in agricultural zones.

It is also important to recognize the importance of landscape context in determining habitat suitability for riparian songbirds. The preservation, restoration and linkage of large parcels of undeveloped and uncultivated lands will provide significant benefits to riparian songbird species. Conservation priorities should be large contiguous areas of riparian vegetation surrounded by "natural" uplands to the greatest extent possible. Restoration priorities should be stream segments with large areas of nearby existing riparian habitat.

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Figure B-1. Study Sites

Figure B-2. Central Valley Vegetation

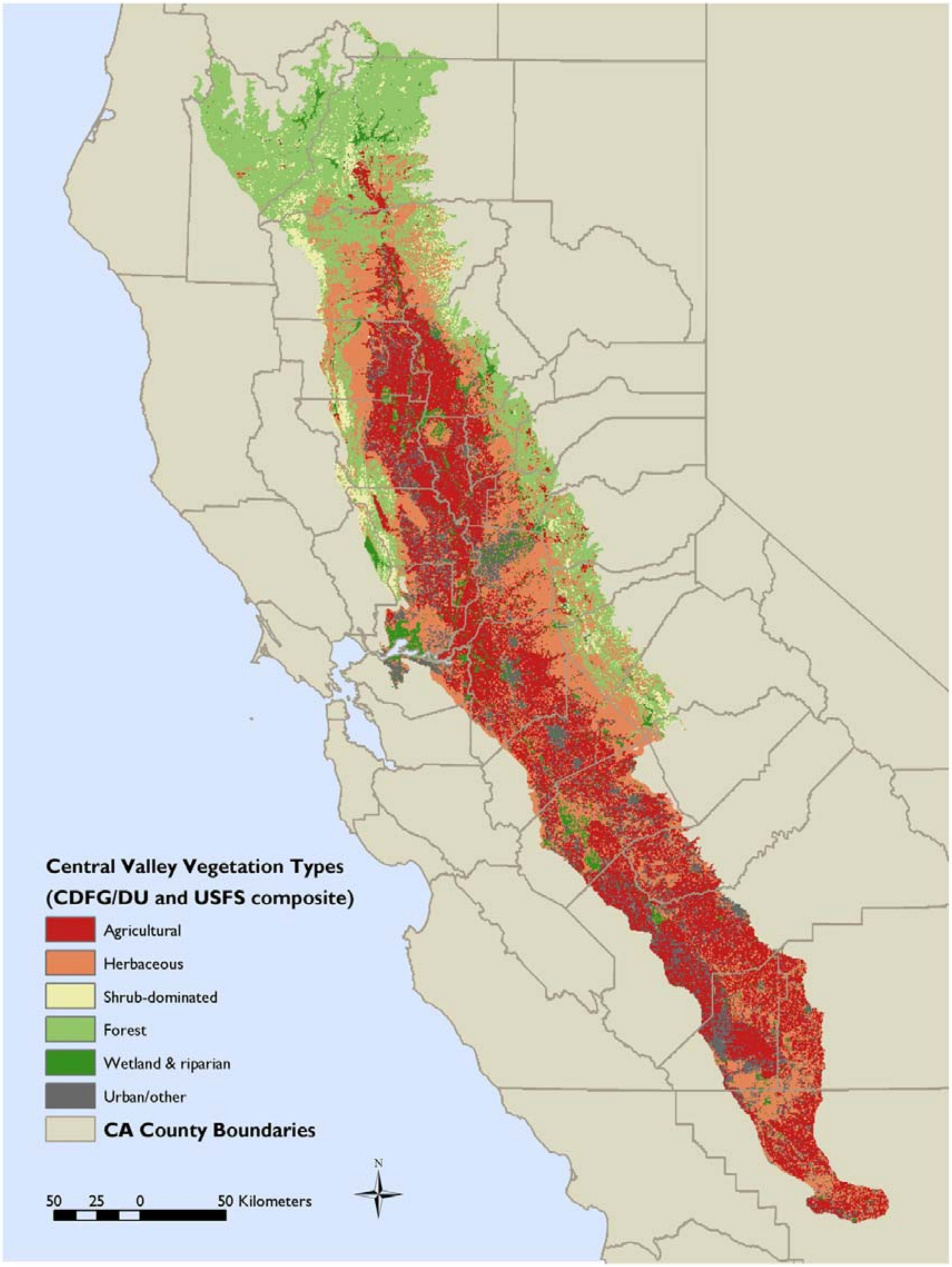


Figure B-3. Central Valley Land Use

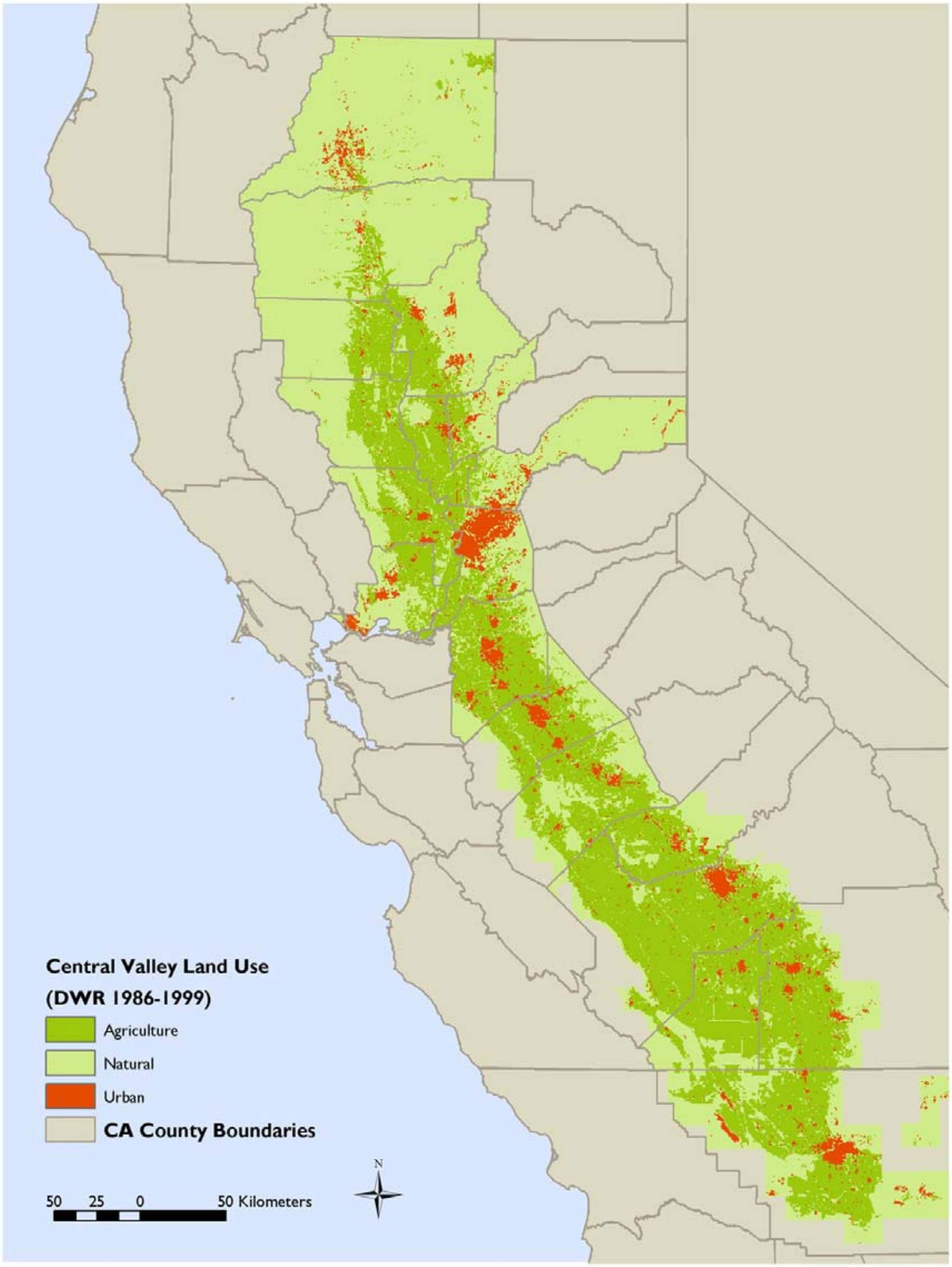
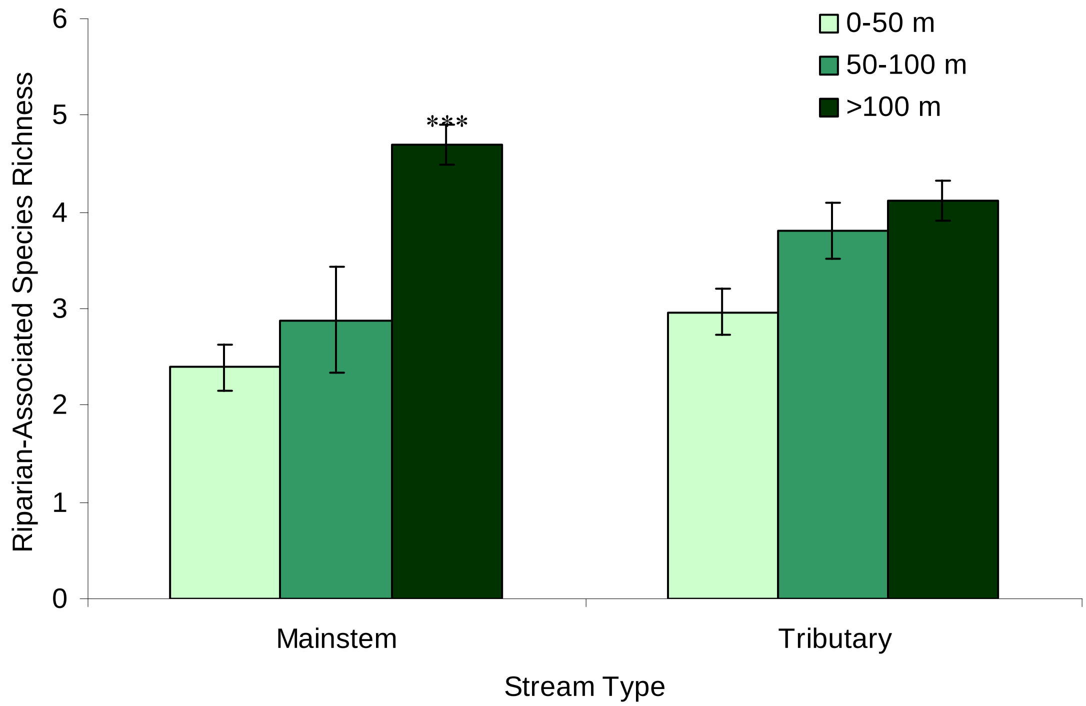


Figure B-4. Mean riparian-associated bird species richness by riparian width category (0-50 m, 50-100 m, >100m) and stream type (mainstem, tributary and wetland). Error bars represent standard errors. Significantly different means are denoted by asterisks (*** = < 0.001)



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Short note

The effects of stock type and radicle pruning on blue oak morphology and field performance

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Summary — Blue oak (*Quercus douglasii* Hook & Arn) acorns were germinated and divided into three groups or stock types. The first group was directly sown in the field; the second was sown into containers and grown for 4 months before outplanting; and the third was grown for a year before outplanting. In addition, each of these groups was further divided into three radicle pruning treatments: i) radicles left intact; ii) 2–3 mm cut from radicle tip; and iii) radicles pruned back to 1 cm. Results indicated that radicle pruning dramatically altered the morphology of container seedlings, but had almost no effect on field performance. Stock type, however, dramatically influenced field growth and survival, with the directly sown acorns and the 4-month-old seedlings growing far faster than the 1-year-old seedlings.

blue oak / radicle pruning / regeneration / seedling production / California

Résumé — Les effets de la qualité des plants et du cernage racinaire sur la morphologie et la croissance de *Quercus douglasii*. *Des glands de* Quercus douglasii *ont été mis à germer et répartis en trois groupes ou types de plants. Le premier a été semé directement au champ, le second a été élevé en conteneurs pendant 4 mois, et le troisième pendant un an avant transplantation. De plus, chacun de ces groupes a été subdivisé en trois traitements de cernage racinaire : i) racines intactes, ii) ablation de 2–3 mm à l'apex, iii) cernage à 1 cm. Les résultats indiquent que le cernage a fortement modifié la morphologie des semis en conteneurs, mais n'avait pratiquement aucun effet sur les performances de croissance après transplantation. En revanche, le type de plants a fortement affecté la croissance et la survie au champ, les semis directs et les plants de 4 mois présentant de bien meilleures croissances que les plants d'un an après transplantation.*

cernage de racines / *Quercus douglasii* / production de plants / Californie

INTRODUCTION

Blue oak (*Quercus douglasii* Hook & Arn) is one of three species of native California oaks that is reported to be regenerating poorly in portions of the state (Bolsinger, 1988; Muick and Bartolome, 1987). It is a white oak, endemic to California, which grows primarily in the foothills surrounding the state's Central Valley. Blue oak woodlands are the most extensive hardwood type in the state, comprising over a million hectares (Bolsinger, 1988), and are vital habitats to a wide range of wildlife species. These woodlands are also extremely important to water quality and yield – a subject of increasing public scrutiny and concern – since a large percent of the state's water originates at high elevations and flows through the oak woodlands before being diverted for agriculture, domestic uses, or flowing to the ocean. Oak woodlands are also very important aesthetically, since the tree-covered hillsides provide a distinctive character to the state's landscape. In the minds of many, oaks and oak woodlands are emblematic of California's appearance.

To assist in developing successful artificial regeneration techniques for blue oak, the following study was undertaken. It was designed to help evaluate and compare different stock types, including directly sown acorns, 4-month-old seedlings and 1-year-old seedlings. This project also examined the effects of trimming the radicles of germinated acorns on seedling morphology and field performance.

MATERIALS AND METHODS

Acorn collection and planting

Acorns for this study were collected in early October 1989, from a single blue oak tree located 3 km from the planting site, and placed in cold storage (2–5 °C). In late November, the acorns were removed and examined. Those that had begun to germinate, and had radicles at least 1.5 cm long, were returned to cold storage. Those that had not yet germinated, or had short radicles, were removed and placed on their sides in flats containing moist vermiculite to stimulate germination. These flats were kept on a laboratory bench and checked daily. When an acorn's radicle was 1.5 cm or longer, that acorn was removed and put into cold storage.

In early December, when approximately 800 acorns had radicles in the desired range (1.5–3 cm), the acorns were divided into three equal groups and assigned to different stock-type treatments. Stock type 1 were acorns to be directly sown into the field planting site. Stock type 2 were to be grown for 4 months in containers and then transplanted to the field. Stock type 3 were to be grown for a full year in containers before transplanting. Each of these groups were further divided into the following three treatments:

Treatment 1: control, radicles left intact;

Treatment 2: 2–3 mm of the radicle pruned from the tip;

Treatment 3: radicles pruned back to 1 cm.

Two of the groups were taken to the California Department of Forestry and Fire Protection Nursery at Davis, CA, for planting into containers, while the third was directly sown in the field during the following week.

The radicle pruning was done using a razor blade or sharp knife. After treatment, the acorns taken to the nursery were planted individually in open-ended paper containers, 5 cm square and 20 cm tall, using a potting mix containing peat moss, fir bark and vermiculite. They were then placed in an unheated shadehouse where they were regularly watered and fertilized.

Field planting and maintenance

The field planting site was located at the Sierra Foothill Research and Extension Center (SFREC), 30 km northeast of Marysville, at an elevation of approximately 200 m. Directly sown acorns were placed on their sides and positioned such that the radicles were pointing down. They were covered with 1–2 cm of soil.

The field plot consisted of 360 planting spots, on 1.2 m centers, within a deer and cattle exclosure. The plot layout contained four blocks. Within each block were ten rows of nine seedlings each. Each row contained one randomly positioned seedling from each of the nine treatment combinations (three stock types x three pruning treatments).

In November 1989, prior to planting, each planting spot was augured to a depth of 60 cm using a tractor mounted 15 cm diameter auger. Afterwards, the soil was placed back in the holes and several liters of water were added to help settle the soil before planting. A 21 g slow release fertilizer tablet (20-10-5 NPK) was also placed in each hole at a depth of 20–30 cm. These tablets were placed in the ground in winter 1989 for the direct seeded acorns and 4-month-old seedlings, and in fall 1990 for the 1-year-old stock.

The 4-month-old seedlings were brought to the research center and planted in the field plot in early April 1990. At the time of planting, it had not rained for some time so the soil was quite dry and crumbly. We were concerned that the seedlings might not survive so we decided to provide 2 L of water to each seedling as they were planted. No further irrigation was provided to these, or to seedlings from the other stock types, during the remainder of the study. The 1-year-old seedlings were kept at the nursery until December 1990, when they were brought to the research center and planted.

The plot was kept moderately weed-free during the course of the study using a combination of herbicides and mowing. Glyphosate was sprayed on the plot before the study began, and again in the early spring of each year before the seedlings had commenced leaf-out. However, there was generally also a crop of late-season weeds which were removed mechanically.

Seedling morphology

At the time of field planting, 15 seedlings from each radicle pruning treatment for both the 4-month and 1-year-old seedlings were destructively harvested and a variety of morphological traits measured. The potting mix was carefully removed from the roots using both water and tweezers. The height, basal diameter and number of tap roots (main roots originating at the radicle trim point) were measured and recorded. Seedlings were then cut at the cotyledon scars, and the shoots and roots dried at 70 °C for 2 days. These were then weighed and the total seedling weights and shoot root ratios calculated.

Field measurements

The emergence date of the directly sown acorns was recorded in spring 1990. The plot was evaluated twice a week and the date when the shoot was first visible at the soil surface was noted. At the end of each growing season (usually late fall), when all late season flushing had ceased, the year-end height and basal diameter of each seedling planted in the field was recorded. The height was the distance from the ground to the tip of the longest branch. The diameter was the stem diameter approximately 2 cm above the ground. Average height, diameter and emergence date were calculated for surviving seedlings only. Since it was difficult to accurately assess the seedling mortality in the fall, year-end survival for a given year was considered to be the number of seedlings that leafed-out the following spring.

Statistical analysis

For the field plot, the average emergence date (direct seeded acorns in 1990 only), year-end height, diameter and survival for each of the nine treatment combinations (three stock types x three pruning treatments) were calculated for each block. Each variable was then analyzed using analysis of variance for a randomized block design. When significant differences were found for main effects (stock types or radicle pruning treatments), a least significant difference (LSD) test at $P = 0.05$ was performed to determine which treatments were significantly different from one another.

The morphological data were analyzed separately for 4-month-old and 1-year-old seedlings. Each of the variables was analyzed using a one-way analysis of variance to determine if there were significant differences ($P = 0.05$) among the pruning treatments.

RESULTS

Emergence date

Seedlings emerged over a 12-week interval beginning in early March. There were no significant differences in average emergence date among pruning treatments, although there was a general trend for seedlings from acorns with the most severe pruning to emerge slightly later.

Survival

Survival was nearly 100% for the outplanted 4-month-old seedlings at the end of their 1993 growing season (table I). Only two of the 120 seedlings originally planted died, apparently from the clipping of roots by gophers during the third field season. Survival of the 1-year-old seedlings was less (90%), but not significantly different. However, survival for the direct seeded acorns (76%) was significantly less than for either container type. The reduced survival of the acorns appeared mainly due to acorn losses within the first few weeks after sowing. Most of this appeared to result from the augured holes sinking after the first heavy rains (in spite of our efforts to water them in), causing exposure of the acorns, which were then discovered and removed by rodents.

For the 1-year-old seedlings, almost all of the mortality occurred during the first year, and appeared to be due to the poor physiological quality of the planting stock. Many seedlings turned partially brown and bent over and appeared to be suffering from transplant shock. This is also supported by the fact that height growth of the surviving 1-year-old seedlings during the first year was extremely small.

Survival of the three radicle pruning treatments, on the other hand, was almost identical. In 1993, survival of the three treatments, averaged over stock types, varied by 1% or less (table II).

Table I. Field performance of different stock types in 1993.

Stock type	*Survival (%)*	*Height (cm)*	*Diameter (mm)*	*Height increment (cm)*	*Diameter increment (mm)*
Acorns	76[b]	141.4[a]	23.8[a]	43.5[a]	8.0[a]
4-month-old seedlings	99[a]	148.5[a]	24.8[a]	44.0[a]	8.3[a]
1-year-old seedlings	90[a]	90.8[b]	15.6[b]	36.5[b]	5.5[b]

In each column, values not followed by the same letter are significantly different ($P \leq 0.05$) by a Fisher's protected LSD test.

Table II. Field performance of seedlings from different radicle pruning treatments in 1993.

Radicle pruning treatment	*Survival (%)*	*Height (cm)*	*Diameter (mm)*	*Height increment (cm)*	*Diameter increment (mm)*
Control (radicle intact)	88	131.3	21.8	40.3	7.3
3 mm cut off radicle tip	89	125.7	21.6	41.8	7.5
1 cm of radicle left	88	123.8	20.8	41.9	7.0

There were no significant differences ($P \leq 0.05$) among radicle pruning treatments using analysis of variance.

Height growth

There was a consistent pattern in total height among stock types over the 4 years of the study, with direct seeded acorns and 4-month-old seedlings growing significantly more than 1-year-old seedlings. By the end of 1993, average height of seedlings from these first two treatments was more than 50% greater than that of seedlings from the 1-year-old stock type (table I). However there were no significant differences among radicle pruning treatments for height or height increment during any of the years of the study, including 1993 (table II).

Diameter growth

Diameter growth followed a similar pattern to height growth, with the 1-year-old stock type growing much less than the other two types in. At the end of 1993, the average diameters of acorns and 4-month-old seedlings were well over 50% greater than that of the 1-year-old seedlings (table I).

As with height, differences among radicle pruning treatments were slight, with no significant differences in 1993 (table II).

Seedling morphology

Both 4-month-old and 1-year-old seedlings exhibited similar morphological responses to the radicle pruning treatments (tables III and IV). For both stock types, cutting off part of the radicle prior to planting caused the formation of significantly more main tap roots, but resulted in significantly less root weight and total seedling weight. The average number of main tap roots resulting from either radicle trimming was close to three for both stock types. The average number for the control 4-month-old seedlings was almost exactly one, while it was 1.7 for the 1-year-old seedlings. However, the only difference in the other morphological variables was for shoot root ratio for the 4-month-old seedlings, where the ratio for the control seedlings was less than that for the most severely pruned. For both seedling types, there were no significant differences between the two treatments that removed part of the radicle.

Not surprisingly, at the time of destructive sampling for morphological characteristics, the 1-year-old seedlings were much larger than the 4-month-old seedlings, because of their additional 8 months of growth. Their average dry weight was approximately ten

Table III. Morphology of 4-month-old seedlings from different radicle pruning treatments.

Radicle pruning treatment	*Shoot height (cm)*	*Shoot diameter (mm)*	*Shoot weight (g)*	*Root weight (g)*	*Number of main tap roots*	*Shoot root ratio*	*Total seedling weight (g)*
Control (radicle intact)	7.2	2.1	0.36	0.70[a]	1.0[a]	0.54[a]	1.06[a]
3 mm cut off radicle tip	8.3	2.3	0.33	0.52[b]	2.9[b]	0.67[ab]	0.86[b]
1 cm of radicle left	7.7	2.2	0.33	0.47[b]	3.1[b]	0.70[b]	0.80[b]

In each column, means not followed by the same letter are significantly different ($P \leq 0.05$) by a Fisher's protected LSD test.

Table IV. Morphology of 1-year-old seedlings from different radicle pruning treatments.

Radicle pruning treatment	*Shoot height (cm)*	*Shoot diameter (mm)*	*Shoot weight (g)*	*Root weight (g)*	*Number of main tap roots*	*Shoot/ root ratio*	*Total seedling weight (g)*
Control (radicle intact)	36.1	5.4	3.5	7.7^{a}	1.7^{a}	0.47	11.2^{a}
3 mm cut off radicle tip	35.1	4.8	2.9	5.0^{b}	2.8^{b}	0.58	7.9^{b}
1 cm of radicle left	27.2	5.0	2.6	6.2^{ab}	3.0^{b}	0.44	8.8^{b}

In each column, values not followed by the same letter are significantly different ($P \leq 0.05$) by a Fisher's protected LSD test.

times as great, and their shoot height about four times as great.

DISCUSSION

As a member of the white oak group, blue oaks do not have embryo dormancy. As a result, they begin to germinate rapidly (even in cold storage) and in general cannot be stored for more than 4–6 months (Bonner and Vozzo, 1987). This early germination can cause viability problems, since the fleshy radicles are vulnerable to pathogenic fungi and can be severely damaged. Also, once the radicles grow over several centimeters long, they are difficult to plant either in containers or in bareroot nurseries without injury. However, this may not be a serious problem since Bonner (1982) reported that the breaking of radicles prior to sowing for Shumard (*Q shumardii* Buckl) and cherrybark oak (*Q falcata* var *pagodaefolia* Ell) did not adversely affect seedling production.

Some nursery operators intentionally clip off part of the radicles of germinated acorns prior to sowing. Schettler and Smith (1980) reported that tip-pinching of radicles was used to induce root branching. This practice generally inhibits the development of a main carrot-type tap root, and causes the formation of several tap roots and a more fibrous root system. It is thought that such a root system may confer an advantage to seedlings, by providing a greater root surface area for the absorption of moisture and nutrients. However, to date, there has been relatively little research on this subject. Harmer (1990) reported that without any modification of the radicles, northern red oak (*Q rubra* L) seedlings produced single tap roots that had little or no branching in the top 5 cm. Barden and Bowersox (1990) found that radicle clipping of northern red oak resulted in greater height increment. But they also found that the response to the treatments varied greatly by family, with several families producing more new roots following clipping, while others showing no change.

This is the first study that we are aware of that examines the effects of radicle clipping on a California oak species. While clipping tended to produce a more branched root system for blue oak seedlings grown in containers, it had no discernible effect on field performance of these seedlings, or of directly sown acorns. This is somewhat surprising since root morphology of both red and white oaks has been closely tied to field performance, with seedlings having greater numbers of first order lateral roots more successful and competitive after outplanting (Schultz and Thompson, 1992).

Stock type, however, greatly influenced field performance. The most striking result was the poor growth of the 1-year-old container seedlings compared to either directly sown acorns or 4-month-old seedlings. The poor growth was obvious the first field growing season, and continued into the fourth year. This may have resulted from the fact that these seedlings had outgrown their containers during the year they spent in them, and consequently, became 'pot-bound'. As a result, they had difficulty adapting to their new environment after outplanting, and grew slowly or died.

The extremely high survival and rapid growth of the 4-month-old seedlings was also surprising, since almost all container oaks produced in California are grown for a year or longer before outplanting. By 1993, this stock type had significantly greater height, diameter, and height and diameter increments than the 1-year-old seedlings. These results suggest that this type of planting material may be very desirable for regenerating blue oaks in California. This is encouraging since 4-month-old seedlings are much cheaper to produce than 1-year-old seedlings. With such a short rearing interval, it may also be possible for a container nursery to raise more than one crop of seedlings in a single year.

It is more difficult to compare the 4-month-old seedlings with the directly sown acorns. While the height, diameter and height and diameter increments of the 4-month-old seedlings were generally greater than those of the acorns, none of these differences were significant during any year of the study. The acorns did have significantly less overall survival (76 versus 99% in 1993), but the mortalities appeared mainly due to rodents, and this might not be a problem at planting sites where rodents are not present, or populations are low. Needless to say, acorns would be far cheaper to plant than 4-month-old seedlings.

Finally, the field results suggest that if a seedling survives through the first year after field planting, there is a high likelihood that it will remain alive. The average survival in 1993 was only slightly less than that in 1990.

CONCLUSION

This study indicates that trimming off part of the radicle of germinated blue oak acorns prior to planting has little or no influence on field performance of either directly sown acorns or container seedlings, and is therefore not recommended. The type of planting material used, on the other hand, can have a large influence on field performance. Both 4-month-old seedlings and directly sown acorns can perform well in the field, with average height growth in excess of 30 cm annually, even though blue oak is considered one of the slower growing species of California oaks. If large numbers of acorn-eating rodents are present at the planting site, seedlings should be used. Otherwise, acorns should be planted.

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University of California
Oak Woodland Management

How to Grow California Oaks

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Introduction

Native oaks are a vital and important component of the vegetation of California. They grow in a wide variety of habitats and help provide a distinctive character to the landscape. Not only are they beautiful to look at, but they also provide food and shelter for many wildlife species, they stabilize soil, and they help counteract the "greenhouse effect" by taking up carbon dioxide and producing oxygen.

It is estimated that one or more species of oaks grow on over 20 percent of the state's 100 million acres of land. Unfortunately, there are also reports that some native oaks may not be regenerating very well in some locations. Poor natural regeneration raises concerns about the long term fate of these species. To assist Mother Nature in establishing new oak trees, efforts are underway to plant acorns and small seedlings. Such regeneration efforts will ensure that our magnificent oaks, which have graced California valleys and foothills for thousands of years, will be around for future generations to enjoy also.

The following guidelines provide successful techniques for growing oak trees. While there are many ways to get an oak tree started, the procedures described have proved successful for a variety of species and environments.

Acorns or Seedlings?

Oak trees can be started by either directly planting acorns or transplanting small seedlings. However, since relatively few native oak seedlings are produced in the state, it may be difficult to purchase them. Those that are produced are generally grown in containers ranging in size from a few cubic inches to 5 or 15 gallons. Seedlings grown in the smaller containers should be no more than one year old before transplanting since they quickly outgrow small pots. Even with large containers, it is important that seedlings be transplanted within a couple of years since oaks tend to produce massive root systems and can easily become "*pot-bound*."

Some bareroot oak seedlings are also available. For the past several years the California Department of Forestry Nursery at Magalia has been growing, and making available to the public, several species of oaks. The supply of both container and bareroot oak seedlings should increase in future years as techniques for rearing them are developed and perfected, and more people express an interest in planting native oaks.

The choice of whether to plant acorns or seedlings depends on a whole host of factors including availability of planting material and conditions at the planting site. Generally, acorns are easier to plant, but the survival of seedlings may be greater if they are planted correctly at the right time of the year. Another factor that may influence the choice is what kinds of animals are present at the planting site. If there are high populations of acorn-eating rodents (ground squirrels or deer mice), it may be easier to plant seedlings than trying to protect the acorns.

Maintain Local Seed Sources

Since most tree species have adapted to the specific environments where they grow, it is important to only plant a given oak species in areas where it naturally occurs or where it may have grown in the past. Even within a species, you must be careful to only plant acorns or seedlings that come from a parent tree growing in the same general environment. If you took an acorn from a blue oak tree growing on the coast and planted it in the foothills of the Sierra Nevada, for instance, it would probably grow poorly, or die, even though blue oaks grow in both locations. Since coastal trees are genetically adapted to more temperate, moister conditions, they would be subject to injury from the colder, drier conditions of the interior. If you collect acorns yourself, you can be sure where they come from, and know that they are also handled and stored properly. If you buy from a nursery, make sure you find out the location and elevation of the acorns collected, and insist on seed sources from as near your planting site as possible.

Collecting Acorns

Acorns can be collected either directly from the trees or from the ground beneath. However, the healthiest acorns are generally those picked from the trees. Those that fall to the ground often dry out and are damaged especially if they lie exposed for more than a few days during hot and dry weather. If you do collect acorns from the ground, leave behind those that are very small, cracked or feel light and hollow. Acorns collected directly from trees can be hand-picked or knocked to the ground using long poles or pieces of plastic pipe. It's easy to pick them up if tarps are placed under the trees first.

The best time to collect acorns is generally in the early fall, when they are just starting to turn from green to brown and some are falling to the ground. It's probably too early to collect them if they are all dark green and it is difficult to remove their caps (the cup covering the rounded end). Wait a couple of weeks and check them again.

Storing Acorns

Prior to storage, the caps on all acorns should be taken off. They should come off easily when twisted. Acorns collected directly from the trees should be put in plastic bags and immediately placed in a refrigerator. Refrigeration slows the metabolic activity and helps prevent them from heating up or drying out both of which can be damaging. A recent study indicated that storing acorns in a refrigerator for a month or so before planting resulted in faster and more complete germination than planting acorns immediately.

Acorns picked up off the ground should be soaked for a day before they are placed in cold storage. Those that float should be discarded. "Floaters" are generally acorns that have been damaged by insects or have dried out while they were on the ground. "Sinkers" should be saved. Remove the acorns from the water and place them on cloth or paper towels for a half hour to dry their surface. Then place the acorns in plastic bags in the refrigerator. Check them occasionally for molds. If molds do develop, take the acorns out and rinse them, and then put them back in the refrigerator. Leaving the plastic bag partially open at the end seems to reduce the tendency for molds to develop.

Another problem that can develop in cold storage is premature germination. Blue oak acorns are especially prone to this. The white tip emerging from the pointed end of the acorn is actually the start of the new root system. Once these roots have grown for a few weeks, they can start to go bad and turn dark brown or grey and mushy. Therefore, if you see the acorns starting to germinate in storage, it's best to plant them as soon as possible.

Acorn and Seedling Planting

Acorns can be planted from early November (after the first rains have soaked the soil) until early March. However, it's generally better to plant acorns early in the season since the earlier they are placed in the ground, the earlier they start to grow. Early planting also reduces the problems associated with premature germination during storage.

Plant the acorns one-half to one inch below the soil surface. Dig a hole using a hand trowel, hoe, or shovel. It's best to dig the hole several inches deeper than the acorn is actually planted, and then partially fill the hole back up with loose soil. This gives the new root a chance to get a good start in soft, easy to penetrate soil. If the acorns have germinated, try not to break the root tip, and position it in such a way that the root is pointing down. Even if the tip of the root has begun to turn brown, the acorns should still be okay as long as some of the root is white and fleshy. Place ungerminated acorns on their side in the hole and cover with soil.

Planting seedlings requires a little more care since there is greater risk of transplant shock and root injury. Seedlings should be planted between December and February, when the soil is wet but not frozen. When planting potted seedlings, try to keep the soil from falling off the roots when the seedling is removed from the container. Place the seedlings in the ground such that the top of the soil from the container is even with the ground line. It is especially important not to plant the seedlings so shallow that the potting mix sticks up in the air, since this can cause moisture to "wick-out" and the seedlings to dry up. If you are planting bareroot seedlings, be sure not to "J-root" them (planting in too shallow a hole so the root bends up). Also, tamp the soil down in the planting hole so that air pockets are removed. If possible, water the transplants when they are planted. This settles the soil, ensures there is adequate moisture, and helps eliminate air pockets.

Recent studies have indicated that augering holes 1-2 feet below planting spots and backfilling with the broken-up soil can promote deep root development and stimulate vigorous growth. This is especially beneficial if you are planting in hard, compacted ground. Deep root development provides seedlings with greater access to moisture, thus reducing the ill effects of summer drought. Placing a fertilizer tablet a few inches below and to the side of the bottom of the root can also help ensure that the developing seedling will have plenty of nutrients for its initial growth.

The site where you choose to plant acorns or seedlings may also be critical for their success. Choose a sunny spot that has loose, well-drained soil and is fairly free of weeds. Also, avoid areas where there are lots of pocket gopher mounds or ground squirrel activity. If you do feel that the acorns may be threatened by rodents such as squirrels or mice, plant them a little deeper say, two inches below the surface. If they are planted deeper, it will be harder for these animals to dig them up. However, if they are planted too deep, they may rot or not be able to grow up to the soil surface.

Planting Layout

The number of acorns or seedlings to plant in a given area will depend on how many oaks you eventually want to grow there. Unfortunately, it is very difficult to predict how many trees will be produced from plantings, since a whole host of uncertain factors including weather, animals and competing vegetation can influence this. When laying out the planting area, consider spacing seedlings or acorns in a naturalistic manner, rather than in straight rows, using surrounding oak trees as a model. On open rangeland, it is recommended that trees be established in small clumps or clusters, with the goal of about 40 planting spots per acre. This comes out to an average of one cluster every 30-40 feet. Within each cluster, plant 3-4 seedlings. In restoration projects in riparian zones, a greater density is usually desirable, so have the clusters closer together say 15-20 feet apart.

Seedling Maintenance and Protection

Another critical factor affecting young oak seedlings is competing vegetation. Adjacent plants especially grasses can use up so much of the available soil moisture that little is left for the seedlings. It is therefore recommended that a 2-3 foot radius circle around the planting spots be cleared of other vegetation. This can be done by hand weeding, hoeing, scalping, or by spraying a contact herbicide. However, with any of these methods, be sure to check back in the spring and early summer to remove any additional weeds that may have come up. It is generally best to keep the weeds away for at least 2 years after planting.

Another way of reducing weeds near seedlings is to place some type of mulch around the planting spots. Bark chips, straw, compost, mulching paper, or even black plastic can be used. Mulches have an added benefit in that they also help conserve moisture by reducing evaporation from the soil surface. In areas where water is accessible, several deep irrigations (2 gallons per seedling) during the late spring and early summer can also help ensure that the seedlings are not damaged by drought.

Since acorns are an important food source for a whole host of animals, there is always a risk some of them will be dug up and eaten. As the seedlings start to grow in the spring, there is a also a chance that their tender young shoots will be eaten by livestock, rabbits, grasshoppers, or other animals. The risk of such injury to both acorns and seedlings can be reduced by placing protective cages around the planting spots. One type of cage that has worked well in research plots consists of an 18x18-inch aluminum screen that is formed into a 5-inch diameter cylinder and stapled to a 1x2x24-inch wooden stake. The cylinder is folded closed at the top. The stake is driven into the ground so that the screen cage covers the spot where the acorn or seedling is planted. This cage will keep out rodents, insects, and browsing animals.

A new type of protector is a rigid translucent tube. These "tree shelters" vary in height from one to six feet. These shelters not only keep away insects and browsers, but appear to stimulate height growth as well. Recent research indicates that tree shelters secured with metal fence posts can even protect seedlings from cattle and sheep. These protectors also facilitate chemical weed control around planting spots.

Another cage protector consists of a screen cylinder placed around a 1-quart yogurt or cottage cheese container that is open at both ends. Place the quart container in the soil so that the top is at the soil surface. This protective cage will not only prevent shoot damage, but will also help keep away burrowing animals such as gophers which can damage roots.

When the seedlings grow to the top of the screen cages, open the cages up so the seedlings can continue to grow. You're now well on your way to establishing an oak tree!

prepared and edited by John M. Harper and Richard B. Standiford

Quercus kelloggii Newb.

California Black Oak

Fagaceae -- Beech family

Philip M. McDonald

California black oak *(Quercus kelloggii.)* exceeds all other California oaks in volume, distribution, and altitudinal range. Yet this deciduous hardwood has had little sustained commercial use and almost no management, even though its wood closely resembles that of its valuable, managed, and heavily used counterpart-northern red oak *(Quercus rubra)*-in the Eastern United States.

First collected in 1846 near Sonoma, CA, the species was not named until. 1857 when John Newberry called it *kelloggii* in honor of Albert Kellogg, a pioneer California botanist and physician (17). In later botanical works, the species was called Q. californica and black oak or Kellogg's oak.

Acorns of California black oak were carried from San Francisco to England in 1878. Thirty-two years later, trees from these acorns were described as being 30 feet tall and making good growth (10).

Habitat

Native Range

The north-south range of California black oak is about 1255 kin (780 mi). In Oregon, its natural range extends from just north of Eugene, southward through the valleys west of the Cascade Range. The species is especially frequent along lower slopes in fairly dry sections of the Klamath and Cascade Mountains but never grows near the Pacific Ocean. In California, black oak is found in the northern Coast Range from the Oregon State line to Marin County and then intermittently in the Santa Cruz and Santa Lucia Mountains. This oak becomes more common on the San Bernardino, San Jacinto, and Agua Tibia Mountains, extending to just south of Mt. Laguna, and is now recognized as being in Baja California (5). In California's Sierra Nevada, the species grows abundantly along the west side, from near Lassen Peak to near. Kings Canyon. California black oak becomes intermittent southward to the Tehachapi Mountains, where it again increases in abundance. California black oak is generally confined to the westside, but a few stands have been found along the eastside of the Sierra Nevada. The species approaches the Nevada State line northeast of Beckwourth Pass but is not reported in Nevada.
-*The native range of California black oak.*

Climate

Hot dry summers and cool. moist winters characterize the climate where California black oak grows. Within the species' natural range, average annual precipitation varies widely. In the valleys of southwestern Oregon, it exceeds 760 mm (30 in); in northwestern California, it ranges from 760 to 2540 mm (30 to 100 in); and in northeastern California, only 300 to 380 mm (12 to 15 in) of rainfall annually. Throughout the range of black oak in north-central and central California, annual precipitation averages 1010 to 1780 mm (40 to 70 in) but may exceed 2920 mm (115 in) locally. In these areas less than 4 percent of the yearly precipitation falls from. June through September. In the mountains of southern California, precipitation averages 910 mm (36 in). Black oak achieves its best size and abundance in areas where snowfall accounts for 10 to 50 percent of the year's precipitation.

Average mean daily temperatures range from -1° to 8° C (31° to 46° F) during January, and from 19° to 28° C (66° to 82° F) in July. The last killing spring frost is expected between March 15 and June 9, and the first killing frost in the fall between August 30 and November 30. Periods free of killing frosts range from 82 to 270 days. Throughout an 18-year period, the highest temperature recorded at 1125 m (3,700 ft) elevation in the center of black oak's zone of greatest size and abundance was 39° C (103° F); the minimum temperature was -15° C (5° F). The maximum number of frost-free days was 215 and the minimum was 116 (35).

Soils and Topography

Probably the most important single soil variable that limits the presence of California black oak is internal drainage. Black oak is not found growing "with its feet wet." The species is adapted to soils derived from diverse parent materials-andesite, basalt, granite, pumice, quartz diorite, sandstone, schist, shale, and volcanic tuffs and breccias. California black oak only rarely is found on soils originating from serpentine. Occasionally it grows on soils derived from ultrabasic parent material, but mostly where above-average amounts of calcium seem to offset the deleterious effects of magnesium.

Soil textures favoring this oak range from medium-textured loams and clay-loams to the more coarse-textured gravelly-clay-loams and sandy-loams. Increasing clay content in the surface soil usually means a decreasing incidence of black oak. In fact, this species rarely is found on soils with clay topsoils, particularly if the clay is heavy and sticky. Black oak usually grows on thin soils and rocky slopes, but always at the cost of abundance or form, or both. In general, black oak grows best on medium- to coarse-textured, deep, and well-drained soils.

About 75 soil series in California have been identified by the California Cooperative Soil-Vegetation Survey and the National Cooperative Soil Survey as supporting California black oak. Important soil series in the California Coast Range include Boomer, Cohasset, Josephine, Sites, and Sheridan. In the Sierra Nevada, Aiken, Chawanakee, Holland, Stump Springs, Corbett, and Tish Tang support abundant black oak. Soils in the southern Cascade and Klamath Mountains that often are clothed with black oak include Aiken, Cohasset, McCarthy, Sites, Tournquist, Behemotosh, Horseshoe, and Neuns. Fourteen soil series have been identified in Oregon, mostly on series similar to those in California. Most of the soils in both States are found at higher elevations and support forest vegetation rather than oak woodland or chaparral. Soil orders are mostly Alfisols and Inceptisols, occasionally Mollisols.

The best black oak stands in the Coast Range and Klamath Mountains are found on deep, slightly acid loams and gravelly-clay-loams derived from sandstone and shale. In the southern Cascade Range and northern Sierra Nevada, black oak grows best on deep loams and clay-loams originating from metavolcanic rocks. In the central and southern Sierra Nevada and in the Transverse and Peninsular Ranges, this oak grows well on deep, acid to moderately acid sandy-loam soils derived from granitic rock.

California black oak grows within a wide elevational range-from the level gravelly floors of low valleys to alluvial slopes, rocky ridges, and high plateaus. Most of the terrain is rugged, steep, and dissected by major streams and ephemeral drainages.

In Oregon, the elevational range of black oak varies from 137 in (450 ft) near Eugene, to more than 305 m (1,000 ft) on the low rounded hills in the Umpqua River drainage (13). The oak also is found within this elevational range on the eastern slopes of the Coast Range and the western slopes of the Cascades. In south central Oregon and the Klamath Mountains, black oak grows at higher elevations of 610 to 915 m (2,000 to 3,000 ft).

In California's Coast Range, black oak is found from about 152 in (500 ft) along the Mattole River in Humboldt County to 1830 in (6,000 ft) in the Yolla Bolly Mountains. Black oak reaches its lowest elevation (60 m or 200 ft) in the Napa and Santa Rosa Valleys. Most black oak in the central portion of the Coast Range grows between 305 to 1525 m (1,000 to 5,000 ft), gradually increasing in elevation but narrowing in range to 1220 to 1982 m (4,000 to 6,500 ft) in Santa Barbara and eastern Ventura Counties. Farther south in the Transverse Range the species is found at elevations of 1403 to 2135 m (4,600 to 7,000 ft) (39). In the San Jacinto Mountains, black oak reaches 2440 in (8,000 ft) and, at its southernmost extension in the Peninsular Range of San Diego County, it grows within the 1525- to 1830-m (5,000 to 6,000-ft) elevation.

The elevational range of black oak in California's Cascade Range is from about 183 m (600 ft) in western Shasta County to 1906 in (6,250 ft) in southcentral Shasta County. In the Sierra Nevada, lower elevational limits for black oak range from 458 in (1,500 ft) in the north to 1220 in (4,000 ft) in the south. Upper limits increase north to south from about 1982 to 2380 m (6,500 to 7,800 ft).

California black oak is most abundant and attains its largest size in the Sierra Nevada. Extensive stands of excellent development also are found in eastern Mendocino and Humboldt Counties of the north Coast Range. Elevation and aspect often interact to govern abundance and development. At elevations below 305 in (1,000 ft) in north-central California, black oak is found primarily in sheltered draws or on north slopes. With increasing elevation, favorable aspects increase until at 762 to 915 m (2,500 to 3,000 ft) all aspects support California black oak, providing soil is deep enough. Above 1067 in (3,500 ft), north- and east-facing slopes often are devoid of black oak, although other vegetation grows well. In the southernmost mountains, black oak is found on west-facing slopes, but only where soils are deep, temperatures are cool, and soil moisture is adequate.

Associated Forest Cover

California black oak is a component of six forest cover types (11). It is the prime constituent of California Black Oak (Society of American Foresters Type 246) and a major component in two others: Douglas-Fir-Tanoak-Pacific Madrone (Type 234) and Pacific Ponderosa Pine-Douglas-Fir (Type 244). Black oak becomes important in Sierra Nevada Mixed Conifer (Type 243) and Pacific Ponderosa Pine (Type 245) after severe disturbance or fire. The oak is a minor component in Canyon Live Oak (Type 249).

The successional status of California black oak is not clear. It has been implied that the species was climax because the type in which it was a part represented a degree of mesophytism between that of the chaparral and the conifer forest (7). The species was also thought to be more a persistent subclimax than climax.

California black oak, or its fossilized equivalent *(Quercus pseudolyrata),* was much more widespread in past ages than now. Fossil remains indicate that the species was abundant in sedimentary deposits near Spokane and Ellensburg, WA, in the John Day Valley and Blue Mountains of Oregon, and in northwestern Nevada (6). These deposits date back to the Miocene epoch of 12 to 26 million years ago. Increasing aridity is the probable cause for the smaller natural range of black oak today.

The most common botanical associate of black oak is ponderosa pine *(Pinus ponderosa* var. *ponderosa).* The two species intermingle over vast acreages, except that black oak is found at lower elevations, on sites too poor to support pine, and in certain areas within the redwood region of California where pine does not grow. Another exception is that this oak is rarely found in Interior Ponderosa Pine (Type 237) (11). In California and Oregon, therefore, where the natural ranges of the two species coincide, ponderosa pine sites generally are fertile ground for black oak. And black oak sites are almost always fertile ground for ponderosa pine.

At lower elevations, black oak often serves as a nurse tree to conifers. Ponderosa pine, Douglas-fir *(Pseudotsuga menziesii),* and incense-cedar *(Libocedrus decurrens)* seedlings often become established beneath the sheltering crowns of large black oaks while adjacent ground remains bare (2).

A rule-of-thumb is that black oak never grows through a stand of ponderosa pine but can grow through brush (9). Without disturbance, black oak is eventually crowded out of the best sites and remains only as scattered remnants in mixed-conifer forests. Here it often exists on "islands" of soil or terrain not favorable for natural regeneration of conifers.

Black oak grows individually or in groves, some of which are quite extensive. Usually each grove is of one age-class, the result of sprouting after fire (34). Rarely does it exist as an understory, especially beneath a closed canopy. The species is usually a component of hardwood stands or of mixed hardwood and conifer forests. Tanoak *(Lithocarpus densiflorus)* and Pacific madrone *(Arbutus menziesii)* are the most common hardwood associates of black oak. Other hardwood associates at lower elevations are Oregon white oak *(Quercus garryana),* interior live oak *(Q. wislizenii),* coast live oak *(Q. agrifolia),* Engelmann oak *(Q. engelmannii),* and blue oak

(Q. douglasii). At higher elevations Pacific dogwood *(Cornus nuttallii),* bigleaf maple *(Acer macrophyllum),* California-laurel *(Umbellularia californica),* and canyon live oak *(Quercus chrysolepis)* intermix with California black oak.

Besides ponderosa pine, conifer associates at low elevations are knobcone pine *(Pinus attenuata),* Monterey pine (P. *radiata),* Digger pine *(P. sabiniana),* and redwood *(Sequoia sempervirens).* At intermediate elevations within the natural range of California black oak are California white fir *(Abies concolor* var. *lowiana),* grand fir *(A. grandis),* incense-cedar, Coulter pine *(Pinus coulteri),* sugar pine *(P. lambertiana),* giant sequoia *(Sequoiadendron giganteum),* Douglas-fir, California torreya *(Torreya californica),* and bigcone Douglas-fir *(Pseudotsuga macrocarpa).* At higher elevations black oak intermingles with western juniper *(Juniperus occidentalis)* and Jeffrey pine *(Pinus jeffreyi).*

Shrub associates include at least 30 species, some of the most important of which are greenleaf manzanita *(Arctostaphylos patula),* whiteleaf manzanita *(A. viscida),* deerbrush *(Ceanothus integerrimus),* bear-clover *(Chamaebatia foliolosa),* oceanspray *(Holodiscus discolor),* Brewer oak *(Quercus garryana* var. *breweri),* Sierra coffeeberry *(Rhamnus rubra),* Sierra gooseberry *(Ribes roezlii),* and poison-oak *(Toxicodendron diversilobum).* In parts of Shasta and Trinity Counties, and perhaps elsewhere, black oak itself takes a shrub form. The stands so formed usually are dense and tangled-ideal habitat for deer and upland game.

Except on the fringe of black oak's natural range, especially at the lowermost elevations, most shrubs generally are not competitive, nor particularly abundant over most of the forest land where black oak grows. After heavy cutting or fire, however, some of the more aggressive shrubs often compete strongly with black oak sprouts.

When compared with 15 of its most common shrub associates in the Klamath Mountains of northern California, black oak ranked ninth in need of soil moisture, third in demand on soil nutrients, eighth in terms of tolerance, and first in rapidity of sprouting (32). The species is able to withstand high moisture stress (37) and to become established and grow well on harsh sites where few other species are capable.

Life History

Reproduction and Early Growth

Flowering and Fruiting- California black oak flowers from mid-March to mid-May depending on elevation, physiography, and local climatic conditions. In general, trees near the coast and at lower elevations bloom earliest.

Flowers on black oak are unisexual. The plant is monoecious. Staminate flowers are long (3.5 to 7.5 cm or 1.4 to 3.0 in) hairy aments that emerge from buds in the leaf axils of the previous year's growth. The five to nine stamens in each ament have bright red anthers and pale green filaments. The calyx is light green. Pistillate flowers are borne singly or two to seven on a short stalk that originates from leaf axils of the current year's growth. The stigmas are dark red.

Acorns mature in the second year. Early in the second summer the immature acorn resembles a small globe about 6 mm (0.2 in) in diameter. At this stage, the acorn is completely encapsulated in the cup. At maturity the light brown, thin-scaled cup encloses from 0.5 to 0.75 of the acorn. Acorns form singly, or in clusters of two to six, and vary widely in dimension. Sizes range from 1.9 to 4.4 cm (0.7 to 1.7 in) long and from 0.9 to 3.8 cm (0.4 to 1.5 in) in diameter.

Seed Production and Dissemination- In natural stands, black oak must be 30 years or older before it produces viable seed. The oak produces some acorns sporadically between ages 30 and 75 but seldom large quantities before 80 to 100 years. A few trees bear at least some acorns every year. Others of similar diameter and crown characteristics rarely produce acorns. Trees that are good seed producers continue abundant acorn production at least to 200 years.

Age, diameter of bole, and crown width influence acorn yield (22). A general relationship for a medium seed crop on a good forest site is that acorn yield increases as bole and crown diameter increase, at least through age 200:

Age	**Bole diameter**		**Crown diameter**		**Acorn yield**	
yr	*cm*	*in*	*m*	*ft*	*kg*	*lb*
30	13	5	5	15	0	0
50	23	9	6	20	2	5
80	33	13	8	26	9	20
100	43	17	10	32	27	60
150	61	24	12	41	45	100
200	81	32	16	52	64	140

Estimates of acorn production by tree or size of seed crop are scarce. One large, 150- to 200-year-old black oak in Butte County, CA, produced about 6,500 acorns for a crop year rated as fair. Acorns were large and heavy, numbering 115/kg (52/lb). Black oak acorns usually are smaller, numbering between 115 and 324/kg (52 and 147/lb). Large acorns have been observed at both low and high elevations and small acorns at medium elevations. The factors influencing acorn size probably are many, but little is known about their interaction. A single, large, well-developed tree at a low elevation in Shasta County, CA, produced sound acorns each year as follows:

1974	700
1975	1,000
1976	65
1977	0
1978	320
1979	231
1980	125

The magnitude and periodicity of seed crops appear to be quite variable. One study reported that abundant seed crops for entire stands were produced at 2- to 3-year intervals (31). At 760 m (2,500 ft) elevation in Yuba County, CA, medium to bumper seed crops were produced in 4 of 20 years. At 850 in (2,800 ft) elevation in south-central Shasta County, medium to bumper crops were borne on large black oaks in 4 of 8 years. At a lower elevation in Shasta County (170 m or 560 ft), black oaks yielded sound acorns in 6 of 7 years. Of these, two each rated as bumper, medium, and light.

Insects destroy many acorns, primarily in the developmental stage. Immature acorns are attacked by both lepidopterous and coleopterous pests. The filbertworm *(Melissopus latiferreanus)* and the filbert weevil *(Curculio uniformis)* are particularly destructive, in some places infesting up to 95 percent of the acorns and destroying most of a crop (16). Fire may lessen these losses. On the Shasta-Trinity National Forests in California, a prescribed burn in March 1978 resulted in a bumper crop of sound black oak acorns, while trees on unburned ground nearby bore only unsound acorns. Apparently, destructive insects in the duff and soil were reduced greatly by the fire (33).

Fully developed acorns begin falling in mid-August at lower elevations, and in mid-September at higher elevations. Almost all acorns that fall first are hollow or infested with insects. Some are still green or greenish yellow. Sound acorns begin dropping from late September to early November and cease by November 15 at lower elevations. At higher elevations almost all acorns have fallen by early December.

Acorns generally drop just before or during leaf fall. Once on the ground, temperature can be critical to continued viability, and fallen leaves help keep acorn temperatures below lethal thresholds. In one instance, fully mature acorns exposed to the hot fall sun had withered cotyledons after 9 days. Acorns from the same trees showed full-sized cotyledons after 21 days, if protected by leaves and branches (21). Likewise, cotyledons of acorns exposed to freezing temperatures turned gray and flaccid, although cotyledons of acorns beneath tree crowns and covered with leaves remained white, crisp, and firm.

A blue-gray mold also damages fallen seed. At one location, acorns covered for about 2 months by wet leaves showed mold at the blunt ends that had progressed well within the seeds. For other acorns in this same environment, cutting tests showed that cotyledons were unaffected. American Indians, however, gathered only freshly fallen acorns to avoid the mold (15).

Because the acorns are large and heavy, most fall directly beneath tree crowns. Few bounce or roll far on steep slopes covered by duff, leaves, and litter. Animals play a vital role in dissemination of acorns because they transport some of them away from the parent tree. The western gray squirrel and the scrub jay are the most important disseminators, for they bury the acorns, sometimes spreading the species to areas nearby.

Black oak acorns are eaten by at least 14 species of song and game birds, many species and subspecies of small mammals (mostly rodents), and mule deer (20). Black bears in the San Bernardino Mountains of southern California utilize the California black oak type in spring, summer, and fall (28). For many of these creatures, acorns are the primary foodstuff in the fall.

Without acorns, populations are affected. Fawn survival rates, for example, increase and decrease with the size of the acorn crop.

Cattle, and, to a lesser extent, sheep, also consume many black oak acorns each year.

Seedling Development- California black oak reproduces from seed, but natural regeneration tends to be scanty, poorly distributed, and uncertain. The most likely place to find black oak seedlings is beneath large parent trees, where they number up to $45/m^2$ ($4/ft^2$).

Before the seeds begin to germinate, a period of after-ripening to overcome dormancy is required. Overwintering beneath the litter on the forest floor normally breaks dormancy under natural conditions. For artificial regeneration, acorns can be stratified by cold storage in sealed polyethylene bags thick enough to inhibit moisture loss, but porous enough to freely emit respiration byproducts. Storage temperature should be just above freezing and moisture content of acorns maintained at a level where cotyledons are turgid or slightly flaccid, but not dried out.

Natural seedbed requirements for germination are not exacting. Either undisturbed leaflitter or, to a lesser extent, moist, well-aerated mineral soil are good seedbeds. Establishment of black oak is almost nonexistent on heavy clay soils or soils compacted by logging machinery. These conditions reduce the ability of the radicle to penetrate the soil far enough and fast enough to avoid searing soil surface temperatures or the seasonal drying of upper soil layers.

Acorns germinate in the spring when the weather warms. Germination is hypogeal and highly variable, both in magnitude and timing. The radicle is first to emerge and grows downward for some time, often 10 to 20 days, before the epicotyl appears above ground. This process benefits the seedling in getting to and staying in available soil moisture, and in minimizing transpirational losses. Sometimes a single acorn may put forth several epicotyls, particularly if upward progress is hampered by a stony or crusty soil.

Under optimum conditions, 15 to 25 days elapse between sowing of stratified acorns and the beginning of germination. In nature, the germination period may be several weeks or even months. Germinative capacity varies considerably and changes with degree of insect infestation, amount of mold, and depth of acorn in soil, among other variables. Germination has been reported as high as 95 percent and also as scanty (21 percent). Germinative capacities in large-scale field tests in the northern Sierra Nevada were 31 and 38 percent (22).

Black oak seedlings often reach heights of 10 to 15 cm (4 to 6 in) and extend their taproots downward as deep as 76 cm (30 in) in the first growing season. Development of a deep-thrusting vertical root is necessary for seedlings to cope with the hot dry summers characteristic of California black oak's range. For the first few years, therefore, both lateral root development and shoot growth are slow. Shoot growth probably does not begin to accelerate until root capacity is extensive enough to obtain adequate moisture. This may take 6 or 7 years or longer. Shoot growth of some seedlings, particularly those stressed by competing *vegetation, never accelerates and these* seedlings eventually die.

Studies evaluating artificially regenerated California black oak on the Plumas and Angeles National Forests in California indicate that artificial regeneration of black oak is possible, providing that competing vegetation and pocket gophers are controlled. Fall planting of 1-year-old seedlings, without artificial watering, resulted in good survival and growth on the San Bernardino National Forest, California (30).

Fertilization appears to be one technique for enlarging root capacity and stimulating height development of seedlings. In a test in the northern Sierra Nevada, fertilized seedlings were more than three times taller than unfertilized seedlings (0.2 as against 0.8 m or 0.7 as against 2.5 ft) after five growing seasons. Fertilizer in the proportion of 1620-0 for nitrogen, phosphorus, and potassium was applied at about 0.1 kg (0.25 lb) per seedling early in the spring of each year (22).

Young black oak seedlings are killed mostly by drought and pocket gophers. Grasshoppers and other insects damage young seedlings, and freezing by late spring frosts injures them. These injuries usually are mitigated by sprouting from the root crown.

Vegetative Reproduction- California black oak sprouts profusely after trees are cut or burned. Most sprouts develop from latent buds, which lie under the bark at, or slightly above, the root collar. Other sprouts originate from the top of the stump or between the top and the ground. These are called stool sprouts and are undesirable for two reasons. They are weakly attached to the parent stump and frequently broken off by wind and snow, and are prone to heart rot at an early age.

The size and vigor of the parent tree determine the number of sprouts and their height and crown spread. In general, stumps from larger trees produce a larger number of sprouts and more vigorous ones. Only old, moribund trees fail to produce sprouts after cutting.

Low stumps of nearly all diameters produce many more sprouts than high stumps. High-stumping an older, larger tree yields undesirable stool sprouts, and often no sprouts from below ground.

Root crown sprouts grow vigorously, especially in full sunlight. Forty-nine stumps were studied in stands on a good site in the northern Sierra Nevada. Sprout density, height, and crown width were evaluated in clearcuttings and in shelterwood stands where 50 percent of the basal area had been removed (22). Number of sprouts, crown width, and especially height growth were consistently greater in the clearcuttings (table 1).

Table- Development of California black oak stump sprouts in a northern Sierra Nevada forest 10 years after cutting

Year after cutting	Sprouts per stump		Height		Crown width	
	Clearcut	Shelterwood	Clearcut	Shelterwood	Clearcut	Shelterwood
	no.		*m*			
0	55+	28	--	-- --	--	--

2	55+	23	1.2	0.9	1.2	0.7
4	35	17	2.4	1.2	1.8	1
6	23	15	3.7	1.5	2.3	1.2
8	18	13	4.9	1.8	2.6	1.6
10	15	12	6	2.1	2.9	2.2
	no.			***ft***		
0	55+	28	--	--	--	--
2	55+	23	4	3	4	2
4	35	17	8	4	6	3
6	23	15	12	5	8	4
8	18	13	16	6	9	5
10	15	12	20	7	10	7

The environment typical of shelterwood cuttings apparently is more favorable to a cynipid gall wasp *(Callirhytis perdens)* than that in clearcuttings. Damage to terminal shoots by this pest is greater under shelterwood stands, accounting in part for the poorer height growth of sprouts. Thinning sprouts to three or four per stump at age 4 showed no gain in height but resulted in undesirable damage to the bole from sunscald and increased forking of stems (22).

Young black oak sprouts grow faster in height than other vegetation, including coniferous associates. Consequently, they remain dominant for many years. Although black oak seedlings extend the species into new areas, sprouts keep the oak in the same area and are responsible for regenerating many more stands than seedlings. Only after the living crown has moved considerably up the bole does black oak begin its role as a nurse tree, aiding conifers to become established and grow to equal or dominant positions in the stand.

Propagation by layering, rooting of cuttings, or grafting has not been reported. But the wartime shortage of cork in the 1940's stimulated grafting of cork oak *(Quercus suber)* to black oak stocks. In a greenhouse trial, 70 percent of the grafts were successful (27).

Sapling and Pole Stages to Maturity

Growth and Yield- Because fire incidence throughout its natural range is high, nearly all black oak trees originated from sprouts. Consequently most California black oak stands are even-aged.

Number of sprouts per stump influences growth, form and, eventually, yield. The number per clump decreases rapidly with age. By the time the sprouts are pole-size, competition within individual clumps has reduced them to two or three, or occasionally, four stems. By age 100, only one or two stems remain. These data are based on 180 clumps at many California sites (21).

The form of California black oak varies greatly. On the fringe of its range and on marginal sites, black oak trees assume a scrubby form. In closed stands on good sites, the oaks tend to be tall and straight with clear boles and thin crowns. When open-grown, black oaks generally fork repeatedly, becoming multistemmed and broad-crowned.

The general age-height relationship of California black oak, based on 393 dominant trees in northern and central California, is curvilinear until age 140. Thereafter, tree height remains constant regardless of age. Selected age-heights are 20 years, 8 m (26 ft); 40 years, 13 m (43 ft); 60 years, 17 m (56 ft); 100 years, 22 m (72 ft); and 140 years, 25 m (82 ft) (21).

Position on long continuous slopes also influences growth and form. Trees at the toe of slopes or on gently sloping benches, where deeper soils are likely, generally grow best and have good form. Those at midslope are shorter and more scrubby. On upper slopes, trees grow slowly and are even shorter. Aspect also influences growth. Of the 393 trees noted earlier, 100-year-old trees averaged about 26 m (85 ft) in height on east aspects; 22 m (72 ft) on north aspects; 21 m (68 ft) on west; and 17 m (56 ft) in height on south aspects.

Average site index at base age 50 years is about 15 m (50 ft); better than average, about 18 m (60 ft); and poor, only 11 to 12 m (35 to 40 ft) (29).

Diameter growth is often slow during the first 25 years of a black oak's life. Competition for position in the canopy tends to favor height growth over diameter growth. At 25 years, the average tree is nearly 11 m (35 ft) tall and about 10 cm (4 in) in d.b.h. and is one of three sprouts in the clump. Black oak grows fastest in diameter from age 25 to 65 (table 2). Its growth can reach one ring per centimeter or three rings per inch. At age 65 the tree is about 29 cm (11.5 in) in d.b.h. and has grown almost 0.5 cm/yr (0.2 in/yr).

Table 2- Diameter growth in natural stands, California black oak, 1968[1]

Age	**D.b.h.**		**Average cumulative increment per decade**	
yr	***cm***	***in***	***cm***	***in***
20	9	3.4	4.32	1.7
30	14	5.4	4.57	1.8
40	18	7.2	4.57	1.8
50	23	9	4.57	1.8
60	27	10.8	4.57	1.8
70	31	12.2	4.42	1.74
80	34	13.4	4.27	1.68
90	37	14.6	4.11	1.62
100	40	15.6	3.96	1.56
110	42	16.6	3.84	1.51
120	44	17.5	3.71	1.46

[1] Basis: 405 dominant trees in 45 even-aged stands, many
California sites.

Black oak in an understocked stand averages 33 to 35 cm (13 to 14 in) in d.b.h. at 65 years; in an overstocked stand, it averages between 18 and 23 cm (7 to 9 in). After age 65, diameter growth slowly declines. By age 90 most trees are mature.

Diameter growth of California black oak can be increased greatly by thinning. On a good site in the northern Sierra Nevada, diameter growth rates of trees thinned when 60 years old were twice that of unthinned trees of similar age 8 years after thinning (23).

Black oak may live to be almost 500 years old, but age-diameter relationships beyond 120 years are uncertain. Trees 51 cm (20 in) in d.b.h. can range between 70 and 175 years. Trees 41 to 63 cm (16 to 25 in) in d.b.h. were 175 to 275 years old, and those more than 102 cm (40 in) were 175 to 325 years old.

Black oak seldom exceeds 1.5 m (5 ft) in d.b.h. or 40 m (130 ft) in height. The largest living black oak known measures 274 cm (108 in) in d.b.h. and 37.8 m (124 ft) in height. This tree grows in the Siskiyou National Forest, OR (1).

Yield data are difficult to find. The "average" stand contains 1,086 trees per hectare (440/acre), 8.9 cm (3.5 in) and larger in d.b.h., and would yield slightly more than 409 m^3/ha (5,845 ft^3 or 65 cords/acre). In 60-year-old mixed-hardwood stands on good sites in the northern Sierra Nevada, black oak produces 76 m^3/ha (1,085 ft^3 or 12.1 cords/acre).

Rooting Habit- Various investigators have described the rooting system of black oak as having no taproot but large spreading roots (18); as deep and long lived; with a strong taproot; and possessing strong laterals, more or less deep, depending on depth to ground water (3).

Observations at road cuts indicate the general rooting pattern of this oak. Usually, from one to several vertical roots extend through the soil and penetrate to rock. Then they become lateral and spread out directly above the rock. At fissures, "sinker" roots penetrate the rock itself. A number of roots are found near the surface, probably to exploit the nutrients there.

Reaction to Competition- The tolerance of black oak to shade varies with age. It most accurately can be classed as intolerant because this condition exists throughout most of its life (9). The oak is moderately tolerant in early life, growing well in full sunlight but persisting in dense shade (31). As a sapling and small pole, black oak is less tolerant and often grows tall and thin until it reaches a position in the canopy where it can receive light. The need for top light increases as the tree ages. In dense stands, black oak often fills a "hole" in the canopy, sometimes leaning 15 to 20 degrees to do so. If overtopped, the oak either dies outright or dies back successively each year. Short epicormic branches keep the tree alive for a time, but with continued overtopping, death is inevitable.

Damaging Agents- Fire is black oak's worst enemy. Crown fires kill trees of all ages and ground fires are often fatal. Only a little radiative heat kills the cambium and only a small amount of flame along the trunk leaves long vertical wounds. Bark thickness on mature trees varies from 2 to 5 cm (1 to 2 in), but even the thickest bark provides little insulation to fire. Scars from burning can become a point of entry for fungi. On larger trees, repeated fires often enlarge old scars, sometimes toppling the tree. Fluctuations in weather also cause injury. Heavy, wet snow breaks branches and stems, particularly at forks, and sudden high temperatures following cool wet weather severely injure leaves (25).

California black oak is especially susceptible to fungi. Heart rot of the bole and large limbs of living trees, caused mainly by two pathogens, *Inonotus dryophilus* and *Laetiporus sulphureus*, is the principal damage (24). These rots enter the tree through broken branches or open wounds resulting from fire or logging. Both fungi often reduce the bole and large limbs of older, decadent trees to mere shells. The hedgehog fungus *(Hydnum erinaceus)* also is found in the heartwood of living trees and *Polyporus adustus* in the sapwood, though neither is prevalent.

By the time a natural black oak stand is 85 years old, the proportion of infected trees begins to increase rapidly. Almost 40 percent of trees 110 to 120 years old show incipient heart rot (21). Rotation age of stands grown for wood products could be influenced by this incidence-age relationship.

Another serious pathogen, *Armillaria mellea*, causes decay of the roots and butt of older decadent black oak. Sometimes it weakens the root system so much that the tree topples over on a perfectly calm, still day (36). This pathogen is indigenous in black oak, but younger vigorous trees do not seem to be affected by it.

A comparatively recent damaging agent to black oak in the San Bernardino Mountains of southern California is air pollution. Although the oak appears less susceptible to air pollution damage than associated conifers, radial growth has decreased in some trees (12). Where high ambient oxidant air pollution levels are chronic, damage to California black oak is expected to be significant (26).

One virulent pathogen that black oak escapes, and indeed is resistant to, is *Heterobasidion annosum* (14). For this reason, California black oak is being planted in numerous infection centers in southern California forests where conifers are dead or dying.

California black oak is prone to several leaf diseases including the oak leaf fungus *(Septoria quercicola)*, oak anthracnose *(Gnomonia veneta)*, powdery mildews *(Microsphaera* and *Sphaerotheca* spp.), a leaf blister fungus *(Taphrina caerulescens)*, a leaf rust *(Cronartium* spp.*)*, and true mistletoe *(Phoradendron villosum* subsp. *villosum).* Damage from each of these pests has not been determined but loss of growth increment probably is minor.

Animal damage to black oak is mostly from browsing. Foliage is eaten during all seasons, but especially in spring when new growth is tender and in winter when twigs are eaten. Deer eat acorns, seedlings, sprouts, and foliage. Even in midsummer, newly germinated seedlings with acorns attached often are consumed (8). Occasionally, browsing is fatal. In Mendocino County, CA, for example, a deer population of 1/2.4 ha (1/6 acres) almost eliminated oak over large areas of the Coast Range. Cattle also browse black oak, but in national forests, at least, their numbers are declining.

Many insects derive sustenance from black oak. The damage is usually secondary, reducing growth but seldom killing trees. Among sucking insects, the pit scales *(Asterolecanium minus* and *A. quercicola)* have the greatest potential for damage (4). The most destructive insect, however, is probably the carpenterworm *(Prionoxystus robiniae),* whose larvae mine the wood of trunk and limbs and cause injuries that appear later as defects in lumber (16).

Other insects are capable of heavy damage, especially when infestations become epidemic. The Pacific oak twig girdler *(Agrilus angelicus)* is the most damaging insect to oak in southern California during drought years (4). In northern California, the California oakworm *(Phryganidia californica)* is noted for defoliating trees. So is the fruit-tree leafroller *(Archips argyrospila)* which, in 1968, caused heavy damage throughout a wide area in the Sacramento River drainage.

Special Uses

Several attributes qualify the wood of California black oak for commercial use: attractive grain and figure for paneling and furniture, hardness and finishing qualities for flooring, and strength properties for pallets, industrial flooring, and other uses (19). The forks of open-grown black oaks were put to good use in the 1870-80's in Mendocino County.

Those of specific dimensions were used as "naturally assembled" ship keels and ribs. Wood products currently produced are high grade lumber and pallets, industrial timbers, sawdust for mulching, and bulk and prepackaged firewood. The wood is prized for fuelwood and in some areas unrestricted cutting is eliminating oak stands.

Although not presently utilized, black oak acorns, high in edible oils, are a potential source for thousands of tons of human food (38).

Genetics

Two natural hybrids are recognized: *Quercus x ganderi C. B. Wolf (Q. agrifolia x Q. kelloggii)* and *Quercus x moreha* Kellogg *(Q. kelloggii x wislizenii).* Another hybrid, *Quercus x chasei (Q. agrifolia x kelloggii)* has been described in Monterey and Santa Clara Counties, CA.

Of the hybrids, *Q. moreha* is by far the most widespread, ranging throughout California and even found, though rarely, in south-central Oregon. The tree is distinguished readily in the winter by its sparse evergreen foliage in contrast to the completely deciduous black oak. New leaves in spring form a dense mass of shiny green foliage on the hybrid.

Forma cibata, a form by which black oak has been described, is a low shrub common to steep, rocky, talus slopes at higher elevations. Although described as a true shrub form, this status is questionable. No criteria are known for distinguishing between it and scrubby black oak trees.

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A Tradition of Stewardship
A Commitment to Service

2010

Napa County Voluntary Oak Woodland Management Plan

October 26, 2010

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Napa County Voluntary Oak Woodland Management Plan

October 26, 2010

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Napa County Voluntary Oak Woodland Management Plan

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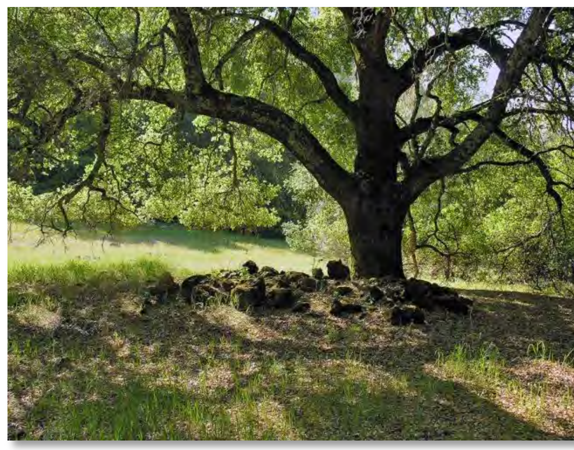
I. Introduction

Napa County has the greatest density of oaks of any county in California, with thirty-three percent of the county covered by oak woodlands[1]. These oak woodlands are one of the defining features of Napa County's scenery, and provide numerous recreational and ecological benefits. In addition to more common species of oak, Napa County contains many of California's remaining vanishing valley oaks, which make up only one percent of the state's oak population, but almost six percent of Napa County's oaks[2].

Despite Napa County's slow growth conservation efforts, oak woodlands remain at risk from development and natural hazards. To address these and other risks, public agencies, non-profit organizations, and property owners can all work together to protect our natural resources. This voluntary management plan will help to coordinate conservation efforts to preserve and restore Napa County's oak woodland resources.



A. Purpose

The purpose of this Voluntary Oak Woodlands Management Plan is to provide a conservation framework for the preservation of our oak woodland resources. This Plan provides a summary of the location, condition and value of Napa County's oak woodlands; identifies potential threats; outlines conservation strategies; supports landowners/ agencies/ non-profits eligibility for grants under the California Oak Woodlands Conservation Program; and improves communication and collaboration among those interested in the long-term health and viability of Napa County's oak woodlands.

This Oak Woodlands Management Plan will help to achieve the following:

1. Protect existing oak woodlands by creating a voluntary protection and conservation program, including landowner incentives, for conservation and enhancement of oak woodland;

2. Direct conservation and enhancement funding toward areas that have the highest oak woodland resource values;

3. Direct mitigation for oak woodland impacts to areas that have the highest oak woodland resource values and are in need of protection and/ or enhancement;

4. Encourage the long-term stewardship and vitality of existing oak woodlands to maintain or improve oak woodland resource values;

5. Provide funding and technical assistance for oak woodland enhancement efforts that help achieve multiple benefits;

6. Increase the area covered by oak species that are now uncommon in Napa County because they have been cleared from much of their historical range in the county;

7. Encourage land use, transportation, and infrastructure planning that is consistent with oak woodlands conservation efforts; and

8. Maximize the total amount of oak woodland canopy cover to achieve erosion, flood, habitat, and air quality protection benefits, while recognizing the importance of including a variety of canopy cover levels within conserved and restored woodlands to provide habitat diversity.

This Oak Woodlands Management Plan has been designed to be consistent with the Napa County General Plan, the Napa County Regional Parks and Open Space Master Plan, and other applicable local and state conservation plans. The adoption of this Plan by a resolution of the County Board of Supervisors will also enable the County to obtain funding support through the California Oak Woodlands Conservation Act of 2001. The Act provides funding for projects designed to conserve and restore oak woodlands, public education/ outreach, and for landowner assistance.

B. Preparation of the Plan

While California state law does not require that cities and counties adopt oak woodland management plans, the development and adoption of a plan will help to protect this important resource and enable private landowners, public agencies, and non-profit organizations to seek grant funding under the California Oak Woodlands Conservation Act (see Appendix A). This Voluntary Oak Woodland Management Plan was prepared with input from a wide range of community stakeholder groups and representatives concerned about the conservation of oak woodlands in Napa County, which included the Napa Valley Vintners, Sierra Club, Napa County Farm Bureau, Napa Valley Grape Growers, Napa County Resource Conservation District, Natural Resources Conservation Service, and others.

C. Focus on Voluntary Actions

The focus of this Plan is on achieving oak woodlands conservation through voluntary, collaborative action by private and public landowners, public agencies, non-profit and other community organizations, and community volunteers. This Plan establishes the foundation upon which agencies, conservation groups and non-profits will take the lead in working with willing landowners, seeking grants, preparing and holding conservation easements, and designing and implementing stewardship plans to preserve and restore Napa County's oak woodlands. It is anticipated that Napa County, local cities and towns, Napa County Regional Park and Open Space District, the Land Trust of Napa County, Napa County Resource Conservation District, U.S. Natural Resources Conservation Service, and other non-profit conservation organizations will use this Plan as a basis for cooperation.

II. The Value of Oak Woodlands

Oak woodlands provide residents and visitors of Napa County with scenic opportunities and important reminders of our unique local history and ecology. They also provide important wildlife habitat, help improve air and water quality, slow runoff, prevent erosion, mitigate flooding, provide recreational opportunities and benefit vineyard owners through pest management. This section provides a brief overview of these and other resource values provided by oak woodlands

A. Cultural/Historical

Artifacts of the Native American people who historically lived in Napa County tend to be co-located with oak woodlands, which provided them with the acorns they relied upon for food. According to local historian Lin Weber, shamans of the Wappo people would offer prayers for the health of the oak trees, and the Wappo named months of the year after the seasonal phases of oaks.[3] Present day oak stands or individual trees may have historical significance due to past events or structures that were associated with them. Many historical accounts mention the trees and the use of specific trees as landmarks or as boundary markers. The earliest European settlers found refuge from the hot valley sun for themselves and their livestock under oaks and benefited economically from the use of oaks for building material and firewood. Oak woodlands also created venues for recreation and public events. Napa County's remaining oak woodlands continue to serve as a reminder of our cultural and historical heritage.

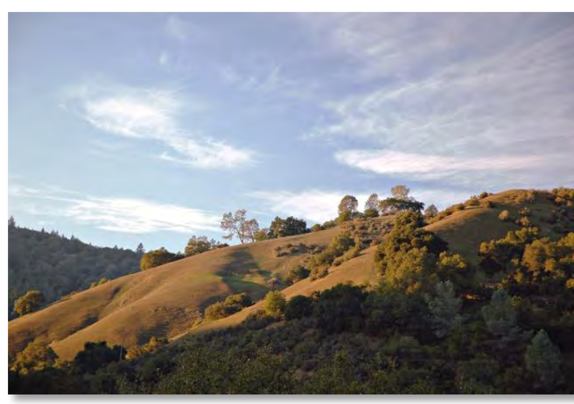
B. Flood Protection

The Napa River is historically prone to flooding, causing damage to homes and vineyards within its floodplains. Oak woodlands play a part in minimizing the strength and effect of the river's floodwaters. Oaks slow the eroding energy of rainfall with their canopies by temporarily hold rainwater on their leaf and stem surfaces during a rainstorm, increasing the amount of time rain takes to reach the ground and contribute to runoff. Oak woodland canopies capture 20-30% more rainfall than do grasslands, and their contribution to organic matter in the soil improves its water holding capacity.[4] As a result, they have a high capacity for detaining peak flows from rainfall events that would otherwise run in larger volumes and at higher velocities into streams, contributing to flooding, erosion, and sediment and nutrient concentrations that can harm water quality. The greatest flood protection/ attenuation benefits related to tree canopy cover are in watersheds that quickly concentrate flows and pose a risk of flash flooding and in areas where runoff conveyance is already near capacity. Oak trees also capture and transpire moisture from the soil during the growing season. Compared to annual vegetation, oaks can extract water from the soil profile to a greater depth. Consequently, soils under oak woodland canopy are able to absorb and hold greater amounts of rainfall than equivalent soils with only annual grassland cover. This extra storage capacity further reduces the potential for flooding during the rainy season and promotes groundwater recharge.

C. Erosion Control

Oaks help control soil erosion in several ways. Oak woodland canopy intercepts raindrops and dissipates rainfall energy, reducing potential surface erosion. Oak leaf-fall and twigs that accumulate on the soil surface under oak woodland canopy also provide further protection against the erosive action of rainfall. In addition, tree roots and their associated symbiotic soil fungi promote the formation and stability of fine and course soil aggregates which help to promote soil cohesion and stability, reducing the risk of landslides and gully/ rill erosion. Oak woodlands located on soils and slopes prone to erosion can also help prevent degradation in water quality and uphold soil/ land productivity. The planting of oaks in areas historically known to support oak woodland that currently exhibit accelerated erosion from lack of tree cover can help to stabilize and prevent further erosion in these areas.

D. Water Quality Protection



Oak woodlands, whether located on the hillsides or on level lands near streams, play an important role in protecting water quality. By minimizing soil erosion as noted above, oak woodlands can help reduce sediment transport and washing of fine sediments into local waterways. High levels of sediment in waterways can negatively impact the aquatic food supply by reducing habitat available for fish, aquatic invertebrates and other organisms important to the diets of fish and birds. The Napa River is currently listed as impaired for sediment and a Sediment Total Maximum Daily Load (TMDL) is in the process of being adopted by the State.

The contribution of oaks and other vegetation to erosion prevention near waterways is especially important if soils contain excessive nutrients, pathogens or high levels of toxic material (natural or human concentrated), such as chemical contaminants, mercury or other heavy metals. Putah Creek, for example, has elevated levels of mercury in the soils of the bed and banks of its tributaries and is the focus of State regulatory efforts (TMDL) to reduce mercury levels. Oaks and other vegetation also help reduce soil contamination by absorbing heavy metals, fertilizer nutrients, and pesticides from the soil and intercepting sediments containing these pollutants, thereby preventing these materials from reaching surface waters. Oaks and associated permanent vegetation along waterways can also reduce potential waterway contamination from airborne pesticide or herbicide drift, since oak foliage can intercept airborne pesticides/ herbicides.

E. Air Quality Protection and Carbon Sequestration

Oaks and other plants directly reduce ozone pollution by absorbing and destroying ozone within their leaves. The leaves also intercept airborne particulates, helping to lower ground level concentration of these pollutants. Oaks, as well as other trees, also sequester carbon in their mass as they grow. Large, long-lived trees such as oaks convert large quantities of carbon dioxide to various organic compounds that make up wood. Oak woodlands therefore provide a means for helping to offset the increase in atmospheric carbon dioxide levels related to the use of fossil fuels. Soils can also sequester carbon, and soils with high organic content such as those found under oak canopies can hold larger amounts of carbon, thereby reducing the amount of greenhouse gasses that contribute to global warming.[5] Oak canopies also mitigate the effects of global warming by reducing ground surface temperatures. In urban/ developed areas oak trees provide protective shading for houses and people, lowering the need for air conditioning and aiding in the maintenance of air quality. Shading provided by trees can also reduce the amount of volatile organic compounds (VOCs) released from vehicles[6]. Because VOCs are precursors to photochemical smog, lower VOC levels result in lower levels of ground-level ozone.

F. Plant and Wildlife Habitat

Oak woodlands are the most diverse terrestrial ecosystems in California, supporting at least 300 vertebrate species (including at least 120 mammal, 147 bird, 60 reptile and amphibian species), 1,100 plant species, 370 fungal species, and 5,000 arthropods species (insects and mites).[7] In Napa County, oak woodlands provide habitats for a wide range of flora and fauna, many of which are threatened or endangered at the state and federal level. Each type of oak woodland found provides unique habitat structure for the plants, invertebrates, fish, and wildlife that inhabit them. Some oak woodland types provide a greater diversity of ecological benefits than others, depending on the complexity of the vegetation structure, oak density (trees per acre), level of canopy cover, distribution of tree sizes and ages, and other factors. The habitat value of any oak woodland type may also vary according to its health, location in the landscape, extent, and current management strategies.

G. Scenic and Public Recreation

Oak woodlands are enjoyed by Napa County residents and visitors alike, simply for their beauty, whether driving or cycling along the roadways or through hiking, birdwatching, equestrian, or other recreational opportunities. Many recreational trails in Napa County are located in or pass through oak woodlands. Recreational activities contribute significantly to the quality of life a well as providing local economic benefits generated by visitors enjoying this important and unique resource. Tourism remains one of Napa County's primary industries. The scenic beauty of the area, known for its lush vineyards against a backdrop of grassy, oak-covered hills, complements and adds to the draw of Napa County as a world renowned destination.

H. Enhanced Property Values

The retention of oak woodlands within a community can contribute to a community's overall economic well being. Woodlands contribute to increased property values and a subsequent increase in property tax revenues. One study in Southern California showed that a 10% decrease in the distance to an open space preserve increased the value of 4,800 surrounding lots by over $20 million dollars, significantly increasing tax revenue to the county. In addition, lots containing native oaks have been found to be valued at a 27% premium over properties having no trees. Individual trees of large size or landmark status within a community were found to increase property values by an additional $18,000 to $50,000 each (Standiford 1999). Studies comparing tree populations and property values also indicate that retaining approximately 40 trees per acre generally provides optimal lot coverage and yields the highest market value premium, roughly 22% to 27%, over bare land (Standiford 1999).[8]

I. Viticultural/Agricultural

Sustainable vineyard practices incorporate biodiversity throughout the vineyard to help minimize insect pests and disease. Oak woodlands are the most diverse ecosystems in California, and when they are in proximity to vineyards they provide habitat for predatory species that help manage the populations of vineyard pests such as deer, rabbits, gophers, and starlings. Cutting down oak trees on the edge of vineyards can increase the chances of Armillaria root rot infecting the vineyards, and may recruit recolonizing species that host Peirce Disease. Sustainable vineyard practices are also being promoted by the Napa Sustainable Winegrowing Group (NSWG), Napa County Farm Bureau, Napa Valley Grapegrowers, the Napa Valley Vintners/ Napa Green Certified Land Program (third party certified voluntary program) and others that seek to restore, protect and enhance the watershed, as well as through various river and stream restoration efforts (e.g. - Napa River Rutherford Reach Restoration Project).

J. Other Values

- provide fodder for grazing livestock;
- provide fuel/ firewood;
- provide wood products
- spiritual/ emotional
- *and others…..*

III. Oak Woodland Communities of Napa County

A. Historic Extent of Oak Woodland Communities

An often overlooked impact to native California habitats is the loss of the state's once expansive valley oak savannas. Among the most iconic and common California landscapes 150 years ago, the open valley floor of Napa County historically contained extensive communities of Valley oak woodland (see map- Appendix B-1). Canopy cover is thought to have been open to locally dense with valley oak the dominant tree. Blue oak, California black oak, and coast live oak were probably minor constituents of this community. The understory was similar to that of native grassland communities, with a mosaic of seasonal wetland interspersed.

Lawrence & Houseworth, 1860/1870. 1796. Mt. St. Helena from Mount Lincoln. Photo courtesy of the Society of California Pioneers: LH1796, album 3 in box B001771

The Wappo Native Americans were the sole inhabitants of the Napa Valley until the late 1700's. Their cultural practices included hunting and the selective gathering of plants, including acorns from several oak species, which were made into flour and comprised an important part of their diet. Spanish colonization began in 1769, when the first expedition to the Bay area arrived, which initiated the decline of the indigenous cultures and began to alter the land use practices. Sheep and cattle ranching began in the early-mid 1800's and intensified following the land grants of this time. As development increased along the valley floors in the mid to late 1800s, Napa County's oaks, particularly valley oaks, decreased in number. A range of more intensive land uses were introduced from 1848-70 including agriculture, with cattle grazing eventually giving way to grain production, followed closely by vineyards.

Turrill & Miller, 1906. Noon Time - Five Tons of Prunes
Photo courtesy of the Society of California Pioneers: C027508

Napa County was created in 1850, as one of the original 27 counties of California. One of the first known hillside vineyards would be planted just south of Calistoga in 1852 by Jacob Schram and vineyard development would continue to grow throughout the 1860-70s. Viticulture would replace grain as the predominant crop by the 1880's and by 1890 there were approximately 18,000 acres in vines.[9] But it would be decimated by disease (phylloxera) in the 1890's leading to a substantial conversion to orchards and by 1900 there were only 2,000 acres remaining.[10]

However, by 1910 the acreage of bearing vines was recovering, with approximately 13,000 acres[11] in vineyards. But orchards remained important, with grapes and prunes the dominant crops along with smaller amounts of pears and walnuts. Prohibition would significantly impact the wine industry from 1919-1933 after which it would begin a gradual recovery until the 1960s, when more rapid expansion would begin again. From the 1970s to the present day, hillside oaks would come under increasing pressure from vineyard conversions as the county's rocky, steep slopes were discovered to produce excellent grapes and wine.

The historical land use and extent of oak woodlands in the Napa Valley from the 1800's to the present day has been studied by the San Francisco Estuary Institute (SFEI) and their work has contributed to our current understanding of the changes that have occurred in our oak communities over time. This historical context plays an important part in developing future restoration and conservation priority areas for valley and riparian oak woodlands. SFEI's research will be published by University of California Press in the upcoming "Napa Valley Historical Ecology Atlas".

Note: A map of the estimated Historical Extent of Oak Woodlands and other natural features for valley floor portions of the Napa Valley of the 19th century is provided in Appendix B-1. Additional mapping of the hillsides is currently under development by the San Francisco Estuary Institute (SFEI) and other areas of Napa County have not been mapped at this time.

The Valley's Great Oaks….

Before 19th-century impacts of orchard agriculture, valley oaks formed a relatively dispersed, open pattern of light and shade that dominated many California valleys, from Ojai to Napa. These oaks provided critical food and habitat for native wildlife, shade and beauty for local people and their livestock, and healthy creeks through nutrient and water retention. Scattered, stately valley oak trees were fundamental to the character of the Napa Valley, and were one of the most celebrated characteristics of the area in early accounts:

"The magnificent oaks are one great secret of Napa's beauty. Their rustling leaves and finely formed tops are the glory of the landscape scenery..." (Smith and Elliott -1878)

The landscape photograph on the opposite page, taken between 1900 and 1910, depicts the dispersed, open pattern of a typical valley oak savanna. The trees dominated the valley landscape and yet, almost paradoxically, they took up relatively little space. The valley was "studded with gigantic oaks……..though not so close together as to render it necessary to cut away to prepare the land for cultivation" (Bartlett -1854).

"A great variety of oaks stood, now severally, now in a becoming grove, among the fields and vineyards" (Stevenson -1883)

B. Current Status of Oak Woodland Communities

There is a great diversity of oaks in California and within Napa County, exhibiting a widespread distribution and a persistence throughout geological time. Some grow as tall and stately trees with large undivided trunks, while others are ground hugging shrubs that are densely branched. Oaks are flowering plants belonging to the genus *Quercus,* which is the Latin name for oak. It is derived from two Celtic words, *quer*, meaning fine and *cuez,* meaning tree. Oak trees also have a unique combination of features which include distinctive wind pollinated flowers, a fruit we all know as the acorn, a strong complex wood, and the ability to live for many decades, and even centuries.[12]

Depending upon various environmental factors, oaks contribute to three *structural* types of natural vegetation: forest, woodland, and savannah. In forests their leaf canopy overlaps to produce a deep and constant shade, usually associated with streams and rivers (riparian) or moist upland slopes (montane). Oak trees also form woodlands which are more open and where sunlight is more penetrating because leaf canopies touch but seldom overlap. Savannahs are the most open and spacious with oak trees far apart and scattered over the grassland, and they are usually the driest and warmest environments[13].

To gain a better understanding of the distribution of oaks you must also look at their natural environment. How an oak grows and reproduces is affected by physical factors such as climate, soil, fire, light and also by biological factors such as the animals and other plants that occur in the same landscape. When considered together oaks and other associated species form an oak community, which reflects the various interactions between the species including competition, herbivory and predation[14].

An overview of the oak woodland communities of Napa County is provided in the following section, along with additional details which can be found in Appendix B.

1. Oak Woodland Communities

Oak woodland communities are categorized by the dominant tree species and the degree of foliage cover, with woodland defined as having a canopy coverage of 10%[15] or greater and trees spaced far enough apart to allow for a variety of shrubs, herbaceous plants, and grasses in the understory[16]. Mixed and coast live oak communities tend to dominate in the southwest of the county, while blue, leather and interior live oak dominate the communities on the hotter, drier eastern areas. California black oak woodlands are found at higher elevations, especially in the Atlas Peak region. Valley oak and associated communities are common within the flat alluvium of the Napa River and its tributaries. Oak riparian woodland resides adjacent to the County‘s streams and waterways, protected from present day development through local stream buffer regulations and state and federal fish and water quality protection programs.

Due to Napa County‘s slow growth and agricultural preservation policies, nearly 90% of the county remains as open space, including grazing lands, agricultural crops, woodland and forest, with oak woodlands the most common land cover. Oak woodland is the most common land cover in the County, occurring on over 167,000 acres or 33% of the County‘s area[17] (see Appendix B and B-2/ map). It occurs throughout the County across a broad range of elevations, on gentle to steep slopes. It is most common in the Southern Interior Valleys of Napa County, where it constitutes almost 70% of the land cover. There are 13 vegetation types (alliances or associations) recognized within the Information Center for the Environment Map (ICE Map/ UC Davis) oak woodland group (BDR-2005). Six of these are dominated by evergreen oak species, six are dominated by deciduous oak species, and one is a mixture of deciduous and evergreen oaks. The four most common oak woodland types in the County are mixed oak woodlands, (evergreen) coast live oak (*Quercus agrifolia*) woodlands and interior live oak woodlands, and (deciduous) blue oak woodlands. Oregon white oak (*Quercus garryana*) woodland and California bay woodlands are considered sensitive communities by the California Department of Fish and Game (DFG 2000). Valley oak woodlands were identified by the *San Francisco Bay Area Gap Analysis* as a high priority for conservation (Wild 2002). Vernal pools, which are also a sensitive community, have been documented to occur within the County‘s oak woodlands.

Note: For a more detailed description of Oak Woodland Vegetation Types/Wildlife/Special Status Species in Napa County see Appendix B. The current mapped Distribution of Oak Woodlands in Napa County (2009) is provided in Appendix B-2.

2. Protected Oak Woodlands

Almost 25 percent or 123,619 acres of the land in Napa County is dedicated open space owned in fee title by public agencies or land conservation organizations, such as the Land Trust of Napa County.[18] The Federal Government is the largest public property owner with nearly 63,000 acres of land and water. The Federal Bureau of Land Management manages most of this land in the northeastern part of Napa County with the Federal Bureau of Reclamation managing the remainder around Lake Berryessa. The State of California is the second largest owner of public open space lands with 42,393 acres. Most of this land is managed by the State Department of Fish and Game and includes the Napa-Sonoma Marshes near the mouth of the Napa River, and property north of Lake Berryessa, including the Knoxville Wildlife Area.

The State Department of Parks and Recreation owns and operates the Robert Louis Stevenson, and Bothe-Napa State Parks. Other State agencies such as the Department of Veterans Affairs own smaller parcels of land. Local governmental agencies such as the cities of Napa and Vallejo which operate domestic water systems own important properties associated with their water supply reservoirs and American Canyon owns the Newell Open Space Preserve. Napa County holds a lease from the state for Skyline Park until the year 2030, and operates the park through a concessionaire agreement with a local non-profit association. These lands provide an important measure of protection for Napa County‘s oak woodlands.

In areas that are privately owned, oak woodlands are effectively protected if they are located on slopes over 35%, within stream setbacks (35-150 ft), or within sensitive domestic watersheds (60/ 40 canopy retention), because of the provisions of Napa County‘s Conservation Regulations(see Section IV.A.3). Oak woodlands that are privately owned and protected through these regulations, compliment the protection provided via public ownership and conservation easements.

Note: A map of Protected Oak Woodlands in Napa County (2009) is provided in Appendix B-3.

IV. Current Oak Woodlands Policies & Regulations

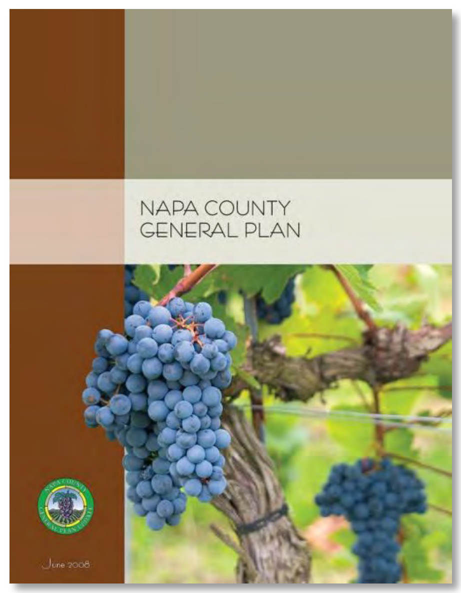
A broad range of existing policies, state and federal regulations, and local ordinances assist Napa County in conserving and protecting oak woodlands. This section discusses the local, state, and federal policies and regulations that are relevant to the protection of oak woodland resources in Napa County.

A. County Policies & Regulations

Napa County has a number of existing policies and regulations that provide for the protection and management of oak woodlands. The following are excerpted or summarized from the Napa County 2008 General Plan Update and associated Environmental Impact Report (EIR) and related implementing actions, mitigation measures and ordinances.

1. Napa County General Plan

The Napa County General Plan serves as a broad framework for planning the future of Napa County and it is the official policy statement of the Board of Supervisors to guide private and public development. The Zoning Ordinance, individual development project proposals, and other related plans and ordinances must be consistent with the goals and policies of the General Plan. While the General Plan was prepared with a time horizon of at least 20 years, periodic review and possible amendment is required to adjust to changing conditions, values, expectations, and needs of the community.



The General Plan program level EIR, certified in June 2008, identified potential future impacts and determined that the impact to sensitive biotic communities, including oak woodlands, would be significant and unavoidable because the potential loss of sensitive biotic communities anticipated by the year 2030 cannot be fully mitigated. However, a number of mitigation measures were identified to lessen anticipated impacts, and were included in the Conservation Element of the General Plan. Oak Woodlands protection is addressed by many of the resulting policies, most specifically in Policy CON-24 and Action Item CON NR-7.

Natural Resources Goals and Policies

Goal CON-2: Maintain and enhance the existing level of biodiversity.

Goal CON-3: Protect the continued presence of special-status species, including special-status plants, special-status wildlife, and their habitats, and comply with all applicable state, federal, or local laws or regulations.

Goal CON-4: Conserve, protect, and improve plant, wildlife, and fishery habitats for all native species in Napa County.

Goal CON-5: Protect connectivity and continuous habitat areas for wildlife movement.

Goal CON-6: Preserve, sustain, and restore forests, woodlands, and commercial timberland for their economic, environmental, recreation, and open space values.

Policy CON-15: The County shall establish and update management plans protecting and enhancing the County's biodiversity and identify threats to biological resources within appropriate evaluation areas, and shall use those plans to create programs to protect and enhance biological resources and to inform mitigation measures resulting from development projects. [Implemented by Action Item CON NR-2]

Policy CON-18: To reduce impacts on habitat conservation and connectivity:

a) In sensitive domestic water supply drainages where new development is required to retain between 40 and 60 percent of the existing (as of June 16, 1993) vegetation on-site, the vegetation selected for retention should be in areas designed to maximize habitat value and connectivity.

Policy CON-22: The County shall encourage the protection and enhancement of natural habitats which provide ecological and other scientific purposes. As areas are identified, they should be delineated on environmental constraints maps so that appropriate steps can be taken to appropriately manage and protect them.

Policy CON-24: Maintain and improve **oak woodland habitat** to provide for slope stabilization, soil protection, species diversity, and wildlife habitat through appropriate measures including one or more of the following:

a) Preserve, to the extent feasible, oak trees and other significant vegetation that occur near the heads of drainages or depressions to maintain diversity of vegetation type and wildlife habitat as part of agricultural projects.

b) Comply with the Oak Woodlands Preservation Act (PRC Section 21083.4) regarding oak woodland preservation to conserve the integrity and diversity of oak woodlands, and retain, to the maximum extent feasible, existing oak woodland and chaparral communities and other significant vegetation as part of residential, commercial, and industrial approvals.

c) Provide replacement of lost oak woodlands or preservation of like habitat at a 2:1 ratio when retention of existing vegetation is found to be infeasible. Removal of oak species limited in distribution shall be avoided to the maximum extent feasible.

d) Support hardwood cutting criteria that require retention of adequate stands of oak trees sufficient for wildlife, slope stabilization, soil protection, and soil production be left standing.

e) Maintain, to the extent feasible, a mixture of oak species which is needed to ensure acorn production. Black, canyon, live, and brewer oaks as well as blue, white, scrub, and live oaks are common associations.

f) Encourage and support the County Agricultural Commission's enforcement of state and federal regulations concerning Sudden Oak Death and similar future threats to woodlands. [Implemented by Action Item CON NR-7]

Action Item CON NR-7:

The County shall adopt a voluntary Oak Woodland Management Plan to identify and mitigate significant direct and indirect impacts to oak woodlands. Mitigation may be accomplished through a combination of the following measures:

a) Conservation easement and land dedication for habitat preservation;

b) Payment of in-lieu fees; and/ or

c) Replacement planting of appropriate size, species, area, and ratio.

Policy CON-25: The County shall disseminate information to land owners regarding habitat conservation and other natural resources goals and build partnerships to accomplish effective outreach regarding policies, incentives, and regulations.

Policy CON-28: To offset possible additional losses of riparian woodland due to discretionary development projects and conversions, developers shall provide and maintain similar quality and quantity of replacement habitat or in-kind funds to an approved riparian woodland habitat improvement and acquisition fund in Napa County. While on-site replacement is preferred where feasible, replacement habitat may be either on-site or off-site as approved by the County.

b) Climate Protection and Sustainable Practices for Environmental Health Policies

Policy CON-65: The County shall support efforts to reduce and offset greenhouse gas (GHG) emissions and strive to maintain and enhance the County's current level of carbon sequestration functions through the following measures:

a) Study the County's natural, agricultural, and urban ecosystems to determine their value as carbon sequesters and how they may potentially increase.

b) Preserve and enhance the values of Napa County's plant life as carbon sequestration systems to recycle greenhouse gases.

Oak Woodlands policies in the General Plan's Conservation Element are complemented by the goals and policies provided in other elements of the General Plan. Agricultural preservation policies, including large minimum lot sizes, concentration of urban uses in designated urban areas, and ―Measure J/ P" requirements for a public vote to change the General Plan land use designation from agricultural to non-agricultural uses have minimized the conversion of oak woodlands and other open spaces. In addition, Recreation and Open Space policies support the acquisition of open space through financial and other incentives to encourage dedication in easement or fee title of significant fish and wildlife habitats and other open space resources to public agencies and non-profit land conservation organizations, acceptance of mitigation funds and dedications of easements or property for the purpose of resource protection, consistent with program goals, and utilization of federal, state, and regional funding to supplement local funding for providing sustainable, long-term stewardship of open space resources and habitats.

2. Napa County Code

The Napa County Code contains a number of ordinances and regulations whose provisions directly and indirectly serve to support the protection, conservation and management of oaks and oak woodlands throughout Napa County. These include the Zoning Ordinance (Title 18), which contains the Conservation Regulations (Chapter 18.108) and the Viewshed Protection Regulations (Chapter 18.106), and the Environment (Title 16) which contains the Floodplain Management Regulations (Chapter 16.04). A summary of some of the applicable provisions of these chapters is provided below.

A. CONSERVATION REGULATIONS – CHAPTER 18.108

The Conservation Regulations were adopted in 1991 and were intended to balance the desires for environmental and agricultural sustainability in Napa County. These regulations established procedures for review of projects that might have an effect on water quality or other natural resources issues. Some of the protections provided by the Conservation Regulations include:

- Preservation of existing vegetation/ trees where necessary for the preservation of threatened plant or animal species(18.108.100);

- Protection of streams with setbacks of 35-150 feet based upon slope, to provide for the retention of existing riparian oak woodland and forest, as well as other riparian plant species (18.108.025);
- Protection of sensitive domestic water supply drainages through maintenance of 60% of tree canopy cover and 40% of shrubby/ herbaceous cover(1993) to help provide water quality protection and the long-term retention of oak and other woodlands, as well as other plant species(18.108.027);
- Protection of erosion hazard areas (18.108.070) by requiring erosion control plans for agricultural projects on slopes over 5%. Discretionary projects also require CEQA review which provides for the evaluation of potential oak woodlands impacts (see Section IV.C.2 on CEQA)

B. FLOODPLAIN MANAGEMENT REGULATIONS – CHAPTER 16

The Floodplain Management Regulations (Chapter 16.04) cover a variety of activities, including the alteration of natural floodplains, stream channels, and natural protective barriers, which help accommodate or channel floodwaters. Floodplain management provisions seek to preserve riparian vegetation in order to preserve fish and game habitats; prevent or reduce erosion; maintain cool water temperatures for fish; prevent or reduce siltation; and promote wise uses and conservation of woodland and wildlife resources of the county. All development activities within riparian zones, 50 feet from the top of stream banks or 100 feet from the top of bank of the Napa River downstream of Zinfandel Lane, require a permit. These regulations also limit the type and amount of riparian vegetation that may be removed within the riparian zone (Sec 16.04.750).

C. VIEWSHED PROTECTION REGULATIONS – CHAPTER 18.106

The Viewshed Protection Regulations were adopted to protect the scenic quality of the County by ensuring that improvements are compatible with existing land forms, particularly ridgelines, and that views of the unique geologic features and existing landscape of hillside areas are protected and preserved. These regulations are intended to:

- Provide hillside development standards to minimize the impact of man-made structures and grading on views of existing landforms, unique geologic features, existing landscape features and open space as seen from designated public roads within the County;
- Protect and preserve views of major and minor ridgelines from designated public roads;
- Minimize cut and fill, earthmoving, grading operations and other such man-made effects on the natural terrain to ensure that finished slopes are compatible with existing land character; and
- Promote architecture and designs that are compatible with hillside terrain and minimize visual impacts.

B. Other Local Policies

1. WICC Strategic Plan

The Watershed Information Center and Conservancy (WICC) educates and supports the community in its efforts to maintain and improve the health of Napa County's watershed lands. The WICC Board of directors serves as an advisory committee to the Napa County Board of Supervisors. The role of the WICC is to assist the Board of Supervisors in their decision-making process and serve as a conduit for citizen input by gathering, analyzing and recommending options related to the management of watershed resources. Although the WICC's focus is more expansive than just oak and oak woodlands, the watershed conservation and management goals and strategies of the WICC serve well to forward the protection and conservation of the County's oak woodlands. The following are excerpts and summaries from the WICC Board's Strategic Plan:

Vision

Napa County's watersheds will maintain a balance of natural processes to support healthy native fisheries, an abundance of native plants and wildlife, and water quality that meets state standards. The Napa River and its tributaries, no longer listed as impaired, will be a nationwide example of what a community, working together, can do to improve the health of its watersheds *(excerpt)*.

Goals

Watershed Conservation & Management

Improve watershed health throughout the entirety of Napa County, which includes its cities and towns, by supporting community efforts to protect and enhance all watershed lands and natural processes with an emphasis on riparian corridors and native species and their habitats.

- Identify, conduct and coordinate watershed studies and monitoring that will improve the community's understanding and management of its watershed resources.
- Identify key watershed areas for restoration, enhancement, and/ or permanent protection.
- Work with and support landowners, citizen organizations, districts and agencies to permanently protect key watershed lands.

Communication, Coordination & Partnerships

Build and strengthen effective partnerships to foster communication, coordination and involvement among all those working to improve the health of Napa County‘s watersheds.

- Coordinate and facilitate watershed planning, research, and monitoring efforts among Napa County organizations, agencies, landowners, and citizen organizations to limit gaps and overlaps and improve consistency between watershed-related activities.
- Support organizations with a watershed restoration focus.

Education and Outreach

Enable the community - those who live in, work in and visit the County's watersheds - to understand the importance of watershed stewardship and watershed health and be actively involved in improving the health of the County's watersheds.

- Provide targeted watershed conservation and stewardship-related education and information to various subsets of the community including the agricultural community, educators, urban and rural residents, and sub-watershed organizations of Napa County.
- Support appropriate public access to Napa County‘s watershed lands where suitable to build appreciation and understanding of the County's watersheds and their resources.

2. Napa County Regional Park & Open Space District Master Plan

The Regional Park and Open Space District (RPOSD) Master Plan (2008-13) is organized around four broad goals of facility development, open space preservation, educational programs and District operations and partnerships. The first three goals are derived from the County General Plan and the resolutions establishing the function and responsibility of the District. The fourth goal addresses District operations and management.

These goals are as follows:

- Provide opportunities for outdoor recreation through the development of a system of parks, trails, water resource activities, open space and related facilities.
- Preserve, restore and protect open space lands, natural resources and special habitat areas.
- Provide historical, cultural and environmental education programming opportunities.
- Provide for District management and interagency partnerships.

In addition to the four goals, the Master Plan identifies and incorporates a number of guiding principals that are intended to define general policies the District should follow during this five year period. Some examples of the guiding principles that provide for the protection of woodland and other natural resources are as follows:

- Pursue acquisitions from willing sellers that will help round out the boundaries of or connect together currently isolated tracts of public lands, in order to improve resource stewardship, protect core habitats as well as habitat corridors and to allow trail connections.

- Within the context of the long-term goals and objectives contained in this Master Plan, take advantage of unique time-sensitive opportunities to acquire or protect significant open spaces and habitat.

C. State Policies & Regulations

1. California Endangered Species Act

The California Endangered Species Act (CESA) protects wildlife and plants listed as endangered or threatened by the California Fish and Game Commission. The CESA is administered by the California Department of Fish and Game (DFG). The CESA prohibits all persons from taking species that are state listed as endangered or threatened except under certain circumstances. The CESA definition of *take* is any action or attempt to ―hunt, pursue, catch, capture, or kill." Section 2081 of the Fish and Game Code provides a means by which agencies or individuals may obtain authorization for incidental take of state-listed species, except for certain species designated as ―fully protected" under the California Fish and Game Code. A take must be incidental to, not the purpose of, an otherwise lawful activity. Requirements for a Section 2081 permit are similar to those used in the federal Endangered Species Act (ESA) Section 7 process, including identification of impacts on listed species, development of mitigation measures that minimize and fully mitigate impacts, development of a monitoring plan, and assurance of funding to implement mitigation and monitoring. Since a number of CESA species rely upon oak woodlands for food, shelter and migration, the CESA provides an important means of offering protection for oak woodlands in Napa County.

2. California Environmental Quality Act

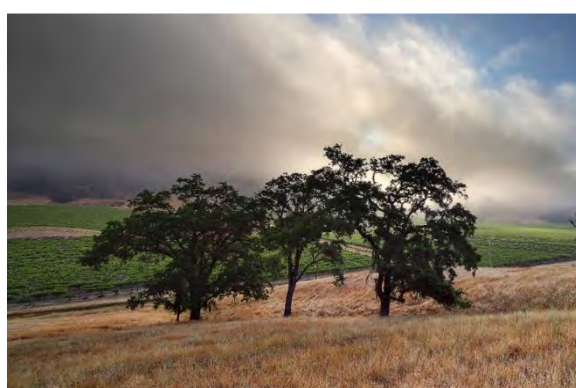
The California Environmental Quality Act (CEQA) is the regulatory framework that requires state and local agencies to identify the significant environmental impacts of their actions and to avoid or mitigate those impacts, if feasible. A ―project" (as defined under statute) would have a significant environmental impact on biological resources if it has the potential to substantially affect a rare or endangered species or the habitat of that species; riparian habitat, wetlands or other sensitive communities; interfere with the movement of resident or migratory fish or wildlife; or diminish habitat for fish, wildlife, or plants. Analysis of environmental impacts under CEQA begins by establishing a baseline of current conditions that may be impacted by a proposed project. Potential oak woodland impacts are currently evaluated through the CEQA review process conducted for discretionary projects. Oak woodland management planning can help to identify oak woodland resources, assess baseline conditions, assist in determining thresholds of significance and offer appropriate and effective impact mitigation opportunities and or programs. Napa County has also adopted Local Procedures for Implementing CEQA (2006) to provide the public with information on the criteria, policies, and procedures used in the environmental review process (www.countyofnapa.org/ceqa). Changes to CEQA specifically addressing oak woodlands were included in the Oak Woodlands Conservation Act described below. Updates to the CEQA Guidelines specific to climate change and greenhouse gas (GHG) emissions are expected in January, 2010.

3. California Oak Woodlands Conservation Act (AB 242-2001) and the Oak Woodlands Conservation Act (SB 1334 - 2004)

The California Oak Woodlands Conservation Act (COWCA) (Assembly Bill 242), enacted in 2001, recognizes the importance of California's oak woodlands, the critical role of private landowners, and the importance of private land stewardship. The Act further acknowledges how oak woodlands increase the monetary and ecological value of real property and promote ecological balance. The Legislature created the Oak Woodlands Program with the expressed intent of accomplishing the following:

1. Support and encourage voluntary, long-term private stewardship and conservation of California oak woodlands by offering landowners financial incentives to protect and promote biologically functional oak woodlands;
2. Provide incentives to protect and encourage farming and ranching operations that are operated in a manner that protect and promote healthy oak woodlands;
3. Provide incentives for the protection of oak trees providing superior wildlife values on private land: and
4. Encourage planning that is consistent with oak woodlands preservation.

To accomplish the legislative intent, the Act identifies the Wildlife Conservation Board (WCB) as the responsible entity to implement the Oak Woodlands Conservation Program. The Act authorizes the WCB to purchase oak woodland conservation easements and provide grants for land improvements and restoration efforts. In addition, the WCB is authorized to award cost-sharing incentive payments to private landowners who enter into long-term agreements, which include management practices that benefit oak woodlands and promote the economic sustainability of farming/ranching operations. To qualify for grant funding, a county or city must have an adopted Oak Woodlands Management Plan, and also certify that grant proposals are consistent with the Plan.



The Act requires that at least 80 percent of the money be used for grants for the purchase of easements, for restoration activities or for enhancement projects. In addition, the funds may be used for grants that provide cost-share incentive payments and long-term agreements. The remaining 20 percent may be used for public education and outreach efforts by local governments, park and open space districts, resource conservation districts and nonprofit organizations. Within the 20 percent category, funds may also be used for grants designed to provide technical assistance and to develop and implement oak conservation elements in local general plans. While the Act specifies how the monies are to be allocated, the Act requires that priority be given to grants that result in the purchase of oak woodland conservation easements.

The Oak Woodlands Conservation Program offers landowners, conservation organizations, cities and counties, an opportunity to obtain funding for projects designed to conserve and restore California's oak woodlands. While the Program is statewide in nature, it provides opportunities to address oak woodland issues on a regional priority basis. The Program is designed to help local efforts achieve oak woodland protection. More importantly, this Program provides a mechanism to bring farmers/ ranchers and conservationists together in a manner that allows both to achieve that which is so valued — sustainable ranch and farming operations and healthy oak woodlands.

The Oak Woodlands Conservation Act (Senate Bill 1334) became law on January 1, 2005 and was added to the CEQA statutes as Public Resources Code Section 21083.4. This act requires that a county must determine whether or not a project would result in a significant impact on oak woodlands. If it is determined that a project may result in a significant impact on oak woodlands, then one or more of the following mitigation measures are required:

1. Conserve oak woodlands through the use of conservation easements;
2. Plant an appropriate number of trees, including maintenance of plantings and replacement of failed plantings;
3. Contribute funds to the Oak Woodlands Conservation Fund for the purpose of purchasing oak woodlands conservation easements; and
4. Other mitigation measures developed by the county.

Exemptions are allowed for certain purposes (CEQA 21083.4.d), including affordable housing projects, and conversion of oak woodlands on agricultural land that includes land that is used to produce or process plant and animal products for commercial purposes.

4. Natural Heritage Preservation Tax Credit Act of 2000 (as amended, AB 94 - 2009)

This Assembly Bill (AB 94) reauthorized the Natural Heritage Preservation Tax Credit Act. The purpose of this Tax Credit Program is to protect wildlife habitat, parks and open space, archaeological resources, agricultural land and water by providing state tax credits for donations of qualified land (fee title or conservation easement) and water rights to a designated organization or agency (state/ local government or non-profit). The program objectives include the fostering of public/ private partnerships to resolve land use and water disputes; assisting habitat stewardship; and demonstrating the state's commitment to protect natural resources by rewarding landowners who perceive habitat as an asset rather than a liability. The property and contribution must be approved by the California Wildlife Conservation Board. A taxpayer is allowed an income tax credit of up to 55% of the donated property's fair market value for donations made on or after January 1, 2010. Any unused credit may be carried over for eight years. The Franchise Tax Board (FTB) is required to report the amount of NHP credit claimed by tax year to the WCB. Protection of oak woodlands through this act provides a tax incentive to landowners wishing to donate their property to a state or locally designated agency or non-profit.

5. Z'Berg Nejedly Forest Practice Act (1973) (California Forest Practice Rules)

The California Forest Practice Rules (Rules) (Title 14, California Code of Regulations Chapters 4, 4.5 and 10) implement the provisions of the Z'berg-Nejedly Forest Practice Act of 1973. Under the Rules, owners of timberland proposing to convert that timberland to another use (as defined in Section 1102) must obtain a Timberland Conversion Permit (TCP) from the California Department of Forestry and Fire Protection. As part of the permitting process, the applicant is also required to submit a Timber Harvest Plan (THP), prepared by a licensed forester, demonstrating that the timber harvest will incorporate feasible mitigation measures to substantially lessen or avoid significant adverse environmental impacts. While oaks are a non-timberland species not directly regulated, a THP/ TCP cannot be approved if implementation of the plan as proposed would result in either a "taking" or finding of jeopardy of a listed species.

6. California Fish and Game Code

The California Fish and Game Code offers protection for a variety of fish and game species and the habitats they rely upon. Oak woodlands offer habitat, shelter and forage for many of California's protected species. Management of oak woodlands for the protection and conservation of California's fish and game go hand in hand with oak woodland preservation goals locally and across the state.

Fully Protected Species

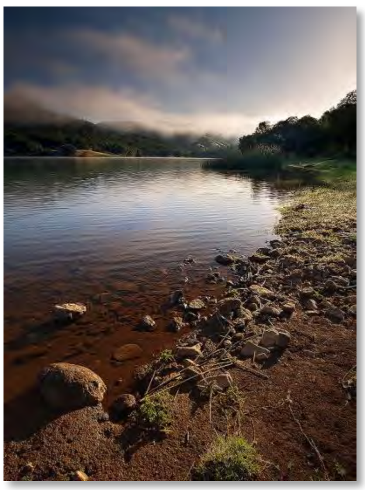
The California Fish and Game Code provides protection from take for a variety of species. Certain species are considered *fully protected*, meaning that the code explicitly prohibits all take of individuals of these species except for take permitted for scientific research. Some species are protected under the California Fish and Game Code, but not fully protected.

The Department of Fish and Game (DFG) maintains the California Natural Diversity Database (CNDDB), a database containing information on the location and characteristics of special-status species occurrences. The database contains information related to the accuracy of each occurrence, such as the spatial resolution of the occurrence mapping, the year when the occurrence was last documented, and the identity of the person who documented the occurrence. Updated CNDDB data are released every six months. Special status species are plants and animals that are legally protected under the federal Endangered Species Act (ESA), California Endangered Species Act (CESA) or other federal, state or local regulations and are designated as endangered, rare, or threatened. Napa County is home to approximately 114 special status plant species and 24 special status wildlife species, with more than 50 special status plant and wildlife species associated with oak woodlands (BDR, 2005).

Protection of Birds and their Nests

Eggs and nests of all birds are protected under Fish and Game Code Section 3503, nesting birds (including raptors and passerines) under Sections 3503.5 and 3513, and birds of prey under Section 3503.5. Migratory non-game birds are protected under Section 3800, and other specified birds under Section 3505.

Stream and Lake Protection



DFG has jurisdictional authority over streams and lakes and the wetland resources associated with these aquatic systems under California Fish and Game Code Sections 1600 et seq. California Fish and Game Code Section 1600 et seq. was repealed and replaced in October of 2003 with new Sections 1600–1616 that took effect on January 1, 2004 (Senate Bill No. 418 Sher). DFG has the authority to regulate work that will ~~"s~~ubstantially divert or obstruct the natural flow of, or substantially change or use any material from the bed, channel, or bank of, any river, stream, or lake, or deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it may pass into any river, stream, or lake." DFG enters into a streambed or lakebed alteration agreement with the project proponent and can impose conditions in the agreement to minimize and mitigate impacts to fish and wildlife resources. A lake or streambed alteration agreement is not a permit, but rather a mutual agreement between DFG and the project proponent. Because DFG includes under its jurisdiction streamside habitats that may not qualify as wetlands under the Federal Clean Water Act (CWA) definition, DFG jurisdiction may be broader than Corps jurisdiction.

7. Greenhouse Gas (GHG) Emission Reduction (AB32 & SB375)

In 2006, the State Legislature enacted Assembly Bill 32 (AB 32), requiring the California Air Resources Board (CARB) to design measures and rules to reduce GHG emissions statewide to 1990 levels no later than 2020. The measures and regulations to meet the 2020 target are to be put in effect by 2012, and the regulatory development of these measures is ongoing by CARB, the designated lead agency. A Scoping Plan was approved by the CARB on December 12, 2008 which provides the outline for actions to reduce California's GHG emissions. The Scoping Plan now requires CARB and other state agencies to adopt regulations and other initiatives reducing GHGs. CARB also adopted California Climate Action Registry (CCAR) Forestry Protocols in 2007 (updated in 2009) to provide tools for voluntary carbon accounting in the forest sector. Forests can absorb (sequester) and store carbon long-term, and they have the potential to provide significant greenhouse gas (GHG) reductions when managed for carbon benefits. Adoption of the protocols represented the Board's endorsement of a technically sound approach for carbon accounting in voluntary forest projects.

In September 2008, the Legislature enacted Senate Bill 375, which established a process for the development of regional targets for reducing passenger vehicle GHG emissions. Through the SB 375 process, regions throughout the state will develop plans designed to integrate development patterns and transportation networks in a manner intended to reduce GHG emissions.

Neither the State nor Napa County has adopted explicit thresholds of significance for GHG emissions. While some might argue that *any* new emission would be significant under CEQA, recent amendments to the State CEQA guidelines suggest that agencies must consider the extent to which a project compiles with requirements adopted to implement a statewide, regional, or local plan for the reduction or mitigation of greenhouse gas emissions. The Bay Area Air Quality Management District adopted CEQA significance thresholds on June 2, 2010 for GHG emissions related to development projects, such as industrial/ commercial and residential development. The BAAQMD guidelines also place emphasis on climate action plans.

D. FEDERAL POLICIES & REGULATIONS

1. Endangered Species Act

The federal Endangered Species Act (ESA) protects fish and wildlife species that have been identified by the U.S. Fish and Wildlife Service and/ or the National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries) as endangered or threatened. It also protects the habitats in which they live. *Endangered* refers to species, subspecies, or distinct population segments that are in danger of extinction throughout all or a significant portion of their range while *threatened* applies to species, subspecies, or distinct population segments that are likely to become endangered in the near future. The ESA protects oak woodlands when they are habitat to an endangered species such as the pallid bat or the Cooper's hawk, both resident species of Napa County's oak woodlands. USFWS and NOAA Fisheries administer the ESA directly or through state and local public trust agencies.

2. Clean Water Act

The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The basis of the CWA was enacted in 1948 and was called the Federal Water Pollution Control Act, but the Act was significantly reorganized and expanded in 1972. "Clean Water Act" became the Act's common name with amendments in 1977.

The CWA is the cornerstone of surface water quality protection in the United States. (The Act does not deal directly with ground water nor with water quantity issues.) The statute employs a variety of regulatory and nonregulatory tools to sharply reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water."

For many years following the passage of the CWA, EPA, states, and Indian tribes focused mainly on the chemical aspects of the "integrity" goal. During the last decade, however, more attention has been given to physical and biological integrity. Starting in the late 1980s, efforts to address polluted runoff have increased significantly. For "nonpoint" runoff, voluntary programs, including cost-sharing with landowners are the key tool. For "wet weather point sources" like urban storm sewer systems and construction sites, a regulatory approach is being employed.

Evolution of CWA programs over the last decade has also included something of a shift from a program-by-program, source-by-source, pollutant-by-pollutant approach to more holistic watershed-based strategies. Under the watershed approach equal emphasis is placed on protecting healthy waters and restoring impaired ones. A watershed approach addresses a full array of issues, including riparian oak woodland services to improve water quality, not just those issues subject to CWA direct regulatory authority.

3. Other Federal Policies/Regulations

At the federal level, the Bureau of Reclamation‘s (BOR) Lake Berryessa property is governed by a Visitors Services Plan (VSP) as presented in a Record of Decision (ROD). The VSP ROD, released in June 2006, prescribes basic management principles to guide and support lake-wide integration of Government and commercial operations in the best interests of the visiting public. The VSP ROD limits future development of the concession areas to facilities that support short-term, traditional, non-exclusive, and diverse recreation opportunities at the lake. Reclamation will partner with other Government agencies, private landowners, and private organizations to design/ construct a regional trail system for non-motorized recreation, to include a multipurpose shoreline trail.

The other major federal agency is the Bureau of Land Management (BLM). The lands under its ownership within Napa County are governed by a Resource Management Plan (RMP) approved in 2006. BLM‘s mission is very broad, encompassing resource protection, resource development, hunting, off-road vehicle use, hiking, camping, mountain bicycling and horseback riding. Each federal agency generally has its own policies to protect oak woodlands, and they are subject to the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), the Federal Land Policy & Management Act (FLPMA), and other internal agency laws, policies, and regulations.

V. Threats to Oak Woodland Communities

Because Napa County has a long history of open space and agricultural preservation policies, the county's oaks are at less risk from development than are other counties in our region, but conversion of oak woodlands does occur and is projected to continue. Conservation of the existing oak woodlands in Napa County is a challenge due to a number of factors that threaten their continued health and longevity. Some of these threats include: lack of regeneration, conversion to agricultural land (primarily vineyards), fragmentation of oak communities, sudden oak death, reduced access to groundwater, increased suppression of fire and risk of catastrophic fire damage both human and natural caused. A summary of current potential threats to our oak woodlands are provided below.

A. Lack of Regeneration

Throughout California, the lack of regeneration in various native oaks has raised serious concern for landowners and managers, public trust agencies, policy makers and the public in general. Several statewide surveys have shown that some native oak species, including blue and valley oak, have inadequate levels of regeneration to sustain their populations over the long term. To be sustainable, oak woodlands need to produce enough new trees to offset the loss of mature trees due to natural mortality as well as human caused factors. The regeneration process relies on the successful establishment and growth of new seedlings and eventual recruitment of these seedlings to the sapling and tree stages. Without adequate regeneration, oak stands thin out over time and eventually disappear as the last remaining oaks die.

Acorn production varies widely from year to year. Most oaks regenerate from a bank of persistent seedlings beneath the canopy, or a "seedling bank." Some species germinate in the winter after they have dropped and do not persist as a seed bank in the soil from year to year. Since most acorns land under or near the canopy of the parent tree, most of the seedling bank is in a very localized area. The shading and buildup of organic mulch beneath oak canopies favors acorn germination and early seedling growth. Although oak canopy enhances seedling establishment, it suppresses the transition of seedlings to saplings. Persistent oak seedlings, which may be no taller than 6 inches in species such as blue oak, may survive for years in the understory. These seedlings can produce a strong root system but show little shoot growth. In fact, shoots of persistent seedlings may periodically die back to the ground, and re-sprout from the seedling base in the following growing season.

Understory seedlings typically remain suppressed until competition is removed or eliminated by the decline, death, or removal of overstory trees. Seedlings released from overstory suppression can respond with relatively rapid shoot growth and can grow into saplings that eventually refill the canopy gap. Although a lack of sapling-sized oaks has been used to suggest that oak regeneration is inadequate, oak saplings are not likely to be found in well-stocked woodlands. A lack of saplings in and near recent canopy gaps, however, is clear evidence of inadequate regeneration. In woodlands with stable canopy cover, low populations of persistent seedlings in the understory are the primary indicators of inadequate regeneration.

Although most oak regeneration occurs through this near-canopy pattern, some acorns are planted beyond the oak canopy by seed-eating animals, especially scrub jays. If these acorns are placed in a favorable seedbed, in areas that have good levels of soil moisture, minimal amounts of plant competition, and little or no impact from herbivores, the acorns can produce vigorous seedlings. Pioneer colonization of this type is seen in gardens, landscape beds, and sometimes along roadsides beyond pasture fences where browsing is minimal and road runoff provides additional soil moisture. Artificial methods for establishing oaks from seed are based on creating favorable germination and growth conditions through weed control and protective enclosures. These conditions are uncommon in open grasslands used for ranging livestock, so oaks do not typically colonize active pastures even if they have historically supported oak woodlands.

Some or all of the following factors may constrain oak regeneration at a given site. Alleviating only one constraint may or may not be adequate to ensure successful regeneration.

1. Low acorn production

Most California oaks that have been studied appear to require cross pollination to produce adequate acorn crops. Because oak pollen is dispersed by wind, adequate pollination will not occur in oaks that are far from others of the same species. Hence, isolated trees may produce few if any acorns.

2. Poor seedbed conditions

Healthy mature acorns normally fall from trees between September and October, often well before the soil has been wetted by fall rains. Natural mulch composed of leaf litter provides protection for acorns. Mulch prevents acorns from being overheated and desiccated and also protects at least some from being eaten. In areas that lack natural mulch and have been compacted by livestock, few acorns may be able to survive and germinate.

3. Herbivory

Animals that eat acorns and seedlings can substantially impact the growth and survival of oak seedlings and saplings. Rodents, deer, wild turkeys and pigs, and livestock all have the potential to limit or eliminate oak reproduction, but the relative importance of each herbivore varies by location. Gophers, ground squirrels, and voles can kill juvenile oaks by chewing and girdling stems. Livestock eat and trample understory seedlings, depleting or eliminating understory advance regeneration. Heavy browsing of released seedlings by livestock or deer can indefinitely suppress their growth and inhibit recruitment to sapling and tree size classes. Interior live oak is less palatable to livestock than valley and blue oak, so grazing impacts these species differently.

4. Water Stress and Groundwater

Due to California's Mediterranean climate, water stress associated with summer drought is an important factor limiting oak seedling survival and growth. Water stress is increased by the presence of non-native annual grasses and forbs in the understory that deplete soil moisture rapidly in the late spring. Shading provided by the oak canopy reduces impacts from temperature and wind speed, thereby reducing water stress. However, overstory oaks ultimately compete with seedlings for soil moisture, suppressing their growth. In riparian areas where soil moisture is less limited, valley oak regeneration can advance to the sapling size class even in the presence of overstory canopy.

Changes in groundwater tables/ levels resulting from overdraft conditions or ―losing" streams and waterways can be particularly problematic for valley oak survivorship. Valley oaks often produce deep sinker roots that can reach the ground water. This allows the tree to access a constant supply of moisture throughout the summer and permits fast growth of the canopy. Because the tree canopy is dependent on this permanent source of water, a substantial drop in the depth of the water table puts the tree under severe water stress. Although root growth can keep pace with minor fluctuations in the groundwater table, roots cannot grow fast enough to compensate for a rapid drop of several feet or more. Furthermore, once the tree becomes severely water stressed, root growth is adversely affected, which can cause a spiraling cycle of increasing water stress that can severely debilitate or kill mature trees. Large, mature valley oaks are more susceptible to rapid reductions in water table depth than are younger trees that may be able to adapt more rapidly to changing conditions.

At any given site, a number of factors may be constraining seedling establishment and growth. Restoring regeneration potential may require changes in management practices to alleviate those factors that completely inhibit oak seedling establishment and sapling recruitment. Management changes can have both positive and negative impacts, however. In some areas, complete cessation of grazing can lead to greater competition from non-native grasses and increased vole populations, leading to more seedling damage and reduced oak seedling establishment. Site-specific assessments are generally needed to assess the status of oak regeneration, identify factors that may be limiting regeneration, and develop management strategies that can promote natural regeneration. These same principles apply in areas where attempts are being made to restore oak woodlands.

B. Fire Frequency and Severity

Napa County has a long and active wildfire history. The County is characterized by narrow valleys surrounded by steep, hilly terrain. With its long, dry summers and rugged topography, Napa County has a high wildland fire potential. In the last several decades the combination of firefighting technology, fire suppression policy, environmental regulations and developmental trends has led to increasing fuel loads, greater occupancy of remote wildlands and greater potential for catastrophic wildfire. Over the past 30 years (mid-1970s to 2004) wildfires have burned approximately 232,000 acres of land in or directly adjacent to Napa County; a County of approximately 482,000 acres (BDR, 2005). The Rumsey fire, which burned 40,000 acres in October of 2004, was the largest of the year. Spread across Yolo and Napa Counties, it cost over $10,000,000 to suppress and caused $1,000,000 in damages. And in 2008, the Wild Horse Valley fire burned more than 4000 acres in eastern hills along the Napa and Solano county line.

Climate and landscape characteristics are among the most important factors influencing hazard levels. Weather characteristics such as wind, temperature, humidity and fuel moisture content affect the potential for fire. Of these four, wind is the dominant factor in spreading fire since burning embers can easily be carried with the wind to adjacent exposed areas, starting additional fires. While the County has a characteristic southerly wind that originates from the San Francisco Bay (which becomes a factor in fire suppression), during the dry season the County experiences an occasional strong north wind that is recognized as a significant factor in the spread of wildland fires (City of Napa 2004). Landscape characteristics such as steep slopes also contribute to fire hazard by intensifying the effects of wind and making fire suppression difficult. Vegetation type influences wildfire hazard levels as well. For example, landscapes dominated by chaparral are more flammable than other vegetation types. The combination of highly flammable vegetation, steep inaccessible wildlands, and high levels of recreational use can result in wildfire risk and hazards of major proportions.

Most of the tree oak species in California are adapted to tolerate fire in varying degrees. Mature oaks can survive frequent, low intensity fires, while younger trees regenerate after low-intensity fires by resprouting. However, studies indicate that while oak seedlings and saplings resprout readily after topkill, many juvenile oaks are killed by fire. After resprouting oak saplings require several to many years to recover their aboveground biomass. Repeated destruction of oak shoots in successive years depletes seedling energy reserves and increases the likelihood of disease and mortality. The combination of repeated fire and grazing is especially damaging to oak regeneration, and was historically used to convert woodlands to grasslands. Native Americans used fire as a tool to manage oak woodlands, although the frequency of anthropogenic burning during the Native American period is unknown. European ranchers used fire to keep rangeland open and to stimulate forage production, probably burning every 8–15 years (Sandiford 1994). Fire suppression beginning in the 1950s has changed the fire regime in oak woodlands from frequent, low-intensity fires to infrequent, high intensity, fires. Such high-intensity fires can lead to the loss of oak woodlands. Approximately 52% of Napa County's oak woodlands are at high or very high risk for fire.[19]

C. LAND USE/HABITAT CONVERSION

Oak woodlands in the County are being lost through conversion to agriculture, urban and rural residential development and to a lesser extent commercial development and infrastructure. In some areas, such as the eastern hills, the rate of oak woodland conversion to vineyards has been higher than in other areas of the county. However, Napa County's large minimum lot sizes, one percent annual limit on growth and urban-centered growth policies have restrained development in the unincorporated county, essentially conserving many natural areas containing oak woodlands.

1. Rural Residential and Urban Development.

Rural residential and urban development may result in the conversion of oak woodlands to other uses if the development occurs in areas where oak woodlands exist today. However, Napa County has historically directed growth to the incorporated cities/ town and to a limited number of designated urbanized areas. The 2008 General Plan Update maintained this policy framework and perpetuated restrictions on the subdivision of large private parcels in the unincorporated area. These growth policies have resulted in the protection of oak woodlands (as well as locally important agricultural land), and the Draft EIR prepared for the General Plan Update estimated that only 119 to 145 acres of woodland (deciduous oak woodland, evergreen oak woodland, and mixed willow woodland) will be lost due to rural residential and urban development in the County between 2005 and 2030.

2. Agricultural Conversion.

Approximately 20 percent of the land area in Napa County is committed to agriculture, including vineyards, orchards, rangeland, and other crops. The extent of vineyard acreage has grown steadily in more recent years due to the growing demand for premium wine and winegrapes. The Draft EIR prepared for the General Plan Update in 2008 assessed the impacts of continued vineyard development by developing a projection of new vineyards (specifically, 10,000 to 12,500 new acres between 2005 and 2030), and by assessing a number of scenarios representing possible distribution (i.e. the location) of vineyard development. The result of this analysis was an estimate that between 2,682 and 3,065 acres of woodlands (deciduous oak woodland, evergreen oak woodland, and mixed willow woodland, non-native woodland, valley oak woodland, and white alder woodland) will be lost due to vineyard development in the County between 2005 and 2030.

While current market conditions have the potential to slow the rate of conversion of oak woodlands to intensive agriculture, oak woodlands that are located on potentially productive agricultural soils remain at risk and make up 58,526 acres, or 36% of Napa County‘s current oak woodlands. Between 1993 and 2002, one half of one percent of Napa County‘s oak woodlands (approx. 733 acres) were converted to vineyards, including several acres of sensitive oak communities.[20]

3. Infrastructure Development.

Local and regional growth in tourism, jobs, and housing increases demand for new infrastructure, including highway and road expansion, as well as electrical, water and wastewater services. The end result of this demand is often the expansion of infrastructure projects which can temporarily or permanently impact existing oak woodlands. On a more regional level, large roadway expansion projects will likely continue to threaten California‘s oak woodland resources.

D. Disease: Sudden Oak Death

Oak woodlands in Napa County are also threatened by Sudden Oak Death (SOD), a fungal disease caused by the pathogen *Phyophthora ramorum*. First detected in the mid-1990‘s, the disease is responsible for widespread tree mortality in the central coast region of California. It is now known to infect over 70 ornamental and wildland plant species and genera and that number has been dramatically increasing every year. SOD is usually recognized as a forest phenomenon and it is not typically seen in true landscape settings, although more recent findings at numerous retail nurseries and wholesale growing grounds may alter that picture. While the term ―sudden" refers to the relatively rapid browning of the foliage, a tree showing these symptoms has in actuality already been infected for months or years with the pathogen.

Fourteen counties in California – from Monterey to Humboldt – are currently known to be infested with SOD in natural settings. Because the pathogen requires a moist environment to germinate and disperse, most infestations are found in fog-belt or densely wooded, riparian areas. Natural spread usually occurs by wind-driven rain, soil erosion, and streams. In Napa County, with a few exceptions, SOD has been confirmed mostly on the western side of the county – in the Mayacamas Mountains. The disease is not expected to survive in hot, dry climatic conditions that exist in such areas as Pope Valley and Lake Berryessa. However, wet years may allow for the spread of the disease throughout the County and there is some concern that the pathogen could adapt to Napa County‘s warmer, drier climate. In Napa County, SOD mainly affects Coast Live Oak, California Black Oak, Tanoak, and California Bay Laurel. Valley Oak, Blue Oak, Oregon Oak, ―scrub" oaks, and other members of the so-called ―white oak" group are not susceptible to SOD. While certain oaks may die from the disease, most other host plants display only leaf spots and/or branch/twig dieback, mortality occurring only under extreme conditions. The Bay Laurel is the primary culprit responsible in California for allowing the spores of P. ramorum to germinate and spread to the oaks.

The vast majority of oak mortality seen in Napa County is due to causes other than SOD. Other diseases and pests like oak root fungus, crown rot, and various insects, as well as soil compaction, grade changes, and root injury contribute significantly to the decline and eventual death of numerous trees.

Comprehensive state, federal, and international quarantine measures have been instituted to minimize the likelihood of the artificial (i.e.-human) spread of SOD. The movement of host plant material, such as nursery stock, firewood, and green waste out of Napa County is tightly restricted. The Napa County Agricultural Commissioner‘s Office has information available for property owners to help reduce the chances of spreading the disease, as well as for those who take part in recreational activities, such as hikers, mountain bikers, and horse riders, in areas that may be experiencing SOD.

E. Climate Change and Ecotone/Species Migration

Napa County is home to a diverse population of plants species which in turn support a wide range of wildlife species, including many rare, threatened and endangered species. Native plants and animals are increasingly at risk as temperatures rise and scientists are reporting more species moving to higher elevations or more northerly latitudes in response. Increased temperatures also provide a foothold for invasive species of weeds, insects and other threats to native species. The increased salinity and flow of water resources could adversely affect the food supply and spawning conditions for native fish, and the natural cycle of plant flowering and pollination could be affected.

In Napa County, climate change may result in decreased genetic diversity, a reduction in seed dispersal, decreased or extirpated populations, and long-term distribution changes. Currently there is an invasion of Douglas Fir in the west and Foothill Pine in the east with subsequent succession causing many oak stands to become overtopped and lose vigor. The current fir and pine populations expansions are taking place to the detriment of oak and other hardwoods.[21]

Natural disasters such as drought, wildfires, and flooding can be instigated by temperature and precipitation changes.[22] Scientists at U.C. Santa Cruz are concerned that rising temperatures and decreasing rainfall associated with global climate change will cause almost half of California‘s oaks to die out by 2090.[23] These forecasts focus particularly on blue oak and valley oak species, both of which are represented in continually decreasing numbers in Napa County.

F. Woodcutting for Firewood Production

Woodcutting can be an integral part of a sustainable woodland management plan that balances sustainable yield harvesting with habitat protection and agricultural use. If firewood harvesting is not severe, effects on wildlife and stand structure can be negligible (Garrison and Standiford 1997). However, indiscriminate cutting without regard for habitat continuity, lack of replanting or protection of saplings, removal of nest or wildlife trees, and thinning to produce a monoculture can all contribute to reduction of overall quality of the woodland habitat and eventual loss of the woodland resources. From an economic (and recreational) perspective, removal of oak trees or damage to the viability of the woodland may also decrease the habitat potential for game species.

VI. Establishing Priorities for Oak Woodland Conservation and Restoration

Successful oak woodland conservation efforts will require an on-going commitment by the community based upon cooperation and collaboration among private landowners, public agencies, non-profits, and others. Napa County has already begun efforts in support of oak woodland conservation and restoration, including several on-the-ground projects, property acquisitions by the Regional Park and Open Space District, and others.

A. Current Efforts

Some of the priority projects currently underway in the County include:

- **Rutherford Dust Napa River Restoration Project.** A plan to provide for the long-term management and restoration of a 4.5 mile reach of the Napa River from Zinfandel Lane bridge to the Oakville Crossroad. Initiated in 2002 by the Rutherford Dust Society (RDS), the RDS and Napa County pioneered an innovative partnership to realize this vision. Project objectives include the reduction of erosion, flood damage and sediment loading, and the restoration of salmonid/aquatic habitat and riparian habitat, including oak woodlands. Project development and funding was provided by the property owners, Napa County/Flood District and multiple state agencies. A comprehensive design for the project was completed in October 2008 and construction began in July 2009. For California's agricultural sector and beyond, this project provides a community-based leadership model for watershed restoration.

- **Oakville Napa River Restoration Project.** The second large-scale Napa River restoration project, this plan provides for the restoration of a 10 mile reach of the river between Oakville Crossroad and Oak Knoll Avenue. As with the RDRT project, the Oak Knoll project is a collaborative effort supported by property owners along the reach. The project is intended to control erosion and flooding, and preserve/ restore salmonid and riparian habitats, including oak woodlands. Napa County provided local matching funding to enable the project to acquire a grant from the State Water Board for the first phase of work. A conceptual design for the project is currently underway.

- **South Wetland Opportunity Area Restoration Project (SWOA).** As part of the restoration objectives for the Napa County Flood Protection Project (Project) the Napa County Flood Control and Water Conservation District (District), in partnership with the Army Corps of Engineers, restored physical processes and enhanced ecological functions and habitat to over 850 acres of naturally functioning floodplains and tidal marshes within the Napa River Watershed; including the creation of over 77 acres of valley oak woodland habitat. The SWOA, purchased with funds from the District and protected in perpetuity through a conservation easement, ensures the permanent protection of a mosaic of native habitat types within Napa County.
- **Acquisition of Berryessa Vista Wilderness Park.** The County in 2008 granted the Napa County Regional Park and Open Space District Proposition 12 capital grant funds available to the County, to assist the District in acquiring 224 acres south of Lake Berryessa. The acquisition ensures permanent protection of this natural landscape, one-third of which consists of oak woodlands comprised of Interior Live Oak.
- **Acquisition of Moore Creek Watershed Lands.** The County in 2008 granted funds to the Napa County Regional Park and Open Space District to match other funding for the acquisition and improvement of 673 acres of open space in the Moore Creek watershed. Approximately one-third of this property is oak woodlands containing valley oak, coast live oak and blue oak.
- **Support for the Napa County Regional Park and Open Space District.** The County annually provides operational funding for the District, which in part assists with preservation and restoration of oak woodlands. In 2008 the District obtained a conservation easement to 39 acres at Linda Falls; approximately 10 acres of this property consists of mixed oak alliance (coast live oak, others). In 2009 the District planted valley oaks and coast live oak as part of the restoration of approximately 1,000 feet of Moore Creek. In addition, in 2010 the District is planning on restoration of 5 acres of valley oak and coast live oak woodland at the Napa River Ecological Reserve.
- **Support for California Native Plant Society.** In 2009 the County's Wildlife Conservation Commission awarded a grant to the California Native Plant Society-Napa Chapter to support their native plant garden and nursery located at Skyline Wilderness Park. The garden helps educate the public about the value of native oaks, and the nursery propagates many species of native plants including local oak varieties for use in restoration projects in many parts of Napa County.

B. Priority Conservation & Restoration Criteria[24]

To support continued conservation and restoration efforts throughout the County, evaluation criteria can help to identify high-priority, voluntary oak woodland conservation and restoration opportunities. This section provides an overview of suggested criteria that can assist willing landowners, public agencies, nonprofit organizations and other project partners in identifying priority areas with the highest oak woodland resource values. The evaluation criteria assess a broad range of oak woodland resource values, such as stand composition and distribution, tree cover and density, plant and wildlife habitat availability (including special status species), historical and cultural significance, and recreational opportunities (see Appendix D-Conservation & Restoration Evaluation Criteria). In addition, the criteria factor in the threat of loss and potential management constraints, and complement countywide conservation and watershed planning efforts.

The evaluation criteria assist in establishing priorities by using a three (3) layered approach to assign an overall priority to a parcel which can be tailored to the specific landowner or funding source requirements. The three-layers considered in the ranking system are:

(1) **resource value** - an aggregate assessment of the natural resource values associated with a-given oak woodland (most important layer in the prioritization system);
(2) **risk category** - an assessment of the likelihood that the resource will be lost or seriously–degraded over various time horizons if no conservation actions are instituted; and
(3) **management constraints** – a measure reflecting the level of land management inputs needed to maintain the resource value (e.g.-control invasive species, promote oak regeneration).

The evaluation criteria are designed to provide flexibility and can be modified over time by adding criteria or adjusting thresholds for priority rankings as needed to address changing resource needs. Specific weighting has not been assigned to the various criteria, as their relative importance may change over time based on the locations and types of conservation projects that are implemented and their effectiveness. The County's Geographic Information System (GIS) provides data on oak woodland species, density and distribution, which can be supplemented by field and other site specific information in areas where the scope and resolution of GIS data may be limited.

Napa County encourages organizations and agencies working on oak woodland conservation activities to use the criteria for establishing priorities for conservation and restoration, and to facilitate projects that are consistent with these priorities through advance planning and transactional assistance. Napa County will use the criteria as part of the process to determine if conservation projects are consistent with the County's Voluntary Oak Woodland Management Plan, as required by the Wildlife Conservation Board's oak woodland grant program. A higher priority will be assigned for conservation or enhancement/ restoration-projects on oak woodland parcels that provide the greatest overall level of benefits based upon the ranking system, with input from property owners and their consulting oak woodland ecologist, the Napa County Regional Park & Open Space District, and the public.

VII. Voluntary Mechanisms to Encourage Long-term Conservation by Private Landowners

A. Outreach & Education

Outreach and education are important cornerstone components in the protection, restoration and enhancement of Napa County's oak woodlands. Targeted outreach and education provides improved awareness, understanding and needed volunteerism. These efforts should be directed toward several key audiences:

- Public at-large
- Private landowners in oak woodland areas
- Public agency managers and decision makers
- Local government decision makers and planners
- Non-profit and volunteer organizations

Implementation actions may include:

- Website/ Online information
- Workshops
- Brochures/ Handouts
- Oaks Appreciation Day/ Week/ Month
- Environmental/ Green event participation/ sponsorship
- Distribution of information to teachers, landowners, decision makers
- Establishment of a Speakers Bureau
- Public service announcements (radio, cable, print)
- Local Cable Access Channel
- Inclusive project coordination and participation
- Others opportunities as they arise.

B. California Oak Woodland Conservation Program

In 2001, the California Legislature passed the California Oak Woodland Conservation Act (COWCA). The Act acknowledged the positive impact that oak woodlands have on the monetary and ecological values of property within these environments. As a result of the COWCA, the Oak Woodland Conservation Program was established within the Wildlife Conservation Board (WCB). The program was designed to provide $10 million annually to help local jurisdictions protect and enhance their oak woodland resources. It offers landowners, conservation organizations, cities, and counties an opportunity to obtain funding for projects designed to conserve and restore California's oak woodlands. It authorizes the WCB to fund land protection, land improvements, oak education, and restoration.

The Act requires that at least 80 percent of program dollars be used for grants that fund land protection, restoration or enhancement projects within oak woodlands. The remaining 20 percent of the funds can be used for public education and outreach efforts by local governments, park and open space districts, resource conservation districts, and nonprofit organizations. Within the 20 percent category, funds can also be used for grants designed to provide technical assistance and to develop and implement oak conservation elements in local general plans (McCreary 2004) (CWCB 2001). The WCB‘s funding in recent years has derived primarily from several large bond initiatives. In 2008, the WCB contributed to more than 100 projects with approximately $112 million of WCB grant expenditures matched by nearly $143 million in partner contributions.

A requirement for program funding under the Act is the preparation of an oak woodland management plan. To qualify for grant funding, a county or city must have an adopted Oak Woodlands Management Plan, and also certify that grant proposals are consistent with the Plan. This document has been prepared to satisfy the Act‘s requirements. Once adopted by the Napa County Board of Supervisors, Napa County and its residents will be eligible for grant funding under the COWCA.

C. Oak Woodland Conservation Easements

A conservation easement is a legal agreement between a landowner and a non-profit organization or government agency that restricts the type of uses allowed on the property in order to protect its conservation values. It allows the landowner to continue to own and use the land, within the constraints of the contract, and to sell it or pass it on to heirs. Each easement is individually negotiated and only certain rights to the land are purchased or donated. For example, the landowner might give up the right to build additional structures, while retaining the right to ranch or grow crops.

Conservation easements run with the land and are generally permanent, with future owners also bound by the terms of the agreement. An easement may apply to just a portion of a parcel and usually does not need to allow public access. In some cases, fee simple purchase may be a preferred alternative, when public ownership and access is also warranted, as in a public park or trails. Currently there are more than 15,000 acres under conservation easements in Napa County, not including lands with easements also owned in fee title by a public agency.[25] If an easement is donated to a qualified public agency or land conservation organization, and benefits the public by permanently protecting important resources, such as oak woodlands, it may qualify as a tax-deductible charitable donation. Conservation easements may also lower the property‘s assessed value (annual property tax), and estate tax when passing land on to the next generation.

In Napa County, lands under a conservation easement are usually assessed at a similar rate as properties protected under the Williamson Act (California Land Conservation

Act of 1965). Conservation easements may also enable landowners and/ or their heirs to avoid paying capital gains taxes. In addition, the State of California offers up to a 55 percent state income tax credit for donations of conservation easements, subject to various limitations.

D. Cost Sharing Agreements

According to information provided by the Wildlife Conservation Board under the Oak Woodlands Conservation Program, agreements for cost-sharing incentive payments can include management practices that benefit the goals of the landowner and oak woodlands. The length of the long-term agreement is dependent upon the nature of the project, the goals of the landowner and benefits to the oak woodlands. Typical long-term agreements could run 15 to 45 years. Cost-share incentive payments could include, but are not necessarily limited to: compensation for not cutting trees for firewood; long-term payment to keep the land in open space, management cost to implement a plan designed to benefit the landowner and the oak woodlands; reimbursements for conservation improvements; and compensation for alternative grazing or farming practices.

The Napa Field Office of the USDA Natural Resource Conservation Service (NRCS) is the largest provider of cost sharing agreements in Napa County. The NRCS provides approximately $100,000 annually in cost share funding for conservation practices, some of which directly benefit native oaks. For the five year duration of the 2008 Farm Bill, the NRCS will continue to provide cost share agreement funding through two USDA programs. The Environmental Quality Incentives Program (EQIP) provides cost share funding for conservation practices by farmers and ranchers and the Wildlife Habitat Incentives Program (WHIP) provides cost share funding for conservation practices benefiting wildlife for any landowner.

E. New Grant Funding Opportunities

While State grant funding opportunities have become more difficult to come by due to the current economic conditions and budget problems, other sources are available to potentially fund oak restoration and conservation efforts. The Wildlife Conservation Commission of Napa County provides annual grants that are intended to support the preservation, propagation, and protection of fish and wildlife in Napa County. The funding for these grants is provided by California Department of Fish and Game fines and settlements, as well as local fines and settlements that are designated for this purpose from enforcement actions.

The Wildlife Conservation Commission consists of eight (8) members: Four (4) At-Large/ Citizen Representatives, One (1) Sportsperson or Angler, One (1) Youth, One (1) Wildlife Conservation Representative and One (1) Member of the Conservation, Development and Planning Commission. The Commission meets annually in August to review the grant applications and make recommendations to the Napa County Board of Supervisors on the expenditure of funds. The total amount of grant funds available for project proposals is typically $12,000 to $15,000, but may be up to $50,000 depending upon funding availability and demonstrated project needs in any given year. Past project proposals have included wildlife rehabilitation, native habitat enhancement, environmental education programs and species monitoring studies.

F. WILLIAMSON ACT

The California Land Conservation Act of 1965, also known as the Williamson Act, is a land protection program established to preserve agricultural and open space lands. By participating in the Williamson Act (Act), landowners are able to protect large tracts of farmland and open space from development and reserve it for agricultural use. Much of this contracted land in Napa County also contains contiguous areas of oak woodland habitat. Williamson Act contracts are established for a rolling term of 10 years. In return, parcels are assessed at a rate which reflects their agricultural and open space uses rather than their full market value. If a contract is not renewed, it normally terminates nine years after non-renewal. Early cancellation of a contract can result in substantial penalties. Currently, there are more than 71,000 acres restricted by Williamson Act contracts[26] in Napa County of which approximately 40 percent[27] is oak woodland.

G. OPPORTUNITIES FOR COLLABORATION

Numerous collaborative efforts are currently underway throughout Napa County that provide excellent examples of voluntary efforts. Some of the more notable projects of the Napa County Regional Park and Open Space District, the Land Trust of Napa County, the Napa Green Certified Land program, and the Napa River Rutherford Dust Restoration Project are outlined below.

The **Napa County Regional Park and Open Space District**, approved by the voters in 2006, was established to partner with other public agencies and land conservation organizations in protecting open space, preserving natural resources and enhancing habitat. Since its formation, examples of District projects included (1) protecting 224 acres of oak woodlands by acquiring the property through a bargain sale from the Land Trust of Napa County, (2) forming a partnership with the Napa County Resource Conservation District and the Department of Fish and Game to restore Valley Oak habitat at the Napa River Ecological Reserve, (3) initiating a partnership with the Napa County Flood Control District for the long-term protection of riparian habitat, oak woodland restoration and improved environmental education opportunities in the South Napa Wetlands, as well as other stream bank restoration efforts, and (4) obtaining grant funding from the State Coastal Conservancy to acquire and protect 673 acres of open space including extensive oak woodlands in the Moore Creek watershed.

The **Land Trust of Napa County** has been conserving agricultural and natural open space for several decades. In addition to holding thousands of acres of oak woodland which are protected through donated conservation easements, the land trust has helped broker major transactions which have enabled other agencies to protect more than

12,000 acres of oak woodlands; the most notable of these is the extensive Knoxville Wildlife Area now managed by the Department of Fish and Game. The Land Trust has completed the acquisition of more than 4,165 acres of open space in Palisades northwest of Angwin. Known as the Wildlake-Duff property, the area contains the Bell Canyon watershed, which provides 80 percent of the drinking water for St. Helena, and will forever provide oak woodland habitat for wildlife, allowing native plant species to thrive in a pristine area. Long-term preservation of the area will likely include cooperative management by the Land Trust, the California Department of Parks and Recreation and the Napa County Regional Park and Open Space District, as well as additional funding from both public and private sources.

Sustainable vineyard practices are being introduced through the **Napa Green Certified Land Program**, a third party certified, voluntary program for Napa County vintners and grape growers that seeks to restore, protect and enhance the regional watershed. The program includes not only farmed or vineyard land, but also non-farmed and wild land, roadways, steam banks, drainage and more within a specific property. Plan details are unique to each owner‘s property and include restoration of wildlife habitat, healthy riparian environments and more with sustainable agriculture practices. Approximately 33,150 acres are currently enrolled in the program and more than 16,900 acres are certified, with thousands more about to receive official certification. A majority (90%) of the Napa River watershed is in private ownership making this public/ private partnership, Napa Green, vital to our community. The certification is in partnership with Fish Friendly Farming, National Marine Fisheries Service, the Napa County Department of Agriculture‘s Department of Pesticide Regulation, and the Regional Water Quality Control Board among others.

In 2002, the Rutherford Dust Society Board of Directors voted unanimously to empower a subcommittee, the **Rutherford Dust (Napa River) Restoration Team** (RDRT or "our dirt"), to initiate a plan to manage and restore the river. This committee includes over 25 riverside property owners. Since that date, RDRT has successfully pioneered an innovative partnership with Napa County to realize this vision. Building upon over 5 years of detailed engineering and ecological studies, a comprehensive design for the entire 4.5 mile reach was released in October of 2008 for environmental and regulatory review. Project construction commenced with Phase 1 in July 2009, starting at the upstream boundary of the project area at the Zinfandel Lane Bridge. For California‘s agricultural sector and beyond, this project provides a community-based leadership model for watershed restoration. It is arguably one of the most ambitious initiatives of its kind, and one of the few comprehensive reach-scale restoration projects in the region to move beyond just planning into on-the-ground implementation.

VIII Oak Woodland Protection Through Sustainable/Best Management Practices (BMPs) & CEQA Mitigation

In addition to adopting and implementing protective policies and regulations, Napa County also supports oak woodland conservation by working with individual applicants to create development plans that optimally preserve oak woodlands while meeting the applicants' needs. This may include the incorporation of a wide range of Sustainable/ Best Management Practices (BMPs) into the design of the projects, as well as the incorporation of effective environmental impact (CEQA) mitigation measures.

A. Sustainable Best Management Practices (BMPs)

For oak woodland as well as other natural resource protection, a wide range of sustainable BMPs can be incorporated into the project design (vineyard, winery or other projects). Project planning and BMPs are important components to developing effective management plans that address all aspects of the property and its use. A set of BMPs can be developed to promote oak woodland management, and outline a suite of practices to achieve soil and water conservation, stable drainage, riparian corridor enhancement, fisheries enhancement and long-term improvement and sustainability.

These are an important part of the Napa Green Certified Land Program and Fish Friendly Farming, where Farm Plans are developed to address all aspects of the vineyard/ property. The planning process involves several steps, which include:

1) An inventory/ assessment of the natural resources, streams, soils, topography, and vegetation of the property as well as an analysis of current management practices;
2) Identification of needed changes to management practices or new vineyard design and application of program Beneficial Management Practices (BMP's) to the property;
3) Identification of erosion site or road repair projects; stream corridor and fisheries habitat projects and other improvements; preparation of an implementation program for both vineyard management changes and restoration projects including potential cost share sources; and
4) A requirement for photo documentation of changing site conditions and progress towards the goals and objectives of the plan and BMP implementation.

Recommendations for Best Management Practices are summarized in Appendix D from various publications on oak woodland protection, maintenance, and restoration, as well as contributions by local and other experts. These include information/guidelines for the maintenance, restoration, and rehabilitation of oak woodlands, disturbance around oaks and protecting trees from construction impacts, care of oak trees, building around oaks and oaks in the home garden, and others. Interested property owners as well as various professionals are encouraged to consult these resources for additional information.

Note: A summary of Sustainable BMPs for Oak Woodlands is provided in Appendix D.

B. CEQA Mitigation

Through the CEQA review process for discretionary projects, such as vineyards and wineries, mitigation measures are included to ensure that potential impacts are addressed. The General Plan Natural Resource Goals and Policies provide the primary direction for oak woodland protection and conservation in Napa County and require the following actions:

Policy CON-24 Maintain and improve **oak woodland habitat** to provide for slope stabilization, soil protection, species diversity, and wildlife habitat through appropriate measures including one or more of the following:

a) Preserve, to the extent feasible, oak trees and other significant vegetation that occur near the heads of drainages or depressions to maintain diversity of vegetation type and wildlife habitat as part of agricultural projects.

b) Comply with the Oak Woodlands Preservation Act (PRC Section 21083.4) regarding oak woodland preservation to conserve the integrity and diversity of oak woodlands, and retain, to the maximum extent feasible, existing oak woodland and chaparral communities and other significant vegetation as part of residential, commercial, and industrial approvals.

c) Provide replacement of lost oak woodlands or preservation of like habitat at a 2:1 ratio when retention of existing vegetation is found to be infeasible. Removal of oak species limited in distribution shall be avoided to the maximum extent feasible.

d) Support hardwood cutting criteria that require retention of adequate stands of oak trees sufficient for wildlife, slope stabilization, soil protection, and soil production be left standing.

e) Maintain, to the extent feasible, a mixture of oak species which is needed to ensure acorn production. Black, canyon, live, and brewer oaks as well as blue, white, scrub, and live oaks are common associations.

f) Encourage and support the County Agricultural Commission's enforcement of state and federal regulations concerning Sudden Oak Death and similar future threats to woodlands.

For green house gases(GHG) and carbon sequestration, the Napa County General Plan calls on the County to complete an inventory of green house gas emissions from all major sources in the County by the end of 2008, and then to seek reductions such that emissions are equivalent to year 1990 levels by 2020. The General Plan also states that "development of a reduction plan shall include consideration of a 'green building' ordinance and other mechanisms that are shown to be effective at reducing emissions." Overall increases in GHG emissions in Napa County were assessed in the Environmental Impact Report (EIR) prepared for the Napa County General Plan Update and certified in June 2008. GHG emissions were found to be significant and unavoidable despite adoption of mitigation measures that incorporated specific policies and action items into the General Plan.

Napa County is currently developing an emission reduction plan, and in the interim requires project applicants to quantify and reduce GHG emission through a variety of strategies. For larger land and agricultural/ vineyard conversion projects involving proposed oak tree removal, the county requires an analysis of pre- and post project change in carbon storage capacity and sequestration rate for remaining and future vegetation. Until the County's Climate Action Plan is complete, determination of significance and applicable mitigations are made on a case by case basis. If impacts are found to be significant, projects may be required to incorporate GHG reduction methods, which could include: avoidance, conservation or preservation of oaks/ trees, replanting native/ drought tolerant vegetation, use of ground cover and limited tilling, limiting the amount of non-pervious materials, building on existing and/ or degraded sites, using existing materials, limiting new vehicle trips, improving the overall energy efficiency and environmental sustainability of the proposed project/ operation, and GHG offsets. Additional mitigation strategies may be developed as a result of the Climate Action Plan effort currently underway *(also see Recommendations for the Future).*

IX. Recommendations for the Future

Oak woodland conservation will require a sustained commitment by the community in order to assure that we will pass on healthy and productive oak woodlands to future generations. Napa County will continue to implement the policies and action items contained in the General Plan as a part of the County's continued commitment to the conservation of natural resources, and the protection of agriculture and open space. Development of a Climate Action Plan for Napa County is also on-going at this time and it is expected to provide further support for the county's oak woodland conservation efforts. Additional recommendations to support the current Oak Woodland protection efforts that are underway in Napa County include:

A. EDUCATION & OUTREACH

- Publications about Napa County's historical and current oak woodland resources (e.g.-SFEI Historical Ecology Atlas)
- Recognition or Designation of Heritage Oak Trees
- Promoting efforts to ―re-oak" the valley by incorporating oak trees into designed landscapes associated with roads, parking lots, residential and non-residential developments.
- Encourage the proper management of existing oak woodlands in Napa County, including the reduction of fire hazard, which can be a significant threat to oak woodlands.

B. MITIGATION BANK

- Development of an Oak woodlands conservation and enhancement fund *(in-lieu mitigation fee, carbon trading/offsets)*

C. PILOT RESTORATION PROJECTS

- Pilot projects/ small experiments to demonstrate or test different methods of oak woodland conservation
- Information sharing regarding projects/ experiments results

D. RESEARCH & MONITORING

- South Wetlands Opportunity Area(SWOA) monitoring/ data
- Hyper-spectral/ remote sensing of vegetation types
- Carbon Sequestration

E. REMOVING OBSTACLES TO RESTORATION

Streamlined permitting from Resource Agencies

F. NURSERY PROPAGATION PROGRAM

Support for local propagation (nursery programs) and availability of seedlings and saplings for replanting and restoration

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Re-Oaking the Valleys......

While the old oak savannas are nearly gone, naturalistic patterns of valley oaks and other native trees could be recreated, even in highly developed areas. Such a re-oaking plan needs to occur at a landscape scale to consider how oaks fit in to the larger picture of natural spaces for humans and wildlife. Within this landscape context, trees could be strategically reintroduced along roads, fence lines, and public spaces, and focused on the several soil types that correlate with most of the historical trees (>50% of trees are associated with ~20% of the soil area). These efforts would build on a significant number of surviving trees that have been maintained as shade tress and landscape elements in public spaces, private residences, wineries and vineyards, and would help reverse the long-term decline in valley oaks. As well as returning a signature part of our California heritage to everyday life, such an effort would also provide a number of other valuable ecological services to the contemporary landscape. Landscape trends and restoration opportunities are currently being observed through projects in Napa Valley, Sonoma Valley, and eastern Contra Costa County. Preliminary investigations with plant ecologists, wildlife ecologists, and urban foresters indicate that the native trees could, with careful design, be re-integrated within developed landscapes in densities and patterns reflective of the historical landscape. Such an effort, coordinated at a regional scale, would benefit native oaks, especially the now relatively rare valley oak, and a range of other native wildlife. It would also provide urban forestry functions such as shading, urban runoff reduction, carbon storage, and aesthetic/ cultural value. A re-oaking plan would show how to maximize ecological benefits, while addressing challenges of appropriate planting context, maintenance issues, and jurisdictional approaches.

Some of the potential benefits include:

- Return a signature aspect of California‘s heritage to local valley communities
- Improve habitat quality and connectivity for species such as the acorn woodpecker, white-breasted nuthatch, oak titmouse, and pallid bat
- Increase valley oak distribution, population connectivity, and genetic viability
- Add younger age-classes to the oak population to prevent eventual extinction
- Increase nutrient and water retention to improve creek and Bay health
- Increase resiliency of the oaks to climate change
- Reduce heat island effect of urbanized areas
- Carbon offsets for municipalities
- Add value to homes and businesses from the . . aesthetic and shade benefits of oaks
- Create opportunities for local residents to learn about and participate in urban ecology.

While more attention is often focused on the environmental enhancement of our coasts, rivers, and uplands, the valleys -- where most people live -- receive little restoration effort because of a perceived lack of ecological opportunity. However, the structure of the native valley oak landscape lends itself to the integration of ecological values with social needs. The potential to dramatically increase oak presence and native wildlife habitat in once prime habitat areas should be recognized.

Note: A concept to reintegrate or in-fill native oak trees within developed landscapes, such as along roads and public spaces (parks, trails), as well as restoration projects and other opportunities.

San Francisco Estuary Institute (SFEI) 2010

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Appendices

Appendix A

Appendix A: California Oak Woodlands Conservation Act (AB 242 - 2001)
Oak Woodlands Conservation Act (SB1334 - 2004)

Appendix B

Appendix B: Oak Woodland Communities

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Appendix A

California Oak Woodlands Conservation Act

Assembly Bill No. 242

CHAPTER 588

An act to add Article 3.5 (commencing with Section 1360) to Chapter 4 of Division 2 of and to add and repeal Section 1363.5 of, the Fish and Game Code, relating to oak woodlands conservation.

[Approved by Governor October 7, 2001. Filed with Secretary of State October 9, 2001.]

LEGISLATIVE COUNSEL'S DIGEST

AB 242, Thomson. Wildlife conservation: oak woodlands. The existing Wildlife Conservation Law of 1947 establishes the Wildlife Conservation Board, and requires the board, among other things, to determine the areas in the state that are most essential and suitable for wildlife production and preservation, as prescribed. This bill would enact the Oak Woodlands Conservation Act to provide funding for the conservation and protection of California's oak woodlands. The bill would create the Oak Woodlands Conservation Fund in the State Treasury, and would authorize the expenditure of moneys in the fund, upon appropriation by the Legislature, for purposes of the act. The bill would require the board to administer the fund, as prescribed, and would provide that moneys in the fund shall be available to local government entities, park and open-space districts, resource conservation districts, private landowners, and nonprofit organizations for implementation and administration of the act, as provided. The bill would require each city or county planning department that receives a grant for the purposes of the act to report to the city councilor board of supervisors of the county, as appropriate, on the uses of those funds within one year from the date the grant is received. The existing Safe Neighborhood Parks, Clean Water, Clean Air, and Coastal Protection Bond Act of 2000 (the Villaraigosa-Keeley Act) provides that not less than $5,000,000 of the proceeds of bonds issued under that act be allocated, upon appropriation by the Legislature, for the preservation of oak woodlands. This bill would provide for the transfer of not less than $5,000,000 and not more than $8,000,000, as determined by the Wildlife Conservation Board, to the Oak Woodlands Conservation Fund to be used for the purposes of the bill.

The people of the State of California do enact as follows:

SECTION 1. The Legislature hereby finds and declares all of the following:

(a) The conservation of oak woodlands enhances the natural scenic beauty for residents and visitors, increases real property values, promotes ecological balance, provides habitat for over 300 wildlife species, moderates temperature extremes, reduces soil erosion, sustains water quality, and aids with nutrient cycling, all of which affect and improve the health, safety, and general welfare of the residents of the state.

(b) Widespread changes in land use patterns across the landscape are fragmenting the oak woodlands wildland character over extensive areas. (c) The future viability of California's oak woodlands resources are dependent, to a large extent, on the maintenance of large scale land holdings or on smaller multiple holdings that are not divided into fragmented, nonfunctioning biological units.

(d) The growing population and expanding economy of the state have had a profound impact on the ability of the public and private sectors to conserve the biological values of oak woodlands. Many of the privately owned oak woodlands stands are in areas of rapid urban and suburban expansion.

(e) A program to encourage and make possible the long-term conservation of oak woodlands is a necessary part of the state's wildlands protection policies and programs, and it is appropriate to expend money for that purpose. An incentive program of this nature will only be effective when used in concert with local planning and zoning strategies to conserve oak woodlands.

(f) Funding is necessary to sufficiently address the needs of conserving oak woodlands resources for future generations of Californians.

(g) California voters recognized the importance of funding that is needed to sufficiently protect the state's oak woodlands by passing Proposition 12, the Safe Neighborhood Parks, Clean Water, Clean Air, and Coastal Protection Bond Act of 2000 (the Villaraigosa-Keeley Act), which included not less than five million dollars ($5,000,000) for oak woodlands conservation.

SEC. 2. Article 3.5 (commencing with Section 1360) is added to Chapter 4 of Division 2 of the Fish and Game Code, to read:

Article 3.5. Oak Woodlands Conservation Act

1360. This article shall be known, and may be cited, as the Oak Woodlands Conservation Act.
1361. For purposes of this article, the following terms have the following meanings:
(a) ‗Board" means the Wildlife Conservation Board established pursuant to Section 1320.
(b) ‗Conservation easement" means a conservation easement, as defined in Section 815.1 of the Civil Code.
(c) ‗Fund" means the Oak Woodlands Conservation Fund.
(d) ‗Land improvement" means restoration or enhancement of biologically functional oak woodlands habitat.
(e) ‗Local government entity" means any city, county, city and county, district, or other local government entity, if the entity is otherwise authorized to acquire and hold title to real property.
(f) ‗Nonprofit organization" means a tax-exempt nonprofit organization that meets the requirements of subdivision (a) of Section 815.3 of the Civil Code.
(g) ‗Oak" means any species in the genus Quercus.
(h) ‗Oak woodlands" means an oak stand with a greater than 10 percent canopy cover or that may have historically supported greater than 10 percent canopy cover.
(i) ‗Oak woodlands management plan" means a plan that provides protection for oak woodlands over time and compensates private landowners for conserving oak woodlands.
(j) ‗Special oak woodlands habitat elements" means multi- and single-layered canopy, riparian zones, cavity trees, snags, and downed woody debris.
1362. It is the intent of the Legislature that this article accomplish all of the following:
(a) Support and encourage voluntary, long-term private stewardship and conservation of California's oak woodlands by offering landowners financial incentives to protect and promote biologically functional oak woodlands over time.
(b) Provide incentives to protect and encourage farming and ranching operations that are operated in a manner that protects and promotes healthy oak woodlands.
(c) Provide incentives for the protection of oak trees providing superior wildlife values on private lands.
(d) Encourage local land use planning that is consistent with the preservation of oak woodlands, particularly special oak woodlands habitat elements.

(e) Provide guidelines for spending the funds allocated for oak woodlands pursuant to the Safe Neighborhood Parks, Clean Water, Clean Air, and Coastal Protection Bond Act of 2000 (the Villaraigosa-Keeley Act (Chapter 1.692 (commencing with Section 5096.300) of Division 5 of the Public Resources Code)).

(f) Establish a fund for oak woodlands conservation, to which future appropriations for oak woodlands protection may be made, and specify grant making guidelines.

1363. (a) The Oak Woodlands Conservation Fund is hereby created in the State Treasury. The fund shall be administered by the board. Moneys in the fund may be expended, upon appropriation by the Legislature, for the purposes of this article.

(b) Money may be deposited into the fund from gifts, donations, funds appropriated by the Legislature for the purposes of this article, or from federal grants or loans or other sources, and shall be used for the purpose of implementing this article, including administrative costs. Funds from the Safe Neighborhood Parks, Clean Water, Clean Air, and Coastal Protection Bond Act of 2000 (the Villaraigosa-Keeley Act (Chapter 1.692 (commencing with Section 5096.300) of Division 5 of the Public Resources Code)), but not including funds dedicated as matching funds for the federal Forest Legacy Program, shall be deposited in the fund.

(c) To the extent consistent with the Safe Neighborhood Parks, Clean Water, Clean Air, and Coastal Protection Bond Act of 2000 (the Villaraigosa-Keeley Act (Chapter 1.692 (commencing with Section 5096.300) of Division 5 of the Public Resources Code)), the board may use money designated for the preservation and restoration of oak woodlands in the Oak Woodlands Conservation Fund for projects in conjunction with the California Forest Legacy Program (Div. 10.5 (commencing with Sec. 12200) of the P.R.C.)), but only for the purposes specified in this article and only if the following requirements are met:

(1) The Department of Forestry and Fire Protection shall make an initial recommendation to the board.

(2) The board may deny any initial recommendation to the Department of Forestry and Fire Protection. Subsequently, if the department alters an initial proposal, in a manner that the board determines to be significant, the board may withdraw its initial approval of the recommendation at any time during the process.

(d) The purposes for which moneys in the fund may be used include all of the following:

(1) Grants for the purchase of oak woodlands conservation easements. Any entity authorized to hold a conservation easement under Section 815.3 of the Civil Code may hold a conservation easement

pursuant to this article. The holder of the conservation easement shall ensure, on an annual basis, that the conservation easement conditions have been met for that year.

(2) Grants for land improvement.

(3) Cost-sharing incentive payments to private landowners who enter into long-term conservation agreements. An agreement shall include management practices that benefit oak woodlands and promote the economic sustainability of farming and ranching operations.

(4) Public education and outreach by local government entities, park and open-space districts, resource conservation districts, and nonprofit organizations. The public education and outreach shall identify and communicate the social, economic, agricultural, and biological benefits of strategies to conserve oak woodlands habitat values, including watershed protection benefits that reduce soil erosion, increase streamflows, and increase water retention and sustainable agricultural operations.

(5) Assistance to local government entities, park and open-space districts, resource conservation districts, and nonprofit organizations for the development and implementation of oak conservation elements in local general plans.

(6) Technical assistance consistent with the purpose of preserving oak woodlands.

(e) Not more than 20 percent of all grants made by the board pursuant to this article may be used for the purposes described in paragraphs (4), (5), and (6) of subdivision (d). Not less than 80 percent of funds available for grants pursuant to this article shall be expended for the purposes described in paragraphs (1), (2), and (3) of subdivision (d).

(f) Notwithstanding any other provision of law, this article governs the expenditure of funds for the preservation of oak woodlands pursuant to paragraph (4) of subdivision (a) of Section 5096.350 of the Public Resources Code.

1363.5. (a) Commencing on June 30, 2003, and annually thereafter, the board shall report to the Legislature and the Governor concerning the activities and expenditures of the fund.

(b) (1) In the first report to the Legislature, the board shall provide its best estimate of the total amount, in terms of acreage, species, and coverage, of oak woodlands habitat purchased with funds from the Habitat Conservation Fund and other funds pursuant to the California Wildlife Protection Act of 1990 (Chapter 9 (commencing with Section 2780) of Division 3.

(2) In each subsequent annual report, the board shall update the information required by paragraph (1) to reflect additional oak woodlands habitat purchased with funds from the Habitat Conservation

Fund pursuant to Chapter 9 (commencing with Section 2780) of Division 3, and any purchases made with moneys deposited in the Oak Woodlands Conservation Fund.

(c) The board shall annually provide its best estimate in the report, the acreage, cover, and species of oak woodlands habitat purchased with all moneys from the Safe Neighborhood Parks, Clean Water, Clean Air, and Coastal Protection Bond Fund.

(d) The board shall make all information available online at its Web site.

(e) This section shall become inoperative on July 1, 2020, and, as of January 1, 2021, is repealed, unless a later enacted statute that is enacted before January 1, 2021, deletes or extends the dates on which it becomes inoperative and is repealed.

1364. Moneys in the fund shall be available to local government entities, park and open-space districts, resource conservation districts, private landowners, and nonprofit organizations for the purposes set forth in subdivision (d) of Section 1363.

1365. The board shall develop and adopt guidelines and criteria for awarding grants that achieve the greatest lasting conservation of oak woodlands. The board shall develop these guidelines in consultation with the Department of Forestry and Fire Protection, the Department of Food and Agriculture, the University of California‘s Integrated Hardwood Range Management Program, conservation groups, and farming and ranching associations. As it applies to the award of grants for the implementation of this article, the board criteria shall specify that easement acquisitions that are the most cost-effective in comparison to the actual resource value of the easement shall be given priority.

1366. (a) To qualify for a grant pursuant to this article, the county or city in which the grant money would be spent shall prepare, or demonstrate that it has already prepared, an oak woodlands management plan that includes a description of all native oak species located within the county‘s or city‘s jurisdiction.

(b) To qualify for a grant pursuant to this article, the board shall certify that any proposed easement was not, and is not, required to satisfy a condition imposed upon the landowner by any lease, permit, license, certificate, or other entitlement for use issued by one or more public agencies, including, but not limited to, the mitigation of significant effects on the environment of a project pursuant to an approved environmental impact report or to mitigate a negative declaration required pursuant to the California Environmental Quality Act (Division 13 (commencing with Section 21000)) of the Public Resources Code.

(c) To qualify for a grant under this article, the applicant shall demonstrate that its proposal provides protection of oak woodlands that is more protective than the applicable provisions of law in existence on the date of the proposal.

(d) A county or city may develop an oak woodlands management plan. A nonprofit corporation, park and open-space district, resource conservation district, or other local government entity may apply to the board for funds to develop an oak woodlands management plan for a county or city, but the county or city shall maintain ultimate authority to approve the oak woodlands management plan.

(e) The process for developing an initial oak woodlands management plan, and the adoption of significant amendments to a plan, as determined by the county or city, are subject to the Ralph M. Brown Act (Chapter 9 (commencing with Section 54950) of Part 1 of Division 2 of Title 5 of the Government Code).

(f) A proposal by a local government entity, nonprofit corporation, park and open-space district, private landowner, or resource conservation district for a grant to be expended for the purposes of this article shall be certified by the county or city as being consistent with the oak woodlands management plan of the county or city. If the land covered by the proposal is in the jurisdiction of more than one county or city, each county or city shall certify that the proposal is consistent with the oak woodlands management plan of each county or city.

(g) If two or more entities seek grant funding from the board pursuant to this article for the same jurisdiction, the county or city shall designate which entity shall lead the efforts to manage oak woodlands habitat in the area.

1367. On or before April 1, 2002, the board and the Department of Forestry and Fire Protection shall develop a memorandum of understanding regarding the protection of oak woodlands that does all of the following:

(a) If necessary, creates a specific process for working together to use money from the fund in conjunction with the California Forest Legacy Program Act of 2000 (Division 10.5 (commencing with Section 12200) of the Public Resources Code).

(b) Lists elements a county or city shall include in its oak woodlands management plan. Items included in the plan shall assist a county or a city to specify conservation priorities and prevent oak woodlands habitat fragmentation while minimizing the cost and administrative burden associated with developing the plan. The elements may include any or all of the following:

(1) Tree inventory mapping.

(2) Oak canopy retention standards.

(3) Oak habitat mitigation measures.

(4) A procedure to monitor the effectiveness of the plan and to modify the plan as necessary.

(c) Designates an online repository for oak woodlands management plans that will be easily accessible to the public and any other state agency involved in oak woodlands conservation efforts.

(d) Discusses the relationship between oak woodlands conservation efforts under this article and efforts by other state agencies to protect oak woodlands, including efforts to combat sudden oak death, and outlines a plan, as necessary, for coordinating with these agencies.

1368. The board may not approve a grant to a local government entity, park and open-space district, resource conservation district, or nonprofit organization if the entity requesting the grant has acquired, or proposes to acquire, an oak woodlands conservation easement through the use of eminent domain, unless the owner of the affected lands requests the owner to do so.

1369. A city or county planning department may utilize a grant awarded for the purposes of this article to consult with a citizen advisory committee and appropriate natural resource specialists in order to report publicly to the city council or the board of supervisors on the status of the city‘s or county‘s oak woodlands. Each city or county planning department that receives a grant for the purposes of this article shall report to the city council or to the board of supervisors of the county, as appropriate, on the use of those grant funds within one year from the date the grant is received.

1370. No money may be expended from the fund to adopt guidelines or to administer the fund until at least one million dollars ($1,000,000) is deposited in the fund.

1372. Nothing in this article grants any new authority to the board or any other agency, office, or department to affect local policy or land use decision-making.

SEC. 3. An amount not less than five million dollars ($5,000,000) and not more than eight million dollars ($8,000,000), as determined by the Wildlife Conservation Board, from moneys in the Safe Neighborhood Parks, Clean Water, Clean Air, and Coastal Protection Bond Fund available for oak woodlands conservation pursuant to paragraph (4) of subdivision (a) of Section 5096.350 of the Public Resources Code shall be transferred to the Oak Woodlands Conservation Fund created pursuant to Section 1363 of the Fish and Game Code, to be used for the purposes of Article 3.5 (commencing with Section 1360) of Chapter 4 of Division 2 of the Fish and Game Code.

BILL NUMBER: SB 1334

CHAPTERED BILL TEXT

CHAPTER 732

FILED WITH SECRETARY OF STATE SEPTEMBER 24, 2004
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AMENDED IN ASSEMBLY JUNE 7, 2004
AMENDED IN SENATE MAY 24, 2004
AMENDED IN SENATE APRIL 28, 2004
AMENDED IN SENATE MARCH 31, 2004

INTRODUCED BY Senator Kuehl
(Coauthor: Senator Romero)
(Coauthors: Assembly Members Hancock, Koretz, and Liu)

FEBRUARY 18, 2004

An act to add Section 21083.4 to the Public Resources Code, relating to oak woodlands conservation.

LEGISLATIVE COUNSEL'S DIGEST

SB 1334, Kuehl. Oak woodlands conservation: Environmental quality.

(1) The Oak Woodlands Conservation Act provides funding for the conservation and protection of California's oak woodlands. The California Environmental Quality Act (CEQA) requires a lead agency to prepare, or cause to be prepared, and certify the completion of, an environmental impact report on a discretionary project that it proposes to carry out or approve that may have a significant effect on the environment, as defined, or to adopt a negative declaration if it finds that the project will not have that effect. CEQA also requires a lead agency to prepare a mitigated negative declaration for a project that may have a significant effect on the environment if revisions in the project would avoid or mitigate that effect and there is no substantial evidence that the project, as revised, would have a significant effect on the environment. CEQA provides some exemptions from its requirements for specified projects. This bill would require a county, in determining whether CEQA requires an environmental impact report, negative declaration, or mitigated negative declaration, to determine whether a project in its jurisdiction may result in a conversion of oak woodlands that will have a significant effect on the environment, and would require the county, if it determines there may be a significant effect to oak woodlands, to require one or more of specified mitigation alternatives to mitigate the significant effect of the

conversion of oak woodlands. The bill would exempt specified activities from its requirements. By imposing new duties on local governments with respect to oak woodlands mitigation, the bill would impose a state-mandated local program.
(2) The California Constitution requires the state to reimburse local agencies and school districts for certain costs mandated by the state. Statutory provisions establish procedures for making that reimbursement. This bill would provide that no reimbursement is required by this act for a specified reason.

THE PEOPLE OF THE STATE OF CALIFORNIA DO ENACT AS FOLLOWS:

SECTION 1. Section 21083.4 is added to the Public Resources Code, to read:

21083.4. (a) For purposes of this section, "oak" means a native tree species in the genus Quercus, not designated as Group A or Group B commercial species pursuant to regulations adopted by the State Board of Forestry and Fire Protection pursuant to Section 4526, and that is 5 inches or more in diameter at breast height.
(b) As part of the determination made pursuant to Section 21080.1, a county shall determine whether a project within its jurisdiction may result in a conversion of oak woodlands that will have a significant effect on the environment. If a county determines that there may be a significant effect to oak woodlands, the county shall require one or more of the following oak woodlands mitigation alternatives to mitigate the significant effect of the conversion of oak woodlands:

(1) Conserve oak woodlands, through the use of conservation easements.
(2) (A) Plant an appropriate number of trees, including maintaining plantings and replacing dead or diseased trees.
(B) The requirement to maintain trees pursuant to this paragraph terminates seven years after the trees are planted.
(C) Mitigation pursuant to this paragraph shall not fulfill more than one-half of the mitigation requirement for the project.
(D) The requirements imposed pursuant to this paragraph also may be used to restore former oak woodlands.
(3) Contribute funds to the Oak Woodlands Conservation Fund, as established under subdivision (a) of Section 1363 of the Fish and Game Code, for the purpose of purchasing oak woodlands conservation easements, as specified under paragraph (1) of subdivision (d) of that section and the guidelines and criteria of the Wildlife Conservation Board. A project applicant that contributes funds under this paragraph shall not receive a grant from the Oak Woodlands Conservation Fund as part of the mitigation for the project.
(4) Other mitigation measures developed by the county. (c) Notwithstanding subdivision (d) of Section 1363 of the Fish and Game Code, a county may use a grant awarded pursuant to the Oak Woodlands Conservation Act (Article 3.5 (commencing with Section 1360) of Chapter 4 of Division 2 of the Fish and Game Code) to prepare an oak conservation element for a general plan, an oak

protection ordinance, or an oak woodlands management plan, or amendments thereto, that meets the requirements of this section.
(d) The following are exempt from this section:
(1) Projects undertaken pursuant to an approved Natural Community Conservation Plan or approved subarea plan within an approved Natural Community Conservation Plan that includes oaks as a covered species or that conserves oak habitat through natural community conservation preserve designation and implementation and mitigation measures that are consistent with this section.
(2) Affordable housing projects for lower income households, as defined pursuant to Section 50079.5 of the Health and Safety Code, that are located within an urbanized area, or within a sphere of influence as defined pursuant to Section 56076 of the Government Code.
(3) Conversion of oak woodlands on agricultural land that includes land that is used to produce or process plant and animal products for commercial purposes.
(4) Projects undertaken pursuant to Section 21080.5 of the Public Resources Code.
(e) (1) A lead agency that adopts, and a project that incorporates, one or more of the measures specified in this section to mitigate the significant effects to oaks and oak woodlands shall be deemed to be in compliance with this division only as it applies to effects on oaks and oak woodlands. (2) The Legislature does not intend this section to modify requirements of this division, other than with regard to effects on oaks and oak woodlands.
(f) This section does not preclude the application of Section 21081 to a project.
(g) This section, and the regulations adopted pursuant to this section, shall not be construed as a limitation on the power of a public agency to comply with this division or any other provision of law.
SEC. 2. No reimbursement is required by this act pursuant to Section 6 of Article XIII B of the California Constitution because a local agency or school district has the authority to levy service charges, fees, or assessments sufficient to pay for the program or level of service mandated by this act, within the meaning of Section 17556 of the Government Code.

Appendix B

Oak Woodland Communities

Oak Woodland Vegetation Types:

a. Mixed Oak Woodland

General Distribution

Most oak woodlands in the County are mixed oak woodlands with more than one co-dominant oak species.

Dominant Plants

Mixed oak woodlands where interior live oak and blue oak are co-dominants are common east of the Napa River watershed. Other mixed oak woodlands are composed of coast live oak and valley oak in low elevations, with canyon live oak on steep slopes. The mixed oak alliance also includes stands dominated by deciduous oaks, such as California black oak (*Quercus kelloggii*) (see below). Other tree species found in mixed oak woodlands include big-leaf maple (*Acer macrophyllum*) in wetter areas and madrone (*Arbutus menqiesii*) in drier settings. Conifers such as Douglas-fir (*Psuedotsuga menzeisii*) or Ponderosa pine (*Pinus ponderosa*) form minor components of this community at higher elevations, as does foothill pine at lower elevations. The understory is characterized by annual grassland species, with patches of shrub species such as hillside gooseberry (*Ribes californica*), and poison oak, vines such as hairy honeysuckle (*Lonicera hispidula*), and herbaceous species such as rigid hedge nettle (*Stachys ajugoides*) and miner‘s lettuce (*Claytonia perfoliata*) (Sawyer and Keeler-Wolf 1995). Other commonly found understory species may also include coffeeberry, toyon, manzanita, and spicebush (Sauer 2010).

Common Wildlife

Most wildlife species associated with the mixed oak habitat are also found in other oak woodlands and chaparral. However, birds such as ash-throated flycatcher (*Myiarchus cinerascens*), Hutton‘s vireo (*Vireo huttoni*), orange-crowned warbler, lark sparrow (*Chondestes grammacus*), Bullock‘s oriole (*Icterus bullockii*), Lawrence‘s goldfinch (*Carduelis lawrencei*) and lesser goldfinch (*Carduelis psaltria*) are primarily found in this type of woodland. This habitat shares many of the same mammal and herpetofauna as chaparral described above. Oak woodlands can be extremely productive for wildlife. Acorns provide an important food source for many species of birds and mammals, as do the numerous insects that feed on oaks. Mature stages of oak woodland development provide suitable or optimal breeding conditions for many wildlife species, with abundant food and large living trees used for nesting (Mayer and Laudenslayer 1988).

Special-Status Species

Golden eagles forage in oak woodlands, while Lewis's woodpecker (*Melanerpes lewis*) is a winter resident of this community. Clara Hunt's milk-vetch (*Astragalus clarianus*) may grow in openings in oak woodlands, while Brewer's western flax (*Hesperolinon breweri*) is found on serpentine slopes in oak woodlands. Additional information and a list of special-status species associated with oak woodlands in the county can be found in the Napa County Baseline Data Report (BDR 2005-appendix B-C).

b. Evergreen Oak Woodland

General Distribution

Coast live oak woodlands are common at low elevations in the southern Napa watershed. They may be found on gentle slopes in low foothills, especially on the east side of the Napa Valley, as well as on steep southerly slopes where it is found with chaparral species. Interior live oak woodlands are found east of the Napa River watershed. Mixed broadleaf woodlands are found on mesic slopes in central and western County (Thorne et al. 2004)

Dominant Plants

Evergreen oak woodlands in the County are dominated by coast live oak and interior live oak.

Coast Live Oak Woodland

The coast live oak woodland community is characterized by an open to nearly closed canopy of coast live oak, with madrone and California bay generally under 10–15% relative cover, and a dense understory of poison oak, rigid hedge nettle, and hairy honeysuckle, in addition to perennial grasses and forbs.

Interior Live Oak Woodland

Relatively pure stands of interior live oak are rare in the County. They often include a minor component of foothill pine and coast live oak, and an understory of toyon, buckeye (*Aesculus californica*), bay, coffeberry, Indian warrior (*Pedicularis densiflora*), and Pacific pea (*Lathyrus vestitus*), in addition to perennial grasses and forbs. Shrubs in the understory may include poison oak and yerba santa (*Eriodictyon californicum*).

Mixed Broadleaf Woodlands

Mixed broadleaf woodlands feature California bay or madrone as co-dominants with coast live oak, California black oak, and canyon oak. Douglas-fir and big-leaf maple may comprise up to 5% of the canopy. Such woodlands occur in approximately 4% of the County. The understory community is typically a mix of hazelnut (*Corylus cornuta*) and oceanspray (*Holodiscus discolor*), and vines such as poison oak, toyon, and California blackberry (*Rubus ursinus*). Grasses are a minor component here including Geyer's oniongrass (*Melica geyeri*) and Torrey's melica. Ferns and leaf litter are prominent on the forest floor.

Tanbark Oak Woodlands

This cover type is uncommon or rare as mapable stands, and it is usually in close proximity to conifers such as Douglas-fir (*Psuedotsuga menzeisii*) or Redwood (*Sequoia sempervirens*) in mesic settings. It is more often a component of the California Bay-Madrone-Coast Live Oak NFD Super Alliance.

Common Wildlife

Many species are primarily associated with oak woodlands, including reptiles such as western skink (*Eumeces skiltonianus*) and northern alligator lizard (*Elgaria coerula*); amphibians such as ensatina (*Ensatina eschscholtzii*) and California slender salamander (*Batrachoseps attenuatus*); and birds such as Nuttall's woodpecker (*Picoides nuttallii*), warbling vireo (*Vireo gilvus*), chestnut-backed chickadee (*Poecile rufescens*), black-throated gray warbler (*Dendroica nigrescens*) and black-headed grosbeak (*Pheucticus melanocephalus*). Typical mammal species found in this habitat include those described for chaparral communities.

Special-Status Species

Lewis's woodpecker is a winter resident of this oak woodland community and golden eagles forage in oak woodlands. Clara Hunt's milk-vetch may grow in openings in oak woodlands, while Brewer's western flax is found on serpentine slopes in oak woodlands. Additional information and a list of special-status species associated with oak woodlands in the county can be found in the Napa County Baseline Data Report (BDR 2005-appendix B-C).

c. Deciduous Oak Woodlands

General Distribution

Blue oak woodlands occur primarily east of Chiles Valley to the County line (Thorne et al. 2004). California black oak woodlands are found at higher elevations, especially in the Atlas Peak region. Valley oak riparian woodlands are found along major riparian corridors, especially along the Napa River and its tributaries.

Dominant Plants

Deciduous oak woodlands in the County are dominated by blue oak. Blue oak woodlands make up approximately 9% of the County. California black oak becomes a more important component of deciduous oak woodlands at higher elevations, and valley oak is more common along riparian corridors.

Blue Oak Woodlands

Blue oak woodlands vary from closed canopies of blue oak to very open stands. In all cases, blue oak makes up at least 80–90% of relative cover (Thorne et al. 2004). The understory is characterized by annual grassland species, with patches of shrub species such as common manzanita (*Arctostaphylos manzanita*), buckeye, hillside gooseberry, and poison oak (Sawyer and Keeler-Wolf 1995). Foothill pine frequently occurs as a minor overstory tree with less than 15% relative cover.

Black Oak Woodlands

Black oak woodlands are located on gentle to moderate slopes trending in most directions except south. They typically occur at higher elevations, particularly in the Atlas Peak region, and comprise a larger component of deciduous woodlands at this elevation.

Oregon White Oak Woodlands

Uncommon as mapable stands, this type is generally a component of more mesic mixed oak stands. Several nearly pure stands were mapped on gentle slopes west of the Napa Valley and north of the city of Napa.

Valley Oak Woodlands

Valley oak riparian woodlands are characterized by one of two suites of co-dominant tree species, either California bay, coast live oak, walnut and ash, or Fremont cottonwood (*Populus fremontii*) and coast live oak. Valley oak woodland also occurs on the open valley floor, where it was historically quite extensive. Valley oak riparian woodlands are described in more detail under the Riparian Woodlands section below.

Common Wildlife

Wildlife communities associated with deciduous oak woodland are similar to those described in evergreen mixed oak woodland. Notable exceptions include relatively rare species including wintering Lewis's woodpecker, yellow-billed magpie (*Pica nuttalli*) and phainopepla (*Phainopepla nitens*).

Special-Status Species

Many special-status species occurring in evergreen oak woodlands also occur in deciduous oak woodlands (Appendix A). Some special-status species are more closely associated with deciduous oak woodlands, sometimes because they are found in the riparian areas or higher elevations where deciduous oak woodlands are found. For example, long-legged myotis (*Myotis volans*) is found in high elevation woodlands, while ringtail cat and marsh checkerbloom (*Sidalcea oregana* ssp. *hydrophila*) are found in riparian woodlands.

d. Riparian Woodland and Forest

General Distribution

Riparian woodlands and forests are an uncommon but highly valuable land cover in the County, occurring on over 11,000 acres (2%) of the total land area in the County. Over half of the County's riparian woodland is found in the Western Mountains (32% of County total) areas and Napa Valley Floor (20%). Eastern Mountains (10%) and Pope Valley (9%) areas also have significant areas of riparian woodland. They occur throughout the County along riparian and stream corridors.

Dominant Plants

There are seven types (alliances or associations) that are strongly associated with riparian and stream corridors, two of which are Valley Oak associations: Valley oak–(California bay-coast live oak-walnut-Oregon ash) riparian forest NFD association; and Valley oak–Fremont cottonwood–(coast live oak) riparian forest NFD association. The others are Coast redwood alliance, Coast redwood–Douglas-fir/ California bay NFD (not formally defined) association, White alder (*Alnus rhombifolia*) (mixed willow–California bay–big leaf maple) riparian forest association, Brewer willow alliance, and Mixed willow super alliance. Several of these communities are considered sensitive by the Department of Fish and Game (DFG): Valley oak woodlands are the most common riparian woodland type in the County, followed by Coast redwood- Douglas-fir/ California bay forests. General distribution and dominant plants of the valley oak-Fremont cottonwood woodlands are discussed with other oak woodland types above.

Valley Oak Riparian Woodlands

Valley oak riparian woodlands are characterized by one of two suites of co-dominant tree species, either California bay, coast live oak, walnut and ash, or Fremont cottonwood (*Populus fremontii*) and coast live oak. Valley oak riparian woodlands, while constituting a small fraction of the County's overall area, are especially valuable in terms of protecting water quality and providing wildlife habitat. If valley oak riparian woodlands are not heavily grazed, they may contain riparian vegetation in the understory, such as bracken fern (*Pteridium aquilinum*), Santa Barbara sedge (*Carex barbarae*), arroyo willow (*Salix lasiolepis*), California rose (*Rosa californica*), common snowberry (*Symphoricarpus albus*), California blackberry, and wild grape (*Vitus californica*). Valley oak woodland also occurs on the open valley floor, where it was historically quite extensive. Although there is little data to help describe this vegetation type, canopy cover is thought to have been open to locally dense with valley oak the dominant tree. Blue oak, California black oak, and coast live oak were probably minor constituents of this community. The understory was similar to that described under native grassland with a mosaic of seasonal wetland interspersed.

Common Wildlife

Riparian woodlands support one of the most diverse groups of plants and animals in the County on a per area basis. Riparian woodlands are highly productive systems because they receive nutrients and water from higher elevations. High bird abundance and diversity in riparian forests and woodlands result from this productivity (Holstein 1984). Intact riparian woodlands are essential for steelhead trout (*Oncorhynchus* spp.) Several species are primarily associated with this riparian habitat, including amphibians such as Pacific tree frog (*Hyla regilla*); birds such as downy woodpecker (*Picoides pubescens*) and wide-ranging mammals such as those described for chaparral and oak woodlands. Many bird species associated with oak woodland habitats are also found in riparian woodlands.

Wildlife habitat is greatly enhanced by riparian vegetation, which provides shade, food, and nutrients for aquatic invertebrates that form the basis of the food chain (Riparian Habitat Joint Venture 2004). Coarse woody debris from riparian trees and shrubs is also an important feature of in-stream habitat, forming scour pools and logjams used by amphibians, insects, and fish (Riparian Habitat Joint Venture 2004). Riparian forests and woodland may be the most important habitat for California landbird species, providing breeding and over wintering grounds, migration stopover areas, and movement corridors (Riparian Habitat Joint Venture 2004). The quality of riparian wildlife habitat is enhanced by multilayered, structurally complex vegetation, including canopy trees and a shrub layer, and food sources such as berries and insects.

Special-Status Species

Of the County‘s 69 special-status wildlife species, 19 depend on this habitat type, while only 2 of the County‘s 81 special-status plant species do. Napa County‘s riparian forests also contain some of the last native remaining stands of Northern California black walnut (*Juglans californica* var. *hindsii*), located in Wooden Valley (California Natural Diversity Database 2004).

e. Chaparral/Scrub

General Distribution

While not an oak woodland community, chaparral/ scrub is included here due to the various species of shrub oaks it contains. It is also the second most common land cover in the County, covering approximately 107,000 acres or 21% of the County (BDR, 2005). This community is dominated by woody shrubs, with less than 10% cover of trees, and generally occurs in settings that are too hot, dry, rocky, and steep to support tree-dominated habitats (Holland 1986). They occur especially on south and southwest-facing slopes. The three most common chaparral/ scrub types present are chamise chaparral, leather oak–white leaf manzanita–chamise (a serpentine chaparral), and scrub interior live oak–scrub oak (*mixed chaparral*). The mixed chaparrals and serpentine chaparrals sub-groups are discussed below.

Dominant Plants

Mixed Chaparral/Scrub

Of the five types of mixed chaparral/ scrub that are mapped, three are classified as evergreen sclerophyllous chaparral. The two remaining types are deciduous (deer brush) or microphyllous (coyote brush–California sagebrush [*Artemisia californica*]) and are both very small in extent in the County. The sclerophyllous chaparral types are dominated by various species of shrubby oaks: interior live oak (*Quercus wislizenii*), leather oak (*Quercus durata*) and scrub oak or manzanitas, and others. Associate species are highly variable depending on type and physical site characteristics. Mixed chaparral occurs on more mesic sites than chamise-dominated chaparral. Oak dominated chaparral is found primarily in the east of the County, where it occurs in dense stands, especially along the crest of Blue Ridge, and forms a total of 2% of the total land cover of the County. This type forms 6% of the land cover in the Berryessa area, and from 2%–6% in five other evaluation areas. It transitions to interior live oak forest on more mesic sites. Manzanita-dominated chaparral occurs in a variety of settings, mostly in the western portion of the County, and also forms a total of 2% of the total land cover.

Serpentine Chaparral

Four types of serpentine chaparral are recognized on the ICE map, and together they form almost 10% of the total land cover of the County. Serpentine chaparral grows on infertile soils derived from serpentinite rock that have a unique mineral composition with high concentrations of iron and magnesium and low concentration of nutrients such as nitrogen and calcium (Kruckeberg 1984). These harsh soils support a distinctive flora, including many endemic species: Ten percent of California's endemic plants are confined to serpentine soils (Skinner and Pavlik 1994). The dominant shrubs of serpentine chaparral are usually leather oak, chamise (*Adenostoma fasciculatum*), or white leaf manzanita (*Arctostaphylos viscida*). Species composition is related to aspect, mineral content, and soil moisture levels, and the transition between chaparral types can be subtle. The ground layer is usually sparse. Serpentine chaparral is found mainly in the north central portion of the County, especially in the Knoxville area, where they form more than 30% of the total land cover, and also in the hills east of Pope Valley (23% land cover of the Pope Valley Evaluation Area), Central Interior Valleys (19% land cover) and Berryessa area (11% land cover). Small amounts are also found in the Eastern Mountains (4%) and the Western Mountains (2%).

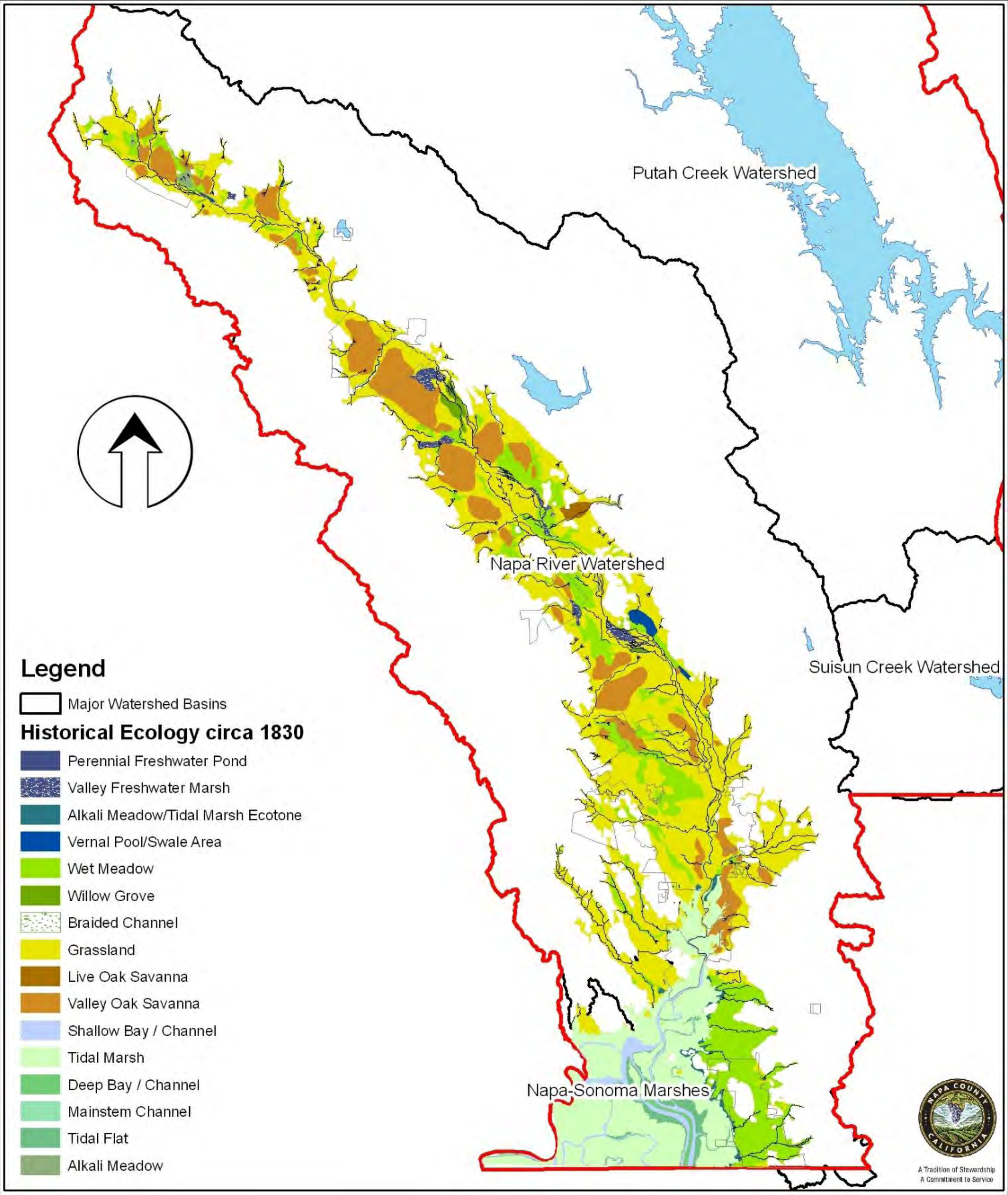
Common Wildlife

Many species are primarily associated with chaparral, including reptiles such as western rattlesnake (*Crotalis viridis*), California mountain kingsnake (*Lampropeltis zonata*); mammals such as desert cottontail (*Sylvilagus bachmanii*) Sonoma chipmunk (*Tamias sonomae*); and birds such as wrentit (*Chamea fasciata*), California thrasher (*Toxostoma redivivum*), rufous-crowned sparrow (*Aimophila ruficeps*), California quail (*Callipepla californica*), Bewick's wren (*Thryomanes bewickii*), and sage sparrow (*Amphispiza belli*). Most of these species are resident and are rarely found outside of this habitat. Other species that occur in chaparral are also found in a variety of woodlands and other habitats including many mammals.

Special-Status Species

A total of 34 special-status plants are associated with chaparral, often with micro-habitats such as openings, rocky outcrops, or swales within this habitat type. Of these, 20 are also found in serpentine chaparral.[xxviii]

Appendix B - 1



Horizontal Datum: NAD 83, CA State Plane Coordinates, Zone II, feet

Disclaimer: This map was prepared for informational purpose only. No liability is assumed for the accuracy of the data delineated hereon.

Historical Extent of Napa Valley Oak Woodlands in Valley Floor Areas (Mapped by SFEI)

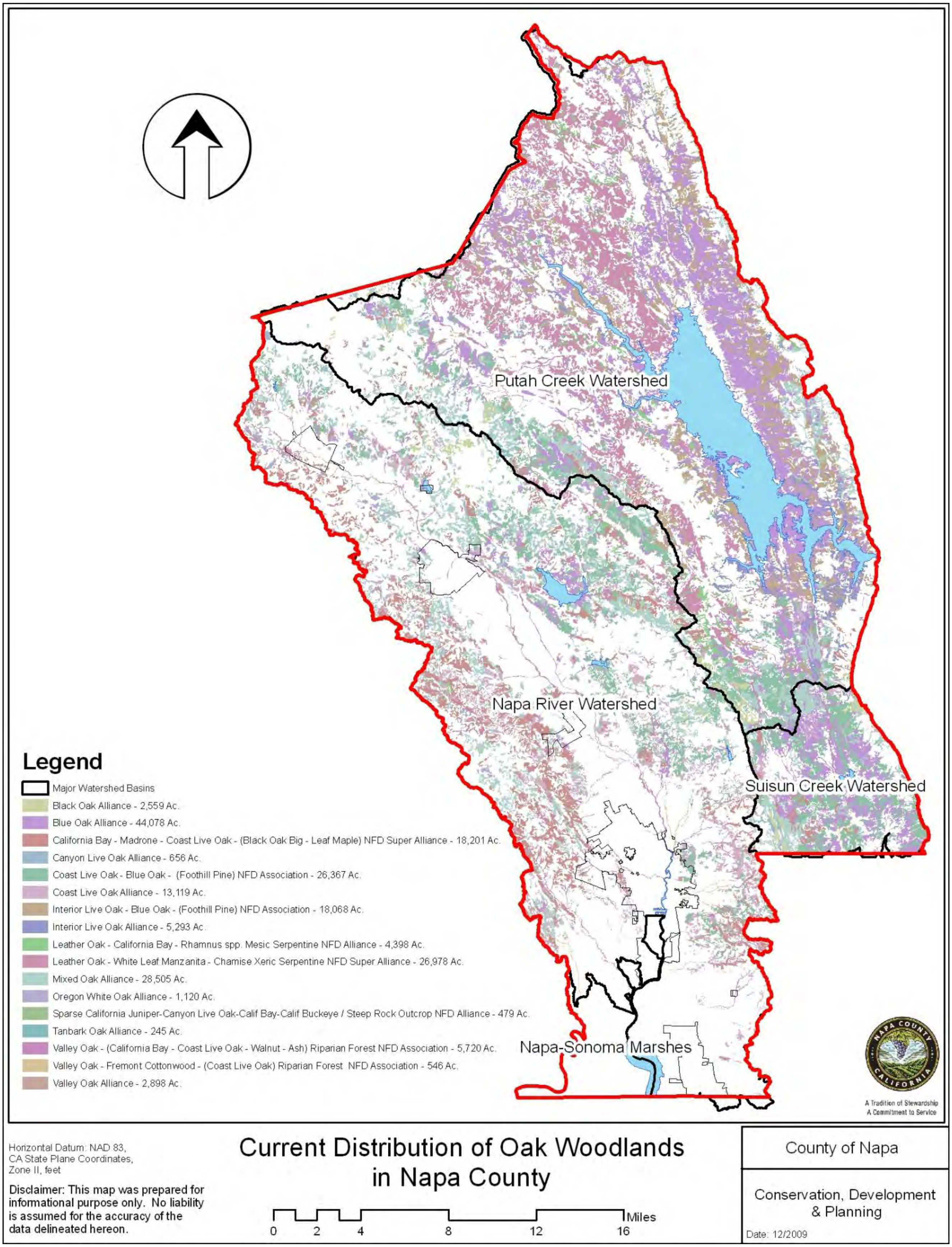
0 1.25 2.5 5 7.5 10 Miles

County of Napa

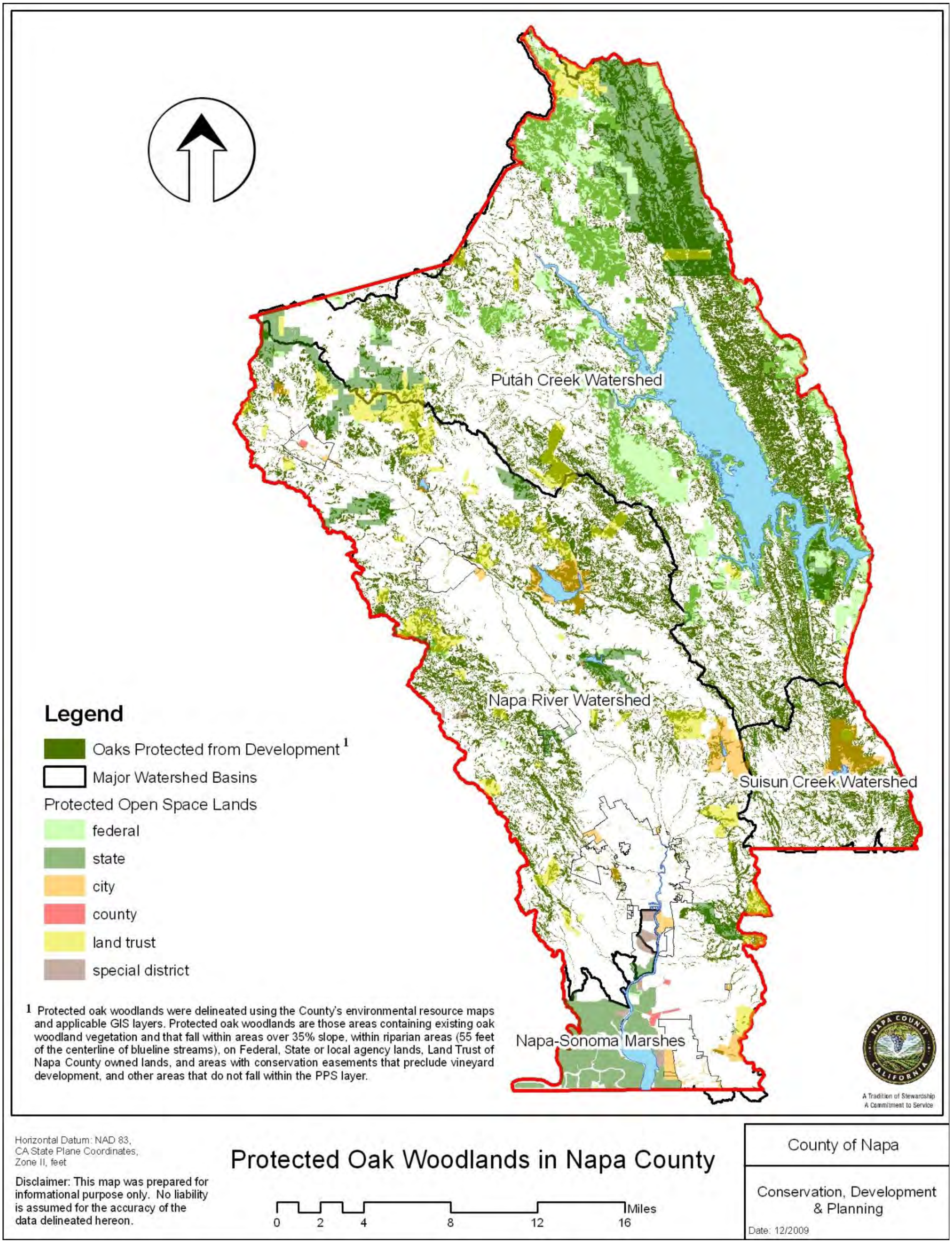
Conservation, Development & Planning

Date: 12/2009 Version 1

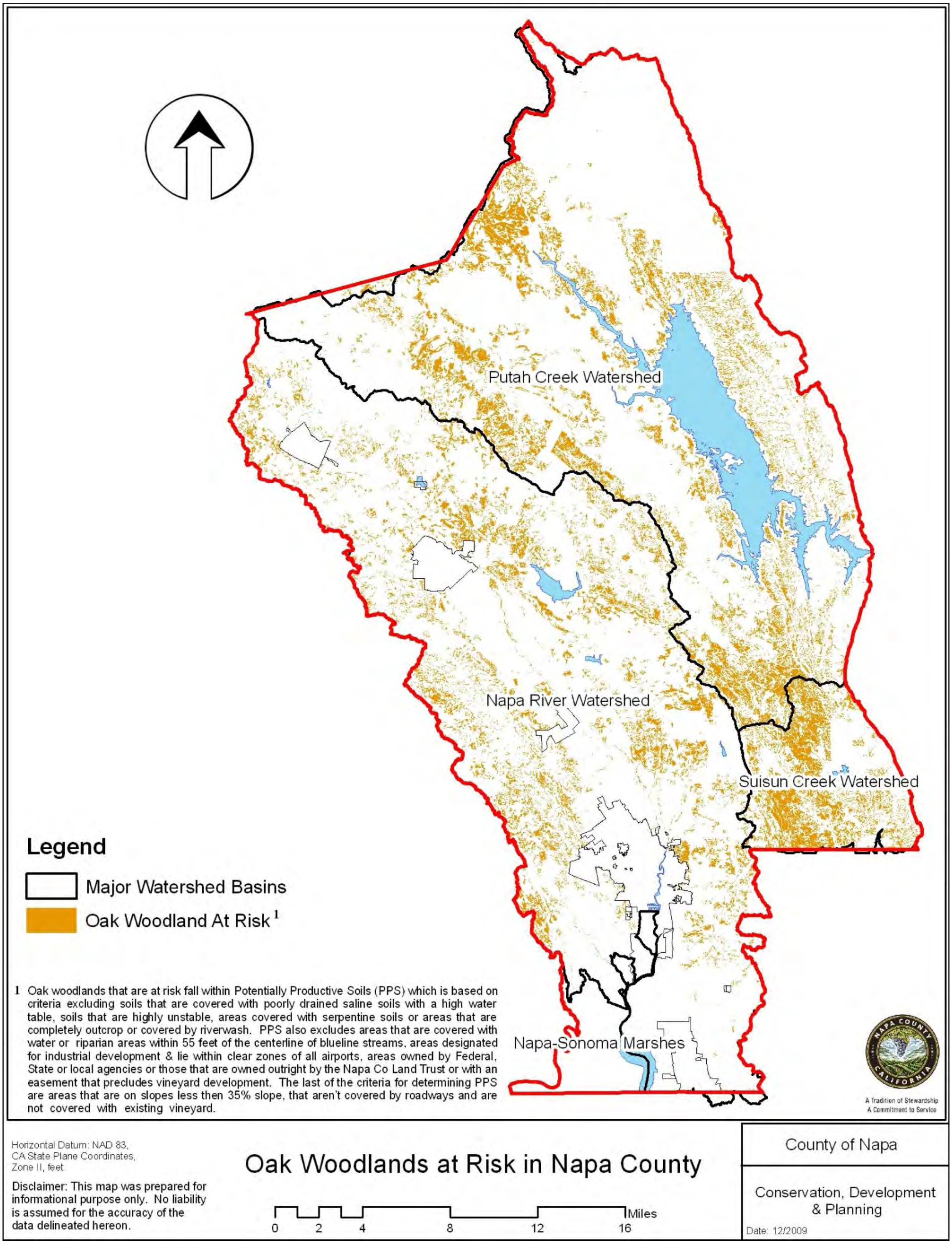
Appendix B - 2


Putah Creek Watershed
Napa River Watershed
Suisun Creek Watershed
Napa-Sonoma Marshes
Legend
Major Watershed Basins
Black Oak Alliance - 2,559 Ac.
Blue Oak Alliance - 44,078 Ac.
California Bay - Madrone - Coast Live Oak - (Black Oak Big - Leaf Maple) NFD Super Alliance - 18,201 Ac.
Canyon Live Oak Alliance - 656 Ac.
Coast Live Oak - Blue Oak - (Foothill Pine) NFD Association - 26,367 Ac.
Coast Live Oak Alliance - 13,119 Ac.
Interior Live Oak - Blue Oak - (Foothill Pine) NFD Association - 18,068 Ac.
Interior Live Oak Alliance - 5,293 Ac.
Leather Oak - California Bay - Rhamnus spp. Mesic Serpentine NFD Alliance - 4,398 Ac.
Leather Oak - White Leaf Manzanita - Chamise Xeric Serpentine NFD Super Alliance - 26,978 Ac.
Mixed Oak Alliance - 28,505 Ac.
Oregon White Oak Alliance - 1,120 Ac.
Sparse California Juniper-Canyon Live Oak-Calif Bay-Calif Buckeye / Steep Rock Outcrop NFD Alliance - 479 Ac.
Tanbark Oak Alliance - 245 Ac.
Valley Oak - (California Bay - Coast Live Oak - Walnut - Ash) Riparian Forest NFD Association - 5,720 Ac.
Valley Oak - Fremont Cottonwood - (Coast Live Oak) Riparian Forest NFD Association - 546 Ac.
Valley Oak Alliance - 2,898 Ac.
NAPA COUNTY CALIFORNIA
A Tradition of Stewardship
A Commitment to Service
Horizontal Datum: NAD 83,
CA State Plane Coordinates,
Zone II, feet
Disclaimer: This map was prepared for informational purpose only. No liability is assumed for the accuracy of the data delineated hereon.
Current Distribution of Oak Woodlands
in Napa County
0 2 4 8 12 16 Miles
County of Napa
Conservation, Development
& Planning
Date: 12/2009

Appendix B - 3


Putah Creek Watershed
Napa River Watershed
Suisun Creek Watershed
Napa-Sonoma Marshes
Legend
Oaks Protected from Development 1
Major Watershed Basins
Protected Open Space Lands
federal
state
city
county
land trust
special district
1 Protected oak woodlands were delineated using the County's environmental resource maps and applicable GIS layers. Protected oak woodlands are those areas containing existing oak woodland vegetation and that fall within areas over 35% slope, within riparian areas (55 feet of the centerline of blueline streams), on Federal, State or local agency lands, Land Trust of Napa County owned lands, and areas with conservation easements that preclude vineyard development, and other areas that do not fall within the PPS layer.
A Tradition of Stewardship
A Commitment to Service
Horizontal Datum: NAD 83,
CA State Plane Coordinates,
Zone II, feet
Disclaimer: This map was prepared for informational purpose only. No liability is assumed for the accuracy of the data delineated hereon.
Protected Oak Woodlands in Napa County
0 2 4 8 12 16 Miles
County of Napa
Conservation, Development & Planning
Date: 12/2009

Appendix B - 4



Putah Creek Watershed
Napa River Watershed
Suisun Creek Watershed
Napa-Sonoma Marshes
Legend
Major Watershed Basins
Oak Woodland At Risk 1
1 Oak woodlands that are at risk fall within Potentially Productive Soils (PPS) which is based on criteria excluding soils that are covered with poorly drained saline soils with a high water table, soils that are highly unstable, areas covered with serpentine soils or areas that are completely outcrop or covered by riverwash. PPS also excludes areas that are covered with water or riparian areas within 55 feet of the centerline of blueline streams, areas designated for industrial development & lie within clear zones of all airports, areas owned by Federal, State or local agencies or those that are owned outright by the Napa Co Land Trust or with an easement that precludes vineyard development. The last of the criteria for determining PPS are areas that are on slopes less then 35% slope, that aren't covered by roadways and are not covered with existing vineyard.
NAPA COUNTY CALIFORNIA
A tradition of Stewardship
A Commitment to Service
Horizontal Datum: NAD 83,
CA State Plane Coordinates,
Zone II, feet
Disclaimer: This map was prepared for informational purpose only. No liability is assumed for the accuracy of the data delineated hereon.
Oak Woodlands at Risk in Napa County
0 2 4 8 12 16 Miles
County of Napa
Conservation, Development & Planning
Date: 12/2009

Appendix C

Oak Woodland Conservation and Restoration Evaluation Criteria

These criteria will assist willing landowners, public agencies, nonprofit organizations and other project partners in identifying priority areas with the highest oak woodland resource values. The evaluation system uses criteria to assess a broad range of oak woodland resource values, such as stand composition and distribution, tree cover and density, plant and wildlife habitat availability (including special status species), historical and cultural significance, and recreational opportunities. In addition, the system factors in the threat of loss and potential management constraints, and complements countywide conservation and watershed planning efforts.

Priority Conservation & Restoration Criteria

The evaluation system to establish priorities uses a three (3) layered approach to assign an overall priority to a parcel which can be tailored to the specific landowner or funding source requirements. The three-layers considered in the ranking system are:

(1) **resource value** - an aggregate assessment of the natural resource values associated with a-given oak woodland (most important layer in the prioritization system);
(2) **risk category** - an assessment of the likelihood that the resource will be lost or seriously-degraded over various time horizons if no conservation actions are instituted; and
(3) **management constraints** – a measure reflecting the level of land management inputs needed to maintain the resource value (e.g.-control invasive species, promote oak regeneration).

The evaluation system is designed to provide flexibility and can be modified over time by adding criteria or adjusting thresholds for priority rankings as needed to address changing resource needs. Specific weighting has not been assigned to the various criteria, as their relative importance may change over time based on the locations and types of conservation projects that are implemented and their effectiveness. The County's Geographic Information System (GIS) provides data on oak woodland species, density and distribution, which can be supplemented by field and other site specific information in areas where the scope and resolution of GIS data may be limited.

1. Resource Values

Conservation ranking is based on maintaining existing oak woodlands having high resource values that are already present. Enhancement ranking criteria is based on a combination of both current resource values and the potential resource values in the enhanced/restored state. Resource value criteria are grouped into four general categories:

- Stand Composition, Integrity and Functionality
- Habitat for Plant and Wildlife Species
- Landscape Function
- Human Interactions

The four categories make-up a checklist of twenty-one (21) criteria used to measure resource value. The County will use the checklist to summarize the priority ranking. Since the information available for assessing the various criteria may vary in type and quality, the sources of data used and their overall data quality should be noted in conjunction with the priority ranking. Uncertainty associated with the data should be considered in the overall effort to establish priorities and in comparisons between ranked areas or projects.

Stand Composition, Integrity, and Functionality:	Criteria 1-7
Habitat for Plant and Wildlife Species:	Criteria 8-13
Landscape Function:	Criteria 14-17
Human Interactions:	Criteria 18-21

Stand Composition, Integrity, and Functionality

Criterion 1: Stand Composition. Individual oak species vary somewhat with respect to the type of habitat they provide, the wildlife species they support, and their functions in the landscape. Conservation and enhancement efforts should seek to conserve and maintain the full diversity of oak species present in the county. In considering the oak species present at a site, both the overall rarity of the species within the county and the degree to which the species is protected or threatened will contribute to its overall species ranking. As levels of protection or threat change over time, Napa County may adjust the relative priority of a given species. The priority ranking based on species in the table below should be considered as a general guide rather than an absolute ranking order.

Priority for Conservation and Enhancement	Stand Composition (Oak Species Present)
High	**Valley oak** – This species may have experienced the greatest loss in its historical range within the county, especially on the valley floor. It has also been eliminated from much of its historic range statewide. Valley floor and riparian valley oak stands have especially high priority. **Black oak** – This species is very uncommon in the county. **Canyon live oak** – This species is relatively uncommon in the county. **Oregon White Oak –** This species is uncommon as mapable stands in the county. **Tanbark Oak –** This species is uncommon or rare as mapable stands in the county.
Moderate	**Blue Oak –** This is a more common species in the county and over much of its range in the state. **Coast Live Oak –** This is a more common species in the county **Interior live oak –** This is a more common species in the county and over much of its range in the state. **Mixed oak–** Most oak woodlands in the county are mixed oak woodland with more than one co-dominant species.
Low	**Scrub oak/Leather Oak** – These species are currently relatively common statewide and in portions of the county.

Criterion 2: Distribution of Oak Species. Oak woodlands may contain from one to several oak species. The number of species present typically reflects the variation of environmental and soil conditions at the site. Past management practices, however, can change the composition of the woodlands by selectively removing some species or selectively inhibiting regeneration. Blue oak seedlings, for example, are generally preferred by browsing animals over interior live oak seedlings. As a result, interior live oak may be overrepresented relative to blue oak in areas which were cleared and grazed heavily in the past. A higher conservation priority should be assigned to sites where the current oak distribution is closer to the likely pre-settlement distribution and has not been excessively changed by past management.

Priority for Conservation	Distribution of Oak Species
High	Oak species distribution has not been significantly influenced by past management. Oak species that should be represented on the site are present at levels likely to be representative of historic levels.
Moderate	Oak species distribution moderately influenced by past management. Oak species that should be represented on the site are present but levels appear changed from historic levels.
Low	Oak species distribution heavily influenced by past management. One or more site-appropriate oak species are rare or absent.

Sites with species distributions that have changed as a result of management practices can be appropriate targets for enhancement projects. In general, a higher enhancement rating would apply to sites where an appropriate balance of oak species can be reestablished by encouraging regeneration of species that are poorly represented

Priority for Enhancement	Distribution of Oak Species
High	A site-appropriate balance of oak species can be reestablished by encouraging regeneration of species that are present, but poorly represented, on a site.
Moderate	A site-appropriate balance of oak species can be reestablished by planting with seeds available from appropriate adjacent remnant trees, but the site currently lacks existing regeneration and trees of some site-appropriate species.
Low	Target species for restoration are lacking on the site and no appropriate local seed source is available.

Criterion 3: Tree Cover and Density. Many of the benefits and services provided by oaks woodlands are directly related to the amount of tree canopy cover on the site. Most of the benefits related to air quality (such as carbon sequestration and particulate interception), for example, are directly proportional to total canopy cover. The amount of flood protection and erosion protection provided by oak woodlands is also directly related to canopy cover. The relationship between canopy cover and wildlife habitat is more complex. Some species prefer closed canopy woodlands, whereas others are more apt to utilize openings within the woodlands or edges between woodlands and other habitat types. Hence, sites with less than 100 percent canopy cover may support greater biodiversity overall. One of the goals of the plan is to maximize the total amount of conserved oak woodland canopy cover, while recognizing the importance of including a variety of canopy cover levels within conserved and restored woodlands. Napa County will consider the level of canopy cover present on adjacent conserved lands when evaluating overall canopy cover.

Tree density (the number of trees per unit area) is related to total canopy cover, but a range of tree densities can give rise to a given level of canopy cover. At excessive tree densities (also known as overstocked stands), trees typically compete with each other for available water and light, so tree growth can be slow and tree condition may be poor. Through attrition of suppressed, the stand may eventually self-thin to a sustainable density, but this process can delay the transition of the woodlands to a desirable density. At the opposite extreme, very low density stands, characterized by individual tree canopies separated by large distances (200-300 ft or more) may not be sustainable due to low rates of regeneration, and may be appropriate targets for restoration or enhancement. Apart from these extremes, a relatively wide range of densities may be sustainable, depending on species composition and site characteristics.

For relatively common oak species, such as blue and interior live oak, the following approximate overall ranges of canopy cover can be used: high = 50 percent or more, intermediate = 20 to 50 percent, low = less than 20 percent. For relatively rare species such as valley oak, these cover levels would be inappropriate because canopy cover at most existing sites is relatively low. For species such as valley oak and oak stands that may naturally have densities more typical of oak savannas, canopy cover levels need to be considered on a basis relative to the maximum likely sustainable canopy cover level.

Priority for Conservation	Tree Cover and Density
High	Relatively high levels of tree canopy cover at stand densities that are sustainable for the site.
Moderate	Intermediate levels of tree canopy. Portions of the site may have excessively high or low stand density.
Low	Tree canopy is low or very low. Alternatively, canopy cover levels are higher, but most or all of the stand has unsustainably high tree densities.

Priority for Enhancement	Tree Cover and Density
High	Tree canopy is low or very low, but could be increased through natural or assisted regeneration. Alternatively, canopy cover levels are higher, but portions of the stand have unsustainably high tree densities that could be managed by selective thinning.
Moderate	Intermediate levels of tree canopy. Portions of the site may have low or very low stand density or may show evidence of decline of existing overstory trees.
Low	Moderate to high levels of tree canopy cover at stand densities that are sustainable for the site.

Criterion 4: Stand Size and Connectivity. An overarching goal in conserving and enhancing woodlands is to maintain oak woodlands as functional ecosystems. The functionality of the oak woodland ecosystem is related to its size, its connectivity with other oak woodlands or other native habitats, and its interface with less compatible adjacent land uses. Larger oak woodland stands are more likely to provide the scale needed to allow for ecosystem processes to function, and therefore generally have greater conservation value than smaller areas (if all other factors are equal). The overall biodiversity of a stand tends to increase with size, since a larger variety of habitat features are more likely to exist in a larger area. Also, some species that require relatively large home ranges are likely to occur only in sufficiently large habitat areas. Small stands with a limited number of trees may not have sufficient genetic variation to provide for long term stability, and are more likely to be threatened by impacts such as fire, disease, or long-term climate variation. In assessing the overall size of an oak woodland ecosystem, Napa County will consider the landscape context. Oak woodlands and habitat elements commonly do not end at parcel boundaries, so Napa County will consider the overall size of the woodland area of which a specific parcel is a part. Therefore a relatively small woodland area can have a high conservation value if it is adjacent to other conserved lands, especially if it forms a linkage between conserved habitats.

Priority for Conservation	Stand Size and Connectivity
High	The oak woodland area is relatively large, constitutes a high percentage of the resource (e.g., for species of limited distribution such as valley oak), and/or is connected with a larger network of oak woodlands and other native habitats which are or have the potential to also be conserved.
Low	The oak woodland area is too small to ensure a self-sustaining stand and is not connected with other native habitats.

Since most enhancement projects are of limited size, the overall size of a project is generally a less important consideration for assigning restoration or enhancement priority. The location of the enhancement project within the landscape and its connectivity to existing stands and habitat is a more important consideration.

Priority for Conservation	Stand Size and Connectivity
High	Restored area will help reconnect habitat areas or forms an important extension of a larger woodland into a habitat area that is degraded or no longer extant. Projects that connect with past and/or future projects that allow for a larger total restored area also have a high priority.
Low	Small restoration projects that are not connected with other native habitats.

Criterion 5: Stand Geometry. The geometric shape of a parcel is another consideration in assessing its conservation and restoration value, especially if the parcel is adjacent to lands that have been converted from native plant communities to other uses. Land uses such as residential development and intensive agriculture may adversely affect the habitat value of adjacent oak woodlands, and may also limit the options available for woodland management. Impacts generally increase as the amount of interface or edge between the woodlands and developed land uses increases.

Priority for Conservation and Enhancement	Stand or Project Area Geometry
High	Little or no interface between the stand and an incompatible adjacent land use such as urban/residential or intensive agricultural development.
Moderate	Moderate amounts of interface relative to the area of the stand or project area and/or adjacent land uses are only partially incompatible or incompatible uses are buffered at the interface.
Low	High ratio of developed interface length to the overall area of the stand. May be relatively narrow areas with incompatible land uses on both sides or areas with in-holdings of incompatible land uses.

Criterion 6: Stand Structure and Sustainability. In the pre-settlement era, most of the oak woodlands in the county probably consisted of mixed age stands. Recruitment of new trees would generally have occurred in relatively small canopy gaps that developed from mortality of individual trees or small clusters of trees. Except in chaparral areas, most fires would not have been stand-replacing events, because most of the oak species present are relatively fire resistant. No other natural phenomena are likely to have caused complete stand replacement in these oak woodlands.

With the onset of widespread clearing for agriculture and fuel, relatively large areas were cleared over short time spans. When regeneration did occur, from seedling advance regeneration and/or stump sprouts, the stands that developed typically were much more even-aged. In some areas, multiple rounds of clearing, especially if only partial, have given rise to multi-aged stands, although these stands probably have less age diversity than in the original stands. Old growth trees (more than about 150 years old) are usually rare or lacking in most second and later growth oak woodland stands.

Stands that are composed primarily of trees regenerated from stump sprouts may have a shorter potential lifespan than stands derived from trees originating from seedlings. Stump sprouts can have poor structure and frequently have decay associated with the old stump. These two factors can cause trees to fail at an earlier age than equivalent trees originating from seedlings.

Stands consisting only of old, decadent trees, especially stump re-sprouts, may not be sustainable because a high percentage of the trees in the stand could die over a relatively short time period. Furthermore, decadent trees with wood decay and cavities are more likely to be severely damaged or killed by fire. Since most oak seedlings establish best under tree canopy, rapid loss of canopy could impede natural regeneration.

A uniformly young stand has a longer potential lifespan than a decadent stand, but the lack of larger stems and larger dead or dying trees provides lower habitat value for some wildlife species. Also, a young even-aged stand will eventually become an old even-aged stand that could suffer relatively high rates of mortality and canopy loss. For long-term sustainability, a relatively mixed age stand is probably the most sustainable over the long term without requiring management inputs.

For all but very young stands, the presence of advance regeneration in adequate amounts is important for ensuring sustainability. Levels of advance regeneration may be low due to a variety of reasons related to past and current management and other factors.

Priority for Conservation	**Stand Structure and Sustainability**
High	Multi-aged stands with good levels of old-growth trees and seedling advance regeneration.
Moderate	Older even-aged stands with variable levels of advance regeneration or young even-aged stands with little or no advance regeneration.
Low	Declining even-aged stands lacking advance Regeneration.

Even-aged stands, especially those lacking adequate levels of advance regeneration can be suitable targets for restoration activities aimed at increasing regeneration. By successfully encouraging regeneration to replace dying trees, it may be possible to help re-establish a more mixed-age stand.

Priority for Enhancement	Stand Structure and Sustainability
High	Declining even-aged stands lacking advance Regeneration.
Moderate	Older even aged stands with variable levels of advance regeneration. Multi-aged stands or young even-aged stands with little or no advance regeneration.
Low	Multi-aged stands with good levels of seedling advance regeneration.

Criterion 7: Contribution to Population Genetics. Individual oak trees can live for hundreds of years, but oak woodlands have occupied most of their current range for many thousands of years. The genetic variation present within a population of oaks is shaped by thousands of years of selection pressures imposed by the underlying soils, varying climate conditions, and other site-specific factors. As a result, most forest trees show some level of adaptation to local conditions. Trees growing in a given area may have survival advantages over trees of the same species that originated in a different area and environment.

Oak pollen is disseminated by wind and oak trees generally need to be pollinated by other individuals (that is, they are primarily cross pollinated rather than self-pollinated). Movement of genetic material via wind-borne pollen tends to ensure that there is genetic variation within stands, but also provides a mechanism for the incremental spread of genetic traits between adjoining stands. The exchange of genetic material between populations arrayed across the landscape allows oak populations to adapt over time to the conditions at a site and to remain viable under changing conditions. Oaks and other native species have already been exposed to very rapid environmental changes initiated by the settlement of California. Furthermore, the loss of oak populations over the past 150 years has already narrowed the genetic diversity in the oak population. In order to maintain oak woodlands as a viable resource in the face of these current pressures and future environmental changes, it is important to maintain the full complement of genetic diversity present within the oaks‘ range.

To maintain the widest range of genetic diversity within the county‘s oak population, it is important to maintain oak stands in a variety of oak woodland sites across the range of soil and climate variation found within the county. Populations at the edges of the existing range may be especially critical in that they may represent the greatest level of genetic adaptation to extreme conditions, for example, very dry or wet conditions. In addition, very old trees constitute an important genetic resource in that they may include traits that contribute to longevity, as well as traits that may be less common in the current tree population than they were prior to clearing associated with settlement.

Populations in the main portion of a species‘ range also need to be conserved to provide a complete complement of genetic resources for the species. Genetic traits found in these main populations, however, are likely to be present in many individuals and may therefore be at low risk of being lost. The conservation priority ranking for this criterion is therefore lowest for these populations. The highest priority ranking for this criterion are assigned to populations that may contain unique genetic traits that are found in relatively few extant individuals and are therefore at a high risk of being lost.

Priority for Conservation	Contribution to Population Genetics
High	Viable oak populations at the edge of the existing range of the species in the county or on uncommon soil types or environmental situations (slope, aspect, proximity to water, etc.). Stands containing very old oaks.
Moderate	Marginally viable (due to poor condition or low density) populations at or near the edge of the existing range of the species in the county or on somewhat uncommon soil types or environmental situations.
Low	Oak populations within the main portion of the species‘ range in the county on common soil types / environmental situations.

From the standpoint of enhancement, high priority sites are those that may have unique genetic resources that are likely to be lost without intervention. Such intervention may include operations to salvage and plant seed from particular trees or groups of trees.

Priority for Enhancement	Contribution to Population Genetics
High	Individual very old oaks or unsustainably small oak populations at the edge of the existing range of the species in the county or on uncommon soil types or environmental situations (slope, aspect, proximity to water, etc.).
Moderate	Marginally viable (due to poor condition or low density) populations at or near the edge of the existing range of the species in the county or on somewhat uncommon soil types or environmental situations.
Low	Oak populations within the main portion of the species‘ range in the county on common soil types / environmental situations.

Habitat for Plant and Wildlife Species

The quality of habitat and the number and types of species present in oak woodlands depend on a variety of factors, including:

Oak species present. The type of habitat provided by evergreen oaks, such as interior live oak or canyon live oak, differs from that provided by deciduous oaks, such as valley, blue or California black oak. Some species, especially insects, may only be associated with a single oak species. Other species may prefer stands with a mix of oak species. Some oak species (valley, blue oak) produce acorns that mature in a single year, whereas others (interior live, California black) produce acorns that mature in the second year after flowers are produced. Since acorn production in oaks varies widely from year to year due to weather conditions that occur during flowering, having both one- and two-year acorn producers in the same stand can provide a more reliable source of food for species that consume acorns.

Oak density (trees per acre) and level of canopy cover. Wildlife species vary in the degree to which they utilize stands with varying amounts of canopy cover: some prefer more open stands, whereas others are more likely to be found in dense stands. The level of shading in the understory, which depends on both stand density and species composition, also affects which native or exotic plant species are likely to be present.

Distribution of tree sizes and ages. Various species that utilize cavities in large stems or prefer tall trees are more likely to occur in stands with larger, older trees. The presence of dead trees (snags) and large downed wood (coarse woody debris) improves habitat value for various wildlife species. This in turn is related to both the stand-age distribution and management of the stand, which affects how long downed wood remains on the ground. The presence of various plant species in the understory or in canopy gaps may also be related to soil types or features such as vernal pools or riparian areas.

Spatial distribution on the landscape. The distribution of oak woodlands across the landscape has a large influence on habitat quality. The spatial relationship between patches of woodlands and other habitats can influence which species may be found in the oak woodlands and the quality of habitat that the woodlands provide. Oaks along watercourses, for example, provide critical shaded riparian habitat important for fish and other aquatic species. Connectivity between oak woodlands to provide for wildlife movement is also important for many wildlife species. Some species may use oak woodlands for sheltering or nesting but may forage in adjacent habitats, such as agricultural fields, grasslands, or chaparral.

Disturbance. A high level of disturbance within woodlands and the presence of various exotic plant species can reduce the abundance of native species and reduce the overall habitat value of oak woodlands. Habitat quality can also be degraded by the degree to which the habitat is fragmented by residential or agricultural development, particularly if it interrupts movement corridors.

Criterion 8: Native Biodiversity. Settlement of Napa County resulted in the degradation of natural habitats. In some locations, however, areas exist that still have a relatively diverse array of native species. Even if the native species present are not rare, these areas of high native biodiversity constitute a valuable and relatively rare resource.

Priority for Conservation or Enhancement	Native Biodiversity
High	Oak woodlands include areas with high levels of native biodiversity.
Moderate	Oak woodlands have moderate levels of native biodiversity and/or areas with high native biodiversity are adjacent to the woodland.
Low	Few native species other than oaks are present in or near the woodland.

Criterion 9: Special Status Species. In the broad sense, special status species include species listed by the federal and state government as threatened and endangered species; species that have been proposed for listing but have not yet been officially listed; as well as plant species designated as rare or endangered by the California Native Plant Society (CNPS). Depending on their actual status and other factors, these species may be protected to varying degrees by state and/or federal regulations. Since these species as a group are rare and may be threatened with extinction, conserving their habitat is important for their survival and for maintaining the integrity of the ecosystems in which they are found. Special status species may utilize oak woodlands as an essential part of their habitat, or more commonly, they may utilize oak woodlands habitat in addition to other habitat areas. Furthermore, woodlands adjacent to a given habitat area, such as a stream, may be important for maintaining the integrity of that habitat, for example, by reducing the amount of sediment that would enter the stream via erosion.

Priority for Conservation or Enhancement	Special Status Species
High	One or more special status species utilize a woodland or part of it as essential or preferred habitat.
Moderate	Woodland may be used somewhat by special status species and/or habitat of one or more special status species is adjacent to the woodland.
Low	No special status species utilize the woodland or its adjacent areas.

Criterion 10: Locally Rare or Uncommon Species and Associations. Some species or associations of species (certain plant communities, for example) that are not rare throughout their overall range may be locally uncommon within the county. To maintain the overall biodiversity within the county, it may be important to maintain oak woodlands that are used as habitat for these species.

Priority for Conservation or Enhancement	**Locally Rare or Uncommon Species**
High	One or more locally rare or uncommon species or associations use the oak woodland or part of it as essential or preferred habitat.
Moderate	The woodland may be used somewhat by locally rare or uncommon species and/or habitat of one or more locally rare or uncommon species or associations is adjacent to the woodland.
Low	No locally rare or uncommon species or associations use the woodland or its adjacent areas.

Criterion 11: Contribution to Maintaining Native Plant and Animal Population.
Among areas that serve as habitat for various native species, some areas may be especially critical for various reasons, including:

• Areas that serve as a corridor between different patches of habitat to provide for movement;
• Areas that could serve as important corridors but do not currently serve such a function;
• Habitat patches that are especially large because they benefit species that require a relatively large home range;
• Outlying populations near the edge of the current range that may have unique genetic characteristics because of their importance for the long-term viability of the species;
• Habitat areas that support robust populations of species and are occupied for most of the year, in comparison to areas that only receive occasional use by the species; and
• Habitat used for breeding or foraging during certain seasons. Hence, in addition to considering whether species utilize a given patch of habitat, we also need to consider how that patch of habitat contributes to the overall viability of a species or group of species within the county.

Priority for Conservation and Enhancement	Contribution to Maintaining Native Plant and Animal Populations
High	Oak woodlands include areas that are critical or important for maintaining populations of one or more native plant and animal species of interest.
Low	Oak woodlands do not function significantly in maintaining populations of one or more native plant and animal species of interest.

Criterion 12: Special Habitat Features and Areas. The presence of special habitat features or elements, including those listed below, increases habitat value for various species.

• Vegetation-related features such as old growth trees, dead trees (snags), large downed wood (coarse woody debris), and trees that shade riparian areas

• Aquatic features such as riparian areas, vernal pools, and ponds

• Physical features such as serpentine soils, burrows, high water tables, rock outcrops and caverns

Other features may provide necessary unique substrates for plant growth or contribute to animal diets. In addition, transitional areas between different habitat types, also known as ecotones, may have a greater mix of species present and may include unique species.

Oak woodlands that serve as habitat for various native species noted above will typically contain a variety of these special habitat features. However, even in the absence of detailed information about species presence, an evaluation of the presence and abundance of special habitat features can provide information on habitat quality and the types of species that could potentially be found in oak woodlands.

Priority for Conservation or Enhancement	Special Habitat Features and Areas
High	Woodland includes a wide variety of special habitat features and areas and/or uncommon types of special habitat features/areas.
Moderate	Woodland includes some special habitat features and areas, generally of relatively common types
Low	Very few or no native species special habitat features and areas are present.

Criterion 13: Invasive Species Presence and Abundance. Invasive exotic species can compete with or displace native species, reducing the overall native species biodiversity. Virtually every oak woodland habitat in Napa County is likely to contain some exotic species, especially non-native grasses and forbs in the oak understory. Oak woodlands in which exotics make up a low percentage of the overall species mix,

however, have a higher conservation value. In addition, some invasive species are especially disruptive due to their high reproductive potential, competitive abilities, effects on the overall structure of the plant community, and/or tenacity once established. For example, yellow star thistle and Harding grass are especially problematic in relatively open habitats; tamarisk and arundo are especially disruptive in riparian areas.

Exotic wildlife species can also have a detrimental impact on native species. Wild pigs, for example, negatively affect native habitats. Pigs can directly girdle and kill trees. Their rooting disturbs soil, damaging oak regeneration and making areas subject to increased erosion and invasion by exotic plants. They eat large numbers of acorns, competing with native wildlife for this food source. They also eat large numbers of native bulbs, thereby reducing populations of these slow-growing species. Hence, the presence of a single exotic species can have wide ranging effects on oak woodland habitat.

Priority for Conservation	**Presence and Abundance of Invasive Species**
High	Oak woodland has relatively low amounts of exotic species and especially disruptive exotic species are absent or very rare.
Moderate	Oak woodland has moderate amounts of exotic species and/or may have localized infestations of especially disruptive exotic species.
Low	Oak woodland is dominated by exotic species and/or may have high populations of especially disruptive exotics.

The elimination or reduction of especially disruptive exotic species is an obvious target for habitat enhancement. Given the nature of many exotic species, however, it can be difficult and often expensive to try to reduce well-established populations of exotic species. Especially if funding is limited, it may be more cost-efficient to suppress or eradicate infestations that are limited in area to prevent spread of a target exotic species into a new area

Priority for Enhancement	**Presence and Abundance of Invasive Spec**
High	Oak woodland has limited amounts of especially disruptive exotic species that could potentially be eradicated or kept at very low levels.
Moderate	Oak woodland has high populations of especially disruptive exotics, but meaningful reductions in these populations are feasible.
Low	Oak woodland is dominated by exotic species and/or has such high populations of especially disruptive exotics that it is not feasible to substantially reduce their populations. Alternatively, woodland lacks especially disruptive exotic species and exotic species present are either not at high densities or are not amenable to

	management.

Landscape Function

The benefits provided by an oak woodland and its associated resource value can also be influenced by where it is located on the landscape. Functions such as erosion protection, for example, are more important on steep erodible soils and along watercourses than they are on level ground. In addition, the degree to which a patch of woodland functions as habitat for various species may depend on the degree to which it is adjacent to and connected with other habitats.

Since position in the landscape can affect factors such as wildlife habitat, it is already considered in part in other criteria. However, the relationship between an oak woodland and its surroundings is sufficiently important that it warrants specific consideration. Furthermore, some of the benefits that influence overall resource value are not addressed in the criteria described above.

Criterion 14: Erosion protection. Oaks help reduce soil erosion in several ways. Tree canopy intercepts raindrops and dissipates their energy, reducing their potential to erode soil. Dead leaves and twigs that accumulate on the soil surface under oaks provide further protection against the erosive action of rainfall. Tree roots and their associated mycorrhizal fungi also help to reinforce and stabilize the bulk soil, reducing both the risk of landslides and erosion caused by running surface water (gully erosion and scour along creeks).

A number of factors other than vegetative cover also influence the risk of erosion. Erosion of surface soils is influenced by the amount of rainfall an area receives; the relative erodibility of the soil; and slope steepness, shape, and length. These factors, as well as factors related to vegetation and erosion control practices, are components of the revised universal soil loss equation (RUSLE), which is used to predict soil erosion. On uplands within the county, the erosion protection provided by oak woodlands is most critical in areas with long, steep, convex slopes that have relatively erodible soil types. Landslide risk will also be greatest on steep slopes and varies by soil characteristics. Erosion along drainages and watercourses is affected by soil type, but is also related to the amount and velocity of water flow, which in turn is affected by the geometry of the channel. Undercutting of creek banks by flowing water can cause the banks to fail, dumping large amounts of sediment into the creek. Creek bank failures also expose additional areas of soil to erosion and can lead to severe gullying.

Conservation of woodlands located in areas that are prone to erosion helps prevent the degradation in water quality and overall land resource value that would occur if the trees were removed. Restoring oaks in historically wooded areas that show accelerated erosion in the absence of tree cover can help stabilize these areas and prevent further erosion.

Priority for Conservation or Restoration	Erosion Protection
High	Site surface soils and/or creek banks have a high risk of erosion (for example, highly erodible soils, long, steep slopes, high water flows, narrow channels).
Moderate	Site surface soils and/or creek banks have a moderate risk of erosion (for example, moderately erodible soils, slopes of moderate length and/or incline, wider channels with lower water flows).
Low	Site surface soils and/or creek banks have a low to very low risk of erosion (for example, nearly level soils or erosion-resistant soils on mild slopes, broad channels that only intermittently carry water at low flow rates).

Criterion 15: Water Quality Protection. Oak woodlands on slopes and on nearly level lands near streams play an important role in protecting water quality. As described above, oak woodlands can help minimize sediment loading into creeks and streams. This is especially important in areas where soils contain toxic material, such as mercury or other heavy metals. Trees can also help remediate soil contamination by absorbing heavy metals from the soil. Similarly, oaks and other vegetation along riparian areas can absorb fertilizer nutrients or pesticides associated with agricultural or urban runoff, preventing these materials from reaching surface waters. Because oak foliage can also intercept airborne pesticide drift, oaks along creeks can reduce potential contamination of streams via this route.

Priority for Conservation or Restoration	Water Quality Protection
High	Riparian oak woodlands, especially in areas adjacent to agricultural field or adjacent to urban areas. Upland oak woodlands in areas with heavy metal contamination or other materials of concern that have the potential to run off into streams
Low	Upland oak woodlands in areas lacking toxic soil contaminants and having low risk of erosion into streams.

Criterion 16: Contribution to Flood Protection. Oak and other trees provide protection equivalent to that provided by floodwater detention basins. Trees temporarily hold rainwater on their leaf and stem surfaces during a rainstorm. This increases the amount of time that it takes for the rain to reach the ground and become runoff. By detaining peak flows for a period of time, flooding risk associated with high

rainfall events is mitigated. The greatest flood protection benefits related to tree canopy cover will be in watersheds that quickly concentrate flows and pose a risk of flash flooding and in areas where runoff conveyance is already near capacity.

Trees also deplete moisture from the soil during the growing season. Compared to annual vegetation, oaks can extract water from the soil profile to a greater depth. Consequently, soils under oak woodland canopy are able to absorb and hold greater amounts of rainfall in the soil than are equivalent soils with only annual grassland cover. This extra storage capacity further reduces the potential for flooding during the rainy season.

Priority for Conservation or Enhancement	Contribution to Flood Protection
High	Oak woodlands in watersheds that drain into areas subject to flooding during high rainfall events of relatively short duration.
Low	Oak woodlands in watersheds draining to areas with little or no flooding risk.

Criterion 17: Location Relative to Other Woodlands and Habitats. The habitat value of an oak woodland is strongly influenced by the surrounding landscape, as discussed in the previous section *(Habitat for Plant & Wildlife Species)*. Habitat quality will be greater in oak woodlands that are adjacent to other oak woodlands that increase the overall patch size. The presence of other adjacent native habitats, such as chaparral, can also increase habitat value for some species. In contrast, habitat value for many native species is adversely affected if woodlands are adjacent to developed land uses such as intensive agriculture and urban development. The impact is generally increased as the length of the interface between the woodland and the developed land use increased. Habitat value is further decreased if the woodland habitat is broken into fragments separated by developed uses. Conversely, connections or corridors that fill gaps between woodland patches can improve habitat value.

In addition to effects on wildlife and native plant habitat, other benefits provided by oak woodlands may be affected by the type of land cover on adjacent parcels. Erosion protection and stormwater retention will generally be more effective if oak woodlands cover an entire slope or watershed than if a patch of woodland is surrounded by grasslands.

Priority for Conservation or Enhancement	Location Relative to Other Woodlands and Habitats
High	Position of the oak woodland within the larger landscape amplifies beneficial effects such as wildlife habitat by increasing overall woodland area, minimizing fragmentation, or serving as corridors between patches.
Low	Position of the oak woodland within the larger landscape minimizes beneficial effects such as wildlife habitat because of a high amount of edge with developed land uses, high fragmentation, and lack of connection with other larger functional oak woodlands.

Human Interactions

Another basis for assessing woodland value is the relationship between people and oak woodlands. This relationship is implicit in some of the other ratings. For example, the importance of considering wildlife habitat, erosion protection, and other factors is based in large part on the value that people see in maintaining healthy ecosystems. Beyond the ecosystem services that people derive from oak woodlands, these areas may be valued for their aesthetic qualities, as a recreational resource, and for their cultural or historical significance. As with the landscape functions discussed above, these values are typically dependent on where the woodlands are located. In addition, other factors such as historical uses and events and land ownership (public or private) also influence these values.

Criterion 18: Historic and Cultural Significance. Oak stands or individual trees may have historical significance due to past events or structures that were associated with the trees, historical accounts that mention the trees, the use of specific trees as landmarks or as boundary markers, or other factors. In addition, oak trees and the acorns they provide have been and continue to be important cultural resources for many of the Native American tribes that live in California. Individual oaks or stands of oak may have cultural significance to tribes or individual families. Loss of traditionally-used trees or gathering areas may significantly impact the continuation of cultural practices that span many generations.

In general, oaks and woodlands with historical and/or cultural significance are primarily a target for conservation rather than restoration, though restoration activities that help maintain tree health and the ecological integrity of the site may be appropriate in some situations.

Priority for Conservation or Enhancement	Historic and Cultural Significance
High	Woodlands or trees have documented historical significance and/or past or current use as a Native American cultural resource.
Moderate	Woodlands or trees have possible to likely historical significance and/or past use as a Native American cultural resource, but documentary evidence is not conclusive.
Low	Woodlands or trees have no known or suspected historical significance and/or use as a Native American cultural resource.

Criterion 19: Public Recreation. Compared with various other California counties, Napa County has a relatively small amount of oak woodland acreage that is available for low-impact public recreational activity such as hiking and equestrian use. Oak woodlands that have the potential to be acquired by public agencies or private nonprofit organizations (such as land trusts) and made available for public recreation provide a resource that is currently quite limited within the county. With adequate planning and monitoring, public access can be designed to be compatible with other conservation goals such as providing wildlife habitat. Furthermore, on public access lands using volunteers, it may be feasible to undertake restoration activities that would not be possible on private lands.

To maximize the benefits associated with public access and minimize potential conflicts with adjacent property owners, public-access parcels should be connected to the degree possible with other lands with public access or ownership. Appropriate measures should be provided to buffer public access areas from adjoining private lands.

Priority for Conservation or Enhancement	Public Recreation
High	Oak woodlands that: -provide low-impact public recreational opportunities compatible with conservation objectives, -are connected with other parklands or public-access areas, and - pose a minimum of conflicts with adjoining land uses.
Low	Privately-owned oak woodlands that do not provide opportunities for public access and use.

Criterion 20: Buffering between Incompatible Land Uses. Oak woodlands can be used to provide a buffer between land uses that would otherwise be incompatible. For example, a band of oak woodland that separates intensive agricultural lands from a residential development can serve to provide visual

screening, noise reduction, dust abatement, and protection from pesticide drift that would reduce conflicts between these two land uses. Because uses of woodlands used as buffers would need to be limited to provide buffering capacity, such lands would typically need to be covered by a conservation easement.

Although buffers and hedgerows would primarily be targets for conservation, restoration activities, such as oak planting or invasive species management, may also be directed at these areas to enhance their function.

Priority for Conservation or Enhancement	Buffering Between Incompatible Land Uses
High	Oak woodlands that have the potential to buffer between incompatible land uses by providing physical separation, visual screening, noise reduction, air filtration, and/or other benefits.
Low	Oak woodlands located in areas where they do not serve as buffers.

Criterion 21: Visual Impact. Prominent individual oaks and oak woodlands located in areas where they are commonly seen provide a strong positive visual impact and contribute to the ―sense of place" associated with an area. Such woodlands typically provide a variety of other benefits as well, but may be more appreciated by the public at large due to their aesthetic qualities. As with buffers, stands with high visual impact are typically targets for conservation, but restoration activities that improve stand sustainability or enhance other functions such as wildlife habitat may also appropriate in these stands.

Priority for Conservation or Restoration	Visual Impact
High	Oak woodlands with high visual impact, located within view of communities and major roadways.
Low	Oak woodlands located in areas where they are unlikely to be seen by most people.

2. Risk Categories

Risk categories are based on the likelihood of resource loss or degradation, either through alteration (e.g., change in land use, clearing) or management (e.g., lack of natural regeneration resulting). As illustrated in the matrix below, the Management Plan ranks risk based on both the likelihood of resource loss (high, medium, low) and the expected time frame for the loss (near, mid, long term). A given conservation opportunity/parcel may be rated in multiple categories, as shown by X's in the matrix below.

Example of Risk Categorization

	Likelihood of Loss (Absent Intervention)		
Time Frame	High	Moderate	Low
Near-term (< 5 yrs.)			**X**
Mid-term (5-20 yrs.)		**X**	
Long-term (> 20 yrs.)		**X**	

Current zoning, General Plan designations and urban spheres of influence will be used to help assess likelihood of loss due to urban conversion. Losses due to other activities and processes (change to intensive agriculture, alterations in historic water tables, tree mortality without regeneration) will be estimated from other available information (i.e.-soils, slopes, setbacks, others).

The highest overall risk is assigned to high resource value woodlands that have a high likelihood of being lost in the near term. This category would include lands that contain Sensitive Biotic Species and fall within Potentially Productive Soils.[1] Woodlands with a relatively high long-term risk but low near-term risk may be the more cost efficient targets for funding. Parcels with very low to no intrinsic risk may not be high priority even if they have a high resource value. This category would include lands with existing conservation easements (which address oaks), lands owned in public trust, and lands that are non-developable due to terrain or other factors, provided these lands are managed in a sustainable fashion. Woodlands would need to be both fully protected and permanently managed in a sustainable fashion in order to be considered at no significant risk. Reassessment of risk categorization on a regular basis would also be necessary.

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[1] High Risk/High Value: Sensitive Biotic species that fall within Potentially Productive Soils. Sensitive species include Blue Oak Alliance, California Bay – Madrone – Coast Live Oak – (Black Oak Big Leaf Maple) NFD Super Alliance, Tanbark Oak Alliance, Valley Oak Alliance, Valley Oak – (California Bay – Coast Live Oak - Walnut - Ash) Riparian Forest NFD Association, Valley Oak – Fremont Cottonwood – (Coast Live Oak) Riparian Forest NFD Association, Oregon White Oak Alliance, Leather Oak – White Leaf Manzanita – Chamise Xeric Serpentine NFD Super Alliance and Leather Oak – California Bay – Rhamnus spp. Mesic Serpentine Chaparral NFD Alliance types per UC Davis' Information Center for the Environment GIS database. Potentially Productive Soils (PPS) is based on criteria excluding soils that are covered with poorly drained saline soils with a high water table, soils that are highly unstable, areas covered with serpentine soils or areas that are completely outcrop or covered by riverwash. PPS also excludes areas that are covered with water or within riparian areas within 55 ft of the centerline of blueline streams, areas designated for industrial development & lie within clear zones of all airports, areas owned by Federal, State or local agencies or those that are owned outright by the Napa Co Land Trust or with an easement that precludes vineyard development, areas that are on slopes less then 35% slope, that aren't covered by roadways and are not covered with existing vineyard (see Map/Appendix B-4)

3. Management Constraints

Woodland management constraints can be considered a factor that contributes to the risk of resource loss/degradation. In addition, management can be considered as a separate factor that interacts with the cost-effectiveness of conservation and restoration projects. Woodlands that are conserved need to be managed in a way that retains or improves their resource value if they are to continue to provide benefits and services. If properties are currently being managed in a sustainable fashion to protect or enhance resource values, no change in management will be necessary. Future management savings will be greatest for sites where sustainability is achieved through few or no major management inputs.

In contrast, lands that require a major change in management to attain sustainability may be more expensive to maintain over the long term, particularly if the necessary management changes will be expensive or difficult to implement. For example, good quality riparian oak woodlands on favorable soils typically have good rates of natural regeneration when left in a natural state with little or no active management. In contrast, a riparian oak woodland that has been heavily cleared, compacted, and colonized by invasive species would require significant changes in management, including some intensive inputs (such as eradication of invasives, restoration and near to mid-term maintenance) to attain long-term sustainability.

For lands where restoration is an objective, ease of restoration is considered a management factor for the near and/or mid-term. Sites requiring relatively small inputs to achieve restoration and those having a higher probability of success have higher priority overall. Current land uses need to be evaluated for their compatibility with the protection and enhancement of oak woodland resources. It may also be necessary to consider land uses on adjacent properties to determine if they will affect the management potential of the targeted property. For example, the need to clear vegetation for fire protection around residences may affect the management of the adjacent oak woodland. (Note: consult the Firewise Program for additional information, as oaks are a listed Firewise tree: http://www.napafirewise.org/) Activities upstream from a conserved riparian woodland, such as dredging, excessive erosion or polluted irrigation runoff, could impact the value of aquatic habitat (i.e., resource value) of the downstream woodland.

Management Constraints

Management Constraints	**Ranking**		
	High	**Moderate**	**Low**
Current management compatible with sustained resource value	yes	partially	no
Level of management inputs to attain or maintain sustainability	low		high
Influence of adjacent land uses or other external factors on management practices	little or no significant influence		significantly constrains management options

Oak Woodland Evaluation Criteria - Checklist

	Ranking			Data*		Notes
Resource Values	High	Moderate	Low	Source	Quality	
Stand Composition Integrity, and Functionality						
Oak species present						
Representation of oak species at site						
Tree cover and density						
Stand size, shape, and connectivity						
Stand structure and sustainability						
Contribution to population genetics						
Habitat for Plant and Wildlife Species						
Special status species						
Locally rare or uncommon species or associations						
Overall native biodiversity						
Contribution to maintaining native plant						
and animal populations						
Special habitat features and areas						
Special habitat features						
Invasive species presence and abundance						
Landscape Function						
Erosion protection						
Water quality protection						
Contribution to flood protection						
Location relative to other woodlands and habitats						
Human Interactions						
Historic and cultural significance						
Public recreation						
Buffering between incompatible land uses						
Visual impact						
Risk Factors						
Management Constraints						
Other values not noted above (specify)						

* Indicate the source (aerial photo, GIS layer, site survey, CNDDB, etc) of data used to assign ranking and data quality (good/fair/poor).

Appendix D

Sustainable Best Management Practices (BMPs) for Oak Woodlands

The following recommendations for Best Management Practices (BMPs) are summarized from various publications on oak woodland protection, maintenance, and restoration, as well as contributions by local and other experts.

The information/guidelines for building around oaks and oaks in the home garden can be found in the Integrated Hardwood Range Management Program‘s (IHRMP) publication, Living Among the Oaks. Information on BMPs for disturbance around oaks and protecting trees from construction impacts can be found in the UC Cooperative Extension‘s (UCCE) handout, Disturbance Around Oaks (Frost, 2001) and the California Department of Forestry‘s(CDF) Tree Notes, Protecting Trees from Construction Impacts (Sanborn, 1989). Information on care of oak trees is also available through the California Oak Foundation.

Information on Best BMPs for the maintenance, restoration, and rehabilitation of oak woodlands are from Regenerating Rangeland Oaks in California, University of California Agriculture & Natural Resources Publication 21601 (McCreary, 2001). Additional information can be found in How to Grow California Oaks (http://danr.ucop.edu/ihrmp/oak04.htm) and How to Collect, Store, and Plant Acorns (http://www.californiaoaks.org/ExtAssets/HowTo Acorns'07.pdf).

Qualified professionals and interested persons are encouraged to consult these published resources and other current sources for additional information, including the local Napa County NRCS office, Napa County RCD, UCCE Advisor, the IHRMP and others.

1. **The following are general guidelines or best management practices for tree protection during construction activities, from some of the above sources:**
   - The root protection zone (RPZ) is roughly one-third larger than the drip line (or outermost edge of the foliage based on the longest branch).
   - Install high visibility fencing around the RPZ of any tree or cluster of trees with overlapping canopy that are identified on an approved grading plan as needing protection. The fencing should be four-feet high and bright orange with steel t-posts spaced 8 feet apart.
   - Do not grade, cut, fill or trench within the RPZ.
   - Do not store oil, gasoline, chemicals, construction materials, or equipment within the RPZ.
   - Do not store soil within the RPZ.
   - Do not allow concrete, plaster, or paint washout within the RPZ.
   - Do not irrigate within the RPZ or allow irrigation to filter into the RPZ.
   - Plant only drought tolerant species within the RPZ.

2. **The following are general guidelines for protecting oak trees in gardens and yards.**
   - Avoid summer irrigation.
   - The zone within six feet of the trunk of the tree should be disturbed as little as possible. The base of the tree should be kept dry.
   - Limit plantings beneath oak trees to drought-tolerant species not requiring summer irrigation.
   - Landscape beneath oak trees with non-living plant materials such as wood chips.
   - Refer to Living Among the Oaks or contact the Master Gardener Program (through the UCCE office) for more information on oaks in the home garden.

3. **The following are general guidelines or best management practices for Maintenance, Restoration, and Rehabilitation of Oak Woodlands**

   a. **Acorn Collection and Storage Procedures**
      - Collect acorns in the fall, several weeks after the first ones have started to drop and when those remaining on the tree can be easily dislodged from the acorn cap by a gentle twisting.
      - If possible, collect acorns directly from the branches of trees, rather than the ground.
      - If acorns are collected from the ground, place them in a bucket of water for several hours, and discard any floaters.
      - Stratify acorns from the black oak group (e.g., black oak, interior live oak) by soaking them in water for 24 hours and then storing them in a cooler/refrigerator for 30-90 days before sowing.
      - Store acorns in a cooler or refrigerator in loosely sealed plastic bags, but do not store acorns from the white oak group (e.g., valley oak, blue oak, Oregon white oak) for more than 1 or 2 months before planting to ensure greatest viability.
      - If acorns start to germinate during storage, remove and plant as soon as possible.
      - If mold develops during storage, and acorns and radicles are discolored/slimy, discard acorns.

   b. **Methods for Sowing Acorns of Rangeland Oaks in the Field**
      - Sow acorns in the fall/early winter, as soon as soil has been moistened several inches down.
      - If possible, pregerminate acorns before planting and outplant when radicles are ¼ inch to ½ inch (1/2 cm to 1 cm) long.
      - Cover acorns with ½ to 1 inch (1 to 2 ½ cm) of soil.
      - If acorn depredation is suspected as a serious problem (high populations of rodents are present), plant deeper, up to 2 inches (5cm).
      - If acorns begin to germinate during storage, outplant as soon as possible. Use a screwdriver/pencil to make a hole in the soil; plant with the radicle pointing down..
      - If radicles become too long, tangled, and unwieldy to permit planting, clip them back to ½ inch (1 cm) and outplant.
      - If acorn planting spots have above ground protection (treeshelters), and acorns have not been pre-germinated, plant two or three acorns per spot and thin to the best seedling after 1 year.
      - Keep planting spots free of weeds for at least 3 years after planting.

   c. **Procedures for Planting Rangeland Oaks**
      - Plant oak seedlings early in the growing season, soon after the first fall rains have saturated the soil; do not plant after early March unless irrigation is planned.
      - Make sure seedlings are not frozen, allowed to dry out, or physically damaged before, during, or after planting.
      - Plant seedlings at proper depth, making sure they are not J-rooted, and eliminate air pockets in soil adjacent to seedling roots
      - In hard, compacted soils, break up soil (using a shovel, auger or posthole digger) through the compacted zone prior to planting to promote deeper rooting. If planting holes are augered, make sure that the sides of the holes are not glazed.
      - Select microsites for planting that afford some natural protection and provide the most favorable growing conditions.
      - Plant in a natural pattern, avoiding straight, evenly spaced rows.

d. Weed Control Procedures

- Select method of weed control (herbicides, physical weed removal, or mulching) based on environmental, fiscal, and philosophical considerations.
- Maintain a weed-free circle that is 4 feet (1.2m) in diameter around individual seedlings or acorns for at least 2 to 3 years after planting; if using herbicides to control weeds, remove weeds in circle with a diameter of 6 feet (1.8m)
- Initiate annual weed control by early spring to ensure that weeds do not become established and deplete soil moisture before oak roots can penetrate downward.
- Visit planting sites at least twice annually to remove both early- and late-season weeds that may have grown through mulch.
- If using post-emergent herbicides, make sure that chemicals do not come in contact with foliage or the expanding buds of seedlings.
- After weed control is discontinued, visit plantings regularly to make sure vole populations and damage to seedlings have not increased. If increases are observed, remove thatch.

e. Methods of Protecting Trees from Animals

- Fences and large cages are effective only if livestock and deer are the only animals of concern. Fences require a large initial investment and result in fenced areas being removed from livestock production. Fences and cages must be maintained regularly.
- Screen cylinders provide adequate short-term protection against insects, rodents, and deer but are ineffective against livestock, insects, or small rodents. Shoots that grow through the sides of tubes are vulnerable to browsing.
- Tree-shelters have proven very effective in protecting rangeland oak seedlings from a wide range of animals and stimulating rapid, above-ground growth. While relatively expensive they can greatly reduce time required for seedlings to grow to sapling stage.
- Habitat modification can reduce damage from grasshoppers and some rodents, but it is ineffective for larger ranging animals, such as deer. Care must be taken to monitor the re-growth of vegetation or animals will quickly reoccupy site.

f. Procedures for Tree-shelter Installation

- Select tree-shelter size based on the browsing height of animals that are a threat.
- Install shelters so they are upright and secure them to stakes using plastic ratchet clips or wire; make sure seedlings are not damaged when shelters are secured to posts.
- When tree-shelters are used, plant in an aesthetic, ―natural" arrangement rather than in regular, evenly spaced rows.
- Utilize stakes that are durable enough to last the length of time tree-shelters will be in place and drive them at least 1 foot(31 cm) into the ground before planting seedlings.
- Make sure tops of stakes are lower than tops of shelters to prevent access by rodents that can climb stakes and damage seedling shoots from rubbing against stakes.
- To prevent seedling desiccation, install shelters with the base buried in the ground.
- To prevent bird access, install plastic shelters with the base buried in the ground.
- If tree-shelters are placed in pastures grazed by livestock, secure them to metal posts using wire and thread flexible wire through the top instead of using plastic netting.

g. Tree-shelter Maintenance Procedures

- Visit shelters at least once each year to make sure they are upright, attached to the stake, buried in the ground, and functioning properly.

- Keep a 4-foot (1.2 m) diameter or larger circle around shelters free of weeds for at least 2 years after planting, and remove weeds that grow inside shelters.
- Replace flexible netting that has blown off shelter tops.
- Replace stakes that have rotted or broken.
- Leave shelters in place for at least 3 years after seedlings have grown out the tops, longer if shelters are still intact and and are effectively protecting seedlings.
- Remove shelters if they are restricting growth or abrading seedlings; to remove solid shelters, slice down the sides with a razor or knife, being careful not to damage the seedling inside.

h. Fertilization, Irrigation, and Top Pruning

- Place .74-ounce (21-g), slow release fertilizer tablets (20-10-5) 3 to 4 inches (7.5 to 10 cm) below planted acorns or seedlings.
- Irrigation is not necessary in many situations if there is timely/thorough weed control.
- If irrigation is needed for established and the terrain is steep or percolation of water through soil is slow, construct earthen irrigation basins.
- Provide irrigation in the form of infrequent, deep irrigations rather that frequent, shallow irrigations; time irrigations to extend the rainy season.
- Always control competing vegetation, even where supplemental irrigation is provided.
- Top-prune seedlings at the time of planting if they are too tall and are out of balance with root systems; prune small, liner stock back to a 6-inch (15 cm) top.

4. Natural Resources Conservation Service(NRCS) Conservation-BMPs

The following are USDA-NRCS conservation practices which are relevant to achieving protection, enhancement, and sustainable management of oak woodlands in Napa County, especially on grazed rangelands, managed watershed lands, and along waterways. A full, detailed description of the practices and consultation on the appropriate application of land treatments are available at the Napa NRCS office. Electronic copies can also be accessed at http://efotg.nrcs.usda.gov/

Conservation Cover (NRCS Practice 327) Definition: Establish and maintain perennial vegetation, including native oak savannah grassland species, to protect soil and water resources.
Purposes: Reduce soil erosion, improve water quality, and create or enhance wildlife habitat.

Prescribed Burning (NRCS Practice 338) Definition: Applying controlled fire to predetermined areas.
Purposes: Control undesirable vegetation, reduce wildfire hazard, improve wildlife habitat, and facilitate distribution of grazing animals.

Critical Area Planting (NRCS Practice 342) Definition: Planting vegetation, including trees, native shrubs, and herbaceous plant materials on erodible or eroding areas. Purposes: Stabilize soil, reduce damage from downstream sediment runoff, and improve wildlife habitat and visual resources.

Fence (NRCS Practice 382) Definition: Construct a barrier to livestock or wildlife.
Purposes: Control livestock or wildlife access to sensitive vegetation, eroding areas, or stream channels/banks. Create management units to optimize management of grazed lands, or to facilitate control of noxious weeds.

Fuel Break (NRCS Practice 383) Definition: A strip or block of land on which vegetation and plant debris have been reduced to diminish the risk of fire crossing the area. Purposes: Control and reduce the spread of fire.

Forest Slash Treatment (NRCS Practice 384) Definition: Treating woody residues to achieve management objectives. Purposes: Reduce hazardous fuels, insect and disease risk, increase access to grazing animals, improve soil organic matter, and improve natural or artificial plant regeneration.

Riparian Forest Buffer (NRCS Practice 391) Definition: Establish trees adjacent to and up-gradient from water bodies. Purposes: Create shade to reduce water temperature, provide riparian habitat and corridors for wildlife, reduce excess sediment or other pollutants in surface runoff, and reduce excess nutrients and other chemicals in groundwater flow.

Mulching (NRCS Practice 484) Definition: Applying plant residues or other suitable materials to the soil surface. Purposes: Reduce soil erosion, retain soil moisture near plantings, improve water quality, and create or enhance wildlife habitat.

Tree/Shrub Site Preparation (NRCS Practice 490) Definition: Treatment of areas to improve conditions for establishing trees or shrubs. Purposes: Encourage natural regeneration or permit artificial establishment of desired woody plants.

Prescribed Grazing/Annual Rangeland (NRCS Practice 528/528A) Definition: Controlling grazing through fencing or herding so that each grazing area receives alternating, appropriate periods of grazing and rest. Purposes: Improve or maintain the health of desired vegetation, maintain or improve water quality, reduce accelerated soil erosion. (Note: associated practices such as spring development and wells may sometimes be incorporated into grazing plans to accomplish conservation objectives).

Range Planting (NRCS Practice 550) Definition: Establish adapted perennial vegetation such as trees, shrubs, forbs, and grasses. Purposes: Restore the plant community similar to its historic climax or desired community, improve livestock forage, improve cover for wildlife, and improve water quality.

Tree and Shrub Establishment (NRCS Practice 612) Definition: Establish woody plants, (generally native species) by planting or seeding. Purposes: Provide woody plants for conservation purposes such as erosion control, watershed, or wildlife habitat.

Watering Facility (NRCS Practice 614) Definition: Install a tank or trough to provide livestock or wildlife access to water. Purposes: Protect and enhance vegetative cover by proper distribution of grazing, enhance erosion control, and protect streams and ponds from contamination.

Underground Outlet (NRCS Practice 620) Definition: Install an underground conduit to convey surface water to a suitable protected outlet. Purposes: To dispose of excess water to prevent erosion or flood damage. Designs should include appropriate dispersal outlets to reduce the likelihood of concentrated flows causing downstream impacts.

Restoration of Rare and Declining Habitats (NRCS Practice 643) Definition: Restoring and conserving rare or declining native vegetated communities and associated wildlife. Purposes: Restore native habitats degraded by human activities, provide habitat for rare or declining wildlife species by restoring native plant communities, increase native plant community diversity, manage or conserve declining native habitats, and to control noxious invasive plant species.

Wetland Wildlife Habitat Management (NRCS Practice 644) Definition: Retain, develop or manage wetland habitat for wetland wildlife. Purposes: Maintain, develop, or improve wetland habitat for dependent or associated plants and animals.

Upland Wildlife Habitat Management (NRCS Practice 645) Definition: Creating, restoring, maintaining, or enhancing areas for food, cover, and water for wildlife that use upland habitat.
Purposes: Provide food, cover, and water to benefit desired wildlife species and maintain viable populations.

Forest Stand Improvement/Competing Vegetation Control (NRCS Practice 666D)
Definition: Herbicide or mechanical removal of brush competing with desired tree species. Purposes: Improve wildlife habitat and hydrologic conditions, initiate forest stand regeneration.

Appendix E

Submittal Guidelines:

Napa County Voluntary Oak Woodland Management Plan and WCB Oak Woodland Conservation Program

The Oak Woodlands Conservation Program is administered by the Wildlife Conservation Board (WCB) and offers landowners, conservation organizations, counties and cities the opportunity to obtain funding for projects to conserve and restore California's oak woodlands. While the program is statewide in nature, it provides opportunities to address oak woodland issues on a regional priority basis.

This voluntary state Program is designed to provide incentives for local efforts to achieve oak woodland protection. More importantly this program provides a mechanism to bring farmers, ranchers, other landowners, and conservationists together in a way that allows for both sustainable ranch and farming operations and healthy oak woodlands. The Napa County Voluntary Oak Woodland Management Plan provides the framework for certification of local efforts so they are eligible for submittal and funding consideration by the WCB.

Proposals developed in partnership with landowners, non-profit organizations, local, regional, and state resource specialists bring a diversity of skills, expertise, and ideas to the table, and often the ability to leverage funding that might not otherwise be available for a project.

STEP ONE (1) : Contact the Wildlife Conservation Board (WCB)

First contact the WCB for an Oak Woodland Conservation Program Application and Guidelines at: www.wcb.ca.gov/Oaks/index.html or call (916) 445-8448 with any questions prior to completing an application package.

STEP TWO (2) : Applications for **conservation easements** and restoration

Applications for conservation easements, restoration or other long term conservation methods should be developed with the help of an eligible participant such as a non-profit organization/land trust. These organizations have the expertise to work with property owners to develop customized land conservation easements, and assist with the completion of the Oak Woodland Conservation and Restoration Evaluation Criteria (Appendix C) of the Napa County Voluntary Oak Woodland Management Plan. Contact information for these groups/agencies is available at the Napa County CDPD and at their websites.

Applications for **public outreach** and education

Applications for public education and outreach and technical assistance should be designed and implemented in partnership with local entities such as the Resource Conservation District, NRCS, non-profit organizations, farming/ranching organizations, landowners, Napa County

CDPD, and others. Contact information for these groups/ agencies is available at the Napa County CDPD and at their websites.

STEP THREE (3) : Napa County Certification

Submit the completed WCB application and Oak Woodland Conservation and Restoration Evaluation Criteria (Appendix C) of the Napa County Voluntary Oak Woodland Management Plan to the Napa County Conservation, Development & Planning Department for review and certification by the Planning Director.

Submit applications to:

County of Napa

Director-Conservation, Development & Planning Dept.
1195 Third Street Suite 210
Napa, California 94559

STEP FOUR (4) : Application Submittal

Once an application proposal has been completed and certified by the Napa County CDPD Director, submit it to the WCB for consideration.

Mail completed applications to:

Executive Director, Wildlife Conservation Board
1807 13th Street, Suite 103
Sacramento, California 95811

While applications are accepted on a year-round basis, the WCB generally meets four times a year. Typically, Board meetings are held in February, May, August and November. All applications that comply with the program requirements and meet program eligibility criteria will be scheduled for Board consideration if sufficient money exists to fund the request. Applicants will be notified as to when the project will be considered by the Board. The Board must approve any project to be funded.

Appendix F

RESOLUTION NO. 2010-137

A RESOLUTION OF THE BOARD OF SUPERVISORS OF THE COUNTY OF NAPA, STATE OF CALIFORNIA ADOPTING THE NAPA COUNTY VOLUNTARY OAK WOODLAND MANAGEMENT PLAN

WHEREAS, the purpose of the Napa County Voluntary Oak Woodland Management Plan is to encourage voluntary oak woodland conservation in Napa County and to provide a framework for the conservation of oak woodlands throughout the county; and

WHEREAS, the Oak Woodlands Conservation Act of 2001 as enacted by State Fish and Game Code commencing with Section 1360, directed the State Wildlife Conservation Board (―WCB") to establish and implement the Oak Woodland Conservation Program grant program;

WHEREAS, the WCB Oak Woodland Conservation Program requires that for landowners, local government entities, districts and conservation organizations to participate in the program, that the County adopt by resolution an Oak Woodlands Management Program pursuant to California Fish and Game Code Section 1366; and

WHEREAS, the Napa County 2008 General Plan Update provides goals and policies in support of oak woodland protection and enhancement and an implementation action item providing direction for the development and adoption of a Voluntary Oak Woodland Management Plan; and

WHEREAS, the County of Napa has developed a Voluntary Oak Woodland Management Plan consistent with the General Plan direction and California Fish and Game Code Section 1366 that will allow landowners, local government entities, districts and conservation organizations an opportunity to obtain funding from the WCB Oak Woodland Conservation program; and

WHEREAS, the County of Napa recognizes that the Napa County Voluntary Oak Woodland Management Plan is an important step in informing landowners, farmers, ranchers, land developers, and the general public about the significance of oak woodlands and encouraging their voluntary participation and responsible stewardship in the recognition and protection of oak woodlands; and

WHEREAS, the WCB Oak Woodland Conservation Program requires, pursuant to State Fish and Game Code Section 1366(f) that the County certify that grant proposals are consistent with the Napa County Voluntary Oak Woodland Management Plan prior to submittal to the State Wildlife Conservation Board for consideration; and

WHEREAS, on October 6, 2010, the Napa County Conservation, Development and Planning Commission held a duly noticed public hearing on the Napa County Voluntary Oak Woodlands Management Plan. After closing the public hearing, the Planning Commission recommended that the Board of Supervisors adopt the Napa County Voluntary Oak Woodlands Management Plan without any substantive revisions; and

WHEREAS, the Board of Supervisors has considered a staff report and background information and held a public hearing regarding the Napa County Voluntary Oak Woodlands Management Plan and oak woodlands in the unincorporated areas of Napa County;

NOW, THEREFORE, BE IT RESOLVED by the Board of Supervisors of the County of Napa as follows:

1. The above recitals are true and correct.

2. The Board recognizes the economic value of oak woodlands to landowners and the community at large, and supports farming, ranching and grazing operations that are compatible with oak woodland conservation.

3. The Board recognizes the natural resource values of oak woodlands including the critical role oak woodlands play relative to the health and function of local watersheds, soil and water retention, wildlife habitat, open space and others.

4. The Board supports landowners that participate in the Wildlife Conservation Board's Voluntary Oak Woodlands Conservation Program, and agrees to certify that individual proposals are consistent with the Napa County Voluntary Oak Woodlands Management Plan, pursuant to Section 1366 (f) of the California Fish and Game Code.

5. The Board supports and encourages education and outreach efforts designed to demonstrate the economic, social and ecological values associated with oak woodland.

6. The Board shall review and update the Napa County Voluntary Oak Woodlands Management Plan, as needed.

7. The Board hereby finds that the Napa County Voluntary Oak Woodlands Management Plan would not have a significant effect in the environment and is exempt from the California Environmental Quality Act pursuant to 14 CCR Section 15307 (Class 7 – Actions by Regulatory Agencies for Protection of Natural Resources).

8. The Board hereby adopts the Napa County Voluntary Oak Woodlands Management Plan

9. This Resolution shall become effective immediately upon adoption.

THE FOREGOING RESOLUTION WAS DULY AND REGULARLY ADOPTED by the Board of Supervisors of the County of Napa, State of California, at a regular meeting of said Board held on the 26th day of October, 2010, by the following vote:

AYES:	SUPERVISORS	WAGENKNECHT, CALDWELL, DODD, DILLON
NOES:	SUPERVISORS	NONE
ABSENT:	SUPERVISORS	LUCE

DIANE DILLON, Chair
Napa County Board of Supervisors

ATTEST: GLADYS I. COIL
Clerk of the Board of Supervisors

By:

Approved by the Napa County Board of Supervisors
Date: 10-26-2010

Processed by:
Deputy Clerk of the Board

APPROVED AS TO FORM
Office of County Counsel

By: *Laura J. Anderson (e-signature)*
Deputy County Counsel

Date: October 11, 2010

The oak seedling *at left* is 8 to 10 inches tall and 12 to 16 years old. *Below* is a 6-to 8-inch-tall seedling estimated to be 10 to 15 years old.

Blue oak seedlings may be older than they look

Ralph L. Phillips ❑ Neil K. McDougald ❑ Richard B. Standiford
William E. Frost

A 4-year study indicates that native blue oak seedlings are probably much older than most people would think: Trees less than 6 inches tall could be 10 to 15 years old. Seedlings grow very slowly, if at all, during periods of drought. However, seedling mortality was highest during the year of above-average rainfall.

Blue oak (*Quercus douglasii*) trees are a valuable economic and aesthetic natural resource in the Sierra Nevada foothills. The natural regeneration of these trees may not be adequate in some locations; consequently, it is of concern for landowners, governmental agencies and conservationists. A survey by Standiford, McDougald, Phillips and Nelson (*California Agriculture*, March–April 1991) indicated that while there was a large number of blue oak seedlings less than 1 foot tall, few trees were in the 1-to-5-feet category and even fewer in the 5-to-10-feet category. However, there appeared to be an adequate stand of oaks over 10 feet tall. These data suggest that something is preventing the smaller seedling from growing into larger saplings.

Although animal impact and limited soil moisture induced by competing vegetation have been reported as contributing factors, there is limited biological information to show what factors are influencing blue oak seedling survival. A study was initiated in 1989 to try to uncover the fate of small seedlings and to identify some factors that could be affecting seedling survival in the foothills of Kern County.

A drought extending from 1986 to 1992 coincided with establishment of this long-term study. Due to this climatic event, it will be possible to evaluate the effects of drought on blue oak seedling survival in another study.

Site selection

Much of the oak woodland acreage in Kern County was evaluated for potential study sites during summer 1989. We used three criteria in site selection: (1) the site had to be large enough to accommodate four 0.01-acre replications; (2) each replication had to contain at least 25 seedlings (less than 1 foot tall) and; (3) each site had to be in the savanna oak woodlands. The three sites were characterized using *Monitoring California Annual Range Vegetation,* Leaflet No. 21086, which defines seedlings as trees that do not exhibit mature characteristics. For our study, a seedling was defined as a tree less than 1 foot tall.

Site 1 was located in Section 28 of T29S, R32E at 3,560 feet elevation. The site is characterized by a 10% slope, N44W aspect, moderate residual dry matter (RDM) and a 38% blue oak canopy. Of the blue oak seedlings present, 48% had little or no hedging, 25% were moderately hedged and 27% were closely hedged.

Site 2 was located in Section 17 of T27S, R31E at 4,320 feet elevation. This site had a 10% slope, N20E aspect, high RDM and a 25% blue oak canopy. None of the seedlings at this site showed signs of being hedged.

Site 3 was located in Section 11 of T29S, R31E at 3,960 feet elevation. The site is characterized by a 33% slope, N40E aspect, high RDM and a 51% blue oak canopy. Seventy–four percent of the blue oak seedling present had little or no hedging, 19% were moderately hedged and 7% were closely hedged.

Site 1 had five replications and Sites 2 and 3 had four replications each. The number of seedlings per replication ranged from 25 to 128. Altogether, 604 seedlings were marked with permanent identification numbers consisting of site, replication and individual plant. All seedlings found within each replication were evaluated.

We recorded initial height and evaluated all of the trees in the study every summer, shortly after the annual vegetation had dried up (late June or early July) and again each fall in mid-to-late September. During the evaluation, seedlings were classified as either present or absent. If they were present, it was noted whether they had green leaves or did not. If a seedling was present without green leaves for two consecutive years, or if it disappeared, it was classified as dead.

Since a number of the small seedlings had fairly large root-crown diameters, we suspected they were several years old. Therefore, during the summer of 1990, a study was initiated to try to estimate the age of these small seedlings. Fifteen seedlings (not from the original 604 seedling) were sacrificed from each site. Each seedling was measured for shoot length, number of shoots and root-crown diameter. Cross sections were made of the root-crown area and growth rings were counted using a dissecting microscope. Regression analysis was conducted on the sacrificed seedlings by site for seedling height versus growth-ring counts and root-crown diameter versus growth-ring counts. Only root-crown diameter versus growth-ring counts were statistically significant. The regression equation from each site was used to estimate the age of seedlings in the respective site.

The shoot height and root-crown diameter were measured on each of the surviving seedlings during the early summer of 1993. All data was analyzed using an analysis of variance; a Duncan's multiple range was used to test for differences between means.

TABLE 1. Site means for initial seedling height, change in seedling height between 1989 and 1993 and percent of seedling present in 1993

Location	Initial seedling height	Change in seedling height between 1989 & 1993	Seedling found in 1989 that were still alive in 1993
	inches		%
Site 1	9.99a	−0.17b	81.75a
Site 2	3.53a	0.65a	84.12a
Site 3	3.84a	−1.21c	70.98a

*Values within columns with different letters were different at $P \leq 0.05$. Duncan's multiple range was used to test for differences between means.

TABLE 2. Percent of seedling in approximate age groups by sites

Location	Average age	Age groups in years: 1–10	11–15	16–20	21–25	26 and older
	years	%				
Site 1	14.52a	52.72a	19.90a	9.36a	7.39a	10.56a
Site 2	5.23b	98.39b	1.00b	0.61a	0.00a	0.00a
Site 3	7.15b	88.78b	6.88ab	1.11a	1.67a	1.56a

*Values within columns with different letters were different at $P \leq 0.05$. Duncan's multiple range was used to test for differences between means.

Seedling height

The mean initial seedling height for the three sites were 9.99 inches at Site 1, 3.53 inches at Site 2 and 3.84 inches at Site 3. There were no significant differences between site means, even though average seedling height at Site 1 was considerably taller than the average seedling height for Sites 2 and 3.

The change in seedling height between 1989 and 1993 was small, but there was a significant difference between sites (table 1). Site 2 was the only site where seedlings increased in height (0.65 inch). Site 1 showed a slight decrease in height (-0.17 inch); seedling at Site 3 showed a considerable loss in height (−1.21 inches).

Most years, green shoots were observed on some seedlings in the spring, but by fall these shoots had dried up and appeared to be dead. The average percent of seedlings at each site that had green leaves in the spring but had lost them by fall were 10.59% at Site 1, 4.94% at Site 2 and 16.7% at Site 3. The following spring, the dry shoot did not green up; instead, a new, usually shorter shoot pushed from the root. It appeared that these new shoots were shorter, possibly due to the extended drought.

All three sites were grazed, but at different times of the year. There was no evidence of large ungulate browsing on the oak seedlings at any of the sites during the study period. The characterization of the sites indicated there was some browsing of small oak trees; however, the browsing occurred in trees larger than 1 foot tall. (Several

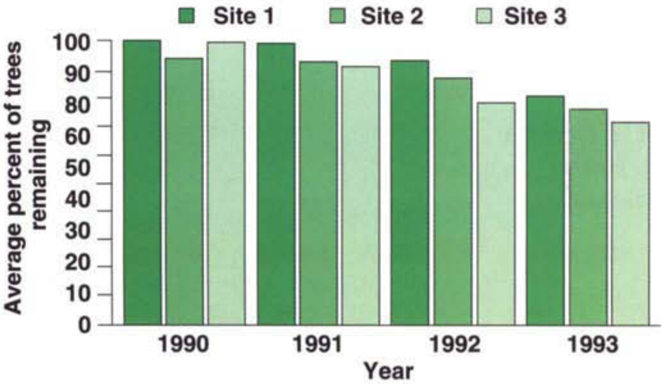

Fig. 1. Average percent of survival at three sites, 1990–1993.

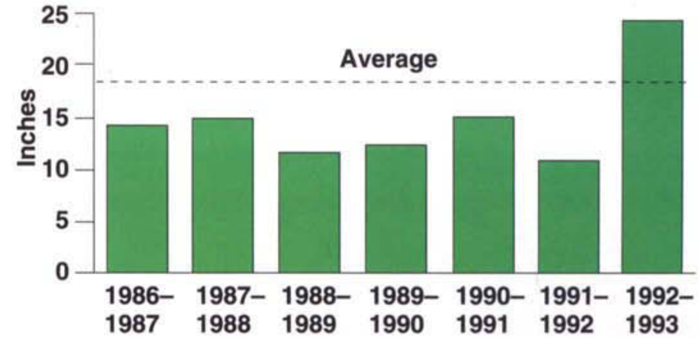

Fig. 2. Total annual rainfall recorded at a weather station in Glennville, 1986–1993. Average annual rainfall indicated by dotted line.

studies have indicated that the browsing of small oak trees usually occurs when trees are taller than 1 foot.)

The initial heights of seedlings that died during the study were not significantly different between sites (Site 1: 3.09 inches; Site 2: 2.25 inches and Site 3: 1.93 inches).

Seedling mortality

Figure 1 shows the percent of original seedlings that survived at each site from 1990 to 1993. Seedling mortality was similar between the three sites each year. There was no difference in seedling mortality between 1990 and 1992; however, mortality increased statistically for all three sites between 1992 and 1993.

There was very little rodent activity at Site 1, but Site 2 and Site 3 each had considerable gopher activity. However, rodent damage did not appear to be a major cause of seedling mortality. Only 3% of seedling mortality could be attributed to rodent activity.

Figure 2 shows annual rainfall from 1986–87 through 1992–93 recorded by the closest weather station, located in Glennville. The annual rainfall was below average for 2 years before the study and the 4 years during the study.

Of the 4 years evaluated, the greatest seedling mortality occurred during 1993, which had above-average rainfall. There are several possible explanations. One is that the criteria used to determine seedling death did not accurately reflect when death occurred, and there was possibly a 1- to 2-year delay in recording individual seedling mortality. Another explanation is that a single year's rainfall does not influence seedling mortality as much as a prolonged drought. (Tietje, Weitkamp, Jensen and Garcia (*California Agriculture*, November-December 1993), found that prolonged drought had a similar effect on the survival of oak sapling.)

Regression analysis indicated that there was a significant relationship between root-crown diameter and growth-ring counts. The R^2 values for Sites 1, 2 and 3 are 0.75, 0.63 and 0.77, respectively.

During other analysis of the age data, we found it was necessary to have a regression equation for each site. The equation for one site could not accurately estimate the ages of the trees at another site.

Table 2 shows the percent of seedlings in each approximate age group by site. Site 1 had the oldest stand of seedlings with only 52.72% in the 0-to-10-year age group, as compared to 98.39% for Site 2 and 88.78% for Site 3. Again, Site 1 had a larger percentage of seedlings in the 11-to-15-year group (19.90%) than Site 2, but not Site 3 (Site 2 had 1% and Site 3 had 6.88%). The trend for Site 1, having a larger percentage of the older seedling than Sites 2 and 3, continued through the 16-to-20-year; the 21-to-25-year and the 26-year-and-older groups, but these differences were not significant. Also, Site 1 had the higher mean age of 14.52 years, followed by Site 3 with 7.15 years and Site 2 with 5.23 years.

Seedlings were not categorized above 26 years because the ages of seedlings used to develop the regression equations did not extend beyond this point. However, several seedlings that had root-crown diameters of 1.13 inches and were only 6.5 inches tall could well have been older than 26 years.

Blue oaks grow slowly

This study indicates that there is considerable difference in age distribution of oak seedling between sites. Even very small plants, it appears, can be very old, some over 25 years of age. Also the study showed that blue oak seedling grow very slowly and, in many cases, actually *decrease* in height and still survive for several years. Since we did not measure the amount of native vegetation at each site, we cannot determine the influence that competition from native vegetation may have on oak seedling. The data from this study should be useful in establishing some baseline information for understanding the biology of blue oaks growing under natural conditions and limited rainfall, when compared to other areas of California.

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California Wildlife Habitat Relationships System
California Department of Fish and Game
California Interagency Wildlife Task Group

Blue Oak Woodland

Lyman V. Ritter

Vegetation

Structure-- Generally these woodlands have an overstory of scattered trees, although the canopy can be nearly closed on better quality sites (Pillsbury and De Lasaux 1983). The density of blue oaks on slopes with shallow soils is directly related to water stress (Griffin 1973). The canopy is dominated by broad-leaved trees 5 to 15 m (16 to 50 ft) tall, commonly forming open savanna-like stands on dry ridges and gentle slopes. Blue oaks may reach 25 m (82 ft) in height (McDonald 1985); the tallest tree, found in Alameda County, measured 28.7 m (94 ft) high and had a crown spread of 14.6 m (48 ft) (Pardo 1978). Shrubs are often present but rarely extensive, often occurring on rock outcrops. Typical understory is composed of an extension of Annual Grassland vegetation.

Composition-- Blue oak is the dominant species, comprising 85 to 100 percent of the trees present. Common associates in the canopy are coast live oak in the Coast Range, interior live oak in the Sierra Nevada, valley oak where deep soil has formed, and western juniper in the Cascade Range. In the Tehachapi and Paiute Ranges in Kern County, this habitat mixes with species from east of the mountains California juniper and single-leaf pinyon. In interior sections of the southern Coast Range, as in San Luis Obispo County, it mixes with California juniper (V. L. Holland, pers. comm.). Associated shrub species include poison-oak, California coffeeberry, buckbrush, redberry, California buckeye, and manzanita spp. The ground cover is comprised mainly of annuals, such as brome grass, wild oats, foxtail, needlegrass, filaree, fiddeneck, and others. Comprehensive descriptions of different BOW's can be found in White (1966), Griffin (1977), Baker et al. (1981), and Pillsbury and De Lasaux (1983).

Other Classifications-- The habitat is referred to as Foothill Woodland by Munz and Keck (1959), Blue Oak Phase of the Foothill Woodlands by Griffin (1977), Blue Oak Series by Paysen et al. (1980), Blue Oak Savanna by Verner and Boss (1980), and Blue Oak Community by Parker and Matyas (1981). BOW's and Blue Oak-Foothill Pine Woodlands are considered a single habitat in Küchler's (1977) Blue Oak-Foothill Pine Forest (25) and in the Blue Oak-Foothill Pine (250) type of the Society of American Foresters (Eyre 1980).

Habitat Stages

Vegetation Changes-- 1;2-5:S-D. Details of successional trends in this habitat type are poorly known. Succession presumably proceeds directly from annual grasslands to tree stages. Most stands of BOW exist as medium or large tree stages with few or no young blue oaks present (White 1966, Holland 1976, Griffin 1977, Baker et al. 1981). Therefore, only structural classes 3-5:S-D are likely to be found. Few areas can be found in California where successful recruitment of blue oaks has occurred since the turn of the century (Holland 1976). This may be due to changes in land use; increased consumption or damage of acorns and seedlings by insects, livestock, and native animals; competition between seedlings and introduced annuals for available soil nutrients and moisture; and the absence of appropriate climatic conditions. Where germination of acorns occurs, survival and growth of the seedlings typically fail. Probably in the drier savanna-like stands, the grassland openings will simply become larger as older trees die. Griffin (1977) suggests that live oaks may replace deciduous oaks in some areas, because their seedlings are more browse resistant. Many authorities question whether conditions will ever again support the recruitment of blue oaks needed to maintain these important woodlands.

Duration of Stages-- Valid generalizations about the duration of various successional stages leading to mature stands of BOW are not possible, because adequate quantitative studies have never been done. The successional sequence probably takes at least 50 years, even on good sites. Age studies in the Coast Range (White 1966, Pillsbury and De Lasaux 1983) and the southern Sierra Nevada (Brooks 1969) indicate that most blue oak stands are currently 80 to 120 years in age. Blue oaks are relatively slow-growing, long-lived trees. Large blue oaks range in age from 153 to 390 years (White 1966). Estimation of tree age based on dbh measurements is risky, however, because the dbh relationship varies tremendously depending on site quality. Moreover, height growth is extremely slow or even ceases after trees reach 65 cm (26 in) in dbh (McDonald 1985).

Biological Setting

Habitat-- This type usually intergrades with Annual Grasslands or Valley Oak Woodlands at lower elevations and Blue Oak-Foothill Pine woodlands at higher elevations.

Wildlife Considerations-- The importance of oak habitats to wildlife in California has recently been reviewed by Barrett (1980) and Verner (1980a.), but they give few details relevant specifically to BOW's. Verner and Boss (1980) give data on wildlife use in blue oak savannahs of the western Sierra Nevada. They indicate that 29 species of amphibians and reptiles, 57 species of birds, and 10 species of mammals find mature stages of this type suitable or optimum for breeding, assuming that other special habitat requirements are met. Griffin (1971) concluded that acorns buried by scrub jays, yellow-billed magpies, western gray squirrels and California ground squirrels are more likely to germinate because they root better and are less likely to be eaten. Although many wildlife species benefit from the use of oaks and even enhance oak germination, additional information is needed on many aspects of oak-wildlife relationships before this habitat can be properly managed.

Physical Setting

BOW's are usually associated with shallow, rocky, infertile, well-drained soils from a variety of parent materials (McDonald 1985). Blue oaks are well adapted to dry, hilly terrain where the water table is usually unavailable (Griffin 1973). The climate is Mediterranean, with mild wet winters and hot dry summers. Climatic extremes are relatively great in these woodlands, because they have a considerable geographic and elevational range. Average annual precipitation varies from 51 to 102 cm (20 to 40 in) over most of the blue oak's range, although extremes are noted from 25 cm (10 in) in Kern County to 152 cm (60 in) in Shasta County (McDonald 1985). Blue oaks have an unusual tolerance of severe drought, even shedding their leaves during periods of extreme moisture stress. This survival trait contributes to its pattern of distribution, as it competes most successfully with other tree species on drier sites (McDonald 1985). Mean maximum temperatures are from 24 to 36 C (75 to 96 F) in summer, and minima are from 2 to 6 C (29 to 42 F) in winter. The growing season ranges from 6 months in the north to the entire year in the south, with 175 to 365 frost-free days (Burcham 1975).

Distribution

BOW's occur along the western foothills of the Sierra Nevada-Cascade Ranges, the Tehachapi Mountains, and in the eastern foothills of the Coast Range, forming a nearly continuous ring around the Central Valley. The habitat is discontinuous in the valleys and on lower slopes of the interior and western foothills of the Coast Range from Mendocino County to Ventura County. It is generally found at elevations from 152 to 610 m (500 to 2000 ft) at the northern end of its range and on the western slopes of the Sierra Nevada, from 76 to 915 m (250 to 3000 ft) in the central Coast Range, and from 168 to 1370 m (550 to 4500 ft) in the Transverse and Peninsular Ranges (Sudworth 1908).

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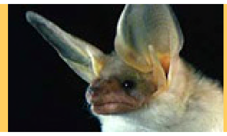

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Impact of firewood harvesting on hardwood rangelands varies with region

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Abstract

Aerial monitoring of hardwood rangelands over a 4-year period revealed that almost 70,000 cords of firewood ware harvested annually on approximately 6,000 acres. This represents less than 0.1% of the total hardwood rangeland in the state. Over 50% of the firewood volume harvested during these 4 years was in Shasta and Tehama counties, although these two counties represent less than 10% of the hardwood rangeland acreage in the state. In Tehama County, tree growth outpaced harvest, but in Shasta County, harvest exceeded growth by 30%. Both counties' governments adopted resolutions calling for a retention of 30% crown cover following firewood harvest. This retention level attempts to balance the needs for profitable livestock management with wildlife habitat needs.

Full Text

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Firewood harvesting on hardwood rangelands was observed on 6,000 acres annually between 1988 and 1992.

California's hardwood rangelands cover an estimated 7.4 million acres in the state. This area is characterized by an overstory canopy cover of at least 10% hardwood tree species, predominantly in the oak genus (*Quercus spp.*), with an understory of annual grasses and occasional native perennial grasses. Since European settlement of California, hardwood rangelands have been managed primarily for livestock production. These areas recently have taken on new importance as people realize hardwood rangelands provide one of the richest wildlife habitats in the state, with 331 vertebrate species relying at least partly on oak woodlands for habitat. Other public values provided by these areas include water quantity and quality, outdoor recreation and aesthetics. California's hardwood rangelands are unique in the West in that 80% of this acreage is privately owned.

TABLE 1. General summary statistics of CDF aerial monitoring of hardwood rangelands over a 4-year period (fall 1988 to fall 1992) for the four CDF regions

Harvest characteristics	Region 1	Region 2		Region 3	Region 4	Total
		Shasta/Tehama	Other counties			
Cords	16,486	142,983	47,164	5,777	66,514	278,924
Acres	1,404	15,025	4,225	450	3,610	24,714
Precut crown cover	49%	53%	55%	58%	76%	58%
Postcut crown cover	13%	15%	8%	22%	33%	18%
Number of harvests	24	40	17	9	30	120
Annual percent acres harvested	0.02%	0.41%	0.12%	0.01%	0.02%	0.11%

Region 1 (Coast Region): includes Del Norte, Humboldt, Marin, Mendocino, Lake, Colusa, Glenn, Napa, Solano, Alameda, Contra Costa, Santa Clara, Santa Cruz counties
Region 2 (Sierra Cascade Region): includes Siskiyou, Modoc, Lassen, Shasta, Trinity, Tehama, Plumas, Sierra, Placer, Nevada, Yuba counties
Region 3 (Southern Region): includes San Diego, Imperial, Riverside, Orange, Los Angeles, San Bernardino, Inyo, Mono, Ventura, Santa Barbara, San Luis Obispo counties
Region 4 (Central Region): includes Eldorado, Sacramento, San Joaquin, Merced, Amador, Calaveras, Tuolumne, Mariposa, Madera, Fresno, Monterey, Kings, Tulare, Kern counties

[View Enlargement]

TABLE 1. General summary statistics of CDF aerial monitoring of hardwood rangelands over a 4-year period (fall 1988 to fall 1992) for the four CDF regions

Because of the significant ecological values supplied by hardwood range-lands, sustainability of these oak-dominated habitats has great public importance. In 1986, UC, along with the California Department of Forestry and Fire Protection, the California Department of Fish and Game, and the State Board of Forestry, initiated a program of research, education and monitoring to conserve the state's hardwood rangelands: the Integrated Hardwood Range Management Program (IHRMP).

Since 1945, an estimated 1 million acres of hardwood rangelands have been converted to other land uses. Beginning in the mid-1970s, firewood harvest on hardwood rangelands — often coupled with range improvement practices — increased as markets for firewood expanded. However, little information existed on the amount of firewood being harvested, the regional distribution of harvest or its impact on resource values.

This paper summarizes the results of several assessments of firewood harvest on hardwood rangelands, and shows how this information is being used to develop policies designed to sustain hardwood rangeland values.

Statewide firewood harvest trends

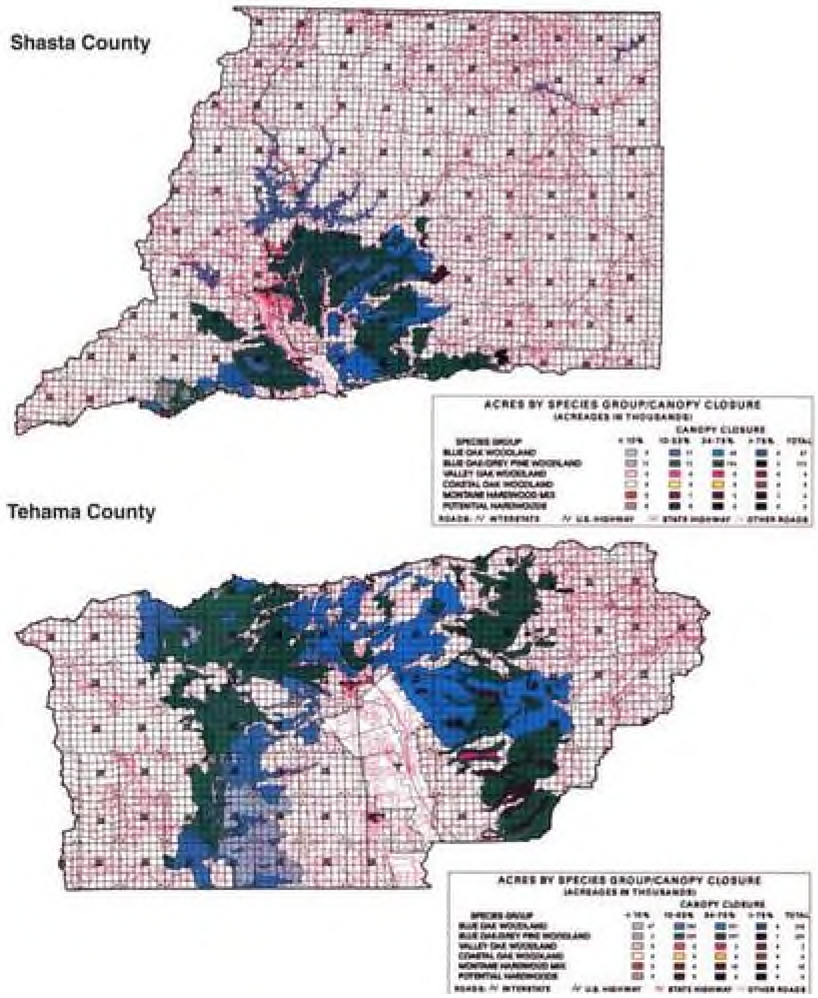
The California Department of Forestry and Fire Protection (CDF) was given responsibility by the IHRMP for monitoring the status of hardwood rangelands in the state. In an initial assessment of the statewide impact of firewood harvest, CDF conducted aerial monitoring from fall 1988 through fall 1992, using fixed wing aircraft flyovers and local agency observers to examine firewood harvest. All the principal hardwood rangeland regions in the state were surveyed three times over the 4-year period. This aerial survey was designed to show general trends in the acreage of harvest and level of canopy reduction. Local CDF personnel flew systematic grids over regions under their jurisdiction, attempting to locate all major firewood harvesting operations that had taken place in the past year or since the previous flyover. Each harvest location was recorded spatially and on the CDF Hardwood Rangeland Geographic Information System (GIS). Aerial observers estimated precut canopy cover of harvested areas by comparing the adjacent uncut areas, as well as postcut canopy cover and acreage of harvest.

Using these canopy cover estimates, the volume per acre harvested also could be estimated for each location using the general relationship between crown cover and volume (see *California Agriculture* July-Aug. 1988). The total volume harvested at each location was estimated by multiplying the calculated volume per acre by the acreage of the operation. Table 1 shows the general 4-year harvest levels derived from these CDF aerial observations. Almost 280,000 cords were harvested on nearly 25,000 acres. These figures represent a conservative estimate: the aerial surveys may have omitted small or very light, partial harvests since they would have been difficult to detect from the air. However, local observers felt that virtually all major commercial harvest operations during this period were included.

More than half of the firewood volume harvested during these 4 years was in Shasta and Tehama counties, although these two counties represent less than 10% of the hardwood rangeland acreage in the state. Over the 4 years, statewide annual firewood harvest averaged only 0.1% of all hardwood rangeland acreage in the state. Despite this low percentage, however, there is still concern that many of the harvest sites exceed the minimum canopy retention threshold of 25% cover in the IHRMP's *Preliminary Guidelines for Managing Hardwood Rangelands*, and the Department of Fish and Game's 40% canopy retention standards. In fact, 96 of the 120 firewood harvest sites detected in the aerial survey fell below these recommended canopy retention minimums. This may create locally significant impacts in some watersheds and will be investigated in future landscape analysis projects.

Growth and harvest

To assess the sustainability of harvesting a much higher percentage of hardwood rangeland, we compared total oak tree volume growth and harvested hardwood in Shasta and Tehama counties. The CDF Hardwood Rangeland GIS maps hardwood range-lands by cover type and crown cover percentage for the entire state (Pillsbury, et al., 1991). Using these hardwood rangeland mapping units, crown cover was converted to volume in cubic feet and cords, using the same relationships described above. General growth equations based on volume and site index (see *California Agriculture* July-Aug. 1988) were used to assess projected growth for each mapping unit in the two-county area. Growth for the hardwood rangelands in each county was determined by multiplying calculated per-acre growth per mapping unit by the number of acres in that unit. An annual accounting was made to shift acreage from its precut to its postcut canopy class.



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The California Department of Forestry and Fire Protection Hardwood Rangeland GIS maps hardwood rangelands by cover crop and crown cover percentage for the entire state. Crown cover was converted to volume in cubic feet and cords to compare total oak tree volume growth and harvested hardwood. In Tehama County, growth exceeded harvest by 3%. In Shasta County, harvest levels exceeded growth by 30%.

[View Enlargement]

Specialist Standiford examines oak stump sprouts, which grew 1 to 3 feet annually following firewood harvest.

[View Enlargement]

Oak seedlings less than 1 foot in height were found on 39% of the sample plots in Shasta and Tehama counties following firewood harvest.

In Tehama County, growth exceeded harvest by 3% for the 4 years of the survey (fig. 1). This approximate balance between growth and harvest indicates that for the short term, hardwood rangelands for the county as a whole are expected to remain fairly stable. In Shasta County, harvest levels exceeded growth by 30%, indicating that current harvest levels will decrease volumes per acre and canopy cover. These levels of harvest likely would not be sustainable given the expected growth rates of the residual trees and the unharvested areas.

Impacts on stand structure

A relatively small percentage of hardwood rangeland acreage was harvested statewide, based on the 4-year aerial observation. On a statewide basis, the annual acreage of firewood harvest amounted to slightly more than 6,000 acres. This is significantly less than the 30,000 acres estimated by IHRMP and U.S. Forest Service to be converted each year to residential or commercial development. The regional impacts of firewood harvesting appear to be concentrated in the northern Sacramento Valley.

Volume and crown cover of hardwood rangelands are only one measure of impact from firewood harvest. To provide baseline information on hardwood rangeland stand structure following firewood harvesting, a study was initiated in 1993. The study, funded by the CDF, was conducted at the ranch level by IHRMP and Cooperative Extension offices in Shasta and Tehama counties. It assessed the intensity of harvesting that has taken place in the past 10 years, the effectiveness of regeneration by seedling and stump sprouting, changes in wildlife habitat elements, and other stand structure characteristics. We also evaluated specific site factors to assess the spatial distribution of areas with adequate or inadequate regeneration.

TABLE 2. General characteristics of 103 sample plots on hardwood rangeland harvest sites in Shasta and Tehama counties (harvests from 1985 to 1994)

Characteristics		Shasta	Tehama	Both counties
Oak overstory	Precut	59	62	61
crown cover %	Postcut (1991–1994)	21	16	18
	Postcut (1985–1990)	23	7	14
	Postcut (1985–1994)	22	12	15
Vol per acre	Precut	851	679	742
cubic feet	Postcut	418	170	260
Trees per acre	Precut	145	261	219
	Postcut	61	42	49
Basal area per	Precut	53	49	51
acre *feet^2*	Postcut	25	12	16
Average tree	Precut	8.2	5.9	6.5
diameter *inches*	Postcut	8.6	7.1	7.8
Probability of	Brush cover	14	19	17
wildlife habitat	Brush piles	27	37	34
Elements following	Snags/granary trees	22	21	21
harvest %	Woody debris	49	58	55
Probability of	<1 foot seedling	41	38	39
natural regen.	1–3 ft. seedling	3	18	13
after harvest %	3–6 ft. sapling	3	5	4

[View Enlargement]

TABLE 2. General characteristics of 103 sample plots on hardwood rangeland harvest sites in Shasta and Tehama counties (harvests from 1985 to 1994)

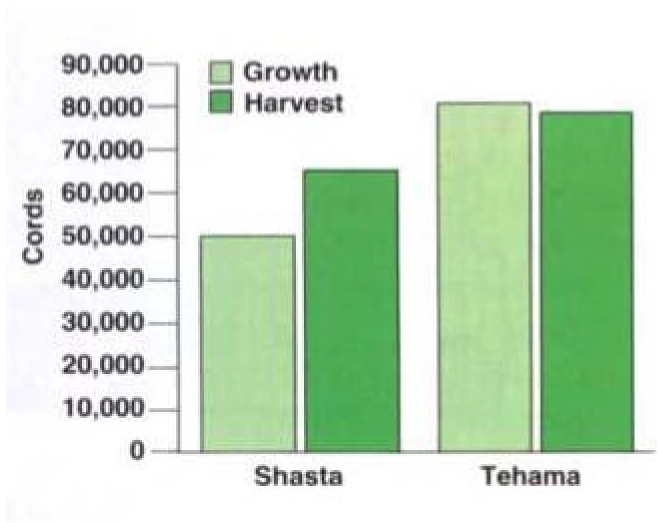

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Fig. 1. Comparison of harvest and growth on hardwood rangelands in Shasta and Tehama counties, fall 1988 to fall 1992.

This information will help in evaluating the effectiveness of current oak firewood harvesting practices on the long-term sustainability of the hardwood range resources in the Northern Sacramentc Valley foothills.

Nineteen sample ranches were randomly selected — 12 ranches in Tehama County and seven in Shasta County — in areas that had been harvested over the past 10 years. Information was collected from each study area on specific harvest location, date harvested, rainfall, soils, oak site index, precut and postcut canopy cover and diameter distribution, species composition and management practices. Data were collected on overstory trees, brush, stumps and resprouts in five to seven 1/10-acre circular plots randomly located within each harvested area. A belt transect was established at each plot to assess seedling regeneration and brush cover. Additional data were collected at each plot on wildlife habitat elements, including snags, dead and down woody material, number of cavities and acorn production.

Table 2 shows the initial results from 103 sample plots on the 19 ranches. Average preharvest canopy cover in the two counties was fairly similar. However, preharvest volume levels and average tree size were higher in Shasta County. In general, harvest intensity was higher in Tehama County, with the average residual canopy lower than in Shasta County. There has been a trend, however, of increasing residual canopy level over the last 4 years in Tehama County. This may well reflect the success of educational programs presented at the local level by Cooperative Extension and other agencies. The average residual canopy in Shasta County was not significantly less than the 25% minimum threshold discussed in the IHRMP's guidelines.

[View Enlargement]

Aerial reconnaissance was carried out to evaluate preharvest and postharvest oak canopy between 1988 and 1992.

There was a fairly high probability for stump sprouting of trees cut on hardwood rangelands in the two counties (fig. 2). Overall stump sprouting averaged more than 54%. There was a strong negative correlation between stump diameter and sprouting success. Future studies will attempt to determine other site and management factors influencing sprouting success. There was an extremely low percentage of plots with naturally regenerated seedlings over 1 foot in height (table 2). This low probability, coupled with a slow growth rate, seems to suggest that stump sprouting will be the dominant method of regeneration in these stands following firewood harvest.

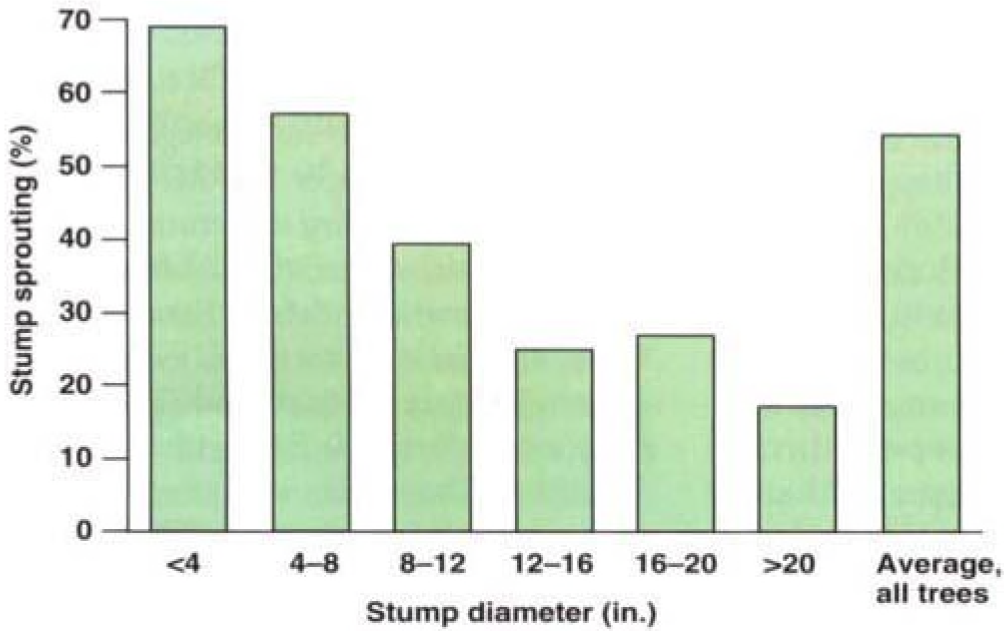

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Fig. 2. Stump sprouting percent following firewood harvest in Shasta and Tehama counties.

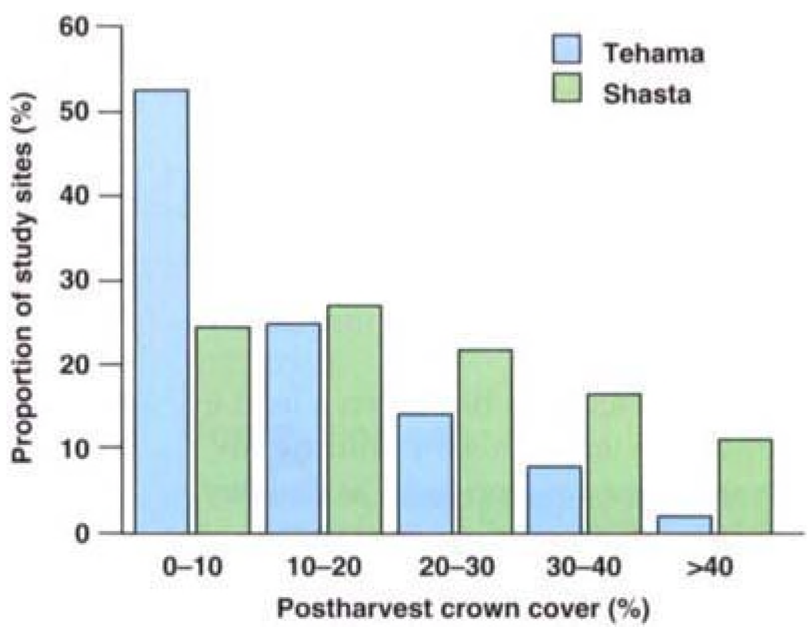

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Fig. 3. Distribution of postharvest crown cover of 103 sample sites following firewood harvesting in Shasta and Tehama counties (harvests from 1985 to 1994).

[View Enlargement]

Residual oak canopy cover ranged from 0 to 50% following firewood harvest in Shasta and Tehama counties.

The overall effect of this general sprouting percentage and poor natural seedling regeneration is that these levels of oak harvest will result in hardwood rangeland stands with a lower crown density, fewer trees per acre, and a larger average tree size. Changes in overstory canopy also resulted in a higher proportion of harvested areas with dead and down woody debris and brush piles. Approximately 20% of the harvested plots had snags or granary trees, which could be used by wildlife. The effect of these stand level changes on biological diversity will be addressed in future studies.

Policy direction

Tehama County has taken a lead in the state in using this monitoring information to develop local, voluntary oak harvesting guidelines on hardwood rangelands. The county board of supervisors appointed an oak harvest committee to develop a county conservation strategy, which was adopted by the board in 1994. Because of the major impact of firewood harvesting in the county, the main emphasis of the policy was on firewood harvesting and retention standards. Shasta County followed suit, and has passed a voluntary oak management policy that will form the basis of its educational outreach.

Both the Shasta and Tehama counties resolutions call for a retention of 30% crown cover following firewood harvest. This retention level attempts to balance the needs for profitable livestock management with wildlife habitat needs. For Tehama County, less than 10% of the sample plots harvested in the past 10 years had over 30% canopy retention (fig. 3). For Shasta County, slightly more than 25% of the sample plots had over 30%

canopy cover. Both county resolutions also call for educational outreach to convey these voluntary guidelines to landowners. Shasta and Tehama counties already have mailed a copy of their guidelines to all landowners of hardwood rangelands in the county. Increasing the proportion of stands that meet these locally derived retention standards is one measure of the success of this outreach. An increase in canopy retention in Tehama County over the past 5 years (from 7% to 16% retention) is a good indication that landowners are receptive to such efforts.

These assessments show that from a statewide perspective firewood harvest is not a dominant factor affecting hardwood rangelands. Regional differences in the sources of impacts to hardwood rangelands were well documented at 1993 Board of Forestry hearings on hardwood rangelands. On the basis of this information, the board decided to direct local governments to develop their own policies to conserve hardwood rangelands, rather than pass statewide regulations that might not apply to most of the state. Similar local voluntary initiatives are being developed in several other counties. These include countywide ordinances on tree removal, modifying the open space requirements of the county general plan to address hardwood range-lands, and developing hardwood rangeland criteria for California Environmental Quality Act review of specific projects, depending upon local factors that jeopardize the sustain-ability of hardwood rangelands.

It is critical that counties continue to monitor trends in harvest, regeneration and stand structure on hardwood rangelands. Data such as that gathered in the studies described here can help determine whether existing local policies are accomplishing the goal of conserving the public values derived from privately owned hardwood rangelands.

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Author Notes

For more information, see Pillsbury, N., M. DeLasaux, R. Pryor, and W. Bremer, 1991. Mapping and GIS Database Development for California's Hardwood Resources. *California Dept. of Forestry and Fire Protection, Sacramento.*

Modeling the Effectiveness of Tree Planting to Mitigate Habitat Loss in Blue Oak Woodlands[1]

Richard B. Standiford,[2] Douglas McCreary,[3] and William Frost[4]

Abstract
Many local conservation policies have attempted to mitigate the loss of oak woodland habitat resulting from conversion to urban or intensive agricultural land uses through tree planting. This paper models the development of blue oak (*Quercus douglasii*) stand structure attributes over 50 years after planting. The model uses a single tree, distance independent growth model, calibrated to data derived from a blue oak plantation. The results vary based on initial planting density and plantation management intensity. Data on crown cover, basal area, and average tree diameter and height are presented. For the range of modeled conditions, canopy cover after 50 years is projected to range from 7 to 33 percent, with an average DBH after 50 years ranging from 3.4 to 4.1 inches (8.6 to 10.4 cm). The cost of these tree replacement strategies is evaluated, and the effectiveness of tree planting as a mitigation tool, especially as it relates to the creation of wildlife habitat, is discussed.

Introduction
California has one of the most rapidly growing human populations in the world. The state's population has grown from less than 100,000 people in 1850, to over 31 million people today (an average annual rate of growth of 3.4 percent) to a projected 63 million people in the next 50 years (Medvitz and Sokolow 1995). This population growth is having an impact on oak woodlands. Although California's oak woodlands cover 7.4 percent of the state (Bolsinger 1988), and are the most biologically diverse broad habitat in the state (Pavlik and others 1991), they are also one of the most rapidly urbanizing areas in California (Duane 1999). A survey of oak woodland owners showed that the majority of all owners now live less than 5 miles (8 km) from a subdivision (Huntsinger and Fortmann 1990, Huntsinger and others 1997). This also showed that approximately one-third of the properties changed owners between 1985 and 1992, and 5 percent were subdivided for residential development.

Over the past 40 years, California's oak woodlands have decreased by over one million acres (405,000 ha) on a statewide scale (Bolsinger 1988) due to human-induced factors. Major losses from 1945 through 1973 were from rangeland clearing for forage production enhancement. Major losses since 1973 were from conversions to residential and industrial developments. Regionally, some oak woodlands have

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decreased from urban expansion (Doak 1989), firewood harvesting (Standiford and others 1996), range improvement (Bolsinger 1988), and conversion to intensive agriculture (Brooks and others 1999). Habitat fragmentation, increased conflicts between people with different value systems, predator problems, and soil and water erosion, have resulted. Blue oak woodlands (*Quercus douglasii* Hook. and Arn.), covering 23 percent of the state's woodlands (Bolsinger 1988), are one of the areas with the largest concerns about conversion.

Concerns about conserving the environmental values of oak woodland resources in the face of conversions to other land uses from rapid urbanization and changing agricultural markets, has led planners to develop strategies to mitigate these effects. Tree planting technologies for blue oak have improved tremendously in the past 15 years, and widespread success from planting is possible (McCreary 1990, McCreary 1995b, McCreary and Lippit 1996, McCreary and Tecklin 1993). Tree planting is often proposed as part of mitigation strategies to replace habitat losses (Giusti and Tinnin 1993, Bernhardt and Swiecki 1991, Fulton 1999). Many mitigation plans regularly call for tree planting on a replacement basis (1:1 to as high as 20:1) for trees lost. However, since there is little experience with growth rates of planted native oaks beyond 10 to 15 years, there has not been an opportunity to assess how oak woodland habitats will develop over time from areas planted, and whether this mitigation approach on overall habitat quality is effective.

The purpose of this study was to evaluate blue oak tree planting as a mitigation strategy for habitat loss. The results should help assess the long-term impacts of tree planting on oak woodland habitat development.

There have been a number of studies evaluating growth of blue oak seedlings, and reporting on height, diameter, and canopy development with various management strategies (McCreary 1990, 1995a, 1995b; McCreary and Lippit 1996; McCreary and Tecklin 1993). There is no information on stand structure development extending beyond 10 to 15 years. There have been several long term whole stand growth models of blue oak woodlands developed by Pillsbury and DeLasaux (1985), and Standiford and Howitt (1988, 1993). However, these do not provide detailed information on stand structure development, but only general volume and basal area growth. A single tree, distance independent growth model has been developed for blue oak natural stands (Standiford 1997) which offers some promise for a more detailed assessment of stand development.

Methods

This study utilized a modeling approach to evaluate blue oak plantation development. *Figure 1* depicts the model used to predict the attributes of a planted stand over time. The individual tree size data (height, diameter, crown spread) 10 years after planting provided the input variables for the model. Individual tree basal area growth was modeled as a function of tree size, competition of each tree with adjacent trees, and site quality (Standiford 1997). Individual tree height growth and canopy development were correlated with basal area increment. The summation of the individual trees provided the stand totals for the first 10 years (basal area per acre, average DBH, average height, crown cover percent). The tree list and stand attributes were updated for every 10-year interval by a growth model that was based on actual blue oak stand age and structure data (Standiford 1997). Woodland productivity was assessed with a height-diameter site index relationship developed for blue oak sites

(Standiford and Howitt 1988). This was derived to give an index number for the height of a dominant tree in a stand when it averages 10 inches (25 cm) diameter at breast height (DBH). A site index of 50 feet (15 m) was assumed for the models presented below, which means that when the dominant trees average 10 inches (25 cm) DBH, they will average 50 feet (15 m) in height.

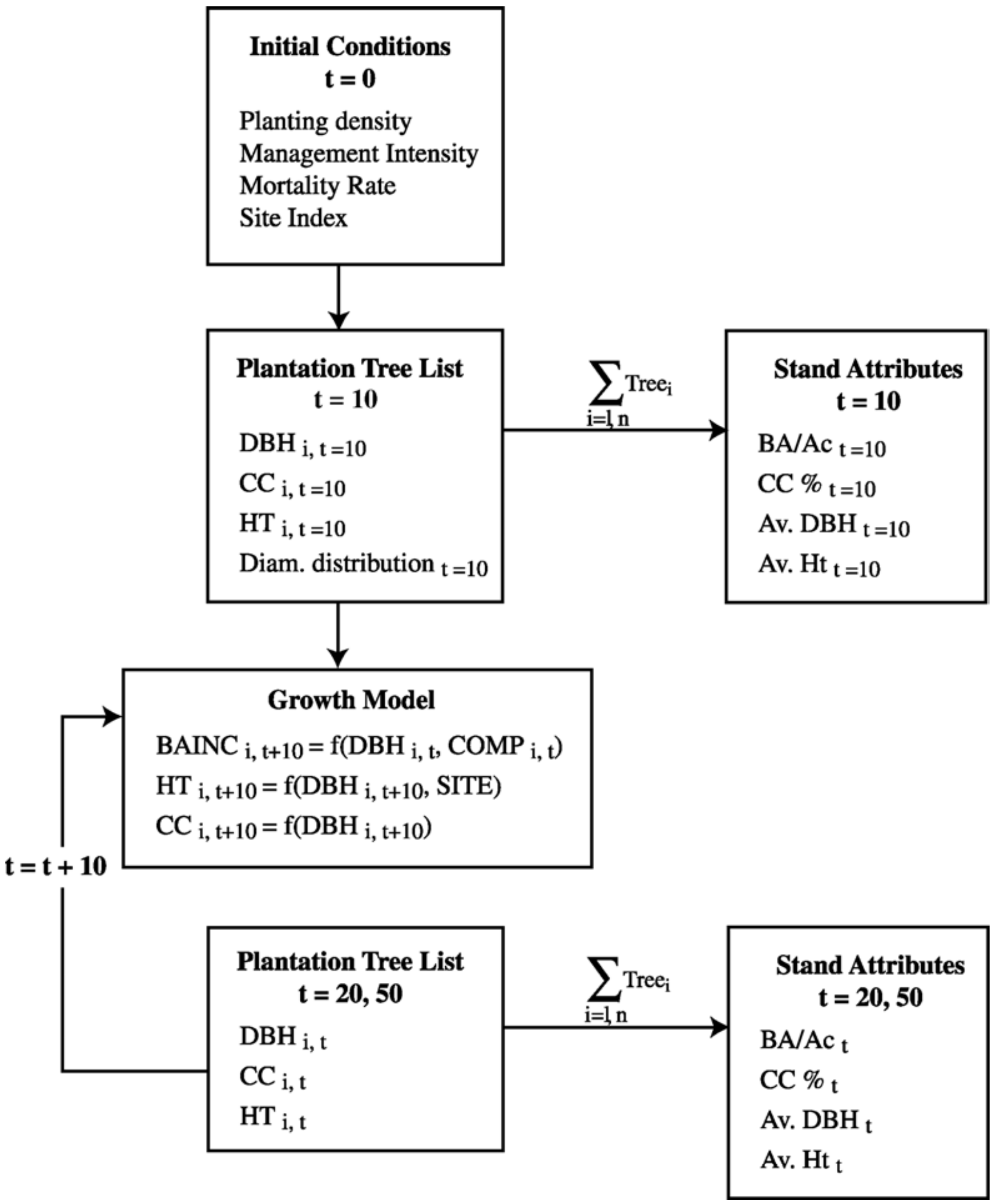

Figure 1—Modeling schematic to evaluate individual tree growth and stand characteristics of planted blue oaks over time. Where: DBH $_{i,t}$ is diameter at breast ht. (4.5 ft) of tree i at time t, CC $_{i,t}$ is canopy cover in sq. ft. of tree i at time t, HT $_{i,t}$ = total height of tree i at time t; BAINC $_{i,t+10}$ is basal area increment model for tree i for ten year period after time t, COMP $_{i,t}$ = competition index (Standiford 1997) for tree i at time t, BA/Ac $_t$ = stand basal area in square feet per acre at time t.

Data was collected from 55 sample blue oak trees in a ten-year old blue oak plantation at the Sierra Foothill Research and Extension Center (SFREC) in Yuba County, California, approximately 40 miles (64 km) northeast of Sacramento. The correlation between individual tree basal area and height and crown surface area was evaluated.

Based on the yield table of modeled stand attributes, a general assessment of wildlife habitat relationships was made using the Version 7.0 California Wildlife Habitat Relationships (CWHR) model (Giles and others 1999). The modeled stand is referred to as a "mitigated stand" since it represents tree planting designed to mitigate expected environmental impacts from tree removal in a particular project. The CWHR habitat types were evaluated based on the attributes of the mitigated stand, and applying the classification rules for CWHR (Mayer and Laudenslayer 1988). The list of vertebrate species generated by CWHR for the mitigated stand at different time periods was compared to a natural mature blue oak stand. These differences in vertebrate species were evaluated to see how the mitigated stand compared to the habitat lost in the mature stand.

Results

A regression equation was developed to predict the height and crown canopy area of the individual trees on the basis of the basal area of the individual tree at breast height (derived from DBH). This relationship helped to assess height and crown changes of the planted trees over time, for which there were no existing growth models. Equations 1 and 2 show the results of the regression of blue oak plantation tree height and crown surface area with individual tree basal area. A logarithmic form was utilized to represent the curvilinear shape of the relationship.

$$\ln(HT_i) = 3.164 + 0.213 \times \ln(BA_i) \qquad (1)$$

(**) (**) R2 = .67

$$\ln(CC_i) = 5.018 + 0.427 \times \ln(BA_i) \qquad (2)$$

(**) (**) R2 = .60

where: CC_i is canopy cover of tree i in square feet per tree, HT_i is total height of tree i in feet, BA_i is basal area of tree i at breast height (4.5 feet) in square feet per tree, ln is natural logarithm, and ** is significant at 0.01 level

These equations were applied to individual tree basal area, and basal area after growth projections, to develop tree height and crown cover for each tree. The initial tree list was based on diameter distribution data for a plantation that was monitored for 10 years after planting. Two different management regimes were assumed. A high management intensity scenario assumed that complete weed control was maintained for a 3-year period, and that best management strategies for planting seedlings were followed (McCreary 1995a). The assumption is that these stands would average 2 inches (5 cm) DBH after 10 years, and there would be a 90 percent seedling survival. The moderate management scenario assumed that weed control was for the first year only, resulting in stands averaging 1.5 inches (3.8 cm) DBH, with an 85 percent seedling survival. These assumptions are based on actual plantation growth

(McCreary 1990, 1995a, 1995b; McCreary and Lippit 1996; McCreary and Tecklin 1993) and observations of operational restoration projects.

Table 1 shows the results of the simulation of the blue oak mitigation planting. Initial planting densities were evaluated from 100 to 400 trees per acre (247 to 988 trees per hectare) for both the high and moderate management intensities. These results show that for both the high and moderate intensity category, planting only 100 trees per acre (247 trees per hectare) does not result in a stand with over 10 percent canopy cover after 50 years. Mature blue oak stands may only have 40 to 50 trees per acre (99 to 124 trees per hectare) (Bolsinger 1988), so planting 100 trees per acre (247 trees per hectare) would represent a 2:1 replacement strategy. After 50 years, these planted stands would still be classed as annual grasslands by the CWHR classification system since tree canopy cover is less than 10 percent.

Table 1 also shows the CWHR habitat seral stages for the mitigated stand over the 50-year simulation period. The two habitat stages projected to occur in the planted stands 50 years from establishment (Blue oak 2S and Blue oak 2P) were evaluated with the CWHR model. Since the purpose of the modeling was to evaluate the impacts on wildlife species associated with the hardwood tree component of blue oak woodlands, the list of species was reduced by eliminating species primarily associated with aquatic or conifer habitats, and species with an average habitat quality less than "medium." The area chosen for study was the central Sierra Nevada foothills. The results of the vertebrate wildlife projected to occur in these stands showed that 73 species would have medium or high quality habitat values in the two habitat stages projected to exist in planted stands in 50 years (1 amphibian, 40 bird, 19 mammal, and 13 reptile species).

The mitigated stand species list was compared to a natural blue oak stand, averaging 10 inches (25 cm) DBH, with a 30 percent canopy cover (Blue Oak 3P seral stage). The natural stand is assumed to have small and medium size downed wood, snags, acorns and trees with cavities. A natural stand with this habitat condition is projected to have 102 vertebrate wildlife species with medium or good habitat. The impacts were compared by evaluating the percent change in habitat quality between the natural and mitigated stand, using equation 3 below:

$$\left(\frac{H_{nat} - H_{mit}}{H_{nat}}\right) \times 100 = \text{Percent change} \qquad (3)$$

where: H_{nat} is habitat quality for natural stand, H_{mit} is habitat quality for mitigated/planted stand.

Garrison (1994) points out the difficulties in determining the biological significance of CWHR predictions. Garrison and Standiford (1997) address the tenuous nature of these predictions by utilizing a 50 percent change as the significant impact threshold. This is considered a relatively conservative threshold, representing an average habitat suitability change of at least one rating class.

Table 1—*Modeled blue oak stand characteristics after planting*

Planting density	Management intensity[1]	Age yrs.	Crown cover pct.	Basal area sq. ft/ac (sq. m/ha)	Av. diam. breast ht. in. (cm)	Av. height ft. (m)	CWHR seral stage[2]
100 trees per acre (247 trees per hectare)	High	10	6	2.0 (0.5)	2.0 (5.1)	11 (3.4)	AG 1D
		20	7	3.0 (0.7)	2.6 (6.6)	14 (4.3)	AG 1D
		30	7	4.2 (1.0)	3.1 (7.9)	15 (4.6)	AG 1D
		40	8	5.4 (1.2)	3.6 (9.1)	18 (5.5)	AG 1M
		50	9	6.7 (1.5)	4.1 (10.4)	21 (6.4)	AG 1M
	Moderate	10	4	1.1 (0.3)	1.5 (3.8)	10 (3.0)	AG 1D
		20	5	1.9 (0.4)	2.1 (5.3)	12 (3.7)	AG 1D
		30	6	2.8 (0.6)	2.6 (6.6)	14 (4.3)	AG 1D
		40	7	3.8 (0.9)	3.1 (7.9)	15 (4.6)	AG 1D
		50	7	4.9 (1.1)	3.6 (9.1)	18 (5.5)	AG 1D
200 trees per acre (494 trees per hectare)	High	10	12	4.1 (0.9)	2.0 (5.1)	11 (3.4)	BO 2S
		20	13	6.0 (1.3)	2.5 (6.4)	14 (4.3)	BO 2S
		30	15	8.1 (1.9)	3.0 (7.6)	15 (4.6)	BO 2S
		40	16	10.4 (2.4)	3.5 (8.9)	18 (5.5)	BO 2S
		50	17	12.8 (2.9)	4.0 (10.2)	20 (6.1)	BO 2S
	Moderate	10	9	2.2 (0.5)	1.5 (3.8)	10 (3.0)	AG 1M
		20	11	3.6 (0.8)	2.0 (5.1)	12 (3.7)	BO 2S
		30	12	5.3 (1.2)	2.5 (6.4)	13 (4.0)	BO 2S
		40	13	7.3 (1.7)	3.0 (7.6)	15 (4.6)	BO 2S
		50	14	9.3 (2.1)	3.5 (8.9)	17 (5.2)	BO 2S
300 trees per acre (741 trees per hectare)	High	10	18	6.1 (1.4)	2.0 (5.1)	11 (3.4)	BO 2S
		20	20	8.9 (2.0)	2.5 (6.4)	14 (4.3)	BO 2S
		30	22	11.9 (2.7)	3.0 (7.6)	15 (4.6)	BO 2S
		40	24	15.3 (3.5)	3.5 (8.9)	17 (5.2)	BO 2S
		50	25	18.8 (4.3)	3.9 (9.9)	20 (6.1)	BO 2P
	Moderate	10	13	3.3 (0.8)	1.5 (3.8)	10 (3.0)	BO 2S
		20	16	5.4 (1.2)	2.0 (5.1)	12 (3.7)	BO 2S
		30	18	7.9 (1.8)	2.5 (6.4)	13 (4.0)	BO 2S
		40	20	10.6 (2.4)	3.0 (7.6)	14 (4.3)	BO 2S
		50	21	13.6 (3.1)	3.5 (8.9)	17 (5.2)	BO 2S
400 trees per acre (988 trees per hectare)	High	10	24	8.2 (1.9)	2.0 (5.1)	11 (3.4)	BO 2S
		20	27	11.8 (2.7)	2.5 (6.4)	14 (4.3)	BO 2P
		30	29	15.8 (3.1)	3.0 (7.6)	15 (4.6)	BO 2P
		40	31	20.1 (4.6)	3.4 (8.6)	17 (5.2)	BO 2P
		50	33	24.6 (5.1)	3.9 (9.9)	20 (6.1)	BO 2P
	Moderate	10	18	4.3 (1.0)	1.5 (3.8)	10 (3.0)	BO 2S
		20	21	7.1 (1.6)	2.0 (5.1)	12 (3.7)	BO 2S
		30	24	10.3 (2.4)	2.5 (6.4)	13 (4.0)	BO 2S
		40	26	13.9 (3.2)	3.0 (7.6)	14 (4.3)	BO 2P
		50	28	17.8 (4.1)	3.4 (8.6)	17 (5.2)	BO 2P

[1] Management Intensity Assumptions—10 years after Planting—High–average 2 inches (5 cm) DBH with 90 percent survival; Moderate–1.5 inches (3.8 cm) DBH with 85 percent survival.

[2] CWHR Seral Stages—AG 1D is annual grassland, grass height less than 12 inches (0.3 m), over 60 pct. cover; AG 1M is annual grassland, grass height less than 12 inches (0.3 m), 40 to 59 pct. cover; BO 2S is blue oak woodland, 1-6 in. (2.5 to 15.2 cm) DBH, 10-24 pct. cover; BO 2P is blue oak woodland, 1-6 in. (2.5 to 15.2 cm) DBH, 25-39 pct. cover.

The mature blue oak (3P) was compared to planted blue oak stands (2P and 2S). The mitigation resulted in 17 species that showed significant decreases in habitat compared to the natural stand. For the 2S seral stage (projected to occur with planting densities of 200 trees per acre), 18 species had a significant increase in habitat quality after the mitigation. There were 10 species with a significant increase in habitat quality for the 2P seral stage (projected to occur with planting of 300 to 400 trees per acre [740 to 988 trees per hectare]). Seventy-five species had no significant change in quality for the 2S stage, and 67 had no change for the 2P stage.

The species that were projected to have significant decreases in habitat suitability were acorn and cavity dependent species such as various woodpecker species, the western bluebird, and the western gray squirrel. Species with significant increases in habitat suitability were wildlife that prefer meadows and open stand types, including the California pocket mouse, the California vole, the horned lark, and the Western meadowlark.

Discussion

This approach provides planners, developers and the restoration community with a tool to evaluate how important characteristics of the stand will develop over time. The projected structure of planted blue oak stands over a 50 year period from this study can be compared directly to actual stand data for areas that will possibly be lost in a conversion project that will need mitigation.

The general results of this study raise questions as to whether the structure of planted stands adequately mitigate the loss of mature stands. As these results show, average tree size after 50 years under fairly aggressive restoration efforts, is still quite small. The largest mean diameter of the stand is only 3.9 inches (9.9 cm), with a canopy cover of 33 percent.

Using CWHR as a tool to evaluate the wildlife habitat quality of the planted stand showed that in general, the overall biodiversity figures are not greatly affected from the mature stand chosen for comparison in this paper. However, the species composition shifts from wildlife species that utilize cavities, acorns, and downed wood, to species that utilize open meadows and grasslands.

Another factor to be considered is the cost of tree planting as a mitigation strategy. Although planting technology has advanced tremendously, restoration costs may range from $210 (moderate intensity) to $280 (high intensity) per acre for 100 trees per acre ($519 to $692 per hectare for 247 trees per hectare), up to $470 (moderate intensity) to $765 (high intensity) per acre for 400 trees per acre ($1161 to $1890 per hectare for 988 trees per hectare) (Standiford and Appleton 1993). These costs were updated to 2001 dollars using the producer price index. In some cases, it may be more cost effective to utilize the mitigation funds to ensure that existing mature habitat is conserved, through the purchase of conservation easements, the set aside of large blocks of commonly-owned land and density credits, or the establishment of public open space.

Conclusion

The results suggest that it is important to evaluate if tree planting is a viable method of mitigation. It appears to be a very costly, long-term effort, to restore an area. Many important habitat elements, such as cavities, acorns, snags, and woody debris may not be mitigated - at least in the 50-year interval evaluated in this study - through a tree planting strategy alone. Although procedures for discounting habitat decreases for woodland species and habitat increases for meadow species are not established, the results can be used as part of discussions about appropriate mitigation strategies.

These results rely on modeling extrapolated from relatively young tree plantations and natural stand growing conditions. It will be important to consider if the long-term growth of planted stands follows these preliminary projections. Actual height and crown growth models are needed, rather than relying on the correlation with basal area growth. Continued evaluation of planted stands is required to develop these improved models. It is also important to conduct on-site wildlife evaluations to determine the reliability of CWHR projections.

Although the results of this work point out that blue oak plantations develop habitat conditions slowly, and it may take in excess of 50 years to replace mature habitat that is lost in a particular project, tree planting is still an important conservation tool. The great strides that have been made in oak planting on hardwood rangelands should still be encouraged as part of an overall restoration strategy. Effective mitigation, however, may well require a more diverse array of tools to address the impacts of various woodland conversion projects.

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Rehabilitation of a Blue Oak Restoration Project[1]

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Abstract: *Two remediations were tested for improving height growth and survival on a 2-year-old, failing, blue oak (*Quercus douglasii*) restoration project. Replanting acorns and seedlings with plastic treeshelters resulted in 75 and 88 percent survival, respectively, in areas previously showing almost total mortality. After 3 years, average height of replants (141 cm) exceeded the original planting (19 cm). In a second remediation, treeshelters retrofitted onto original planting survivors showed highly significant differences in height (*$P < 0.0001$*) and survival (*$P = 0.0001$*) between protected and unprotected pairs. Protected survivors were almost five times taller than unprotected, and averaged nearly an eight-fold height increase (130 cm), while average height of unprotected plants had not quite doubled (28 cm). Treeshelters inhibited vole, but not grasshopper predation. Results indicate treeshelters release stunted seedlings and could rehabilitate poorly performing projects.*

Natural regeneration of two endemic California oaks, blue oak (*Quercus douglasii*) and valley oak (*Q. lobata*), has been widely recognized to be a problem statewide on many sites (Bolsinger 1988, Griffin 1971, Muick and Bartolome 1987, Swiecki and Bernhardt 1993). Lack of recruitment to the sapling stage has been identified as a widespread occurrence. This has created great interest in developing techniques for artificial regeneration of these species (see Adams, and Plumb and DeLasaux in these proceedings for general reviews). At the Sierra Foothill Research and Extension Center (SFREC), located 27 km northeast of Marysville, California, we have been able to grow blue oaks to sapling size within 5 years on small (approximately 0.25-ha) plots inside cattle exclosures. This has been accomplished using weed control and with little or no irrigation, with and without screen protection of seedlings (McCreary 1991). When attempting to expand these successful attempts on a larger scale, however, we encountered setbacks. In a 1.6-ha plot intended as a demonstration for oak woodland landowners, we found that we could not duplicate the rapid height growth we had experienced previously, and that herbivory by insects and mammals was greater than anticipated. Since a large number of restoration and mitigation oak plantings have been established in the past decade throughout the state in response to perceived oak regeneration problems, we believed it likely that some of these efforts might be similarly frustrated in meeting their goals. We therefore attempted to rehabilitate our original planting, in order to evaluate readily available measures applicable to improving oak restoration efforts.

Methods

Two remedial measures were tested, both utilizing rigid plastic treeshelters (Supertubes). Both were conducted on the original planting which we deemed to be performing below expectations. This original planting was on 1.6 ha at the SFREC, on a northeast aspect at 300-m elevation. The site had been cleared with herbicides and burning in the mid-1960's. Before that time it had been oak woodland with a dense shrub component. It had been grazed by cattle continuously since 1967. The original demonstration planting, completed in 1990-91, consisted of 1440 blue oaks. Three stock types and five types of weed control

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were evaluated, and the plot was fenced to exclude cattle. Planting spots were spaced 3 m apart in 36 rows, comprising six replications. End-of-season height and survival were taken in 1991 and 1992 and tested using a split-block ANOVA, with weed control treatments as main plots and stock types as subunits. Where significant differences were found ($P \leq 0.05$), a Fisher's Least Significant Difference test was conducted ($P \leq 0.05$). *Tables 1, 2* are given here as an illustration of the status of the plot when remediation was first employed. Our decision to employ remediation was subjectively arrived at, considering repeated die-back and mortalities caused by mid-summer grasshopper (*Melanoplus devastator*) herbivory in both years. Vole-caused (*Microtus californicus*) mortalities were also extensive and seemed to be rising because of increasingly dense vegetative cover in non-herbicide treated areas and our exclusion of cattle grazing.

Table 1—Percent survival of original restoration planting after 2 years, before remediation treatments[1]

	Survival	
	1991	1992
Stock type	---- *pct* ----	
Acorns	[a]67	[a]49
Bareroot	[b]45	[b]26
3-month seedlings	[c]19	[c]14
Weed control		
None	[a]23	[a]9
Plastic mat	[ab]36	[b]23
Scalping	[c]54	[bc]32
Glyphosate once	[c]56	[d]45
Glyphosate twice	[bc]50	[cd]42
Plot pct survival	44	30

[1]Different superscript letters in Stock Type and Weed Control categories within columns indicate significant differences ($P \leq .05$) by a Fisher's Protected Least Significant Difference test.

Table 2—Average heights of the original restoration planting after 2 years, before remediation treatments[1]

	Mean height, 1992
Stock types	----- *cm* -----
Acorns	14
Bareroot	16
3-month Seedlings	18
Weed treatment	
None	[a]16
Plastic mat	[b]21
Scalping	[a]13
Glyphosate once	[a]15
Glyphosate twice	[a]16

[1]Different superscript letters in Stock Type and Weed Control categories indicate significant differences ($P \leq .05$) by a Fisher's Protected Least Significant Difference test.

The first remedial measure was a partial replanting of the least successful original treatment. Our objective was to raise our stocking level, while comparing treeshelter protected acorn and seedling replants in our predator-rich plot. Sixty pre-germinated blue oak acorns and 60 3-month-old seedlings from the same source were planted in January and March of 1993 into the same spots where there had been no initial weed control and almost complete seedling mortality. Ten acorns and 10 seedlings were planted into each of the six replications that had been controls in our previously designed restoration study. All plantings were protected with a 1.2-m (4-ft) plastic treeshelter sunk 8-10 cm into the soil. Glyphosate (1.5 percent) was sprayed in a 1-m radius around each treeshelter. Spraying was repeated in spring of 1994 and 1995. We assessed height and survival annually. Differences in survival and height between stock types were tested with a one-way analysis of variance (rejection level, $P \leq 0.05$).

The second remediation tested whether better performance of surviving seedlings from the original planting could be stimulated by the addition of treeshelter protection. Eighty-three pairs of survivors were matched by replication, treatment group, proximity to one another within the replication, and height. In spring 1993, one of each of the 83 pairs was randomly selected and fitted with a treeshelter; the other was left unprotected. Average height of the two groups was nearly the same at this time (protected group 17 cm, unprotected 16 cm). Each pair continued to receive the weed treatment it originally had been assigned. Treatments were maintained for 3 years, and height and survival were assessed annually. Heights of stems were found to be normally distributed using the Wilk-Shapiro statistic and were then tested with a paired *t*-test (rejection level, $P \leq 0.05$). A chi-square test for independence was used to evaluate the differences in numbers of survivors from the protected and unprotected groups in each of the 3 years.

Each year, heights were measured to the maximum height reached that season. For seedlings greatly damaged by voles or grasshoppers, mainly those unprotected, this gave the most optimistic estimate of their potential for future growth, since many of these plants were so badly damaged that they would resprout only from the root crown in succeeding years. Similarly, survival was assessed in the most optimistic manner. Survival for 1995 could only be truly determined by resprouting in spring 1996 (which is yet to come), so survival was assumed for all plants whose status was questionable at this time.

Results

After 3 years, average height of replanted acorns and seedlings had exceeded the original planting (*table 3*), though the latter group had 2 more years of field

Table 3–Average height and survival of acorn and seedling replants after 3 years, compared to unremediated original planting[1]

	Mean height			Survival		
	1993	1994	1995	1993	1994	1995
		cm			*pct*	
Original plot	17	20	19	16	16	16
Acorn replants	91	133	141	[a]78	[a]80	75
Seedling replants	91	140	141	[b]95	[b]93	88
P-values, ANOVA	0.96	0.27	0.99	0.01	0.03	0.06

[1]Different superscript letters indicate significant differences ($P < .05$) for acorn and seedling replants by a one-way ANOVA performed on acorns and seedlings for each year. Original plot averages were not part of this test.

growth. Average height of replants (141 cm) was more than seven times greater than the original planting (19 cm). There were no significant differences between heights of acorn or seedling replants, and after 3 years they had identical average heights. While seedlings had statistically significant higher survival (88 percent) than direct seeded acorns (75 percent), both of these protected replants exceeded the original planting, which had stabilized at 16 percent survival.

The original restoration planting continued to be attacked by both voles and grasshoppers. Forty-four percent of these unprotected seedlings showed severe damage clearly attributable to voles, and this did not include those plants clipped off entirely (an ambiguous sign of vole predation), for which no sure cause of damage was evident. None of the protected replants received vole damage, but all that grew above the 1.2-m treeshelter height were annually defoliated by grasshoppers. While apparently severe, this defoliation was followed by refoliation generally within 2 months. In 1995, for example, all plants were stripped of their leaves between August 1 and August 22. During October, they refoliated and even experienced some late season growth flushes. Few of the unprotected plants of the original planting, which were attacked with equal severity, refoliated in this manner.

In our second remediation, evaluating protected versus unprotected pairs, there were clear benefits of treeshelter protection. Height and survival differences between pairs were highly significant for all 3 years ($P < 0.001$). Mean height of the unprotected group increased only slightly in the first season (average height at start = 16 cm), while their protected counterparts (average height at start = 17 cm) showed more than a three-fold increase in height (*table 4*). After 3 years, unprotected seedlings had not quite doubled in height, while protected ones had grown more than seven times taller than their initial height.

Table 4—Average height and survival after 3 years for pairs of survivors of original restoration planting with and without retrofitted treeshelter protection

	Mean height			Survival		
	1993	1994	1995	1993	1994	1995
		cm			*pct*	
Unprotected (n=83)	20	29	28	87	77	76
Protected (n=83)	60	98	130	100	99	98
P-values[1]	<0.0001	<0.0001	<0.0001	0.0006	<0.0001	0.0001

[1]P-values for height in each year resulted from paired t-tests; P-values for survival resulted from Chi-Square tests on numbers of survivors.

Survival in the unprotected group continued to decline, but not dramatically. Even so, 98 percent of protected plants survived, while 76 percent (best case) of the unprotected survived after 3 years. According to our chi-square analysis, these were highly significant differences. By the third year of this study, no protected plants showed signs of vole predation, while 23 percent of those unprotected showed definite signs of vole damage or mortality. Grasshopper defoliation and subsequent refoliation were similar to the replanting remediation above.

Discussion

Since the early 1980's, evidence has been mounting for the use of treeshelters to increase growth and survival of oaks. Windell's (1992) review of the literature and reprinting of some of the early research papers reports overall beneficial results for a number of British and eastern U.S. oak species. Our results concur with these generally positive findings, but the California experience does not present a uniform picture. Enhanced height growth and survival of blue oaks grown in treeshelters at the Sierra Foothill Research and Extension Center (McCreary and Tecklin 1993; McCreary and Tecklin, these proceedings), which inspired the use of these devices to rehabilitate our demonstration planting, have not been duplicated at the Hopland Center (Costello and others 1991, 1996). In that north coastal California setting, blue oaks grew and survived better in treeshelters only if irrigated, and valley oaks responded more favorably than blue oaks. Plumb and DeLasaux (these proceedings) in central-coastal California, moreover, found that treeshelters enhanced height growth of coast live oak (*Quercus agrifolia*), but not survival, probably due to micro-climate-induced pest problems inside the shelters. It remains to be clarified if these are regional, specific, or other differences.

In replanting our plot with treeshelter-protected acorns and seedlings, we attempted to overcome what we perceived to be a vole predation problem in the densest cover on our plot where there was almost complete initial seedling mortality. The simple technique of sinking the treeshelters 8-10 cm into the soil was meant to inhibit vole access. This technique seems to have succeeded, but the rapid height growth and improved survival that we report in this remediation could be confounded by the weed treatment they received and may not be solely attributable to a treeshelter effect. In the case of our treeshelter retrofitted pairs, however, plants tested were from all weed treatments and stock types, although a smaller sampling was from the least effective weed treatments. We are, thus, more confident in ascribing the improved height growth and survival the first year after treatment and thereafter to treeshelters. We were never able to achieve comparable height growth among unprotected plants elsewhere in the plot, even with thorough weed control treatment.

The complete absence of vole predation of our protected replants is consistent with the experience of others who have tested treeshelters as effective protection against voles (Davies and Pepper 1989). Though treeshelters did not completely protect seedlings against grasshopper defoliation, there was a difference in the severity of attack on protected and unprotected plants. Unprotected plants were vulnerable to defoliation, regardless of age or height. Young, thin stems were often girdled, at best setting growth back to root crown level. So long as protected plants were below the tops of their treeshelters, they were rarely defoliated by grasshoppers. Once they over-topped their treeshelters as older, thicker-barked plants, they may have been more resistant to severe grasshopper damage, and thus refoliated quickly, as was observed.

Retrofitting treeshelters onto surviving oaks in restoration plantings offers possibilities for improving the performance of these seedlings that have been able to overcome the often unpredictable environmental challenges of the planting site. Such seedlings are a valuable resource for successful restoration, and our results indicate it is possible to release them from a stunted condition. We are aware of only two other studies that retrofitted survivor seedlings, but these were carried out on eastern U.S. and British species. One reported a doubling of height after one year (Myers and others 1991), and the other showed a four-fold increase after 2 years (Tuley 1985). Both are consistent with our findings.

Under adverse natural conditions, blue oak seedlings often persist for many years, perhaps as advance regeneration, but exhibit little height growth and finally die (Allen-Diaz and Bartolome 1992, Swiecki and others 1991). While numerous seedlings can be found on most sites, it is common to find sites lacking sapling-sized blue oaks, or with low sapling-to-tree ratios (Bolsinger 1988, Muick and Bartolome 1987, Swiecki and Bernhardt 1993). Could natural regeneration be enhanced with treeshelters, as our study indicates is possible with planted stock? Where this has been tried with northern red oak (*Quercus rubra*), the results were not promising (Walters 1991), but we have yet to evaluate how naturally recruited blue oak seedlings in California might respond.

Conclusions

Extensive planting of oaks is recent to California: most projects are no more than 5 years old. There are published accounts of successful larger-scale establishment of oaks (Bernhardt and Swiecki 1991, Griggs, Costello and others, both in these proceedings), but assessment of the long-term success of artificial regeneration of oaks in California continues. Accounts of the eastern U.S. experience (Lorimer 1993, Pope 1993) should alert us to expect some failures in these efforts.

Should oak restoration projects fall short of their objectives, restorationists should consider retrofitting survivors or replants with treeshelters. The price of treeshelters has decreased; a 1.2-m treeshelter currently costs less than $2. They are proving to be effective protection of trees from rodents, a consideration on most sites. In addition, seedlings in shelters grow far more rapidly, and it is much easier to spray herbicides around protected seedlings for weed control. They may not be the "silver bullet" for oak restoration, but further use of these devices will give us a better idea of their utility for California conditions. Further experiments should also test their applicability in growing seedlings, both planted and of natural occurrence, to the sapling stage, a vexing problem in California.

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Monitoring Land Cover Changes in California

California Land Cover Mapping and Monitoring Program

Northeastern California Project Area

January 2002

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ABSTRACT

This report summarizes vegetation change statistics between 1991 and 1996 for the Northeastern California project area. This area covers all of Amador, Butte, El Dorado, Lassen, Modoc, Nevada, Placer, Plumas, Sierra, Sutter, Yolo and Yuba counties; and partially covers Alpine, Colusa, Glenn, Lake, Napa, Sacramento, Shasta, Siskiyou, Solano and Tehama counties. Data are generated from the California Land Cover Mapping and Monitoring Program (LCMMP). This program uses Landsat Thematic Mapper (TM) satellite imagery to map vegetation and derive land cover change (losses and gains) within five-year time periods. This program also determines the cause of land cover change. The statistical tables provide estimates of land cover change by lifeform type, Wildlife Habitat Relationships System (WHR) type, ownership and cause.

For more information about the LCMMP, or to download data and maps visit our webpage at http://frap.cdf.ca.gov/projects/land_cover/index.html.

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SUMMARY AND HIGHLIGHTS

The Northeastern California project area covers approximately 18.7 million acres including all of Amador, Butte, El Dorado, Lassen, Modoc, Nevada, Placer, Plumas, Sierra, Sutter, Yolo and Yuba counties, and partially includes Alpine, Colusa, Glenn, Lake, Napa, Sacramento, Shasta, Siskiyou, Solano and Tehama counties. It encompasses six national forests (Eldorado, Tahoe, Lake Tahoe Basin Management Unit, Plumas, Lassen and Modoc) and other federal, state and privately owned lands. This report assesses land cover changes on 14.8 million acres within conifer, hardwood, shrub, chaparral and grass vegetation types. Although the total project area spans 18.7 million acres of land, 3.9 million acres are not forest, shrub, chaparral or grass lands (e.g., urban, agriculture and water).

Changes in land cover are generated from the California Land Cover Mapping and Monitoring Program (LCMMP) using Landsat Thematic Mapper satellite imagery, which has a spatial resolution of 30 meters^2. For the Northeastern California project area, changes are determined between 1991 and 1996. Changes in land cover range from little or no change to small, moderate and large gains and losses. The causes of change are also determined for change areas. The monitoring data is very reliable, with an overall accuracy of 89%.

All Vegetation

- Results indicate that 93% of the total project area (14.8 million acres) did not show a change between 1991 and 1996.
- Decreases in cover for all vegetation types totaled approximately 475,000 acres or 3%, and increases totaled 570,000 acres or 4%.
- Hardwoods registered approximately the same amount of cover decrease and increase at 2% each.
- Conifers registered approximately the same amount of cover decrease and increase at 4% each.

Hardwoods

- For the hardwoods, approximately 45,000 acres (2%) show a decrease in cover and 46,000 acres (2%) show an increase, with the majority of decrease and increase falling within private ownership.
- The montane hardwood type experienced a decrease in cover on 22,185 acres (4%) and an increase in cover on 22,729 acres (4%).
- Wildfire accounts for the largest amount of hardwood change within the project area.

County Highlights

- All counties except Nevada have a greater acreage of hardwood cover decrease than increase.
- Shasta County has the greatest amount of total hardwood cover decrease at 11,568 acres (4% of its area), with most decrease occurring in blue oak woodland (5,330 acres).
- Harvesting and wildfire are the dominant causes of hardwood change in Shasta County.
- Wildfire is the largest cause of hardwood change in Tehama County.

National Forest Highlights

- The Lassen National Forest has the largest acreage of hardwood change with 2,747 acres (7%) of hardwood cover decrease and 2,662 (7%) acres of hardwood cover increase.
- Wildfire is the largest cause of hardwood change on national forest lands.

Conifers

- For conifers, approximately 360,000 acres (5%) show a decrease in cover and 263,000 acres (4%) show an increase, with the majority of decrease falling within private ownership and the majority of increase falling within public ownership.
- The Sierran mixed conifer class exhibits the largest change of all conifer types with a decrease in cover on 237,869 acres (8%) and an increase in cover on 167,120 acres (5%).
- Harvesting accounts for most of the conifer change followed by wildfire and regeneration.

County Highlights

- All counties except Tehama have a have a greater acreage of conifer cover decrease than increase.
- Modoc County has about six times more decrease than increase with most in the eastside pine and Sierran mixed conifer types.
- Wildfire is the largest cause of conifer change in Shasta County.
- Harvesting is the largest cause of change in Lassen County.
- Regeneration is largest in Plumas County and development is largest in Butte County.

National Forest Highlights

- All national forests except the Plumas and Lake Tahoe Basin have a greater acreage of conifer cover decrease that increase.
- The Lassen National Forest has the largest acreage of conifer cover decrease at 44,393 acres.
- Regeneration is the largest verified change on national forest lands followed by wildfire and harvesting.

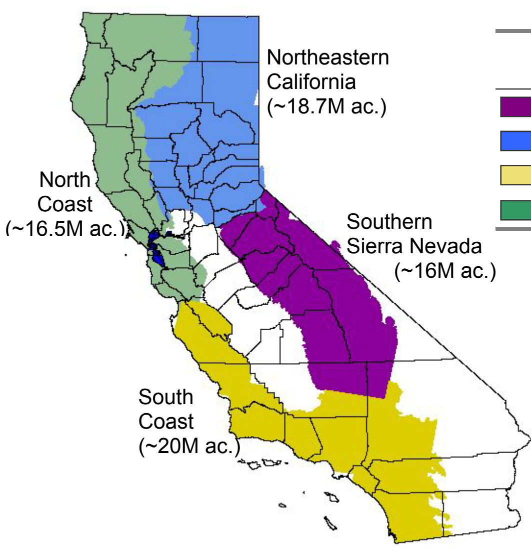
Shrub/Chaparral

- Shrub and chaparral change within the project area totals approximately 50,000 acres decrease (1%) and 180,000 acres increase (4%), with the majority occurring in private ownership.
- The sagebrush type experienced the largest amount of change with 17,814 acres (1%) showing a decrease in cover and 64,889 acres (3%) showing an increase in cover.
- Modoc County has the greatest shrub and chaparral cover decrease with most in the sagebrush and montane chaparral types.
- Wildfire accounts for the largest amount of shrub and chaparral change, with most in private ownership.

INTRODUCTION

The California Land Cover Mapping and Monitoring Program (LCMMP[*]) is a collaboration between the USDA Forest Service (FS) and the California Department of Forestry and Fire Protection (CDF) to create seamless vegetation and monitoring data across all ownerships and vegetation types within the state. This program uses Landsat Thematic Mapper (TM) satellite imagery to derive land cover change (losses and gains) within five-year time periods. It also determines the cause of change through fieldwork, aerial photo interpretation and GIS analysis. Monitoring data created by the LCMMP quantify changes in California's landscape and provide necessary information for regional assessment across jurisdictional boundaries. These data provide consistent, high quality information to manage, assess and protect California's diverse vegetation resources at a low per acre cost (2 cents per acre).

Monitoring vegetation change for the first statewide cycle occurs in one of four unique project areas per year (Figure 1) and will revisit each project area during the second cycle. Analysis is complete for all project areas in the first cycle. Reporting is also complete or in progress for these areas.



Project Area	Image Dates (approximate)	Change Data Complete
Southern Sierra	1990 to 1995	1996
Northeastern CA	1991 to 1996	1997
South Coast	1993 to 1997	1999
North Coast	1994 to 1998	2000

Figure 1. Location and extent of project areas with monitoring schedule.

The FS and CDF have vegetation mapping, resource management and resource protection responsibilities across much of the non-irrigated land in Northeastern California. The FS manages most resource activities within the national forests, such as timber management, forest health programs, fire protection, and grazing allotments. Permittees and state collaborators manage developed recreational areas and some fish and wildlife habitat projects on national forest lands. CDF owns and manages a 10,000-acre demonstration forest within the Northeastern California project area, is responsible for providing fire protection on most private and state lands, regulates timber harvesting on private lands and monitors resource conditions across all wildlands in the area. Monitoring information provides a single consistent source of

[*] For additional information visit our web pages at http://frap.cdf.ca.gov/projects/land_cover/index.html

current landscape level and site-specific change to both the FS and CDF as well as other interested federal (e.g., Fish and Wildlife Service, National Park Service, Bureau of Land Management), state (e.g., Fish and Game, Parks and Recreation, State Water Resources Control Board), county and city governments and other interested parties.

The Northeastern California project area covers approximately 18.7 million acres (Figure 2). This area covers all of Amador, Butte, El Dorado, Lassen, Modoc, Nevada, Placer, Plumas, Sierra, Sutter, Yolo and Yuba counties, and partially covers Alpine, Colusa, Glenn, Lake, Napa, Sacramento, Shasta, Siskiyou, Solano and Tehama counties. It encompasses six national forests (Eldorado, Tahoe, Lake Tahoe Basin Management Unit, Plumas, Lassen and Modoc) and other federal, state and privately owned lands (Figure 3).

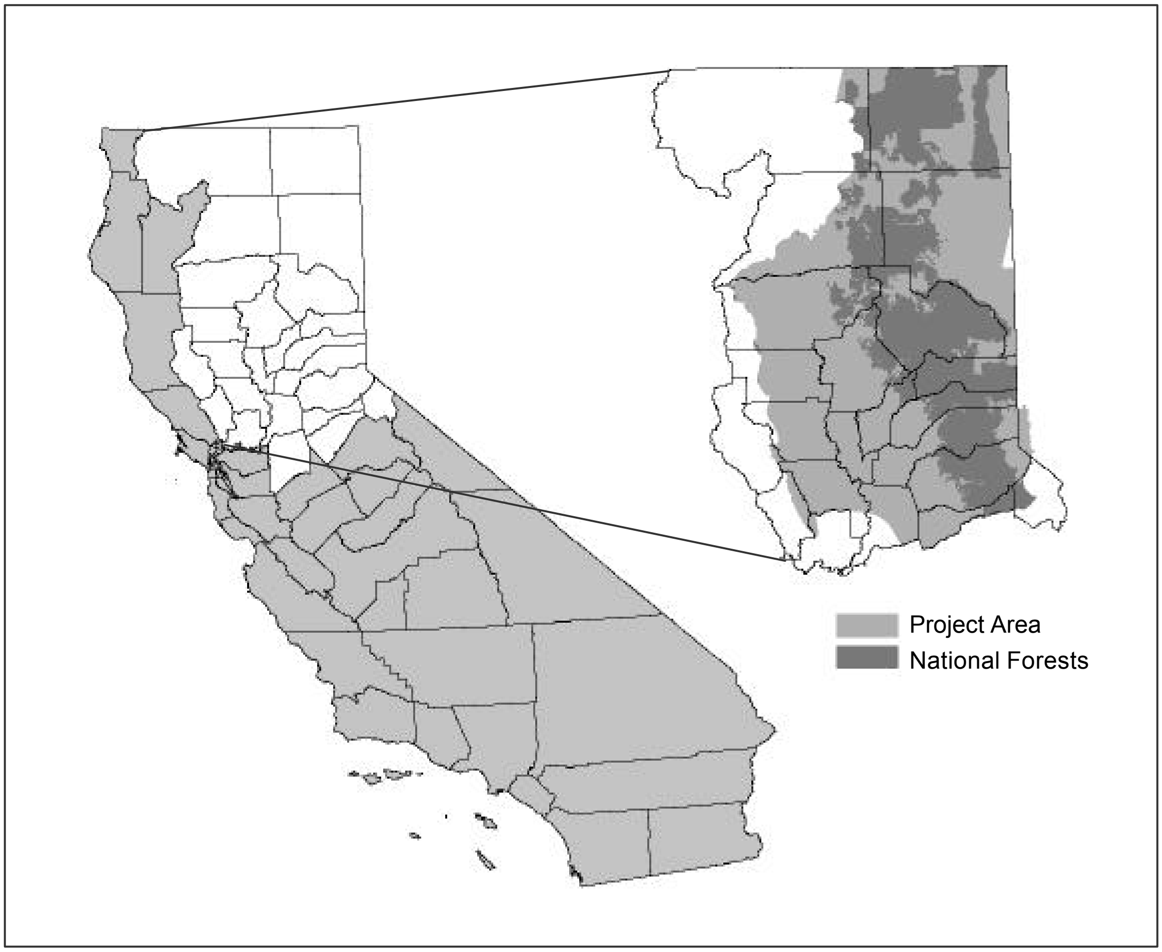


Figure 2. Location of the Northeastern California Project Area.

Table 1 shows the distribution of county acres within the project area. All counties, including those with only partial coverage, are analyzed in this report. Portions of national forests along the project area boundary are excluded in the discussion and analysis of this report since they are included in their entirety in other project areas. Those excluded include the Mendocino, Shasta-Trinity, Klamath, Stanislaus and Toiyabe.

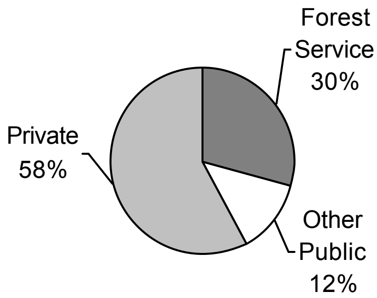


Figure 3. Ownership distribution.

This report assesses land cover changes on 14.8 million acres within conifer, hardwood, shrub, chaparral and grass vegetation types. Although the total project area spans 18.7 million acres of land, 3.9 million acres are not forest, shrub, chaparral or grass lands (e.g., urban, agriculture and water).

Table 1. Proportion of Public and Private Ownership by County within Project Area

COUNTY	PRIVATE	PUBLIC	TOTAL COVERED	
	Acres	Acres	Acres	%
Alpine	5,345	71,729	77,074	16
Amador	294,640	87,311	381,951	100
Butte	881,665	191,044	1,072,709	100
Colusa	594,931	30,348	625,279	85
El Dorado	609,822	535,988	1,145,810	100
Glenn	585,809	21,214	607,023	72
Lake	8,185	14,659	22,844	3
Lassen	1,171,218	1,780,779	2,951,996	100
Modoc	966,555	1,720,853	2,687,407	100
Napa	65,645	31,693	97,337	19
Nevada	423,053	200,199	623,252	100
Placer	592,762	367,515	960,277	100
Plumas	496,032	1,177,675	1,673,707	100
Sacramento	398,199	13,043	411,241	65
Shasta	918,564	438,152	1,356,716	55
Sierra	183,227	432,357	615,584	100
Siskiyou	78,170	266,859	345,029	8
Solano	22,369	2,937	25,306	4
Sutter	385,798	3,497	389,294	100
Tehama	1,311,378	282,469	1,593,847	84
Yolo	542,032	29,921	571,953	100
Yuba	326,227	85,750	411,977	100

MONITORING PROCEDURES

The LCMMP uses two dates of TM imagery to derive land cover changes. (Refer to Appendix A for a complete list of data sources). A difference in spectral reflectance (the amount of sunlight reflected from surface features to the satellite in space) between these image dates indicates where change probably occurred. The change detection process interprets these spectral reflectance differences and produces an image depicting various levels of vegetation change. (Refer to Appendix B for a complete methodological description). These levels range from little or no vegetation cover change to large, moderate and small increases and decreases in vegetation cover (Figure 4).

Comparing 300 randomly selected change areas with known reference information of the same areas assesses the accuracy of the change map. The overall accuracy of the change map is 89.3%. This means that of the 300 sample sites, 268 were correctly classified. Areas classified as a decrease were always a decrease, although the correct class was not always assigned. The same is true for the areas classified as an increase. Refer to Appendix C for more details on accuracy assessment procedures.

The causes of change are determined through GIS overlay, fieldwork and photo interpretation. The CDF forest practices database, the FS stand record system database and the CDF fire history database are overlaid onto the change map to attribute changes caused by harvests, regeneration and wildfires (Figure 5). FS resource managers interpret change maps by applying local knowledge and fieldwork to identify sources of change on national forest lands. Similarly, UC Integrated Hardwood Rangeland Management Program (IHRMP) personnel consult private landowners to identify sources of change in hardwood rangelands.

INTERPRETING RESULTS

Vegetation cover increase and decrease represent vegetated areas (e.g., hardwood, conifer, shrub, etc.) that underwent some form of change between image dates. For hardwood and conifer types, the increase and decrease relates to changes in canopy cover. For shrub, chaparral and grass types, the change relates to ground cover. The little or no change class indicates that change within the existing vegetation is either nonexistent or too subtle for the methods to detect. Vegetation changes in conifer types will not always capture change in total biomass or seral stage once full crown cover is achieved. Also, vegetation cover increase, particularly a small increase, does not necessarily represent a gain in canopy or extent of a specific vegetation type. In some cases the increase represents understory regrowth, seasonal variation, or succession following a disturbance. The hardwood, shrub and chaparral types with low canopy cover are particularly sensitive to this phenomenon due to the presence of understory grasses and forbs within these types.

Vegetation change measured by canopy cover within the conifer types is not proportional to change in conifer volume measured by the size and number of trees. Essentially all canopy reductions, whether from clear cuts, selective harvests or wildfires, are captured by the change data, while only the first decade of regrowth after a disturbance is captured. The differences can be seen in Figure 5 where all the timber harvest units are captured as decreases while increases in canopy cover are only captured for the most recent plantations. In fact all the remaining forests in the photo grew substantially during the 1991 to 1996 period. Based on regional timber inventory data developed by the USFS Forest Inventory Analysis (FIA), these other sites probably increased total volume by at least ten percent over the five-year period (Waddell and Bassett, 1997 a,b). Since there was not a significant change in canopy cover on these sites, they were not recorded as conifer canopy increases. A thorough analysis of changes in conifer forest requires the use of the spatially explicit changes in canopy cover described here combined with the statistically developed regional measurements of changes in forest inventories from the USFS FIA or private land owners.

Results are particularly difficult to interpret for brushland types. Land uses that cause type conversion from brushlands (e.g. development) are most likely to result in detectable levels of vegetation change. Disturbances that do not result in type conversion (e.g., changes in grazing

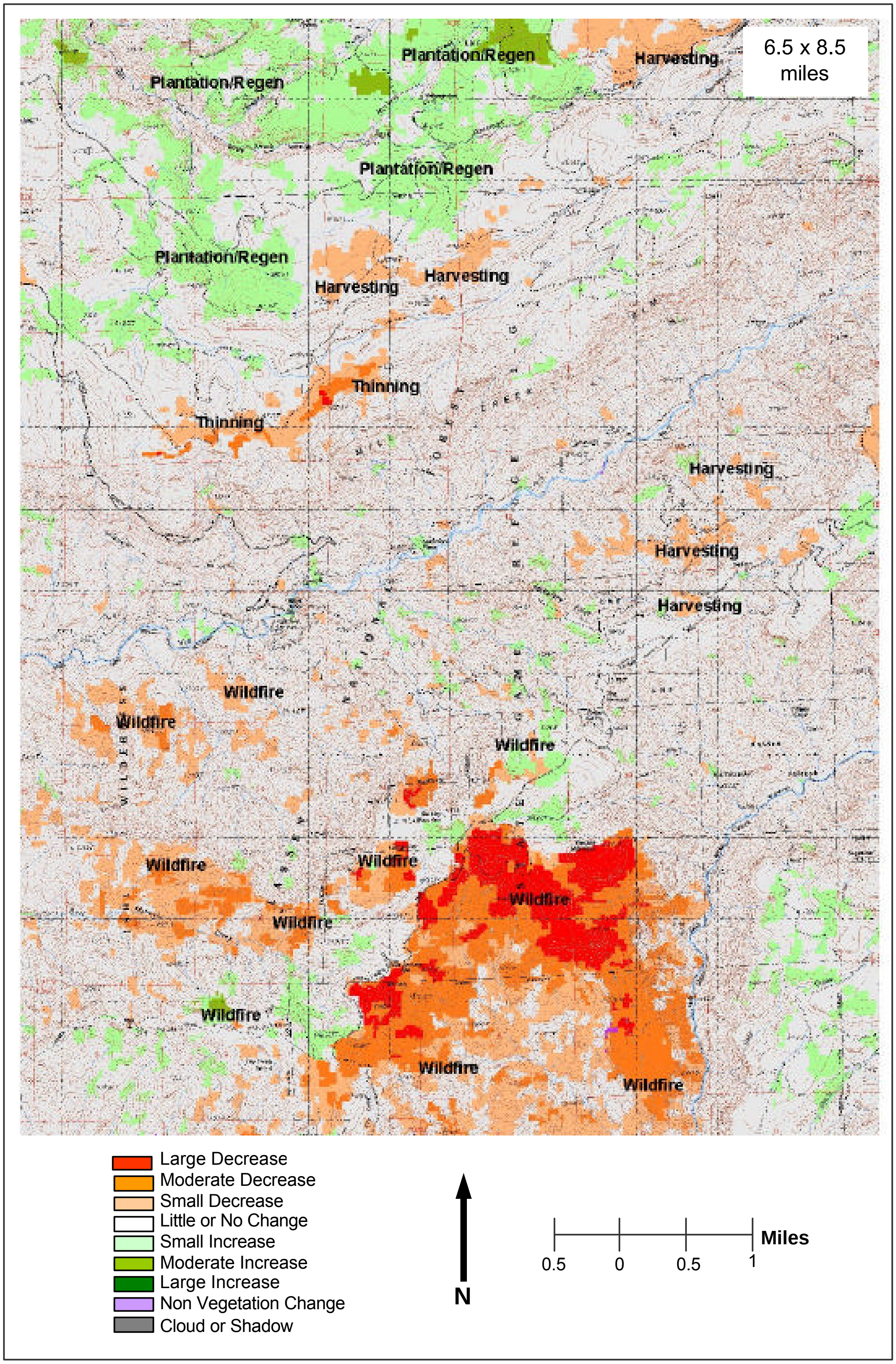


Figure 4. Portion of change map with verified cause in the Barkley Mountain quadrangle, Lassen National Forest.

- Background image is a 1:15,840 aerial photograph.
- Orange crosshatched polygons indicate a decrease in vegetation cover.
- Green crosshatched polygons indicate an increase in vegetation cover.
- Letters represent silvicultural systems:
  CC clearcut
  AP alternative prescription
  P plantation
- White line is a Timber Harvesting Plan boundary.

Figure 5. Portion of change map on aerial photograph showing change areas compared with known harvest activities.

intensity) may escape detection. For example, Figure 6 shows two fires that burned chaparral dominated areas in 1990. The monitoring process detected regrowth in the northernmost fire, but not in the southernmost. Complex interactions between factors such as site quality, vegetation composition and structure, and fire intensity determine conditions at the two monitoring dates, and thus whether a change can be detected. Additional research is needed to explore potential improvements in the methodology for monitoring brushlands

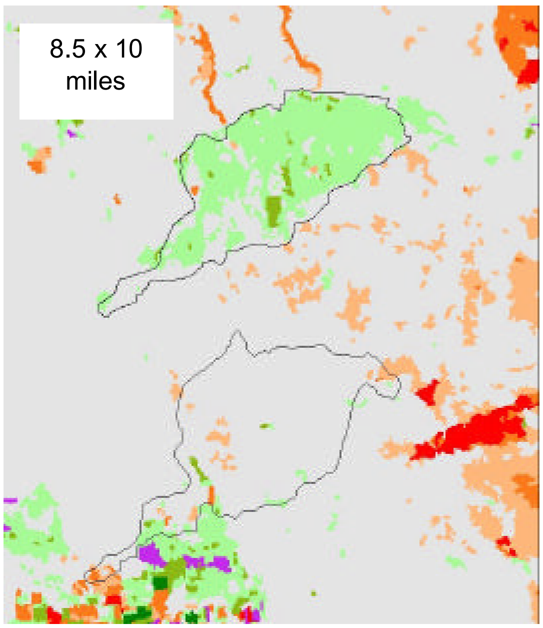


Figure 6. Comparison of two fires that burned in chaparral dominated areas.

When interpreting results by cause it is important to note that some ancillary data sources are more complete than others. Change caused by wildfire is easily verified because the FS and CDF maintain a comprehensive fire perimeter data layer. Harvesting and regeneration on national forest lands is also easily captured using the FS stand record data. Other sources of change are more difficult to verify as data is unavailable and fieldwork cannot be exhaustive.

The interaction between change classes and cause are complex. Wildfire and harvest are mainly responsible for vegetation cover decrease; however, they can represent increase in cover. For example, if the fire or harvest occurred prior to the first imagery date the area will show vegetation regrowth. Regeneration usually produces an increase in vegetation cover except when some form of management (e.g., herbicide spray and manual vegetation release) creates a loss in vegetation within a plantation. Some causes may be detected as having an increase in vegetation cover even though their effect is actually a loss in vegetation cover. Development can have this effect when a dry area is developed and irrigation of lawns and landscaping creates a detected vegetation cover increase. Seasonal changes can be a decrease or increase, particularly within areas that have a large grass understory such as, hardwood rangelands and shrub areas. This cause reflects different amounts of moisture in the vegetation and usually does not alter the vegetation composition.

DISCUSSION OF RESULTS

All Vegetation

Approximately 93% of the 14.8 million acres within the project area showed no change between 1991 and 1996. Decreases in vegetation cover totaled approximately 3% and increases 4%. Most of these vegetation cover changes are in the small decrease and small increase change classes. Small vegetation cover decreases have roughly three times the acreage of the moderate and large decreases combined, and small vegetation cover increases have roughly eight times the acreage of the moderate and large increases combined.

The conifer type has the greatest acreage amount of change, with most in the small decrease and small increase change classes. The conifer type also has the most acreage in the large and moderate decrease classes compared to the other lifeform types. The hardwood type registers approximately the same amount of total decrease and increase. Increases in the shrub, chaparral and grass lifeform type are much larger that the decreases. Overall, changes are occurring in small degrees throughout the project area relative to total acres per lifeform class.

Hardwood

Within the project area, hardwood vegetation types total approximately 2.4 million acres. Blue oak, blue oak / foothill pine and montane hardwood types cover most of this area (96%) and contain the greatest amount of change. Hardwood change within the project area totals 2% decrease and 2% increase, with the majority falling within private ownership (Table 2). Most of this change occurs in the small decrease and increase classes.

Table 2. Acres of Hardwood Change by Ownership

Ownership	Hardwood Acreage	Acres with Decrease	Acres with Increase
Forest Service	213,081	4,638	6,103
Other Public	171,595	1,635	5,058
Private	2,041,071	39,303	35,442
All Owners	**2,425,747**	**45,576**	**46,603**

Hardwood cover changes are greatest in the montane hardwood type. This hardwood type has a decrease in cover on 22,185 acres and an increase in cover on 22,729 acres. These acreages represent about 4% of the montane hardwood area. Blue oak woodland exhibits a similar pattern with more acres increasing than decreasing, while blue oak / foothill pine shows more decrease than increase in cover (approximately three times more decrease).

Cause of hardwood change is verified on 41,453 acres, or 43% of the total hardwood area that has some form of change. Wildfire accounts for the largest amount of change across this area, with most occurring within private ownership (Table 3). Seasonal change, harvest and development are also large contributors to hardwood change.

Table 3. Percentage of Verified Hardwood Change by Ownership

Ownership	Verified Acres	Wildfire %	Harvest %	Development %	Regeneration %	Thinning %	Seasonal %
Forest Service	6,429	71	5	0	12	0	11
Other Public	3,289	47	1	4	1	1	46
Private	31,735	45	15	8	4	5	18
All Owners	**41,453**	**49**	**12**	**7**	**5**	**4**	**19**

All counties, except Lassen, Modoc, Nevada, Plumas and Yuba have a greater acreage of hardwood cover decrease than increase (Table 4). Shasta County has the greatest acreage amount of hardwood cover decrease at 11,568 acres (4% of its area), with most decrease occurring in blue oak woodland (5,330 acres). Tehama County follows with 10,634 acres of hardwood cover decrease (2% of its area) then Butte, El Dorado, Nevada, Placer and Amador counties. Hardwood cover decrease within blue oak woodland and blue oak / foothill pine is also greatest in Shasta County, while montane hardwood cover decrease is greatest in El Dorado County. Tehama County has the greatest acreage of total hardwood cover increase (9,394 acres), with most occurring in blue oak woodland.

Table 4. Acres of Hardwood Change by County

County	Decrease in Veg.	% Decrease	Increase in Veg.	% Increase	Total Change	Total % Change
Amador	1,670	1	242	0	1,912	1
Butte	5,301	2	5,100	2	10,401	4
El Dorado	4,422	2	986	0	5,408	2
Lassen	1,239	9	1,502	11	2,741	21
Modoc	519	7	1,109	15	1,628	22
Nevada	3,413	2	5,652	3	9,065	5
Placer	2,377	1	1,982	1	4,359	2
Plumas	595	1	2,432	4	3,027	5
Shasta	11,568	4	3,226	1	14,794	5
Tehama	10,634	2	9,394	2	20,028	4
Yuba	1,495	1	2,889	2	4,384	4
Total	**43,233**	**2**	**34,514**	**2**	**77,747**	**4**

Within each county, the causes of hardwood change vary (Table 5). Wildfire is the largest cause of hardwood change in Eldorado, Nevada and Tehama counties. Harvesting is the largest cause of hardwood change in Amador, Butte, Shasta and Yuba counties.

Table 5. Acres of Verified Hardwood Change by Cause and County

County	Wildfire	Prescribed Fire	Harvest	Mortality	Development	Regeneration	Total
Amador	93	253	258	81	231	0	916
Butte	543	273	1,246	0	587	642	3,291
El Dorado	632	0	313	0	393	102	1,440
Lassen	0	0	0	0	0	0	0
Modoc	66	0	10	0	0	0	76
Nevada	3,695	0	259	0	170	372	4,496
Placer	21	0	249	0	11	256	537
Plumas	37	0	99	0	0	325	461
Shasta	2,530	135	3,998	0	530	397	7,590
Tehama	9,136	0	231	0	415	0	9,782
Yuba	34	0	225	0	43	143	445
Total	**16,787**	**661**	**6,888**	**81**	**2,380**	**2,237**	**29,034**

The Lassen National Forest (NF) has the most acreage of hardwood cover decrease at 2,747 acres or 7% of its hardwood area and increase at 2,662 acre or 7% (Table 6). The Plumas NF also has a large amount of hardwood cover increase at 1,843 acres (2% of its area).

Table 6. Acres of Hardwood Change by National Forest

Forest	Decrease in Veg.	% Decrease	Increase in Veg.	% Increase	Total Change	Total % Change
Eldorado	134	1	24	0	158	2
LTBMU	30	4	170	24	200	29
Lassen	2,747	7	2,662	7	5,409	13
Modoc	64	1	904	17	968	18
Plumas	573	1	1,843	2	2,416	3
Tahoe	909	1	374	1	1,283	2
Total	**4,457**	**2**	**5,977**	**3**	**10,434**	**5**

Wildfire is the largest cause of hardwood change within national forests (Table 7). The Lassen NF has the largest amount of hardwood change caused by wildfire.

Table 7. Acres of Verified Hardwood Change by Cause and National Forest

Forest	Wildfire	Prescribed Fire	Harvest	Mortality	Development	Regeneration	Total
Eldorado	18	0	9	0	0	7	34
LTBMU	0	0	0	0	0	0	0
Lassen	4,352	6	18	0	8	68	4,452
Modoc	0	0	0	0	0	0	0
Plumas	29	0	76	0	0	490	595
Tahoe	79	0	219	0	12	194	504
Total	**4,478**	**6**	**322**	**0**	**20**	**759**	**5,585**

Conifer

It is important to reiterate that vegetation change measured by canopy cover within the conifer types is not proportional to change in conifer volume measured by the size and number of trees (See the Interpreting Results section). Essentially all canopy reductions, whether from clear cuts, selective harvests or wildfires, are captured by the change data, while only the first decade of regrowth after a disturbance is captured. The differences can be seen in Figure 5 where all the timber harvest units are captured as decreases while increases in canopy cover are only captured for the most recent plantations.

Coniferous vegetation types in the project area total approximately 6.2 million acres. The distribution of conifer types varies from north to south and west to east across the project area. Sierran mixed conifer, eastside pine, juniper, ponderosa pine, red fir and Jeffrey pine cover 92% of the conifer area, with the Sierran mixed conifer type covering approximately 50% of this area.

Conifer change within the project area totals 5% decrease and 4% increase, with the majority of decrease in private ownership and the majority of increase in public ownership (Table 8). Most of the acres of change in all conifer types are in the small decrease and increase classes.

Table 8. Acres of Conifer Change by Ownership

Ownership	Conifer Acreage	Acres with Decrease	Acres with Increase
Forest Service	3,566,500	142,773	160,669
Other Public	396,934	8,721	4,338
Private	2,235,787	208,770	97,993
All Owners	**6,199,221**	**360,264**	**263,000**

The Sierran mixed conifer class exhibits the largest change among all conifer types with a decrease in cover on 237,869 acres and an increase in cover on 167,120 acres. These acreages represent an 8% decrease and a 5% increase. These large numbers reflect the extensive distribution of Sierran mixed conifer within the project area, which contains a mix of pine, fir and giant sequoia. Eastside pine has the next largest total cover decrease acreage (40,395) and Jeffrey pine the next largest total cover increase acreage (28,920). Conifer types exhibiting more acres with cover decrease than increase include, eastside pine, ponderosa pine and Sierran mixed conifer. Ponderosa pine has 5% more decrease than increase in cover, while the other types have roughly 2-3% more decrease than increase in cover.

Cause of conifer change is verified on 394,132 acres, or 63% of the total conifer area that has some form of change. Harvesting accounts for most of the verified change at 34%, followed by wildfire at 30% and regeneration at 27% (Table 9). Most harvesting occurs on private ownership while most regeneration occurs on national forests.

Table 9. Percentage of Verified Conifer Change by Ownership

Ownership	Verified Acres	Wildfire %	Harvest %	Development %	Regeneration %	Thinning %	Seasonal %
Forest Service	199,899	30	23	0	44	1	1
Other Public	3,589	25	47	0	15	3	8
Private	190,644	31	46	2	9	6	2
All Owners	**394,132**	**30**	**34**	**1**	**27**	**4**	**2**

All counties except Plumas and Tehama have a greater acreage with decrease in conifer cover than increase (Table 10). Modoc County has about six times more decrease than increase with most occurring in the eastside pine and Sierran mixed conifer types. Plumas County has about three times more increase than decrease, with most occurring in the Sierran mixed conifer type.

Table 10. Acres of Conifer Change by County

County	Decrease in Veg.	% Decrease	Increase in Veg.	% Increase	Total Change	Total % Change
Amador	3,783	4	1,795	2	5,578	5
Butte	16,128	10	11,508	7	27,636	17
El Dorado	20,408	10	7,285	4	27,693	14
Lassen	37,231	9	12,562	3	49,793	13
Modoc	23,854	9	3,054	1	26,908	10
Nevada	5,829	5	1,521	1	7,350	6
Placer	7,683	5	2,900	2	10,583	7
Plumas	13,616	5	17,939	7	31,555	12
Shasta	57,397	17	19,930	6	77,327	23
Sierra	8,312	10	2,269	3	10,581	13
Siskiyou	721	3	494	2	1,215	5
Tehama	11,208	8	16,743	11	27,951	19
Yuba	4,174	12	1,158	3	5,332	15
Total	**210,344**	**9**	**99,158**	**4**	**309,502**	**14**

Within each county, the cause of conifer change differs (Table11). Shasta County has the most verified change (72,824 acres, or 75% of changed conifer area) primarily from wildfire and harvesting. Lassen County also has much verified change (62,851 acres, or 65% of changed conifer area) caused mostly by harvesting. Regeneration is largest in Plumas County and development is largest in Butte County.

Table 11. Acres of Verified Conifer Change by Cause and County

County	Wildfire	Prescribed Fire	Harvest	Mortality	Development	Regeneration	Total
Amador	53	3	1,390	23	67	327	1,863
Butte	921	1,455	7,722	0	3,462	4,833	18,393
El Dorado	19,181	71	6,504	169	313	13,281	39,519
Lassen	6,634	0	49,589	18	0	6,610	62,851
Modoc	1,290	0	23,774	1,124	0	4,070	30,258
Nevada	551	0	2,454	0	284	6,682	9,971
Placer	546	0	3,644	51	563	6,708	11,512
Plumas	10,197	0	11,290	0	19	39,371	60,877
Shasta	41,675	0	23,930	0	69	7,150	72,824
Sierra	32,188	0	2,083	0	0	9,163	43,434
Siskiyou	0	0	1,183	0	0	614	1,797
Tehama	6,049	0	8,204	0	2	5,288	19,543
Yuba	16	0	2,674	0	1	2,400	5,091
Total	**119,301**	**1,529**	**144,441**	**1,385**	**4,780**	**106,497**	**377,933**

The Eldorado, Lassen, Modoc and Tahoe NFs have a greater acreage of conifer cover decrease than increase (Table 12). The Lassen NF has the largest acreage of conifer cover decrease at 44,393 acres (6% of its area), with most occurring in Sierran mixed conifer (28,748 acres). The Tahoe NF also has a large amount of conifer cover decrease at 36,413 acres (6% of its area), mostly in Sierran mixed conifer (28,302 acres). Conifer cover decrease in eastside pine is greatest on the Lassen and Modoc NFs, Jeffrey pine and red fir on the Tahoe NF, and ponderosa pine on the Eldorado NF.

Table 12. Acres of Conifer Change by National Forest

Forest	Decrease in Veg.	% Decrease	Increase in Veg.	% Increase	Total Change	Total % Change
Eldorado	18,331	4	16,009	3	34,340	7
LTBMU	382	0	1,018	1	1,400	1
Lassen	44,393	6	30,967	4	75,360	10
Modoc	21,176	3	9261	1	30,437	4
Plumas	16,495	2	72,008	9	88,503	11
Tahoe	36,413	6	29,517	1	65,930	7
Total	**137,190**	**4**	**158,780**	**5**	**295,970**	**8**

On NF lands, 64% of conifer change has cause verified. Regeneration is the largest verified change on NF lands (Table 13). Wildfire accounts for the most conifer cover decrease, and re-growth from harvesting or wildfire accounts for the most conifer cover increase. The Plumas NF has the most verified change, primarily from regeneration, wildfire and harvesting (52,569 acres, or 51% of changed area). The Tahoe NF has 50,904 acres (63%) of verified change primarily from wildfire and regeneration. The Lassen NF has 44,231 acres (49%) primarily from harvesting and regeneration. The Eldorado NF has 23,604 acres (66%) primarily from wildfire and regeneration. The Modoc NF has 20,977 acres (45%) primarily from harvesting and regeneration.

Table 13. Acres of Verified Conifer Change by Cause and National Forest

Forest	Wildfire	Prescribed Fire	Harvest	Mortality	Development	Regeneration	Total
Eldorado	9,213	47	2,882	25	6	11,431	23,604
LTBMU	0	0	192	0	0	0	192
Lassen	7,605	13	24,056	0	21	12,536	44,231
Modoc	501	0	13,161	503	0	6,812	20,977
Plumas	13,605	0	2,492	0	13	36,459	52,569
Tahoe	24,636	0	5,061	0	66	21,141	50,904
Total	**55,560**	**60**	**47,844**	**528**	**106**	**88,379**	**192,477**

Shrub/Chaparral

The shrub and chaparral vegetation types cover roughly 4.2 million acres within the project area. Sagebrush is the most abundant type at 2.3 million acres. Montane chaparral, mixed chaparral low sage, bitterbrush and alkali scrub cover most of the remaining area. Shrub and chaparral change within the project area totals 1% decrease and 4% increase with the majority occurring in private ownership (Table 14). Most of this change occurs in the small decrease and increase classes.

Table 14. Acres of Shrub and Chaparral Change by Ownership

Ownership	Shrub / Chaparral Acres	Acres with Decrease	Acres with Increase
Forest Service	1,394,011	16,912	38,558
Other Public	1,282,340	2,790	26,165
Private	1,521,669	31,037	115,606
All Owners	**4,198,020**	**50,739**	**180,329**

Changes in shrub and chaparral are greatest in the sagebrush type. This type experienced a decrease in cover on 17,814 acres (1% of sagebrush area) and an increase in cover on 64,889 acres (3% of sagebrush area). The montane chaparral type had a decrease in cover on 3% of its area and an increase in cover on 7% of its area, and the mixed chaparral type had a decrease in cover on 2% and an increase on 6% of its area. The remaining shrub and chaparral types have considerably more cover increase than decrease.

Cause of shrub and chaparral change is verified on 110, 637 acres (43%) of the total shrub and chaparral area that registered some form of change (Table 15). Wildfire accounts for the largest amount of change, with most in private ownership. Seasonal change also accounts for much of the total verified change within these cover types.

Table 15. Percentage of Verified Shrub and Chaparral Change by Ownership

Ownership	Verified Acres	Wildfire %	Harvest %	Development %	Regeneration %	Seasonal %
Forest Service	29,627	56	5	0	24	15
Other Public	10,631	24	1	0	3	72
Private	70,379	34	12	1	19	29
All Owners	**110,637**	**39**	**9**	**1**	**19**	**30**

All counties except Shasta and Sierra have a larger acreage of shrub and chaparral cover increase than decrease (Table 16). Lassen County has the most acreage of shrub and chaparral cover increase with most occurring in the sagebrush type. Modoc County has the largest acreage of shrub and chaparral cover decrease with most in the sagebrush and montane chaparral types.

Table 16. Acres of Shrub and Chaparral Change by County

County	Decrease in Veg.	% Decrease	Increase in Veg.	% Increase	Total Change	Total % Change
Butte	1,658	3	4,430	8	6,088	10
Lassen	5,978	0	51,356	3	57,334	4
Modoc	14,237	2	20,963	3	35,200	4
Plumas	3,953	1	15,451	5	19,404	6
Shasta	11,537	6	6,849	3	18,386	9
Sierra	8,589	6	3,748	3	12,337	9
Tehama	1,403	1	12,884	12	14,287	13
Total	**47,355**	**2**	**115,681**	**4**	**163,036**	**5**

Wildfire is the largest cause of shrub and chaparral change in Lassen, Shasta, Sierra and Tehama counties (Table 17). Regeneration accounts for the most change in Butte, Modoc and Plumas counties. Harvesting accounts for shrub and chaparral change in all counties, but is only a large component in Modoc County.

On all NF lands the acreage of shrub and chaparral cover increase (30,539 acres) is greater than the acreage of cover decrease (14,267 acres) (Table 18). The Tahoe NF has the most shrub and chaparral cover decrease (most in the mixed chaparral type) and the Plumas NF has the most cover increase (primarily in the montane chaparral type).

Table 17. Acres of Verified Shrub and Chaparral Change by Cause and County

County	Wildfire	Prescribed Fire	Harvest	Mortality	Development	Regeneration	Total
Butte	175	210	681	0	340	1,434	2,840
Lassen	1,989	0	975	0	0	1,074	4,038
Modoc	1,819	0	4,545	0	0	6,553	12,917
Plumas	2,939	0	584	0	57	3,001	6,581
Shasta	5,376	11	629	0	42	3,871	9,929
Sierra	8,888	0	103	0	0	1,268	10,259
Tehama	12,339	0	58	0	18	326	12,741
Total	**33,525**	**221**	**7,575**	**0**	**457**	**17,527**	**59,305**

Table 18. Acres of Shrub and Chaparral Change by National Forest

Forest	Decrease in Veg.	% Decrease	Increase in Veg.	% Increase	Total Change	Total % Change
Eldorado	389	2	612	3	1,001	4
LTBMU	143	1	1,343	7	1,486	8
Lassen	1,633	1	7,049	4	8,682	5
Modoc	2,532	1	6,449	1	8,981	2
Plumas	3,023	1	9,134	4	12,157	5
Tahoe	6,547	4	5,952	4	12,499	8
Total	**14,267**	**1**	**30,539**	**3**	**44,806**	**4**

The largest source of change in the shrub and chaparral types with national forests is wildfire (Table 19). The Tahoe and Lassen NFs have most verified change within these types from wildfire. Regeneration is largest in the Plumas and Modoc NFs.

Table 19. Acres of Verified Shrub and Chaparral Change by Cause and National Forest

Forest	Wildfire	Prescribed Fire	Harvest	Mortality	Development	Regeneration	Total
Eldorado	72	0	110	0	0	299	481
LTBMU	0	0	9	0	0	0	9
Lassen	5,505	0	416	0	0	304	6,225
Modoc	208	0	335	0	0	852	1,395
Plumas	2,299	0	368	0	0	3,055	5,722
Tahoe	6,769	0	205	0	0	2,304	9,278
Total	**14,853**	**0**	**1,443**	**0**	**0**	**6,814**	**23,110**

DATA AVAILABILITY

The land cover monitoring images are available in Arc/Info GRID format and the cause data are available in Arc/Info polygon format. These data are available in UTM zone 10 and Albers projections using the North American datum of 1927 (NAD27). To obtain these data, visit the CDF-FRAP website at http://frap.cdf.ca.gov, or contact the USDA Forest Service at (916) 454-0803 or CDF-FRAP at (916) 227-2651.

TERMINOLOGY

CALVEG – A vegetation classification scheme based on the Classification and Assessment with Landsat of Visible Ecological Groupings system. This classification system, developed by the USDA Forest Service, describes existing vegetation communities. It is appropriate for mapping vegetation using Landsat TM imagery and recognizes eight regions within California.

Change Classes – Classes of vegetation change for this program. These levels are relative amounts of change in vegetation cover (a small decrease has less vegetation change than a moderate decrease). The Cloud/Shadow class includes areas covered by clouds, cloud shadows and terrain shadows. The Non-vegetation class accounts for changes in lake water levels and snow in higher elevations.

Co-registration – The process of aligning pixels in one date of imagery to the corresponding pixels in another date of imagery that are in the same path and row.

Landsat TM Imagery – Thematic Mapper image data from the Landsat satellite. Each image covers approximately 13,225 square miles, has a pixel resolution of 30 square meters and contains seven bands of data. Each data band contains information on the amount of reflected sunlight from ground features within specific wavelengths.

Lifeform – A plant community aggregation into the broad land cover classes of hardwood, conifer, shrub and grass.

Minimum Mapping Unit – The minimum size or dimensions for features to be mapped as lines or areas.

Mosaic – The process of piecing together several images into one larger image.

Nearest Neighbor Resampling – A resampling method where the output pixel value is the same as the input pixel value, but whose coordinates are closest to the resampled coordinates of the output pixel.

Pixel – The smallest unit of information in an image or raster map. Also referred to as a cell in an image.

Polygon – A multi-sided feature representing an area and defined by the arcs that make up its boundary.

Radiometric Correction – The process of correcting variations in atmospheric conditions and sun angles in multiple dates of imagery.

Supervised Classification – Classification algorithms that examine the unknown pixels in an image and aggregate them into a number of classes based on analyst interpretation of training samples.

Unsupervised Classification – Classification algorithms that examine the unknown pixels in an image and aggregate them into a number of classes based on the natural groupings or clusters present in the image values.

WHR – A vegetation classification scheme based on the California Wildlife Habitat Relationships System. This classification system describes wildlife habitats of vertebrate animals and tends to have broad vegetation classes.

COUNTY TABLES and CHANGE MAPS

For Each County:
1. Change Map
2. Acres of Classified Change by Lifeform and Owner Class
3. Acres of Classified Change by Hardwood Cover Type and Owner Class
4. Acres of Classified Change by Conifer Cover Type and Owner Class
5. Acres of Verified Change by Cause and Hardwood Cover Type
6. Acres of Verified Change by Cause and Conifer Cover Type

Note: Some counties do not contain change by conifer type or change by cause.

Amador County Monitoring Data Map

See appendix F

Table C-1 Acres of Classified Change in Amador County by Lifeform and Owner Class

	National Forest								Other Public							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	177	0	0	0	3	0	37	1	2	0	0	0	0	0
SDVC	14	3	1,373	2	0	0	26	1	80	1	40	3	2	0	0	0
NCH	479	97	53,722	95	114	86	3,456	99	5,394	98	1,550	97	539	99	44	100
SIVC	0	0	1,374	2	17	13	12	0	2	0	0	0	4	1	0	0
MIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	14	0	2	2	3	0	13	0	0	0	3	1	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	493	100	56,661	100	133	100	3,500	100	5,526	100	1,592	100	547	100	44	100

	Private								All Owners							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	9	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0
MDVC	206	0	126	0	82	1	3	2	243	0	305	0	82	1	6	0
SDVC	1,324	1	2,065	5	298	2	1	1	1,418	1	3,477	3	300	2	27	1
NCH	127,966	98	42,647	94	14,488	96	153	94	133,839	98	97,919	95	15,141	96	3,652	99
SIVC	222	0	421	1	78	1	5	3	224	0	1,794	2	99	1	17	0
MIVC	17	0	1	0	1	0	0	0	17	0	1	0	1	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	486	0	35	0	133	1	0	0	500	0	49	0	138	1	3	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	130,231	100	45,293	100	15,081	100	162	100	136,250	100	103,546	100	15,761	100	3,706	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow

Table C-2 Acres of Classified Change in Amador County by Hardwood Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Blue Oak Woodland								
LDVC	0	0	0	0	6	0	6	0
MDVC	0	0	1	0	21	0	22	0
SDVC	0	0	5	1	165	1	170	1
NCH	3	100	691	99	23,922	98	24,616	98
SIVC	0	0	1	0	49	0	50	0
MIVC	0	0	0	0	4	0	4	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	1	0	194	1	195	1
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	3	100	699	100	24,361	100	25,063	100
Blue Oak/Foothill Pine								
LDVC	0	0	0	0	1	0	1	0
MDVC	0	0	19	4	65	0	84	0
SDVC	0	0	28	6	295	1	323	1
NCH	0	0	443	89	42,617	99	43,060	99
SIVC	0	0	0	0	42	0	42	0
MIVC	0	0	0	0	1	0	1	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	6	1	175	0	181	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	496	100	43,196	100	43,692	100
Montane Hardwood								
LDVC	0	0	0	0	2	0	2	0
MDVC	0	0	17	0	119	0	137	0
SDVC	14	3	47	1	864	1	925	1
NCH	447	97	4,253	98	61,425	98	66,124	98
SIVC	0	0	1	0	131	0	132	0
MIVC	0	0	0	0	12	0	12	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	6	0	118	0	124	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	462	100	4,323	100	62,671	100	67,455	100
Valley Oak Woodland								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	0	0	8	100	0	0	8	100
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	8	100	0	0	8	100
Montane Riparian								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	26	100	0	0	4	100	30	100
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	26	100	0	0	4	100	30	100
TOTAL	491		5,526		130,233		136,249	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-3 Acres of Classified Change in Amador County by Conifer Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Douglas Fir								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	26	5	26	5
NCH	0	0	0	0	477	95	477	95
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	504	100	504	100
Ponderosa Pine								
LDVC	0	0	0	0	0	0	0	0
MDVC	6	0	0	0	4	0	10	0
SDVC	193	4	6	26	285	8	484	6
NCH	4,391	95	17	74	3,436	92	7,844	94
SIVC	41	1	0	0	6	0	47	1
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	4,631	100	23	100	3,730	100	8,384	100
Red Fir								
LDVC	0	0	0	0	0	0	0	0
MDVC	21	0	0	0	1	0	22	0
SDVC	266	2	0	0	26	2	292	2
NCH	15,570	97	0	0	1,603	97	17,173	97
SIVC	264	2	0	0	22	1	287	2
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0			0	0	0	0
TOTAL	16,122	100	0	0	1,652	100	17,774	100
Ponderosa Pine								
LDVC	0	0	0	0	0	0	0	0
MDVC	6	0	0	0	4	0	10	0
SDVC	193	4	6	26	285	8	484	6
NCH	4,391	95	17	74	3,436	92	7,844	94
SIVC	41	1	0	0	6	0	47	1
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	4,631	100	23	100	3,730	100	8,384	100
Red Fir								
LDVC	0	0	0	0	0	0	0	0
MDVC	21	0	0	0	1	0	22	0
SDVC	266	2	0	0	26	2	292	2
NCH	15,570	97	0	0	1,603	97	17,173	97
SIVC	264	2	0	0	22	1	287	2
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0			0	0	0	0
TOTAL	16,122	100	0	0	1,652	100	17,774	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-3 Acres of Classified Change in Amador County by Conifer Cover Type and Owner Class (continued)

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Subalpine Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	2	0	0	0	0	0	2	0
SDVC	117	1	0	0	4	1	121	1
NCH	9,596	96	0	0	510	90	10,106	96
SIVC	230	2	0	0	54	9	284	3
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	14	0	0	0	0	0	14	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	9,958	100	0	0	568	100	10,526	100
Sierran Mixed Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	149	1	0	0	71	1	220	1
SDVC	789	3	17	18	285	4	1,091	3
NCH	24,057	93	76	81	7,458	94	31,590	93
SIVC	835	3	0	0	104	1	938	3
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	25,830	100	93	100	7,917	100	33,839	100
White Fir								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	2	43	0	0	9	28	11	29
NCH	3	57	0	0	23	72	26	71
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	5	100	0	0	32	100	36	100
Undetermined Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	2	0	51	0	52	0
SDVC	3	5	17	1	1,430	5	1,450	4
NCH	62	95	1,458	99	29,140	94	30,659	95
SIVC	0	0	0	0	236	1	236	1
MIVC	0	0	0	0	1	0	1	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	35	0	35	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	65	100	1,476	100	30,892	100	32,433	100
TOTAL	56,611		1,592		45,293		103,496	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-4 Acres of Verified Change in Amador County by Cause and Hardwood Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Blue Oak Woodland										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	1	0	5	6
SDVC	8	2	16	0	1	4	12	0	42	85
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	2	2
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	4	4
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	8	2	16	0	1	4	13	0	53	97
Blue Oak / Foothill Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	14	17	0	0	5	0	19	0	17	72
SDVC	58	74	0	0	29	8	55	0	17	241
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	4	4
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	2	0	0	2
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	72	91	0	0	34	8	76	0	38	319
Montane Hardwood										
LDVC	0	0	0	0	0	0	1	0	0	1
MDVC	0	6	27	0	0	0	37	0	49	119
SDVC	13	154	163	8	9	69	103	0	125	644
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	10	10
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	1	0	1	2
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	13	160	190	8	9	69	142	0	185	776
TOTAL	93	253	206	8	44	81	231	0	276	1,192

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-5 Acres of Verified Change in Amador County by Cause and Conifer Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Ponderosa Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	3	0	0	0	0	0	0	3
SDVC	9	0	98	0	0	0	0	0	0	107
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	42	0	42
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	9	0	101	0	0	0	0	42	0	152
Red Fir										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	16	0	0	0	0	0	0	16
SDVC	0	0	5	0	0	0	0	0	0	5
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	122	0	122
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	21	0	0	0	0	122	0	143
Sierran Mixed Conifer										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	188	0	0	0	0	0	0	188
SDVC	38	0	552	0	0	2	0	0	0	562
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	763	0	763
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	38	0	710	0	0	2	0	763	0	1,513
Undetermined Conifer										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	2	0	24	0	0	0	10	0	4	40
SDVC	4	3	532	0	2	21	57		39	658
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	6	3	556	0	2	21	67	0	43	698
TOTAL	53	3	1,322	0	2	23	67	927	43	2,506

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Butte County Monitoring Data Map

See appendix F

Table C-6 Acres of Classified Change in Butte County by Lifeform and Owner Class

	National Forest								Other Public							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	26	0	418	0	0	0	0	0	4	0	6	0	0	0	0	0
MDVC	59	0	502	1	0	0	22	0	47	0	12	0	4	0	1	0
SDVC	203	1	1,561	2	0	0	168	1	143	1	88	2	15	1	27	1
NCH	26,084	97	84,268	91	6	81	10,820	94	18,338	92	5,273	92	1,819	78	1,854	87
SIVC	532	2	5,141	6	1	16	412	4	693	3	218	4	119	5	113	5
MIVC	39	0	809	1	0	3	25	0	140	1	53	1	19	1	73	3
LIVC	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
NVG	22	0	24	0	0	0	54	0	513	3	82	1	344	15	69	3
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	26,965	100	92,723	100	8	100	11,501	100	19,878	100	5,731	100	2,321	100	2,138	100

	Private								All Owners							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	486	0	1,013	1	4	0	21	0	517	0	1,438	1	4	0	21	0
MDVC	869	0	2,929	2	40	0	189	0	975	0	3,442	1	44	0	212	0
SDVC	3,465	1	12,185	7	226	1	1,230	3	3,811	1	13,834	5	241	1	1,425	2
NCH	228,094	96	139,359	83	14,617	96	39,344	88	272,516	96	228,901	86	16,442	94	52,018	89
SIVC	2,832	1	10,458	6	203	1	3,257	7	4,057	1	15,817	6	323	2	3,782	6
MIVC	599	0	804	0	37	0	543	1	778	0	1,665	1	56	0	641	1
LIVC	263	0	247	0	20	0	6	0	263	0	247	0	20	0	6	0
NVG	135	0	12	0	36	0	322	1	669	0	117	0	380	2	445	1
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	236,743	100	167,007	100	15,182	100	44,912	100	283,586	100	265,461	100	17,510	100	58,551	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow

Table C-7 Acres of Classified Change in Butte County by Hardwood Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Blue Oak Woodland								
LDVC	0	0	0	0	8	0	8	0
MDVC	0	0	11	0	138	0	149	0
SDVC	0	0	48	1	1,055	2	1,103	1
NCH	50	91	5,269	93	66,678	97	71,997	97
SIVC	5	9	146	3	709	1	860	1
MIVC	0	0	60	1	41	0	102	0
LIVC	0	0	0	0	12	0	12	0
NVG	0	0	139	2	19	0	158	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	55	100	5,673	100	68,660	100	74,388	100
Blue Oak / Foothill Pine								
LDVC	0	0	4	1	14	0	19	0
MDVC	0	0	0	0	38	0	38	0
SDVC	0	0	22	3	472	2	494	2
NCH	4	86	728	86	26,863	97	27,595	97
SIVC	1	14	55	6	147	1	203	1
MIVC	0	0	10	1	14	0	24	0
LIVC	0	0		0	0	0	0	0
NVG	0	0	25	3	7	0	31	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	5	100	844	100	27,556	100	28,404	100
Montane Hardwood								
LDVC	26	0		0	458	0	485	0
MDVC	59	0	36	0	683	1	778	0
SDVC	203	1	73	1	1,810	1	2,085	1
NCH	25,808	97	12,322	93	128,310	96	166,440	96
SIVC	484	2	467	4	1,843	1	2,793	2
MIVC	37	0	70	1	461	0	568	0
LIVC		0	0	0	245	0	245	0
NVG	22	0	349	3	58	0	429	0
CLD/SHA		0		0		0		0
TOTAL	26,640	100	13,316	100	133,867	100	173,822	100
Aspen								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	72	82	5	76	38	74	115	79
SIVC	15	17	2	24	13	26	29	20
MIVC	1	1	0	0	0	0	1	1
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	88	100	7	100	51	100	145	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-7 Acres of Classified Change in Butte County by Hardwood Cover Type and Owner Class (continued)

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Valley Foothill Riparian								
LDVC	0	0	0	0	6	0	6	0
MDVC	0	0	0	0	10	0	10	0
SDVC	0	0	0	1	125	2	126	2
NCH	0	0	8	26	5,875	94	5,883	94
SIVC	0	0	22	73	102	2	124	2
MIVC	0	0	0	0	83	1	83	1
LIVC	0	0	0	0	6	0	6	0
NVG	0	0	0	0	51	1	51	1
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	31	100	6,258	100	6,289	100
Montane Riparian								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	3	1	3	1
NCH	149	84	7	85	330	94	487	91
SIVC	28	16	1	15	17	5	47	9
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	177	100	9	100	351	100	537	100
TOTAL	26,965		19,878		236,742		283,585	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-8 Acres of Classified Change in Butte County by Conifer Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Douglas Fir								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	48	100	0	0	157	90	205	92
SIVC	0	0	0	0	18	10	18	8
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	48	100	0	0	175	100	223	100
Lodgepole Pine								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	3	2	0	0	44	10	46	8
NCH	108	90	0	0	329	73	437	76
SIVC	10	8	0	0	79	17	89	15
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	120	100	0	0	451	100	572	100
Montane Hardwood-Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	9	1	117	4	126	3
NCH	2	100	652	96	2,855	94	3,509	94
SIVC	0	0	16	2	63	2	78	2
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	2	100	676	100	3,035	100	3,714	100
Ponderosa Pine								
LDVC	165	0	5	0	300	0	470	0
MDVC	229	1	8	0	1,233	2	1,470	1
SDVC	643	2	52	2	4,635	7	5,331	5
NCH	31,060	94	2,938	93	57,354	87	91,352	90
SIVC	957	3	108	3	1,979	3	3,044	3
MIVC	133	0	14	0	84	0	231	0
LIVC	0	0	0	0	0	0	0	0
NVG	19	0	18	1	5	0	42	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	33,207	100	3,143	100	65,590	100	101,941	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-8 Acres of Classified Change in Butte County by Conifer Cover Type and Owner Class
(continued)

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Red Fir								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	16	1	0	0	0	0	16	1
NCH	1,256	92	0	0	13	89	1,269	92
SIVC	92	7	0	0	2	11	93	7
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	1,364	100	0	0	14	100	1,378	100
Sierran Mixed Conifer								
LDVC	253	0	0	0	699	1	952	1
MDVC	273	1	0	0	1,602	2	1,875	1
SDVC	856	2	3	1	7,135	8	7,994	6
NCH	47,805	89	541	87	69,548	79	117,895	83
SIVC	3,735	7	60	10	8,215	9	12,011	8
MIVC	670	1	15	2	582	1	1,267	1
LIVC	0	0	0	0	1	0	1	0
NVG	5	0	0	0	0	0	5	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	53,597	100	620	100	87,783	100	142,000	100
White Fir								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	42	1	0	0	30	5	73	1
NCH	3,989	91	0	0	523	87	4,512	91
SIVC	347	8	0	0	41	7	388	8
MIVC	5	0	0	0	7	1	12	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	4,384	100	0	0	601	100	4,985	100
Undetermined Conifer								
LDVC	0	0	1	0	14	0	15	0
MDVC	0	0	4	0	93	1	97	1
SDVC	0	0	24	2	225	2	249	2
NCH	0	0	1,142	88	8,581	92	9,723	91
SIVC	0	0	34	3	61	1	95	1
MIVC	0	0	24	2	130	1	154	1
LIVC	0	0	0	0	246	3	246	2
NVG	0	0	63	5	6	0	69	1
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	1,292	100	9,357	100	10,649	100
TOTAL	92,723		5,731		167,007		265,461	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-9 Acres of Verified Change in Butte County by Cause and Hardwood Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Blue Oak Woodland										
LDVC	0	0	0	0	0	0	4	0	0	4
MDVC	19	0	0	0	0	0	46	0	0	65
SDVC	36	1	7	1	14		310	0	1	370
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	6	2	0	1	5	0	41	0	0	55
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	11	11
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	61	3	7	2	19	0	401	0	12	505
Blue Oak / Foothill Pine										
LDVC	0	0	0	0	0	0	5	0	0	5
MDVC	11	0	0	3	0	0	0	0	0	14
SDVC	16	32	0	77	0	0	26	0	0	151
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	1	0	0	9	0	0	2	0	0	12
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	1	0	0	0	0	3	4
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	28	32	0	90	0	0	33	0	3	186
Montane Hardwood										
LDVC	1	0	328	0	0	0	5	0	1	335
MDVC	239	51	238	0	0	0	30	0	1	559
SDVC	202	178	467	21	0	0	63	0	39	970
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	10	9	62	7	0	0	53	472	0	613
MIVC	2	0	0	0	0	0	1	158	0	161
LIVC	0	0	0	0	0	0	0	5	0	5
NVG	0	0	0	0	0	0	1	3	3	7
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	454	238	1,095	28	0	0	153	638	44	2,650
Montane Riparian										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	3	0	0	0	0	0	0	3
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	2	0	0	0	0	4	0	6
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	5	0	0	0	0	4	0	9
TOTAL	543	273	1,107	120	19	0	587	642	59	3,350

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-10 Acres of Verified Change in Butte County by Cause and Conifer Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Douglas Fir										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	0	0
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	2		2
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0	0	2		2
Lodgepole Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	13	0	30	0	0	0	0	0	0	43
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	20	0	0	0	0	0	0	1		21
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	33	0	30	0	0	0	0	1	0	64
Montane Hardwood-Conifer										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	19	0	0	0	0	11	0	0	30
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	2	0	0	0	0	0	4	0	0	6
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	2	19	0	0	0	0	15	0	0	36
Ponderosa Pine										
LDVC	0	0	317	0	0	0	0	0	0	317
MDVC	0	25	918	0	0	0	96	0	0	1,039
SDVC	10	236	1,487	0	0	0	944	0	0	2,677
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	67	5	69	0	0	0	131	810	0	1,082
MIVC	1	0	3	0	0	0	0	136	0	140
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	78	266	2,794	0	0	0	1,171	946		5,255

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-10 Acres of Verified Change in Butte County by Cause and Conifer Cover Type
(continued)

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Red Fir										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	17	0	0	0	0	0	0	17
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	43	0	43
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	17	0	0	0	0	43	0	60
Sierran Mixed Conifer										
LDVC	59	40	485	0	0	0	158	0	0	742
MDVC	54	123	883	0	0	0	325	0	30	1,415
SDVC	406	844	2,755	0	0	0	1,507	0	193	5,705
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	229	153	635	0	0	0	262	2,750	211	4,240
MIVC	4	10	17	0	0	0	18	1,027	0	1,076
LIVC	0	0	0	0	0	0	0	1	0	1
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	752	1,170	4,775	0	0	0	2,270	3,778	434	13,179
White Fir										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	14	0	0	0	0	0	0	14
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	62	0	62
MIVC	0	0	0	0	0	0	0	1	0	1
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	14	0	0	0	0	63	0	77
Undetermined Conifer										
LDVC	0	0	0	0	0	0	2	0	0	2
MDVC	41	0	2	0	0	0	1	0	0	44
SDVC	15	0	87	0	0	0	3	0	0	105
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	3	0	0	0	0	0	0	3
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	56	0	92	0	0	0	6		0	154
TOTAL	921	1,455	7,722	0	0	0	3,462	4,833	434	18,827

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Colusa County Monitoring Data Map

See appendix F

Table C-11 Acres of Classified Change in Colusa County by Lifeform and Owner Class

	National Forest								Other Public							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	1	0	0	0	7	0	0	0
NCH	0	0	0	0	0	0	0	0	5,034	98	3	100	5,657	96	0	0
SIVC	0	0	0	0	0	0	0	0	85	2	0	0	223	4	0	0
MIVC	0	0	0	0	0	0	0	0	19	0	0	0	7	0	1	100
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0	0	0	5,139	100	3	100	5,894	100	1	100

	Private								All Owners							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	31	0	0	1		0	0	0	31	0	0	1	0	0	0	0
MDVC	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
SDVC	60	0	0	2	43	0	2	100	61	0	0	2	50	0	2	62
NCH	62,140	99	22	92	15,340	96	0	0	67,174	99	25	93	20,997	96	0	0
SIVC	453	1	0	1	459	3	0	0	538	1	0	1	682	3	0	0
MIVC	154	0	0	0	17	0	0	0	173	0	0	0	24	0	1	38
LIVC	119	0	1	4	33	0	0	0	119	0	1	3	33	0	0	0
NVG	58	0	0	1	43	0	0	0	58	0	0	1	43	0	0	0
CLD/SHA	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0
TOTAL	63,017	100	24	100	15,934	100	2	100	68,157	100	27	100	21,829	100	3	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow

Table C-12 Acres of Classified Change in Colusa County by Hardwood Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Blue Oak Woodland								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	1	0	13	0	13	0
NCH	0	0	4,898	98	44,813	99	49,711	99
SIVC	0	0	77	2	319	1	396	1
MIVC	0	0	19	0	108	0	126	0
LIVC	0	0	0	0	63	0	63	0
NVG	0	0	0	0	32	0	32	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	4,995	100	45,347	100	50,342	100
Blue Oak / Foothill Pine								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	0	0	0	0	0	0	0	0
SIVC	0	0	7	100	80	100	88	100
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	7	100	80	100	88	100
Montane Hardwood								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	4	0	4	0
NCH	0	0	116	99	12,386	99	12,501	99
SIVC	0	0	1	1	10	0	11	0
MIVC	0	0	0	0	26	0	26	0
LIVC	0	0	0	0	42	0	42	0
NVG	0	0	0	0	6	0	6	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	117	100	12,475	100	12,591	100
Valley Oak Woodland								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	0	0	0	0	143	100	143	100
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	143	100	143	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-12 Acres of Classified Change in Colusa County by Hardwood Cover Type and Owner Class

(continued)

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Coastal Oak Woodland								
LDVC	0	0	0	0	16	7	16	7
MDVC	0	0	0	0	2	1	2	1
SDVC	0	0	0	0	2	1	2	1
NCH	0	0	0	0	191	82	191	82
SIVC	0	0	0	0		0	0	0
MIVC	0	0	0	0	9	4	9	4
LIVC	0	0	0	0	11	5	11	5
NVG	0	0	0	0	2	1	2	1
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	233	100	233	100
Valley Foothill Riparian								
LDVC	0	0	0	0	15	0	15	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	41	1	41	1
NCH	0	0	21	100	4,608	97	4,629	97
SIVC	0	0	0	0	44	1	44	1
MIVC	0	0	0	0	12	0	12	0
LIVC	0	0	0	0	2	0	2	0
NVG	0	0	0	0	17	0	17	0
CLD/SHA	0	0	0	0		0	0	0
TOTAL	0	0	21	100	4,739	100	4,760	100
TOTAL	0		5,139		63,018		68,157	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

ElDorado County Monitoring Data Map

See appendix F

Table C-13 Acres of Classified Change in El Dorado County by Lifeform and Owner Class

	National Forest								Other Public							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	0	0	30	0	0	0	28	0	2	0	18	0	0	0	0	0
MDVC	14	0	6,872	2	0	0	45	0	40	0	78	1	9	0	0	0
SDVC	121	2	8,400	2	29	1	333	1	108	1	160	2	32	1	3	0
NCH	5,419	96	367,383	93	3,372	85	23,724	93	19,529	99	9,043	95	5,868	99	593	95
SIVC	114	2	12,881	3	453	11	1,211	5	51	0	179	2	13	0	29	5
MIVC	2	0	107	0	0	0	2	0	1	0	56	1	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	1	0	649	0	132	3	55	0	74	0	1	0	15	0	0	0
CLD/SHA	0	0	658	0	0	0	109	0	0	0	0	0	0	0	0	0
TOTAL	5,672	100	396,979	100	3,986	100	25,506	100	19,806	100	9,535	100	5,936	100	626	100

	Private								All Owners							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	176	0	337	0	10	0	242	2	178	0	385	0	10	0	270	1
MDVC	764	0	8,968	4	47	0	139	1	818	0	15,918	3	56	0	184	1
SDVC	3,198	1	11,103	6	320	1	347	3	3,427	1	19,663	3	380	1	683	2
NCH	223,909	98	171,825	86	33,834	98	8,600	85	248,857	98	548,251	90	43,074	97	32,917	91
SIVC	724	0	7,208	4	148	0	742	7	890	0	20,267	3	614	1	1,982	5
MIVC	89	0	77	0	3	0	2	0	92	0	240	0	3	0	3	0
LIVC	4	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0
NVG	526	0	21	0	88	0	7	0	601	0	671	0	234	1	61	0
CLD/SHA	0	0	39	0	0	0	34	0	0	0	697	0	0	0	144	0
TOTAL	229,390	100	199,579	100	34,451	100	10,113	100	254,868	100	606,093	100	44,374	100	36,244	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow

Table C-14 Acres of Classified Change in El Dorado County by Hardwood Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Blue Oak Woodland								
LDVC	0	0	0	0	17	0	17	0
MDVC	0	0	4	0	82	0	86	0
SDVC	5	6	11	1	390	1	406	1
NCH	71	93	1,576	97	30,386	97	32,033	97
SIVC	0	1	15	1	155	0	170	1
MIVC	0	0	0	0	22	0	22	0
LIVC	0	0	0	0	2	0	2	0
NVG	0	0	23	1	119	0	142	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	77	100	1,628	100	31,173	100	32,878	100
Blue Oak / Foothill Pine								
LDVC	0	0	0	0	3	0	3	0
MDVC	0	0	1	0	23	0	24	0
SDVC	0	4	3	0	89	1	92	1
NCH	4	82	1,097	99	16,637	99	17,738	99
SIVC	1	14	4	0	76	0	81	0
MIVC	0	0	0	0	14	0	14	0
LIVC	0	0	0	0		0	0	0
NVG	0	0	9	1	34	0	43	0
CLD/SHA	0	0	0	0		0	0	0
TOTAL	5	100	1,113	100	16,877	100	17,995	100
Montane Hardwood								
LDVC	0	0	2	0	156	0	158	0
MDVC	12	0	35	0	659	0	706	0
SDVC	87	2	95	1	2,719	1	2,900	1
NCH	4,933	98	16,844	99	176,828	98	198,604	98
SIVC	15	0	33	0	487	0	535	0
MIVC	2	0	1	0	53	0	56	0
LIVC	0	0	0	0	2	0	2	0
NVG	1	0	43	0	372	0	416	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	5,050	100	17,051	100	181,277	100	203,378	100
Valley Oak Woodland								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	0	0	0	0	1	87	1	87
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	13	0	13
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	2	100	2	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-14 Acres of Classified Change in El Dorado County by Hardwood Cover Type and Owner Class

(continued)

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Aspen								
LDVC	0	0	0	0	0	0	0	0
MDVC	2	1	0	0	0	0	2	1
SDVC	28	7	0	0	0	0	28	6
NCH	272	68	13	100	56	91	341	72
SIVC	98	24	0	0	6	9	103	22
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	400	100	13	100	62	100	475	100
Montane Riparian								
LDVC	0	0	0	0	0	0		0
MDVC	0	0	0	0	0	0		0
SDVC	1	1	0	0	0	0	1	1
NCH	139	99	0	0	1	100	139	99
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	140	100	0	0	1	100	141	100
TOTAL	5,672		19,805		229,390		254,868	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-15 Acres of Classified Change in El Dorado County by Conifer Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Douglas Fir								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	0	100	0	0	37	100	37	100
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	100	0	0	37	100	37	100
Jeffrey Pine								
LDVC	0	0	0	0	0	0	0	0
MDVC	8	0	0	0	1	0	9	0
SDVC	60	1	0	0	39	0	99	1
NCH	5,490	97	146	100	8,703	99	14,338	98
SIVC	114	2	0	0	62	1	176	1
MIVC	0	0	0	0	1	0	1	0
LIVC	0	0	0	0	0	0	0	0
NVG	11	0	0	0	10	0	21	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	5,683	100	146	100	8,816	100	14,645	100
Ponderosa Pine								
LDVC	15	0	0	0	110	0	125	0
MDVC	852	1	2	3	783	3	1,637	2
SDVC	2,147	3	8	9	1,712	6	3,866	4
NCH	60,129	93	77	89	23,755	88	83,962	92
SIVC	1,102	2	0	0	496	2	1,598	2
MIVC	99	0	0	0	46	0	145	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	64,344	100	87	100	26,901	100	91,332	100
Red Fir								
LDVC	0	0	0	0	0	0	0	0
MDVC	203	0	0	0	12	0	215	0
SDVC	765	1	0	0	56	1	821	1
NCH	72,813	95	42	100	9,320	93	82,175	95
SIVC	2,067	3	0	0	566	6	2,633	3
MIVC	2	0	0	0	0	0	2	0
LIVC	0	0	0	0	0	0	0	0
NVG	16	0	0	0	0	0	16	0
CLD/SHA	558	1	0	0	30	0	588	1
TOTAL	76,424	100	42	100	9,984	100	86,450	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-15 Acres of Classified Change in El Dorado County by Conifer Cover Type and Owner Class

(continued)

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Subalpine Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	5	0	0	0	0	0	5	0
SDVC	87	0	0	0	0	0	87	0
NCH	18,128	90	0	0	145	76	18,273	90
SIVC	1,275	6	0	0	46	24	1,321	7
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	622	3	0	0	0	0	622	3
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	20,117	100	0	0	191	100	20,308	100
Sierran Mixed Conifer								
LDVC	15	0	18	0	53	0	86	0
MDVC	5,804	3	54	1	7,477	7	13,335	4
SDVC	5,312	2	65	1	5,827	5	11,203	3
NCH	210,027	91	4,836	93	87,218	82	302,081	89
SIVC	8,317	4	169	3	5,779	5	14,265	4
MIVC	5	0	56	1	25	0	86	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	100	0	0	0	10	0	109	0
TOTAL	229,580	100	5,198	100	106,388	100	341,166	100
White Fir								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	3	1	3	1
NCH	44	100	0	0	290	99	334	99
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	44	100	0	0	293	100	337	100
Undetermined Conifer								
LDVC	0	0	1	0	174	0	174	0
MDVC	0	0	22	1	695	1	717	1
SDVC	29	4	87	2	3,467	7	3,583	7
NCH	764	96	3,942	97	42,350	90	47,056	91
SIVC	5	1	9	0	259	1	273	1
MIVC	0	0	0	0	6	0	6	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	1	0	11	0	12	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	798	100	4,062	100	46,961	100	51,822	100
TOTAL	396,990		9,535		199,571		606,096	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-16 Acres of Verified Change in El Dorado County by Cause and Hardwood Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Blue Oak Woodland										
LDVC	5	0	2	0	0	0	6	0	0	13
MDVC	9	0	9	0	2	0	8	0	1	29
SDVC	22	0	7	0	12	0	19	0	0	60
NCH	0	0	0	0	3	0	7	0	0	10
SIVC	0	0	0	0	0	0	0	9	3	12
MIVC	0	0	0	0	0	0	1	2	0	3
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	36	0	18	0	17	0	41	11	4	127
Blue Oak / Foothill Pine										
LDVC	0	0	3		0	0	0	0	0	3
MDVC	0	0	0	0	1	0	3	0	0	4
SDVC	0	0	3	0	13	0	10	0	0	26
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	30	0	0	20	0	50
MIVC	0	0	0	0	4	0	0	5	0	9
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	1	0	0	1
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	6	0	48	0	14	25	0	93
Montane Hardwood										
LDVC	89	0	9		0	0	27	0	0	125
MDVC	172	0	25	0	13	0	58	0	4	272
SDVC	335	0	32	16	115	0	237	0	16	751
NCH	0	0	0	0	14	0	13	0	0	27
SIVC	0	0	0	0	0	0	0	52	2	54
MIVC	0	0	0	0	0	0	3	14	0	17
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	1	1
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	596	0	66	16	142	0	338	66	23	1,247
TOTAL	632	0	90	16	207	0	393	102	27	1,467

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-17 Acres of Verified Change in El Dorado County by Cause and Conifer Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Jeffrey Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	4	0	0	2	0	0	0	6
SDVC	0	0	26	0	0	63	0	0	0	89
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	16	0	16
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	30	0	0	65	0	16	0	111
Ponderosa Pine										
LDVC	0	0	118	0	0	0	0	0	0	118
MDVC	649	0	558	11	22	0	15	0	0	1,255
SDVC	792	11	495	92	29	0	9	0	0	1,428
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	48	0	0	0	0	1,249	0	1,297
MIVC	0	0	0	0	0	0	0	110	0	110
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	1,441	11	1,219	103	51	0	24	1,359	0	4,208
Red Fir										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	169	0	0	0	0	0	0	169
SDVC	0	0	30	0	0	4	0	0	0	34
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	834	0	834
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	588	0	588
TOTAL	0	0	199	0	0	4	0	1,422	0	1,625
Sierran Mixed Conifer										
LDVC	0	0	86	0	0	0	0	0	0	86
MDVC	11,268	0	1,693	4	0	2	0	129	0	13,096
SDVC	5,296	60	2,536	70	0	96	0	27	0	8,085
NCH	0	0	0	0	0	0	0	1	0	1
SIVC	334	0	101	0	0	0	0	10,125	0	10,560
MIVC	0	0	7	0	0	0	0	78	0	85
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	110	0	110
TOTAL	16,898	60	4,423	74	0	98	0	10,470	0	32,023
Undetermined Conifer										
LDVC	73	0	93	0	0	0	91	0	0	166
MDVC	263	0	161	0	4	0	130	0	0	428
SDVC	506	0	349	0	8	0	67	0	0	930
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	11	0	0	12	0	23
MIVC	0	0	0	0	0	0	0	2	0	2
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	1	0	0	1
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	842	0	382	0	23	0	289	14	0	1,550
TOTAL	19,181	71	6,253	177	74	169	313	13,281	0	39,519

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Glenn County Monitoring Data Map

See appendix F

Table C-18 Acres of Classified Change in Glenn County by Lifeform and Owner Class

	National Forest								Other Public							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	62	2	7	7	1	0	0	0
NCH	640	100	6	100	96	100	0	0	3,359	94	64	64	1,302	99	0	0
SIVC	0	0	0	0	0	0	0	0	97	3	4	4	9	1	0	0
MIVC	0	0	0	0	0	0	0	0	38	1	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	23	1	26	25	9	1	3	100
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	640	100	6	100	96	100	0	0	3,582	100	101	100	1,321	100	3	100

	Private								All Owners							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	69	0	0	0	0	0	0	0	69	0	0	0	0	0	0	0
MDVC	13	0	0	0	4	0	0	0	15	0	0	0	4	0	0	0
SDVC	306	1	2	6	23	1	0	0	368	1	9	6	24	0	0	0
NCH	47,242	98	26	87	4,038	99	1	100	51,241	98	96	70	5,437	99	1	26
SIVC	264	1	1	4	18	0	0	0	361	1	5	4	27	0	0	0
MIVC	112	0	0	0	0	0	0	0	150	0	0	0	1	0	0	0
LIVC	11	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0
NVG	51	0	1	2	14	0	0	0	74	0	26	19	22	0	3	74
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	48,068	100	30	100	4,097	100	1	100	52,290	100	137	100	5,514	100	4	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow

Table C-19 Acres of Classified Change in Glenn County by Hardwood Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Blue Oak Woodland								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	2	0	4	0	6	0
SDVC	0	0	40	1	98	0	139	0
NCH	557	100	3,044	95	36,579	99	40,180	99
SIVC	0	0	72	2	142	0	214	1
MIVC	0	0	34	1	10	0	44	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	12	0	15	0	27	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	557	100	3,205	100	36,848	100	40,610	100
Blue Oak / Foothill Pine								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	2	0	2	0
SDVC	0	0	0	0	0	0	0	0
NCH	0	0	104	100	1,181	99	1,285	99
SIVC	0	0	0	0	8	1	8	1
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	4	0	4	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	104	100	1,195	100	1,299	100
Montane Hardwood								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	5	1	6	1
SDVC	0	0	22	8	17	3	39	4
NCH	83	100	211	77	614	95	908	91
SIVC	0	0	25	9	9	1	34	3
MIVC	0	0	4	2	0	0	4	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	11	4	1	0	12	1
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	83	100	273	100	647	100	1,003	100
Valley Oak Woodland								
LDVC	0	0	0	0		0	0	0
MDVC	0	0	0	0		0	0	0
SDVC	0	0	0	0		0	0	0
NCH	0	0	0	0	148	100	148	100
SIVC	0	0	0	0		0	0	0
MIVC	0	0	0	0		0	0	0
LIVC	0	0	0	0		0	0	0
NVG	0	0	0	0		0	0	0
CLD/SHA	0	0	0	0		0	0	0
TOTAL	0	0	0	0	148	100	148	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-19 Acres of Classified Change in Glenn County by Hardwood Cover Type and Owner Class
(continued)

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Coastal Oak Woodland								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	2	24	2	24
NCH	0	0	0	0	6	76	6	76
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	8	100	8	100
Valley Foothill Riparian								
LDVC	0	0	0	0	69	1	69	1
MDVC	0	0	0	0	2	0	2	0
SDVC	0	0	0	0	188	2	188	2
NCH	0	0	0	0	8,714	94	8,714	94
SIVC	0	0	0	0	105	1	105	1
MIVC	0	0	0	0	102	1	102	1
LIVC	0	0	0	0	11	0	11	0
NVG	0	0	0	0	32	0	32	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	9,223	100	9,223	100
TOTAL	640		3,582		48,069		52,291	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-20 Acres of Classified Change in Glenn County by Conifer Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Ponderosa Pine								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	6	100	0	0	0	0	6	100
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	6	100	0	0	0	0	6	100
Undetermined Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	7	7	2	6	9	7
NCH	0	0	64	64	26	87	90	69
SIVC	0	0	4	4	1	4	5	4
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	26	25	1	2	26	20
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	101	100	30	100	130	100
TOTAL	6		101		30		136	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Lassen County Monitoring Data Map

See appendix F

Table C-21 Acres of Classified Change in Lassen County by Lifeform and Owner Class

	National Forest								Other Public							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	0	0	893	0	2	0	0	0	0	0	109	0	16	0	0	0
MDVC	0	0	1,958	0	46	0	97	0	1	0	128	0	190	0	2	0
SDVC	8	1	24,593	5	200	0	91	0	19	1	3,667	2	999	0	48	0
NCH	1,316	85	414,222	90	107,224	97	24,767	94	1,904	91	186,046	96	806,155	97	30,071	99
SIVC	181	12	15,013	3	2,385	2	1,179	4	153	7	1,637	1	9,725	1	161	1
MIVC	37	2	1,323	0	251	0	75	0	13	1	221	0	1,878	0	14	0
LIVC	5	0	1	0	0	0	0	0	0	0	0	0	28	0	2	0
NVG	0	0	3	0	511	0	11	0	0	0	20	0	5,079	1	32	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	2,149	1	6,018	1	0	0
TOTAL	1,547	100	458,005	100	110,619	100	26,219	100	2,090	100	193,976	100	830,088	100	30,330	100

	Private								All Owners							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	1	0	1,356	0	88	0	3	0	1	0	2,357	0	106	0	3	0
MDVC	124	1	1,577	0	1,041	0	143	0	125	1	3,663	0	1,277	0	242	0
SDVC	1,086	11	34,298	9	2,399	0	699	2	1,113	8	62,558	6	3,599	0	838	1
NCH	7,069	73	347,053	87	439,340	90	36,136	89	10,289	77	947,321	90	1,352,719	95	90,974	94
SIVC	731	8	11,797	3	33,254	7	3,174	8	1,066	8	28,447	3	45,364	3	4,514	5
MIVC	288	3	764	0	3,388	1	194	0	338	3	2,308	0	5,517	0	283	0
LIVC	93	1	1	0	178	0	1	0	97	1	2	0	206	0	3	0
NVG	276	3	16	0	9,574	2	187	0	276	2	38	0	15,165	1	230	0
CLD/SHA	0	0	94	0	1,175	0	0	0	0	0	2,243	0	7,193	1	0	0
TOTAL	9,667	100	396,956	100	490,439	100	40,537	100	13,304	100	1,048,938	100	1,431,146	100	97,087	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow

Table C-22 Acres of Classified Change in Lassen County by Hardwood Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Montane Hardwood								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	1	0	2	0	3	0
SDVC	0	0	0	0	39	1	40	1
NCH	202	94	935	98	2,910	97	4,047	97
SIVC	12	6	15	2	40	1	68	2
MIVC	0	0	0	0	2	0	2	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	215	100	951	100	2,993	100	4,159	100
Aspen								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	7	1	19	2	11	2	37	1
NCH	1,096	84	845	96	350	83	2,291	88
SIVC	162	12	14	2	36	8	212	8
MIVC	37	3	3	0	16	4	56	2
LIVC	5	0	0	0	2	1	7	0
NVG	0	0	0	0	10	2	10	0
CLD/SHA	0	0	0	0		0	0	0
TOTAL	1,307	100	881	100	424	100	2,613	100
Montane Riparian								
LDVC	0	0	0	0	1	0	1	0
MDVC	0	0	0	0	121	2	121	2
SDVC	0	0	0	0	1,036	17	1,036	16
NCH	19	75	124	48	3,809	61	3,951	60
SIVC	6	25	124	48	656	10	786	12
MIVC	0	0	10	4	271	4	280	4
LIVC	0	0	0	0	90	1	90	1
NVG	0	0	0	0	266	4	266	4
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	25	100	258	100	6,250	100	6,532	100
TOTAL	1,547		2,090		9,667		13,304	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-23 Acres of Classified Change in Lassen County by Conifer Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Juniper								
LDVC	0	0	0	0	12	0	12	0
MDVC	0	0	13	0	16	0	29	0
SDVC	84	1	350	0	220	0	654	0
NCH	16,405	99	129,635	98	51,527	99	197,567	98
SIVC	46	0	477	0	298	1	821	0
MIVC	2	0	96	0	59	0	157	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	20	0	10	0	30	0
CLD/SHA	0	0	2,046	2	92	0	2,138	1
TOTAL	16,536	100	132,637	100	52,235	100	201,408	100
Eastside Pine								
LDVC	32	0	56	0	64	0	152	0
MDVC	255	0	13	0	181	0	449	0
SDVC	8,396	4	409	1	11,233	7	20,038	5
NCH	194,538	93	28,500	95	151,689	90	374,726	91
SIVC	6,695	3	922	3	5,947	4	13,563	3
MIVC	250	0	50	0	270	0	570	0
LIVC	0	0	0	0	1	0	1	0
NVG	2	0	0	0	6	0	8	0
CLD/SHA	0	0	103	0	2	0	105	0
TOTAL	210,168	100	30,052	100	169,392	100	409,612	100
Jeffrey Pine								
LDVC	0	0	0	0	0	0	0	0
MDVC	4	0	0	0	3	0	6	0
SDVC	268	2	11	9	55	4	334	2
NCH	9,421	69	111	91	868	65	10,401	69
SIVC	3,233	24	0	0	211	16	3,444	23
MIVC	648	5	0	0	194	15	842	6
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	13,574	100	122	100	1,331	100	15,027	100
Lodgepole Pine								
LDVC	2	0	0	0	0	0	2	0
MDVC	1	0	0	0	16	0	17	0
SDVC	447	2	45	4	346	8	839	3
NCH	23,063	95	1,053	94	3,707	84	27,823	93
SIVC	644	3	20	2	268	6	933	3
MIVC	155	1	8	1	54	1	217	1
LIVC	1	0	0	0	0	0	1	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	24,314	100	1,125	100	4,392	100	29,831	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-23 Acres of Classified Change in Lassen County by Conifer Cover Type and Owner Class (continued)

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Pinyon-Juniper								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	38	98	0	0	0	0	38	98
SIVC	1	2	0	0	0	0	1	2
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	39	100	0	0	0	0	39	100
Red Fir								
LDVC	68	0	0	0	2	0	71	0
MDVC	122	0	0	0	5	0	127	0
SDVC	983	4	516	5	186	9	1,685	4
NCH	25,126	91	8,866	94	1,894	89	35,886	92
SIVC	1,280	5	6	0	47	2	1,333	3
MIVC	111	0	4	0	0	0	115	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	27,691	100	9,392	100	2,135	100	39,217	100
Subalpine Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	8	2	0	0	0	0	8	2
NCH	340	98	57	100	0	0	397	98
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	347	100	57	100	0	0	405	100
Sierran Mixed Conifer								
LDVC	725	0	53	0	1,272	1	2,050	1
MDVC	1,466	1	94	0	1,350	1	2,910	1
SDVC	14,090	9	2,244	12	22,028	13	38,362	11
NCH	135,978	87	16,590	86	133,820	82	286,388	85
SIVC	3,029	2	177	1	4,909	3	8,115	2
MIVC	154	0	62	0	181	0	398	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	155,443	100	19,220	100	163,562	100	338,224	100
White Fir								
LDVC	65	1	0	0	5	0	70	0
MDVC	110	1	8	1	6	0	123	1
SDVC	317	3	91	7	229	6	638	4
NCH	9,312	94	1,235	90	3,548	91	14,095	93
SIVC	85	1	36	3	117	3	238	2
MIVC	4	0	1	0	6	0	10	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	9,893	100	1,371	100	3,910	100	15,174	100
TOTAL	458,005		193,976		396,956		1,048,938	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-24 Acres of Verified Change in Lassen County by Cause and Conifer Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Salvage Harvest	Development	Regeneration	Other	Total Verified
Eastside Pine											
LDVC	6	0	30	0	0	0	0	0	0	0	36
MDVC	112	0	177	0	0	0	0	0	5	7	301
SDVC	158	0	10,357	2,330	0	4	0	0	7	27	12,883
NCH	0	0	0	0	0	0	0	0	0	0	0
SIVC	1,099	0	277	6	0	0	0	0	4,086	210	5,678
MIVC	176	0	20	2	0	0	0	0	35	0	233
LIVC	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1,551	0	10,861	2,338	0	4	0	0	4,133	244	19,131
Jeffrey Pine											
LDVC	0	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	1	0	0	0	0	0	0	0	1
SDVC	149	0	7	0	0	0	0	0	0	0	156
NCH	0	0	0	0	0	0	0	0	0	0	0
SIVC	3,386	0	0	0	0	0	0	0	31	0	3,417
MIVC	838	0	0	0	0	0	0	0	0	0	838
LIVC	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0
TOTAL	4,373	0	8	0	0	0	0	0	31	0	4,412
Juniper											
LDVC	0	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0	0
SDVC	3	0	12	0	0	0	0	0	0	0	15
NCH	0	0	0	0	0	0	0	0	0	0	0
SIVC	36	0	3	0	0	0	0	0	3	0	42
MIVC	0	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0		0	0
TOTAL	39	0	15	0	0	0	0	0	3	0	57
Lodgepole Pine											
LDVC	0	0	2	0	0	0	0	0	0	0	2
MDVC	0	0	16	0	0	0	0	0	0	0	16
SDVC	0	0	282	15	0	0	0	0	0	0	297
NCH	0	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	88	0	0	0	0	0	10	0	98
MIVC	0	0	13	0	0	0	0	0	1	0	14
LIVC	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	401	15	0	0	0	0	11	0	427
Pinyon-Juniper											
LDVC	0	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	0	0	0
NCH	0	0	0	0	0	0	0	0	0	0	0
SIVC	1	0	0	0	0	0	0	0	0	0	1
MIVC	0	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1	0	0	0	0	0	0	0	0	0	1

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-24 Acres of Verified Change in Lassen County by Cause and Conifer Cover Type
(continued)

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Red Fir										
LDVC	0	0	58	0	0	0	0	0	0	58
MDVC	0	0	102	0	0	0	0	0	0	102
SDVC	0	0	719	0	0	0	0	0	0	719
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	2	0	11	0	0	0	0	650	0	663
MIVC	0	0	1	0	0	0	0	84	0	85
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	2	0	891	0	0	0	0	734	0	1,627
Sierran Mixed Conifer										
LDVC	134	0	1,472	0	0	0	0	0	0	1,606
MDVC	177	0	2,301	13	0	0	0	0	4	2,495
SDVC	135	0	29,078	1,038	0	14	0	0	19	30,284
NCH	0	0	2	0	0	0	0	0	0	2
SIVC	205	0	337	28	0	0	0	1,523	0	2,093
MIVC	8	0	35	5	0	0	0	154	0	202
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	659	0	33,225	1,084	0	14	0	1,677	23	36,682
White Fir										
LDVC	0	0	70	0	0	0	0	0	0	70
MDVC	2	0	122	0	0	0	0	0	0	124
SDVC	7	0	547	0	0	0	0	0	0	554
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	12	0	0	0	0	21	0	33
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	9	0	751	0	0	0	0	21	0	781
TOTAL	6,634	0	46,152	3,437	0	18	0	6,610	267	63,118

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Modoc County Monitoring Data Map

See appendix F

Table C-25 Acres of Classified Change in Modoc County by Lifeform and Owner Class

	National Forest								Other Public							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	0	0	846	0	31	0	3	0	0	0	31	0	57	0	0	0
MDVC	0	0	4,543	1	64	0	7	0	2	1	133	0	56	0	0	0
SDVC	108	2	13,703	2	2,203	0	235	1	2	1	339	1	556	0	1	0
NCH	3,904	82	661,693	97	577,421	98	36,358	94	123	96	54,785	99	214,820	96	472	100
SIVC	464	10	4,097	1	7,828	1	1,943	5	2	2	102	0	7,050	3	0	0
MIVC	274	6	618	0	498	0	21	0	0	0	14	0	163	0	0	0
LIVC	24	0	0	0	4	0	0	0	0	0	0	0	4	0	0	0
NVG	1	0	76	0	1,335	0	53	0	0	0	28	0	1,035	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	4,774	100	685,577	100	589,385	100	38,620	100	129	100	55,432	100	223,740	100	473	100

	Private								All Owners							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	1	0	920	0	792	0	246	1	1	0	1,797	0	880	0	249	0
MDVC	31	1	7,092	3	809	0	2,117	5	32	0	11,768	1	930	0	2,123	3
SDVC	376	16	15,842	6	5,150	2	3,108	7	486	7	29,884	3	7,908	1	3,344	4
NCH	1,633	68	242,616	90	222,034	90	29,390	69	5,660	77	959,095	95	1,014,274	96	66,220	81
SIVC	130	5	2,479	1	13,063	5	7,434	18	596	8	6,677	1	27,941	3	9,377	11
MIVC	134	6	574	0	768	0	91	0	408	6	1,206	0	1,430	0	112	0
LIVC	82	3	1	0	327	0	0	0	105	1	1	0	335	0	0	0
NVG	20	1	67	0	2,879	1	71	0	22	0	171	0	5,249	0	124	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2,406	100	269,592	100	245,822	100	42,457	100	7,309	100	1,010,601	100	1,058,947	100	81,550	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow

Table C-26 Acres of Classified Change in Modoc County by Hardwood Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Montane Hardwood								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	1	2	2	0	3	0
SDVC	46	0	0	0	42	9	88	8
NCH	564	0	53	98	412	89	1,029	91
SIVC	2	0	0	0	4	1	6	1
MIVC	1	0	0	0	1	0	2	0
LIVC	0	0	0	0	1	0	1	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	613	0	54	100	461	100	1,129	100
Aspen								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	2	2	2	0
SDVC	58	2	0	0	9	7	67	2
NCH	2,936	80	5	100	81	64	3,022	79
SIVC	417	11	0	0	15	12	432	11
MIVC	254	7	0	0	16	13	270	7
LIVC	23	1	0	0	2	2	25	1
NVG	1	0	0	0	0	0	1	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	3,688	100	5	100	126	100	3,819	100
Montane Riparian								
LDVC	0	0	0	0	1	0	1	0
MDVC	0	0	0	1	27	1	28	1
SDVC	4	1	2	2	325	18	330	14
NCH	404	85	65	94	1,140	63	1,608	68
SIVC	46	10	2	3	111	6	159	7
MIVC	19	4	0	0	117	6	136	6
LIVC	1	0	0	0	78	4	79	3
NVG	0	0	0	0	20	1	20	1
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	473	100	69	100	1,819	100	2,361	100
TOTAL	4,774		129		2,406		7,309	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-27 Acres of Classified Change in Modoc County by Conifer Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Juniper								
LDVC	4	0	4	0	5	0	13	0
MDVC	316	0	67	0	570	1	953	0
SDVC	848	0	107	0	1,380	2	2,336	1
NCH	264,941	99	49,781	99	84,841	97	399,563	99
SIVC	530	0	98	0	343	0	971	0
MIVC	168	0	14	0	81	0	263	0
LIVC	0	0	0	0	1	0	1	0
NVG	25	0	28	0	30	0	83	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	266,832	100	50,100	100	87,251	100	404,183	100
Eastside Pine								
LDVC	150	0	0	0	661	1	812	0
MDVC	1,364	0	3	0	3,215	3	4,582	1
SDVC	5,684	2	44	1	5,404	5	11,132	3
NCH	268,868	96	3,466	99	107,918	91	380,253	95
SIVC	2,781	1	3	0	1,565	1	4,348	1
MIVC	337	0	0	0	236	0	574	0
LIVC	0	0	0	0	0	0	0	0
NVG	10	0	0	0	35	0	45	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	279,194	100	3,516	100	119,034	100	401,745	100
Lodgepole Pine								
LDVC	0	0	0		0	0	0	0
MDVC	15	0	0		0	0	16	0
SDVC	4	0	0		0	0	4	0
NCH	9,337	98	0		341	100	9,678	99
SIVC	107	1	0		0	0	108	1
MIVC	13	0	0		0	0	13	0
LIVC	0	0	0		0	0	0	0
NVG	4	0	0		0	0	4	0
CLD/SHA	0	0	0		0	0	0	0
TOTAL	9,481	100	0	0	342	100	9,823	100
Subalpine Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	3	0	0	0	0	0	3	0
NCH	4,721	98	0	0	0	0	4,721	98
SIVC	95	2	0	0	0	0	95	2
MIVC	12	0	0	0	0	0	12	0
LIVC	0	0	0	0	0	0	0	0
NVG	6	0	0	0	0	0	6	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	4,837	100	0	0	0	0	4,837	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-27 Acres of Classified Change in Modoc County by Conifer Cover Type and Owner Class (continued)

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Sierran Mixed Conifer								
LDVC	518	1	25	2	218	0	761	1
MDVC	2,201	3	62	4	2,753	5	5,017	3
SDVC	5,931	7	150	10	8,093	14	14,175	10
NCH	76,911	89	1,217	84	47,868	80	125,997	86
SIVC	344	0	0	0	562	1	906	1
MIVC	75	0	0	0	256	0	331	0
LIVC	0	0	0	0	0	0	0	0
NVG	14	0	0	0	1	0	14	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	85,994	100	1,456	100	59,751	100	147,201	100
White Fir								
LDVC	173	0	2	0	36	1	211	0
MDVC	647	2	1	0	554	17	1,201	3
SDVC	1,232	3	38	10	965	30	2,234	5
NCH	36,916	94	320	89	1,648	51	38,884	91
SIVC	239	1	0	0	9	0	248	1
MIVC	14	0	0	0	0	0	14	0
LIVC	0	0	0	0	0	0	0	0
NVG	16	0	0	0	1	0	17	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	39,237	100	360	100	3,213	100	42,811	100
TOTAL	685,577		55,432		269,592		1,010,601	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-28 Acres of Verified Change in Modoc County by Cause and Hardwood Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Montane Hardwood										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	66	0	0	3	0	0	0	0	0	69
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	5	0	0	0	0	0	0	5
MIVC	0	0	1	0	0	0	0	0	0	1
LIVC	0	0	1	0	0	0	0	0	0	1
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	66	0	7	3	0	0	0	0	0	76
TOTAL	66	0	7	3	0	0	0	0	0	76

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-29 Acres of Verified Change in Modoc County by Cause and Conifer Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Eastside Pine										
LDVC	8	0	211	90	0	19	0	0	476	804
MDVC	177	0	1,428	1,783	0	58	0	77	552	4,075
SDVC	17	0	3,409	2,780	0	156	0	40	515	6,917
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	304	0	81	0	0	0	0	2,890	0	3,275
MIVC	96	0	8	0	0	0	0	328	0	432
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	2	21	0	0	0	2	0	25
CLD/SHA	0	0		0	0	0	0	0	0	0
TOTAL	602	0	5,139	4,674	0	233	0	3,337	1,543	15,528
Juniper										
LDVC	0	0	4	0	0	0	0	0	0	4
MDVC	0	0	410	1	0	0	0	0	0	411
SDVC	56	0	679	9	0	0	0	0	0	744
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	33	0	12	0	0	0	0	3	0	48
MIVC	8	0	0	0	0	0	0	0	0	8
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	2	0	0	0	0	0	0	2
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	97	0	1,107	10	0	0	0	3	0	1,217
Lodgepole Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	15	0	0	0	0	0	0	15
SDVC	0	0	3	0	0	0	0	0	0	3
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	1	0	0	0	0	0	0	1
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	19	0	0	0	0	0	0	19
Sierran Mixed Conifer										
LDVC	0	0	669	81	0	3	0	0	0	753
MDVC	14	0	3,134	1,388	0	49	0	0	207	4,792
SDVC	50	0	10,129	876	0	728	0	0	73	11,856
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	299	0	23	0	0	0	0	471	0	793
MIVC	175	0	4	0	0	0	0	141	0	320
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	1	0	0	0	0	5	0	6
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	538	0	13,960	2,345	0	780	0	617	280	18,520
White Fir										
LDVC	0	0	199	0	0	0	0	0	0	199
MDVC	27	0	1,050	0	0	1	0	0	0	1,078
SDVC	7	0	1,647	0	0	110	0	0	0	1,764
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	17	0	5	0	0	0	0	104	0	126
MIVC	2	0	0	0	0	0	0	9	0	11
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	6	0	0	0	0	0	0	6
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	53	0	2,907	0	0	111	0	113	0	3,184
TOTAL	1,290	0	23,132	7,029	0	1,124	0	4,070	1,823	38,468

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Nevada County Monitoring Data Map

See appendix F

Table C-30 Acres of Classified Change in Nevada County by Lifeform and Owner Class

	National Forest								Other Public							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	16	0	168	0	0	0	3	0	4	0	3	0	0	0	0	0
MDVC	18	0	1,096	1	0	0	11	0	14	0	98	1	1	0	0	0
SDVC	131	1	2,683	2	19	0	169	1	104	1	248	3	42	1	0	0
NCH	11,308	97	103,097	89	7,588	95	21,013	92	13,341	96	7,003	95	2,722	85	345	95
SIVC	71	1	7,013	6	318	4	1,284	6	414	3	30	0	398	12	7	2
MIVC	34	0	891	1	1	0	4	0	70	1	4	0	30	1	0	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	27	0	365	0	47	1	456	2	6	0	1	0	5	0	10	3
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	11,605	100	115,314	100	7,973	100	22,941	100	13,953	100	7,387	100	3,198	100	362	100

	Private								All Owners							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	216	0	163	0	26	0	22	0	236	0	334	0	26	0	25	0
MDVC	299	0	1,276	1	63	0	55	0	332	0	2,471	1	64	0	66	0
SDVC	2,610	1	4,390	3	712	2	311	1	2,844	1	7,321	3	774	2	481	1
NCH	167,245	95	118,648	94	33,751	89	27,506	91	191,894	95	228,748	92	44,060	90	48,864	91
SIVC	4,560	3	1,462	1	3,039	8	1,852	6	5,045	3	8,505	3	3,755	8	3,144	6
MIVC	496	0	59	0	110	0	8	0	600	0	954	0	140	0	12	0
LIVC	6	0	0	0	1	0	0	0	6	0	0	0	1	0	0	0
NVG	159	0	226	0	88	0	570	2	193	0	592	0	140	0	1,036	2
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	175,592	100	126,223	100	37,789	100	30,324	100	201,150	100	248,924	100	48,960	100	53,627	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow

Table C-31 Acres of Classified Change in Nevada County by Hardwood Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Blue Oak Woodland								
LDVC	0	0	0	0	18	0	18	0
MDVC	0	0	0	0	18	0	18	0
SDVC	0	0	8	1	322	2	330	2
NCH	15	90	764	81	15,070	91	15,849	90
SIVC	1	5	142	15	927	6	1,070	6
MIVC	0	0	29	3	187	1	216	1
LIVC	0	0		0	1	0	1	0
NVG	1	4	2	0	30	0	32	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	17	100	945	100	16,573	100	17,534	100
Blue Oak / Foothill Pine								
LDVC	0	0	0	0	19	0	19	0
MDVC	0	0	0	0	8	0	8	0
SDVC	0	0	1	0	120	2	121	2
NCH	0	0	153	90	6,031	95	6,184	95
SIVC	0	0	16	10	165	3	181	3
MIVC	0	0	0	0	16	0	17	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	8	0	8	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	171	100	6,367	100	6,538	100
Montane Hardwood								
LDVC	16	0	4	0	179	0	199	0
MDVC	16	0	14	0	272	0	302	0
SDVC	130	1	95	1	2,165	1	2,390	1
NCH	10,853	98	12,424	97	145,697	96	168,975	96
SIVC	62	1	256	2	3,460	2	3,778	2
MIVC	34	0	40	0	294	0	368	0
LIVC	0	0	0	0	5	0	5	0
NVG	19	0	5	0	111	0	134	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	11,130	100	12,838	100	152,182	100	176,151	100
Montane Riparian								
LDVC	0	0	0	0	0	0	0	0
MDVC	2	0	0	0	2	0	4	0
SDVC	1	0	0	0	3	1	4	0
NCH	440	96	0	0	448	95	888	96
SIVC	8	2	0	0	8	2	16	2
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	8	2	0	0	11	2	18	2
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	458	100	0	0	471	100	929	100
TOTAL	11,605		13,953		175,593		201,152	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-32 Acres of Classified Change in Nevada County by Conifer Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Eastside Pine								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	8	2	0	0	127	8	134	6
NCH	482	98	58	100	1,557	92	2,097	94
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	490	100	58	100	1,684	100	2,231	100
Jeffrey Pine								
LDVC	0	0	0	0	0	0	0	0
MDVC	55	0	0	0	56	0	111	0
SDVC	375	3	0	0	431	2	806	3
NCH	10,020	91	560	100	17,767	97	28,347	95
SIVC	590	5	0	0	57	0	647	2
MIVC	0	0	0	0	5	0	5	0
LIVC	0	0	0	0	0	0	0	0
NVG	1	0	0	0	2	0	3	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	11,041	100	560	100	18,318	100	29,919	100
Lodgepole Pine								
LDVC	0	0	0	0	0	0	0	0
MDVC	5	0	24	13	5	0	34	1
SDVC	33	2	25	14	92	2	149	2
NCH	1,945	96	128	73	4,284	97	6,357	96
SIVC	41	2	0	0	35	1	76	1
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	4	0	0	0	0	0	4	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	2,029	100	177	100	4,415	100	6,620	100
Montane Hardwood-Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	8	3	0	0	0	0	8	3
SDVC	12	5	0	0	1	4	13	5
NCH	248	92	0	0	19	96	267	93
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	268	100	0	0	20	100	288	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-32 Acres of Classified Change in Nevada County by Conifer Cover Type and Owner Class (continued)

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Ponderosa Pine								
LDVC	0	0	0	0	0	0	0	0
MDVC	8	1	3	8	5	1	16	1
SDVC	30	4	5	15	40	5	76	5
NCH	760	95	27	76	705	94	1,492	94
SIVC	2	0	0	1	0	0	2	0
MIVC	1	0	0	0	1	0	2	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	801	100	35	100	752	100	1,588	100
Red Fir								
LDVC	0	0	0	0	0	0	0	0
MDVC	127	1	4	3	88	0	219	0
SDVC	413	2	34	24	593	2	1,041	2
NCH	23,148	94	106	73	24,522	94	47,775	94
SIVC	545	2	0	0	774	3	1,320	3
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	308	1	0	0	193	1	502	1
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	24,542	100	144	100	26,170	100	50,856	100
Subalpine Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	5	1	0	0	1	0	6	0
SDVC	9	1	0	0	10	0	19	1
NCH	716	92	0	0	2,047	97	2,763	96
SIVC	4	1	0	0	28	1	32	1
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	47	6	0	0	20	1	66	2
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	781	100	0	0	2,105	100	2,886	100
Sierran Mixed Conifer								
LDVC	168	0	0	0	51	0	220	0
MDVC	880	1	19	3	497	1	1,396	1
SDVC	1,793	2	28	4	1,671	4	3,493	3
NCH	65,432	87	649	92	37,707	93	103,789	89
SIVC	5,829	8	6	1	506	1	6,342	5
MIVC	889	1	0	0	37	0	926	1
LIVC	0	0	0	0	0	0	0	0
NVG	5	0	0	0	4	0	10	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	74,998	100	703	100	40,474	100	116,175	100
Undetermined Conifer								
LDVC	0	0	3	0	111	0	114	0
MDVC	9	2	48	1	625	2	682	2
SDVC	8	2	155	3	1,425	4	1,589	4
NCH	346	95	5,475	96	30,039	93	35,859	93
SIVC	2	0	23	0	62	0	87	0
MIVC	1	0	4	0	16	0	21	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	1	0	6	0	7	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	365	100	5,709	100	32,285	100	38,359	100
TOTAL	115,314		7,387		126,223		248,924	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-33 Acres of Verified Change in Nevada County by Cause and Hardwood Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Blue Oak Woodland										
LDVC	6	0	1	0	0	0	4	0	0	11
MDVC	2	0	0	0	0	0	2	0	1	5
SDVC	29	0	2	0	0	0	27	1	18	77
NCH	0	0	0	0	0	0	1	0	0	1
SIVC	782	0	1	0	0	0	6	7	0	796
MIVC	176	0	0	0	0	0	0	11	0	187
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	4	0	0	0	0	0	0	0	0	4
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	999	0	4	0	0	0	40	19	19	1,081
Blue Oak / Foothill Pine										
LDVC	0	0	0	0	0	0	0	0	16	16
MDVC	0	0	0	0	0	0	0	0	4	4
SDVC	1	0	1	0	0	0	4	0	40	46
NCH	0	0	0	0	0	0	0	0	1	1
SIVC	91	0	0	0	0	0	0	0	0	91
MIVC	1	0	0	0	0	0	0	0	0	1
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	93	0	1	0	0	0	4	0	61	159
Montane Hardwood										
LDVC	38	0	67	0	0	0	10	34	6	155
MDVC	22	0	44	0	0	0	11	21	20	118
SDVC	227	0	131	0	0	0	98	109	153	718
NCH	2	0	3	0	0	0	0	11	5	21
SIVC	2,171	0	9	0	0	0	7	139	0	2,326
MIVC	139	0	0	0	0	0	0	38	0	177
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	4	0	0	0	0	0	0	1	0	5
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	2,603	0	254	0	0	0	126	353	184	3,520
TOTAL	3,695	0	259	0	0	0	170	372	264	4,760

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-34 Acres of Verified Change in Nevada County by Cause and Conifer Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Eastside Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	80	0	0	0	0	0	0	0	0	80
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	80	0	0	0	0	0	0	0	0	80
Jeffrey Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	50	0	0	0	0	0	0	50
SDVC	27	0	158	0	0	0	2	0	0	187
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	32	0	0	0	0	0	0	325	0	357
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	59	0	208	0	0	0	2	325	0	594
Lodgepole Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	0	0
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	17	0	17
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0	0	17	0	17
Ponderosa Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	1	0	0	0	0	0	0	1
SDVC	0	0	0	0	0	0	3	11	0	14
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	1	0	1
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	1	0	0	0	3	12	0	16
Red Fir										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	88	0	0	0	0	0	0	88
SDVC	0	0	59	0	0	0	0	0	0	59
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	168	0	168
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	147	0	0	0	0	168	0	315

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-34 Acres of Verified Change in Nevada County by Cause and Conifer Cover Type
(continued)

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Sierran Mixed Conifer										
LDVC	0	0	203	0	0	0	0	3	0	206
MDVC	3	0	903	0	0	0	32	25	0	963
SDVC	139	0	752	0	0	0	98	34	0	1,023
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	240	0	0	0	0	0	1	5,198	0	5,439
MIVC	9	0	0	0	0	0	0	891	0	900
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	391	0	1,858	0	0	0	131	6,151	0	8,531
Undetermined Conifer										
LDVC	9	0	69	0	0	0	0	0	0	78
MDVC	7	0	84	0	0	0	35	0	0	126
SDVC	4	0	87	0	0	0	113	0	0	204
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	1	0	0	0	0	0	0	8	0	9
MIVC	0	0	0	0	0	0	0	1	0	1
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	21	0	240	0	0	0	148	9	0	418
TOTAL	551	0	2,454	0	0	0	284	6,682	0	9,971

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Placer County Monitoring Data Map

See appendix F

Table C-35 Acres of Classified Change in Placer County by Lifeform and Owner Class

	National Forest								Other Public							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	65	0	147	0	0	0	5	0	1	0	1	0	0	0	0	0
MDVC	34	0	1,231	1	1	0	36	0	17	0	99	1	2	0	0	0
SDVC	188	1	3,365	2	1	0	310	1	160	1	195	2	105	2	6	1
NCH	29,601	98	202,959	94	1,062	97	54,537	93	23,737	98	12,117	97	5,399	95	564	93
SIVC	182	1	6,517	3	8	1	2,697	5	197	1	30	0	155	3	26	4
MIVC	27	0	818	0	0	0	19	0	8	0	5	0	2	0	6	1
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	4	0	328	0	26	2	1,129	2	9	0	1	0	8	0	2	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	30,102	100	215,365	100	1,098	100	58,733	100	24,129	100	12,448	100	5,672	100	604	100

	Private								All Owners							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	174	0	340	0	12	0	4	0	240	0	488	0	12	0	9	0
MDVC	181	0	1,574	1	25	0	80	0	232	0	2,904	1	28	0	115	0
SDVC	1,556	1	5,768	4	318	2	410	1	1,904	1	9,329	3	424	2	726	1
NCH	153,323	98	131,138	92	17,700	96	39,160	93	206,661	98	346,215	94	24,162	96	94,261	93
SIVC	1,219	1	2,797	2	317	2	1,852	4	1,599	1	9,344	3	481	2	4,575	5
MIVC	307	0	98	0	39	0	2	0	342	0	920	0	41	0	28	0
LIVC	41	0	6	0	4	0	0	0	41	0	6	0	4	0	0	0
NVG	158	0	143	0	38	0	545	1	170	0	472	0	72	0	1,676	2
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	156,959	100	141,865	100	18,453	100	42,053	100	211,190	100	369,678	100	25,224	100	101,390	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow

Table C-36 Acres of Classified Change in Placer County by Hardwood Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Blue Oak Woodland								
LDVC	0	0	0	0	23	0	23	0
MDVC	0	1	2	0	15	0	17	0
SDVC	0	0	19	1	217	1	237	1
NCH	27	95	1,705	97	25,568	98	27,300	98
SIVC	1	4	31	2	209	1	241	1
MIVC	0	0	1	0	94	0	95	0
LIVC	0	0	0	0	16	0	16	0
NVG	0	0	3	0	39	0	42	0
CLD/SHA	0	0	0	0		0		0
TOTAL	28	100	1,761	100	26,181	100	27,970	100
Blue Oak / Foothill Pine								
LDVC	0	0	0	0	7	0	7	0
MDVC	0	0	0	0	2	0	2	0
SDVC	0	0	2	2	59	1	61	1
NCH	0	0	119	96	4,272	97	4,391	97
SIVC	0	0	3	2	19	0	22	0
MIVC	0	0	0	0	15	0	15	0
LIVC	0	0	0	0	9	0	9	0
NVG	0	0	0	0	6	0	6	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	123	100	4,389	100	4,512	100
Montane Hardwood								
LDVC	65	0	1	0	144	0	210	0
MDVC	34	0	15	0	164	0	213	0
SDVC	185	1	138	1	1,280	1	1,603	1
NCH	28,170	99	21,903	99	122,991	98	173,064	98
SIVC	107	0	164	1	944	1	1,215	1
MIVC	27	0	7	0	199	0	233	0
LIVC	0	0		0	16	0	16	0
NVG	3	0	6	0	111	0	120	0
CLD/SHA	0	0		0		0		0
TOTAL	28,592	100	22,234	100	125,848	100	176,674	100
Aspen								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	214	77	0	0	28	53	242	73
SIVC	63	23	0	0	23	44	87	26
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	2	3	2	1
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	278	100	0	0	53	100	331	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-36 Acres of Classified Change in Placer County by Hardwood Cover Type and Owner Class (continued)

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Valley Foothill Riparian								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	0	0	0	0	19	100	19	100
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	19	100	19	100
Montane Riparian								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	3	0	0	0	1	0	4	0
NCH	1,190	99	11	100	446	95	1,647	98
SIVC	11	1	0	0	23	5	34	2
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	1,204	100	11	100	470	100	1,685	100
TOTAL	30,102		24,129		156,960		211,191	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-37 Acres of Classified Change in Placer County by Conifer Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Ponderosa Pine								
LDVC	1	0	0	0	2	0	3	0
MDVC	54	0	0	0	139	2	193	1
SDVC	374	3	1	0	632	10	1,007	6
NCH	10,455	96	279	99	5,762	87	16,495	93
SIVC	35	0	0	0	71	1	106	1
MIVC	6	0	0	0	2	0	8	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	10,925	100	280	100	6,607	100	17,812	100
Red Fir								
LDVC	0	0	0	0	0	0	0	0
MDVC	139	0	0	0	37	0	176	0
SDVC	386	1	5	13	665	2	1,055	1
NCH	45,607	96	31	87	30,014	94	75,652	95
SIVC	1,106	2	0	0	1,104	3	2,211	3
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	322	1	0	0	126	0	448	1
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	47,560	100	36	100	31,945	100	79,542	100
Subalpine Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	2	0	0	0	3	1	6	0
NCH	908	99	0	0	582	98	1,490	98
SIVC	8	1	0	0	9	2	17	1
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	919	100	0	0	595	100	1,514	100
Sierran Mixed Conifer								
LDVC	145	0	0	0	252	0	397	0
MDVC	1,023	1	0	0	868	1	1,891	1
SDVC	2,525	2	8	0	3,194	5	5,728	3
NCH	140,439	93	1,972	99	54,648	90	197,059	93
SIVC	5,259	4	17	1	1,438	2	6,715	3
MIVC	810	1	0	0	62	0	872	0
LIVC	0	0	0	0	0	0	0	0
NVG	6	0	0	0	6	0	12	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	150,208	100	1,997	100	60,469	100	212,673	100
White Fir								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	15	97	0	0	898	96	913	96
SIVC	0	3	0	0	38	4	39	4
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	16	100	0	0	936	100	952	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-37 Acres of Classified Change in Placer County by Conifer Cover Type and Owner Class (continued)

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Undetermined Conifer								
LDVC	0	0	1	0	87	0	88	0
MDVC	2	1	99	1	528	2	630	2
SDVC	8	5	180	2	785	3	973	2
NCH	158	92	9,776	97	27,572	95	37,506	95
SIVC	2	1	13	0	96	0	110	0
MIVC	2	1	5	0	34	0	40	0
LIVC	0	0	0	0	6	0	6	0
NVG	0	0	1	0	8	0	9	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	172	100	10,074	100	29,116	100	39,363	100
TOTAL	215,365		12,449		141,865		369,679	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-38 Acres of Verified Change in Placer County by Cause and Hardwood Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Blue Oak Woodland										
LDVC	0	0	0	0	0	0	7	1	0	8
MDVC	0	0	0	0	0	0	1	1	0	2
SDVC	0	0	1	0	0	0	6	0	0	7
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	1	0	0	0	0	0	6	17	0	24
MIVC	0	0	0	0	0	0	2	18	0	20
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	2	0	0	2
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	1	0	1	0	0	0	24	37	0	63
Blue Oak/Foothill Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	0	0
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	2	0	0	2
MIVC	0	0	0	0	0	0	0	1	0	1
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0	2	1	0	3
Montane Hardwood										
LDVC	4	0	99	0	0	0	17	22	0	142
MDVC	0	0	43	0	0	0	8	7	0	58
SDVC	16	0	85	0	0	0	34	1	0	136
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	17	0	0	0	22	146	0	185
MIVC	0	0	3	0	0	0	3	39	0	45
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	6	0	0	6
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	20	0	247	0	0	0	90	215	0	572
Montane Riparian										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	1	0	0	0	0	0	0	1
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	3	0	3
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	1	0	0	0	0	3	0	4
TOTAL	21	0	249	0	0	0	116	256	0	642

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-39 Acres of Verified Change in Placer County by Cause and Conifer Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Jeffrey Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	1	0	0	1
SDVC	0	0	3	0	0	0	352	0	0	355
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	95	0	95
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	3	0	0	0	353	95	0	451
Lodgepole Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	1	0	0	0	0	0	0	1
SDVC	0	0	0	0	0	0	0	0	0	0
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	1	0	0	0	0	0	0	1
Ponderosa Pine										
LDVC	0	0	3	0	0	0	0	0	0	3
MDVC	0	0	41	0	0	0	0	0	0	41
SDVC	25	0	29	0	0	0	0	0	0	54
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	5	0	0	0	0	0	0	19	0	24
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	30	0	73	0	0	0	0	19	0	122
Red Fir										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	71	0	0	0	0	0	0	71
SDVC	0	0	113	0	0	11	0	0	0	124
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	30	0	0	0	0	0	0	694	0	724
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	30	0	184	0	0	11	0	694	0	919
Sierran Mixed Conifer										
LDVC	0	0	390	0	0	0	0	3	0	393
MDVC	0	0	1,492	0	0	4	0	0	0	1,496
SDVC	8	0	1207	20	0	36	210	0	0	1,356
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	456	0	61	0	0	0	0	4,934	0	5,451
MIVC	0	0	46	0	0	0	0	780	0	826
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	2	0	2
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	464	0	2,972	20	0	40	210	5,719	0	9,524
Undetermined Conifer										
LDVC	17	0	35	0	0	0	0	25	0	77
MDVC	5	0	107	0	0	0	0	97	0	209
SDVC	0	0	149	0	0	0	0	32	0	181
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	22	0	22
MIVC	0	0	1	0	0	0	0	5	0	6
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	22	0	292	0	0	0	0	181	0	495
TOTAL	546	0	3,624	20	0	51	563	6,708	0	11,512

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Plumas County Monitoring Data Map

See appendix F

Table C-40 Acres of Classified Change in Plumas County by Lifeform and Owner Class

	National Forest								Other Public							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	2	0	251	0	2	0	3	0	0	0	0	0	0	0	0	0
MDVC	45	0	1,174	0	651	1	148	0	0	0	16	0	9	0	6	0
SDVC	255	1	17,084	2	1,024	1	862	1	6	1	329	2	46	1	14	0
NCH	49,100	96	712,608	89	69,076	94	131,672	95	492	86	18,507	96	7,056	99	4,164	96
SIVC	1,498	3	66,521	8	2,744	4	5,863	4	63	11	397	2	16	0	115	3
MIVC	43	0	5,476	1	99	0	141	0	14	2	32	0	0	0	14	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	11	0	54	0	20	0	151	0	0	0	0	0	0	0	4	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	50,955	100	803,168	100	73,617	100	138,840	100	574	100	19,280	100	7,126	100	4,317	100

	Private								All Owners							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	1	0	171	0	66	0	3	0	4	0	422	0	68	0	5	0
MDVC	19	0	600	0	137	0	99	0	65	0	1,789	0	797	1	253	0
SDVC	266	2	12,845	5	278	1	643	1	526	1	30,257	3	1,348	1	1,519	1
NCH	12,131	92	227,721	88	35,174	94	45,598	89	61,722	95	958,836	89	111,306	94	181,434	93
SIVC	793	6	17,271	7	1,694	5	4,568	9	2,354	4	84,189	8	4,454	4	10,547	5
MIVC	20	0	667	0	54	0	241	0	77	0	6,175	1	154	0	397	0
LIVC	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0
NVG	6	0	34	0	66	0	96	0	17	0	88	0	86	0	251	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	13,236	100	259,309	100	37,470	100	51,249	100	64,765	100	1,081,758	100	118,213	100	194,406	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow

Table C-41 Acres of Classified Change in Plumas County by Hardwood Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Blue Oak Woodland								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	0	0	0	0	21	100	21	100
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	21	100	21	100
Blue Oak/Foothill Pine								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	0	0	0	0	4	100	4	100
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	4	100	4	100
Montane Hardwood								
LDVC	2	0	0	0	1	0	4	0
MDVC	45	0	0	0	16	0	60	0
SDVC	241	1	6	1	248	2	495	1
NCH	46,352	97	395	91	11,395	93	58,141	96
SIVC	879	2	31	7	590	5	1,500	2
MIVC	26	0	0	0	14	0	40	0
LIVC	0	0	0	0	0	0	0	0
NVG	7	0	0	0	6	0	13	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	47,552	100	431	100	12,269	100	60,252	100
Aspen								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	2	0	0	0	0	0	2	0
NCH	428	70	53	55	61	87	542	70
SIVC	174	29	29	31	9	13	212	27
MIVC	5	1	13	14	0	0	18	2
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	609	100	95	100	70	100	774	100
Montane Riparian								
LDVC	0	0	0	0	0	0	0	0
MDVC	1	0	0	0	4	0	4	0
SDVC	11	0	0	0	18	2	29	1
NCH	2,320	83	44	93	650	75	3,015	81
SIVC	445	16	3	7	194	22	642	17
MIVC	12	0	0	0	7	1	19	1
LIVC	0	0	0	0	0	0	0	0
NVG	4	0	0	0	0	0	4	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	2,794	100	48	100	872	100	3,713	100
TOTAL	50,955		574		13,236		64,765	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-42 Acres of Classified Change in Plumas County by Conifer Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Douglas Fir								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	16	22	0	0	2	82	18	23
SIVC	25	33	0	0	0	18	26	33
MIVC	35	45	0	0	0	0	35	44
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	77	100	0	0	2	100	79	100
Eastside Pine								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	12	100	6	90	84	99	103	99
SIVC	0	0	1	10	1	1	1	1
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	12	100	7	100	85	100	104	100
Jeffrey Pine								
LDVC	6	0	0	0	19	0	25	0
MDVC	311	0	9	1	117	0	437	0
SDVC	1,942	2	34	3	906	3	2,882	2
NCH	98,982	83	1,117	92	22,653	87	122,752	84
SIVC	16,991	14	50	4	2,259	9	19,300	13
MIVC	1,261	1	0	0	84	0	1,345	1
LIVC	0	0	0	0	1	0	1	0
NVG	23	0	0	0	0	0	23	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	119,516	100	1,210	100	26,038	100	146,764	100
Lodgepole Pine								
LDVC	2	0	0	0	3	0	5	0
MDVC	3	0	0	0	8	0	11	0
SDVC	168	7	0	0	203	6	371	6
NCH	2,217	86	311	95	2,547	81	5,075	84
SIVC	176	7	17	5	350	11	543	9
MIVC	5	0	0	0	28	1	33	1
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	2,571	100	328	100	3,138	100	6,037	100
Pinyon-Juniper								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	7	1	0	0	0	0	7	1
NCH	1,007	94	0	0	1	100	1,007	94
SIVC	59	6	0	0	0	0	59	6
MIVC	1	0	0	0	0	0	1	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	1,074	100	0	0	1	100	1,074	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-42 Acres of Classified Change in Plumas County by Conifer Cover Type and Owner Class (continued)

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Ponderosa Pine								
LDVC	2	0	0	0	0	0	2	0
MDVC	25	0	0	0	25	0	49	0
SDVC	556	1	9	2	541	4	1,107	2
NCH	46,154	95	368	95	11,282	89	57,804	94
SIVC	1,784	4	9	2	789	6	2,582	4
MIVC	51	0	0	0	31	0	81	0
LIVC	0	0	0	0	0	0	0	0
NVG	5	0	0	0	8	0	13	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	48,577	100	387	100	12,676	100	61,640	100
Red Fir								
LDVC	26	0	0	0	0	0	26	0
MDVC	83	0	0	0	4	0	87	0
SDVC	922	2	28	1	111	8	1,061	2
NCH	51,714	90	4,486	97	1,233	84	57,433	90
SIVC	4,387	8	83	2	122	8	4,592	7
MIVC	229	0	27	1	3	0	259	0
LIVC	0	0	0	0	0	0	0	0
NVG	4	0	0	0	0	0	5	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	57,365	100	4,624	100	1,474	100	63,462	100
Subalpine Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	2	6	0	0	2	6
NCH	0	0	25	81	0	0	25	81
SIVC	0	0	4	13	0	0	4	13
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	31	100	0	0	31	100
Sierran Mixed Conifer								
LDVC	215	0	0	0	145	0	361	0
MDVC	712	0	7	0	445	0	1,164	0
SDVC	12,840	2	245	2	10,892	5	23,977	3
NCH	496,110	89	11,421	96	182,047	88	689,578	89
SIVC	42,413	8	184	2	12,305	6	54,902	7
MIVC	3,877	1	5	0	518	0	4,401	1
LIVC	0	0	0	0	0	0	0	0
NVG	22	0	0	0	26	0	48	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	556,189	100	11,862	100	206,379	100	774,430	100
White Fir								
LDVC	0	0	0	0	4	0	4	0
MDVC	40	0	0	0	0	0	40	0
SDVC	650	4	10	1	192	2	852	3
NCH	16,395	92	773	93	7,857	83	25,025	89
SIVC	685	4	49	6	1,445	15	2,179	8
MIVC	18	0	0	0	4	0	22	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	17,788	100	832	100	9,502	100	28,122	100
TOTAL	803,168		19,280		259,309		1,081,758	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-43 Acres of Verified Change in Plumas County by Cause and Hardwood Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Montane Hardwood										
LDVC	0	0	2	0	0	0	0	0	0	2
MDVC	0	0	2	0	0	0	0	0	0	2
SDVC	9	0	82	0	0	0	0	0	0	91
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	23	0	3	0	0	0	0	205	0	231
MIVC	0	0	0	0	0	0	0	14	0	14
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	32	0	89	0	0	0	0	219	0	340
Aspen										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	0	0
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	1	0	0	0	0	0	0	62	0	63
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	1	0	0	0	0	0	0	62	0	63
Montane Riparian										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	10	0	0	0	0	0	0	10
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	4	0	0	0	0	0	0	42	0	46
MIVC	0	0	0	0	0	0	0	2	0	2
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	4	0	10	0	0	0	0	44	0	58
TOTAL	37	0	99	0	0	0	0	325	0	461

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-44 Acres of Verified Change in Plumas County by Cause and Conifer Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Douglas Fir										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	0	0
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	25	0	0	0	0	0	0	0	0	25
MIVC	35	0	0	0	0	0	0	0	0	35
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	60	0	0	0	0		0	0	0	60
Jeffrey Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	258	0	15	0	0	0	0	0	0	273
SDVC	286	0	538	0	0	0	0	0	0	824
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	4,302	0	3	0	0	0	11	8,492	0	12,808
MIVC	543	0	0	0	0	0	7	637	0	1,187
LIVC	0	0	0	0	0	0	1	0	0	1
NVG	1	0	0	0	0	0	0	0	0	1
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	5,390	0	556	0	0	0	19	9,129	0	15,094
Lodgepole Pine										
LDVC	0	0	2	0	0	0	0	0	0	2
MDVC	0	0	3	0	0	0	0	0	0	3
SDVC	0	0	108	0	0	0	0	0	0	108
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	1	0	0	0	0	115	0	116
MIVC	0	0	0	0	0	0	0	10	0	10
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	114	0	0	0	0	125	0	239
Pinyon-Juniper										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	7	0	0	0	0	0	0	0	0	7
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	58	0	0	0	0	0	0	1	0	59
MIVC	1	0	0	0	0	0	0	0	0	1
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	66	0	0	0	0	0	0	1	0	67

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-44 Acres of Verified Change in Plumas County by Cause and Conifer Cover Type
(continued)

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Ponderosa Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	16	0	0	0	0	0	0	16
SDVC	0	0	193	0	0	0	0	0	0	193
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	103	0	18	0	0	0	0	529	0	650
MIVC	7	0	0	0	0	0	0	27	0	34
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	110	0	227	0	0	0	0	556	0	893
Red Fir										
LDVC	0	0	14	0	0	0	0	0	0	14
MDVC	0	0	29	0	0	0	0	0	0	29
SDVC	0	0	185	0	0	0	0	0	0	185
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	4	0	0	0	0	0	0	2,098	0	2,102
MIVC	0	0	0	0	0	0	0	182	0	182
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	4	0	228	0	0	0	0	2,280	0	2,512
Sierran Mixed Conifer										
LDVC	4	0	135	0	0	0	0	0	0	139
MDVC	17	0	545	0	0	0	0	0	0	562
SDVC	163	0	9,019	0	0	0	0	0	0	9,182
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	3,121	0	139	0	0	0	0	24,322	0	27,582
MIVC	1,262	0	10	0	0	0	0	2,573	0	3,845
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	1	0	1
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	4,567	0	9,848	0	0	0	0	26,896	0	41,311
White Fir										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	36	0	0	0	0	0	0	36
SDVC	0	0	269	0	0	0	0	0	0	269
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	12	0	0	0	0	366	0	378
MIVC	0	0	0	0	0	0	0	17	0	17
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	317	0	0	0	0	383	0	700
TOTAL	10,197	0	11,290	0	0	0	19	39,371	0	60,877

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Shasta County Monitoring Data Map

See appendix F

Table C-45 Acres of Classified Change in Shasta County by Lifeform and Owner Class

	National Forest								Other Public							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	0	0	1,340	1	0	0	0	0	0	0	148	0	0	0	0	0
MDVC	83	1	1,479	1	0	0	154	0	9	0	68	0	0	0	31	0
SDVC	37	0	7,914	4	1	0	182	0	79	1	1,914	3	3	0	35	0
NCH	9,210	97	183,461	91	9,647	99	61,031	97	7,601	96	72,644	96	13,738	100	33,063	97
SIVC	127	1	6,619	3	59	1	1,188	2	234	3	777	1	28	0	797	2
MIVC	4	0	148	0	0	0	117	0	19	0	95	0	0	0	22	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	1	0	0	0	24	0	1	0	0	0	0	0	290	1
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	9,462	100	200,961	100	9,707	100	62,696	100	7,943	100	75,644	100	13,770	100	34,238	100

	Private								All Owners							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	0	0	20,194	6	0	0	0	0	0	0	21,682	4	0	0	0	0
MDVC	2,069	1	9,269	3	98	1	1,063	1	2,161	1	10,815	2	98	0	1,248	1
SDVC	9,290	3	27,933	8	358	3	1,358	2	9,406	3	37,761	6	361	1	1,575	1
NCH	270,188	95	257,860	77	12,270	94	66,682	84	287,000	95	513,965	84	35,655	98	160,776	91
SIVC	2,736	1	19,501	6	303	2	7,809	10	3,097	1	26,897	4	391	1	9,793	6
MIVC	106	0	429	0	8	0	1,351	2	129	0	672	0	8	0	1,490	1
LIVC	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
NVG	46	0	25	0	17	0	684	1	47	0	26	0	17	0	998	1
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	284,436	100	335,212	100	13,053	100	78,947	100	301,840	100	611,818	100	36,530	100	175,881	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow

Table C-46 Acres of Classified Change in Shasta County by Hardwood Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Blue Oak Woodland								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	3	0	408	0	411	0
SDVC	4	11	24	1	4,891	2	4,919	2
NCH	32	89	2,751	98	158,688	97	161,472	97
SIVC	0	0	26	1	1,219	1	1,245	1
MIVC	0	0	1	0	34	0	35	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	17	0	17	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	36	100	2,805	100	165,256	100	168,098	100
Blue Oak / Foothill Pine								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	660	0	660	0
SDVC	0	0	15	0	2,494	3	2,510	3
NCH	92	94	964	100	65,278	95	66,334	95
SIVC	6	6	8	0	475	2	489	2
MIVC	0	0	0	0	31	0	31	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	1	0	10	0	11	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	98	100	987	100	68,949	100	70,035	100
Montane Hardwood								
LDVC	0	0	0	0		0	0	0
MDVC	83	1	6	0	1,002	2	1,091	2
SDVC	33	0	40	1	1,905	4	1,977	3
NCH	9,068	97	3,765	96	46,207	92	59,039	93
SIVC	120	1	119	3	1,040	2	1,278	2
MIVC	4	0	1	0	40	0	45	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	19	0	19	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	9,308	100	3,931	100	50,212	100	63,450	100
Aspen								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	18	95	101	50	16	87	136	57
SIVC	1	5	81	41	2	13	85	36
MIVC	0	0	18	9	0	0	18	7
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	19	100	200	100	19	100	238	100
TOTAL	9,462		7,943		284,436		301,840	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-47 Acres of Classified Change in Shasta County by Conifer Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Juniper								
LDVC	0	0	0	0	0	0	0	0
MDVC	2	0	0	0	1	0	3	0
SDVC	37	1	21	0	7	1	65	1
NCH	4,742	96	6,072	100	1,257	98	12,072	98
SIVC	153	3	0	0	6	1	160	1
MIVC	1	0	4	0	6	0	11	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	4,935	100	6,098	100	1,277	100	12,310	100
Douglas Fir								
LDVC	2	3	0	0	97	9	99	8
MDVC	0	0	0	0	18	2	18	1
SDVC	0	0	0	0	34	3	34	3
NCH	58	96	83	99	920	81	1,061	83
SIVC	1	1	1	1	70	6	71	6
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	60	100	84	100	1,139	100	1,283	100
Eastside Pine								
LDVC	3	0	0	0	17	0	20	0
MDVC	65	0	0	0	24	0	89	0
SDVC	1,335	4	67	1	888	8	2,290	4
NCH	33,072	93	5,924	98	10,030	89	49,026	93
SIVC	1,145	3	63	1	179	2	1,387	3
MIVC	46	0	1	0	84	1	131	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	35,666	100	6,054	100	11,224	100	52,944	100
Lodgepole Pine								
LDVC	2	0	0	0	0	0	2	0
MDVC	0	0	0	0	0	0	0	0
SDVC	134	5	25	2	24	1	183	3
NCH	2,725	92	1,542	96	2,120	94	6,387	94
SIVC	84	3	30	2	105	5	219	3
MIVC	10	0	5	0	1	0	16	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	2,955	100	1,602	100	2,250	100	6,808	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-47 Acres of Classified Change in Shasta County by Conifer Cover Type and Owner Class (continued)

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Montane Hardwood-Conifer								
LDVC	0	0	0	0	16	1	16	1
MDVC	0	0	0	0	2	0	2	0
SDVC	6	0	0	0	65	5	71	3
NCH	1,204	98	111	97	1,176	91	2,491	95
SIVC	13	1	4	3	35	3	52	2
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	1,223	100	115	100	1,294	100	2,632	100
Ponderosa Pine								
LDVC	3	0	0	0	1,493	3	1,496	3
MDVC	10	0	23	2	1,995	4	2,028	3
SDVC	52	2	48	4	4,147	7	4,248	7
NCH	2,817	97	1,073	90	45,561	82	49,450	83
SIVC	19	1	45	4	2,272	4	2,335	4
MIVC	0	0	0	0	49	0	49	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	2,900	100	1,189	100	55,516	100	59,605	100
Red Fir								
LDVC	0	0	0	0	0	1	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	148	2	445	2	0	0	594	2
NCH	7,420	98	22,299	97	27	99	29,746	97
SIVC	22	0	148	1	0	0	170	1
MIVC	1	0	22	0	0	0	23	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	7,591	100	22,914	100	28	100	30,533	100
Subalpine Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	133	6	0	0	133	5
NCH	471	100	1,966	92	19	100	2,457	93
SIVC	0	0	8	0	0	0	8	0
MIVC	0	0	36	2	0	0	36	1
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	471	100	2,143	100	19	100	2,634	100
Sierran Mixed Conifer								
LDVC	1,283	1	148	0	18,555	7	19,986	5
MDVC	1,391	1	38	0	7,215	3	8,644	2
SDVC	5,158	4	1,074	3	22,643	9	28,874	7
NCH	113,936	90	30,051	95	192,407	75	336,394	81
SIVC	4,852	4	435	1	16,697	6	21,984	5
MIVC	88	0	25	0	281	0	395	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	126,708	100	31,770	100	257,798	100	416,277	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-47 Acres of Classified Change in Shasta County by Conifer Cover Type and Owner Class (continued)

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
White Fir								
LDVC	47	0	0	0	16	1	63	0
MDVC	11	0	6	0	4	0	22	0
SDVC	1,043	6	101	3	93	3	1,238	5
NCH	16,935	92	3,440	96	2,894	94	23,270	93
SIVC	330	2	40	1	63	2	433	2
MIVC	1	0	1	0	0	0	2	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	18,368	100	3,588	100	3,071	100	25,027	100
Undetermined Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	10	1	10	1
SDVC	0	0	0	0	32	2	32	2
NCH	81	98	82	96	1,448	91	1,611	91
SIVC	0	0	3	4	74	5	77	4
MIVC	0	0	0	0	8	0	8	0
LIVC	0	0	0	0	0	0	0	0
NVG	1	2	0	0	25	2	26	1
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	83	100	86	100	1,596	100	1,764	100
TOTAL	200,961		75,644		335,212		611,818	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-48 Acres of Verified Change in Shasta County by Cause and Hardwood Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Blue Oak Woodland										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	39	0	32	75	0	0	33	0	27	206
SDVC	873	126	529	492	0	0	195	4	16	2,235
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	96	0	0	10	0	0	8	93	7	214
MIVC	2	0	0	2	0	0	1	2	0	7
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	1,010	126	561	579	0	0	237	99	50	2,662
Blue Oak/Foothill Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	435	90	0	0	33	0	0	558
SDVC	0	0	1,196	420	0	0	91	0	0	1,707
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	6	0	0	21	2	0	29
MIVC	0	0	0	0	0	0	9	1	0	10
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	2	1	0	0	0	0	0	3
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	1,633	517	0	0	154	3	0	2,307
Montane Hardwood										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	861	0	67	45	0	0	23	0	14	1,010
SDVC	460	9	270	274	0	0	111	2	4	1,130
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	186	0	48	2	0	0	5	280	8	529
MIVC	13	0	0	1	0	0	0	13	0	27
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	1	0	0	0	0	0	1
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	1,520	9	385	323	0	0	139	295	26	2,697
TOTAL	2,530	135	2,579	1,419	0	0	530	397	76	7,666

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-49 Acres of Verified Change in Shasta County by Cause and Conifer Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Douglas Fir										
LDVC	100	0	0	0	0	0	0	0	0	100
MDVC	17	0	0	0	0	0	0	0	0	17
SDVC	21	0	8	0	0	0	0	0	0	29
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	25	0	0	0	0	29	0	54
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	138	0	33	0	0	0	0	29	0	200
Eastside Pine										
LDVC	0	0	14	0	0	0	0	0	0	14
MDVC	0	0	69	0	0	0	0	0	0	69
SDVC	304	0	775	0	0	0	0	0	0	1,079
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	1,058	0	12	0	0	0	0	49	0	1,119
MIVC	20	0	0	0	0	0	0	23	0	43
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	1,382	0	870	0	0	0	0	72	0	2,324
Juniper										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	1	0	0	0	0	0	0	0	0	1
SDVC	5	0	0	0	0	0	0	0	0	5
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	146	0	0	0	0	0	0	0	0	146
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	152	0	0	0	0	0	0	0	0	152
Lodgepole Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	34	0	24	0	0	0	0	0	0	58
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	3	0	6	0	0	0	0	26	0	35
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	37	0	30	0	0	0	0	26	0	93
Montane Hardwood-Conifer										
LDVC	16	0	0	0	0	0	0	0	0	16
MDVC	2	0	0	0	0	0	0	0	0	2
SDVC	25	0	13	0	0	0	0	0	0	52
NCH		0	0	0	0	0	0	0	0	0
SIVC	5	0	7	0	0	0	0	1	0	13
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA		0	0	0	0	0	0	0	0	0
TOTAL	48	0	20	0	0	0	0	1	0	83

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-49 Acres of Verified Change in Shasta County by Cause and Conifer Cover Type
(continued)

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Ponderosa Pine										
LDVC	1,464	0	26	0	0	0	0	0	0	1,490
MDVC	1,918	0	53	6	0	0	4	0	0	1,981
SDVC	2,035	0	885	159	84	0	57	2	0	3,222
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	141	0	310	0	0	0	4	349	1	805
MIVC	11	0	5	0	0	0	0	3	0	19
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	5,569	0	1,279	165	84	0	65	354	1	7,517
Red Fir										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	20	0	27	0	0	0	0	0	0	47
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	4	0	0	0	0	0	0	4	0	8
MIVC	1	0	0	0	0	0	0	0	0	1
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	25	0	27	0	0	0	0	4	0	56
Sierran Mixed Conifer										
LDVC	18,432	0	1,399	75	0	0	0	0	0	19,906
MDVC	7,619	0	535	342	0	0	0	0	0	8,496
SDVC	6,038	0	13,159	2,384	0	0	0	5	0	21,586
NCH	1	0	1	0	0	0	0	0	0	2
SIVC	2,051	0	2,952	0	0	0	0	6,497	0	11,500
MIVC	180	0	23	0	0	0	0	75	0	278
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	34,321	0	18,069	2,801	0	0	0	6,577	0	61,768
White Fir										
LDVC	0	0	63	0	0	0	0	0	0	63
MDVC	0	0	12	0	0	0	0	0	0	12
SDVC	0	0	394	0	0	0	0	0	0	394
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	3	0	52	0	0	0	0	82	0	137
MIVC	0	0	0	0	0	0	0	1	0	1
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	3	0	521	0	0	0	0	83	0	607
Undetermined Conifer										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	1	2	0	0	0	0	0	3
SDVC	0	0	1	5	0	0	2	0	0	8
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	2	0	0	2	3	0	7
MIVC	0	0	0	1	0	0	0	1	0	2
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	2	3	0	0	0	0	0	5
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	4	13	0	0	4	4	0	25
TOTAL	41,675	0	20,853	2,993	84	0	69	7,150	1	72,825

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Sierra County Monitoring Data Map

See appendix F

Table C-50 Acres of Classified Change in Sierra County by Lifeform and Owner Class

	National Forest								Other Public							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	10	0	58	0	13	0	347	0	0	0	0	0	0	0	0	0
MDVC	24	0	5,913	2	228	1	1,174	2	0	0	27	1	6	0	4	0
SDVC	440	2	27,615	10	1,979	9	4,526	6	0	0	548	21	204	4	44	3
NCH	27,921	97	236,576	83	18,376	88	64,302	89	0	0	2,000	77	4,881	96	1,235	96
SIVC	181	1	13,777	5	269	1	2,016	3	0	0	15	1	0	0	0	0
MIVC	4	0	1,228	0	0	0	42	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	252	1	34	0	30	0	174	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	28,830	100	285,201	100	20,896	100	72,581	100	0	0	2,589	100	5,091	100	1,283	100

	Private								All Owners							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	0	0	8	0	1	0	26	0	10	0	66	0	14	0	374	0
MDVC	31	0	686	1	16	0	88	0	55	0	6,626	2	251	0	1,266	1
SDVC	217	2	7,619	9	569	2	601	2	657	2	35,781	10	2,752	5	5,171	5
NCH	9,199	95	70,885	87	30,262	97	25,569	92	37,120	96	309,461	84	53,519	94	91,105	90
SIVC	113	1	2,222	3	260	1	1,283	5	294	1	16,013	4	529	1	3,300	3
MIVC	30	0	47	0	0	0	9	0	33	0	1,275	0	0	0	51	0
LIVC	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0
NVG	143	1	33	0	9	0	137	0	395	1	67	0	40	0	311	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	9,733	100	81,499	100	31,120	100	27,714	100	38,563	100	369,289	100	57,107	100	101,578	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow

Table C-51 Acres of Classified Change in Sierra County by Hardwood Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Montane Hardwood								
LDVC	10	0	0	0	0	0	10	0
MDVC	23	0	0	0	31	0	54	0
SDVC	420	2	0	0	216	2	636	2
NCH	25,717	97	0	0	8,756	94	34,473	96
SIVC	126	0	0	0	111	1	236	1
MIVC	4	0	0	0	30	0	33	0
LIVC	0	0	0	0	0	0	0	0
NVG	246	1	0	0	137	1	384	1
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	26,545	100	0	0	9,281	100	35,826	100
Aspen								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	15	11	0	0	0	0	15	9
NCH	117	89	0	0	35	100	152	91
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	132	100	0	0	35	100	167	100
Montane Riparian								
LDVC	0	0	0	0	0	0	0	0
MDVC	1	0	0	0	0	0	1	0
SDVC	5	0	0	0	1	0	6	0
NCH	2,089	97	0	0	408	98	2,497	97
SIVC	54	3	0	0	2	1	57	2
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	5	0	0	0	6	1	11	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	2,155	100	0	0	417	100	2,572	100
TOTAL	28,832		0		9,733		38,565	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-52 Acres of Classified Change in Sierra County by Conifer Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Eastside Pine								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	143	23	143	19
SDVC	0	0	0	0	114	19	114	16
NCH	118	98	0	0	355	58	473	65
SIVC	3	2	0	0	0	0	3	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	121	100	0	0	611	100	732	100
Jeffrey Pine								
LDVC	3	0	0	0	0	0	3	0
MDVC	817	2	20	2	401	2	1,238	2
SDVC	6,407	14	332	26	4,169	22	10,908	17
NCH	35,455	78	898	71	13,594	73	49,947	77
SIVC	2,600	6	14	1	390	2	3,005	5
MIVC	0	0	0	0	7	0	7	0
LIVC	0	0	0	0	0	0	0	0
NVG	4	0	0	0	1	0	5	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	45,287	100	1,265	100	18,562	100	65,113	100
Lodgepole Pine								
LDVC	0	0	0	0	0	0	0	0
MDVC	22	2	0	0	6	0	28	1
SDVC	83	6	0	0	70	3	153	4
NCH	1,320	92	0	0	2,321	96	3,641	95
SIVC	9	1	0	0	8	0	17	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	1,434	100	0	0	2,405	100	3,839	100
Montane Hardwood-Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	14	16	0	0	4	12	18	15
NCH	73	84	0	0	30	88	103	85
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	87	100	0	0	34	100	121	100
Pinyon-Juniper								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	0	0	298	100	235	100	533	100
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	298	100	235	100	533	100
Ponderosa Pine								
LDVC	0	0	0	0	0	0	0	0
MDVC	10	0	0	0	0	0	10	0
SDVC	64	3	0	0	17	7	82	3
NCH	1,845	86	0	100	225	88	2,070	86
SIVC	175	8	0	0	12	5	187	8
MIVC	51	2	0	0	0	0	52	2
LIVC	0	0	0	0	0	0	0	0
NVG	2	0	0	0	0	0	2	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	2,147	100	0	100	255	100	2,402	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-52 Acres of Classified Change in Sierra County by Conifer Cover Type and Owner Class (continued)

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Red Fir								
LDVC	1	0	0	0	0	0	1	0
MDVC	464	1	0	0	37	0	501	1
SDVC	1,646	3	0	7	446	1	2,092	2
NCH	58,713	92	6	93	28,566	95	87,285	93
SIVC	2,743	4	0	0	1,108	4	3,851	4
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	13	0	0	0	26	0	39	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	63,579	100	6	100	30,184	100	93,769	100
Subalpine Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	1	0	0	0	0	0	1	0
SDVC	3	1	0	0	6	2	9	1
NCH	441	98	0	0	320	96	761	97
SIVC	4	1	0	0	8	2	12	2
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	450	100	0	0	333	100	783	100
Red Fir								
LDVC	1	0	0	0	0	0	1	0
MDVC	464	1	0	0	37	0	501	1
SDVC	1,646	3	0	7	446	1	2,092	2
NCH	58,713	92	6	93	28,566	95	87,285	93
SIVC	2,743	4	0	0	1,108	4	3,851	4
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	13	0	0	0	26	0	39	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	63,579	100	6	100	30,184	100	93,769	100
Subalpine Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	1	0	0	0	0	0	1	0
SDVC	3	1	0	0	6	2	9	1
NCH	441	98	0	0	320	96	761	97
SIVC	4	1	0	0	8	2	12	2
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	450	100	0	0	333	100	783	100
Sierran Mixed Conifer								
LDVC	55	0	0	0	8	0	63	0
MDVC	4,599	3	7	1	99	0	4,705	2
SDVC	19,398	11	216	21	2,792	10	22,406	11
NCH	138,607	81	797	78	25,240	87	164,645	82
SIVC	8,242	5	0	0	695	2	8,937	4
MIVC	1,177	1	0	0	40	0	1,217	1
LIVC	0	0	0	0	0	0	0	0
NVG	15	0	0	0	5	0	20	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	172,094	100	1,019	100	28,880	100	201,993	100
Undetermined Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	4	100	0	0	0	0	4	100
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	4	100	0	0	0	0	4	100
TOTAL	285,201		2,588		81,499		369,289	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-53 Acres of Verified Change in Sierra County by Cause and Hardwood Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Montane Hardwood										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	7	0	0	0	0	0	0	7
SDVC	2	0	43	0	0	0	0	0	0	45
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	39	0	4	0	0	0	0	85	0	128
MIVC	0	0	0	0	0	0	0	4	0	4
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	1	0	0	0	0	0	0	0	0	1
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	42	0	54	0	0	0	0	89	0	185
Aspen										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	15	0	0	0	0	0	0	0	0	15
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	15	0	0	0	0	0	0	0	0	15
Montane Riparian										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	1	0	0	0	0	0	0	1
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	0	4
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	1	0	0	0	0	0	0	5
TOTAL	57	0	54	0	0	0	0	93	0	205

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-54 Acres of Verified Change in Sierra County by Cause and Conifer Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Eastside Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	143	0	0	0	0	0	0	0	0	143
SDVC	100	0	0	0	0	0	0	0	0	100
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	3	0	3
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	243	0	0	0	0	0	0	3	0	246
Jeffrey Pine										
LDVC	2	0	0	0	0	0	0	0	0	02
MDVC	1,201	0	0	0	0	0	0	0	0	1,201
SDVC	8,248	0	319	0	0	0	0	0	0	8,567
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	69	0	0	0	0	0	0	1,970	0	2,039
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	2	0	2
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	9,520	0	319	0	0	0	0	1,972	0	11,811
Lodgepole Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	0	0
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	5	0	5
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0	0	5	0	5
Ponderosa Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	4	0	0	0	0	0	0	4
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	3	0	0	0	0	0	0	162	0	165
MIVC	0	0	0	0	0	0	0	51	0	51
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	3	0	4	0	0	0	0	213	0	220

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-54 Acres of Verified Change in Sierra County by Cause and Conifer Cover Type (continued)

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Red Fir										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	162	0	0	0	0	0	0	162
SDVC	0	0	408	0	0	0	0	0	0	408
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	2,313	0	2,313
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	570	0	0	0	0	2,313		2,883
Sierran Mixed Conifer										
LDVC	26	0	27	0	0	0	0	0	0	53
MDVC	4,445	0	59	0	0	0	0	0	0	4,504
SDVC	13,763	0	1,100	0	0	0	0	0	0	14,863
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	3,250	0	4	0	0	0	0	4,411	0	7,665
MIVC	936	0	0	0	0	0	0	244	0	1,180
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	2	0	0	0	0	0	0	0	0	2
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	22,422	0	1,190	0	0	0	0	4,655		28,267
TOTAL	32,188	0	2,083	0	0	0	0	9,163	0	43,434

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Sutter County Monitoring Data Map

See appendix F

Table C-55 Acres of Classified Change in Sutter County by Lifeform and Owner Class

	National Forest								Other Public							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	0	0	0	0	0	0	0	0	98	17	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	81	15	0	0	0	0	0	0
NCH	0	0	0	0	0	0	0	0	381	68	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0	0	0	560	100	0	0	0	0	0	0

	Private								All Owners							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	81	0	0	0	0	0	0	0	179	1	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SDVC	74	0	0	0	1	0	0	0	155	1	0	0	1	0	0	0
NCH	23,548	98	287	100	474	100	0	0	23,929	98	287	100	474	100	0	0
SIVC	132	1	0	0	0	0	0	0	132	1	0	0	0	0	0	0
MIVC	79	0	0	0	0	0	0	0	79	0	0	0	0	0	0	0
LIVC	9	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0
NVG	12	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	23,936	100	287	100	475	100	0	0	24,496	100	287	100	475	100	0	0

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow

Table C-56 Acres of Classified Change in Sutter County by Hardwood Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Blue Oak Woodland	0	0	0	0	0	0	0	0
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	0	0	0	0	647	100	647	100
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	1	0	1	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	648	100	648	100
Blue Oak / Foothill Pine								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	0	0	0	0	177	100	177	100
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	177	100	177	100
Montane Hardwood								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	2	0	2	0
NCH	0	0	0	0	1,339	100	1,339	100
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	1,341	100	1,341	100
Valley Oak Woodland								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	30	0	30	0
NCH	0	0	0	0	18,752	99	18,752	99
SIVC	0	0	0	0	41	0	41	0
MIVC	0	0	0	0	22	0	22	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	6	0	6	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	18,852	100	18,852	100
Valley Foothill Riparian								
LDVC	0	0	98	17	81	3	179	5
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	81	15	42	1	124	4
NCH	0	0	381	68	2,628	90	3,008	87
SIVC	0	0	0	0	91	3	91	3
MIVC	0	0	0	0	57	2	57	2
LIVC	0	0	0	0	9	0	9	0
NVG	0	0	0	0	6	0	6	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	560	100	2,913	100	3,473	100
TOTAL	0		560		23,931		24,491	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-57 Acres of Classified Change in Sutter County by Conifer Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Undetermined Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	0	0	0	0	287	100	287	100
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	287	100	287	100
TOTAL	0	0	0	0	287	0	287	0

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Tehama County Monitoring Data Map

See appendix F

Table C-58 Acres of Classified Change in Tehama County by Lifeform and Owner Class

	National Forest								Other Public							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	0	0	69	0	0	0	0	0	0	0	0	0	0	0	0	0
MDVC	737	2	405	0	0	0	53	0	22	0	0	0	0	0	0	0
SDVC	1,959	5	1,714	2	6	2	959	2	400	1	55	1	21	0	21	0
NCH	32,513	87	95,160	92	390	98	35,066	87	41,041	97	4,114	90	11,812	92	25,987	96
SIVC	2,138	6	5,484	5	0	0	4,150	10	883	2	377	8	956	7	956	4
MIVC	15	0	133	0	0	0	60	0	39	0	27	1	43	0	43	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	3	0	4	0	0	0	6	0	11	0	1	0	2	0	2	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	37,366	100	102,969	100	397	100	40,294	100	42,396	100	4,573	100	12,835	100	27,010	100

	Private								All Owners							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	1	0	704	0	0	0	0	0	1	0	773	0	0	0	0	0
MDVC	737	0	912	1	18	0	82	0	1,496	0	1,317	1	18	0	135	0
SDVC	6,779	2	9,592	6	203	1	288	1	9,138	2	11,361	4	230	1	1,268	1
NCH	416,688	97	121,032	81	25,468	98	47,140	85	490,243	96	220,305	86	37,670	96	108,193	88
SIVC	6,028	1	16,644	11	173	1	7,042	13	9,049	2	22,504	9	1,130	3	12,148	10
MIVC	291	0	99	0	4	0	633	1	345	0	259	0	47	0	736	1
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	48	0	13	0	20	0	45	0	62	0	18	0	22	0	53	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	430,573	100	148,996	100	25,885	100	55,229	100	510,334	100	256,538	100	39,117	100	122,533	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow

Table C-59 Acres of Classified Change in Tehama County by Hardwood Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Blue Oak Woodland								
LDVC	0	0	0	0	0	0	0	0
MDVC	135	1	3	0	101	0	239	0
SDVC	682	3	236	1	3,511	1	4,428	1
NCH	19,226	91	29,819	97	245,114	97	294,158	97
SIVC	1,139	5	610	2	3,838	2	5,586	2
MIVC	4	0	3	0	76	0	83	0
LIVC	0	0	0	0		0		0
NVG	2	0	8	0	26	0	36	0
CLD/SHA	0	0	0	0		0		0
TOTAL	21,186	100	30,678	100	252,665	100	304,531	100
Blue Oak/Foothill Pine								
LDVC	0	0	0	0	1	0	1	0
MDVC	0	0	0	0	141	0	141	0
SDVC	0	0	12	0	1,794	1	1,806	1
NCH	2	100	3,178	99	118,783	98	121,964	98
SIVC	0	0	11	0	242	0	253	0
MIVC	0	0	0	0	5	0	5	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	8	0	8	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	2	100	3,201	100	120,974	100	124,177	100
Montane Hardwood								
LDVC	0	0	0	0	0	0	0	0
MDVC	602	4	11	0	275	1	888	1
SDVC	1,277	8	120	2	870	2	2,268	3
NCH	13,173	82	7,206	96	44,058	94	64,436	91
SIVC	941	6	185	2	1,736	4	2,861	4
MIVC	9	0	6	0	26	0	41	0
LIVC	0	0	0	0	0	0	0	0
NVG	1	0	3	0	15	0	19	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	16,003	100	7,530	100	46,980	100	70,513	100
Valley Oak Woodland								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	45	2	45	2
SDVC	0	0	0	0	107	5	107	5
NCH	0	0	0	0	1,907	89	1,907	89
SIVC	0	0	0	0	8	0	8	0
MIVC	0	0	0	0	67	3	67	3
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	2,132	100	2,132	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-59 Acres of Classified Change in Tehama County by Hardwood Cover Type and Owner Class (continued)

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Aspen								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	33	56	51	51	2	100	86	54
SIVC	23	40	32	32	0	0	55	35
MIVC	2	4	17	17	0	0	19	12
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	59	100	100	100	2	100	160	100
Valley Foothill Riparian								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	8	1	174	2	183	2
SDVC	0	0	32	4	498	6	530	6
NCH	0	0	784	91	6,803	87	7,587	88
SIVC	0	0	33	4	185	2	217	3
MIVC	0	0	9	1	117	2	126	1
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	866	100	7,777	100	8,643	100
Montane Riparian								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	80	69	2	11	22	52	105	58
SIVC	35	31	14	65	20	47	69	39
MIVC	0	0	5	23	0	0	5	3
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	115	100	21	100	43	100	179	100
TOTAL	37,366		42,395		430,573		510,334	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-60 Acres of Classified Change in Tehama County by Conifer Cover Type and Owner Class

	National Forest		Other Public		Private		All Owner	
	Acres	%	Acres	%	Acres	%	Acres	%
Closed-Cone Pine-Cypress								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	8	88	0	0	0	0	8	88
SIVC	1	12	0	0	0	0	1	12
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	9	100	0	0	0	0	9	100
Douglas Fir								
LDVC	0	0	0	0	3	0	3	0
MDVC	6	0	0	0	0	0	6	0
SDVC	18	2	0	0	113	9	130	6
NCH	1,095	97	3	100	1,037	86	2,135	92
SIVC	9	1	0	0	49	4	58	2
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	1,128	100	3	100	1,202	100	2,333	100
Lodgepole Pine								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	40	2	40	2
NCH	141	75	0	0	1,388	81	1,529	80
SIVC	42	23	0	0	286	17	328	17
MIVC	3	2	0	0	4	0	7	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	187	100	0	0	1,718	100	1,905	100
Montane Hardwood-Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	131	22	10	14	451	24	592	23
NCH	398	67	54	81	1,334	71	1,785	70
SIVC	62	10	3	5	82	4	147	6
MIVC	5	1	0	0	4	0	8	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	596	100	66	100	1,870	100	2,533	100
Ponderosa Pine								
LDVC	14	0	0	0	306	1	319	1
MDVC	242	2	0	0	318	2	560	2
SDVC	447	4	10	1	789	4	1,246	4
NCH	10,043	84	607	88	17,837	86	28,487	85
SIVC	1,169	10	75	11	1,468	7	2,713	8
MIVC	24	0	0	0	5	0	29	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	11,939	100	692	100	20,723	100	33,355	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-60 Acres of Classified Change in Tehama County by Conifer Cover Type and Owner Class (continued)

	National Forest		Other Public		Private		All Owner	
	Acres	%	Acres	%	Acres	%	Acres	%
Red Fir								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	157	3	21	1	0	0	179	3
NCH	4,326	93	1,565	93	26	87	5,917	93
SIVC	173	4	83	5	4	13	260	4
MIVC	2	0	10	1	0	0	12	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	4,658	100	1,679	100	30	100	6,367	100
Subalpine Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	6	3	0	0	6	3
NCH	13	98	178	97	0	0	191	97
SIVC	0	2	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	13	100	185	100	0	0	198	100
Sierran Mixed Conifer								
LDVC	56	0	0	0	394	0	449	0
MDVC	155	0	0	0	581	1	736	0
SDVC	873	1	5	0	8,090	7	8,969	5
NCH	69,436	94	1,343	86	91,991	80	162,770	85
SIVC	3,498	5	195	13	14,548	13	18,242	10
MIVC	97	0	17	1	70	0	183	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	74,114	100	1,559	100	115,674	100	191,348	100
White Fir								
LDVC	0	0	0	0	0	0	0	0
MDVC	2	0	0	0	10	0	12	0
SDVC	85	1	0	0	80	1	165	1
NCH	9,424	94	114	86	5,803	96	15,340	95
SIVC	529	5	18	14	143	2	691	4
MIVC	2	0	0	0	0	0	2	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	10,042	100	133	100	6,036	100	16,210	100
Undetermined Conifer								
LDVC	0	0	0	0	2	0	2	0
MDVC	0	0	0	0	3	0	3	0
SDVC	2	1	3	1	28	2	34	1
NCH	275	98	251	98	1,616	93	2,143	94
SIVC	0	0	2	1	64	4	65	3
MIVC	0	0	0	0	17	1	17	1
LIVC	0	0	0	0	0	0	0	0
NVG	4	1	1	0	13	1	18	1
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	282	100	257	100	1,743	100	2,281	100
TOTAL	102,969		4,574		148,996		256,539	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-61 Acres of Verified Change in Tehama County by Cause and Hardwood Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Blue Oak Woodland										
LDVC	0	0	0	0	0	0		0	0	0
MDVC	130	0	0	0	0	0	2	0	0	132
SDVC	1,167	0	0	3	0	0	68	0	0	1,238
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	3,593	0	0	0	0	0	0	0	0	3,593
MIVC	20	0	0	0	0	0	0	0	0	20
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	4,910	0	0	3	0	0	70	0	0	4,983
Blue Oak/Foothill Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	2	22	0	0	43	0	0	67
SDVC	7	0	79	34	0	0	292	0	0	412
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	7	0	81	56	0	0	335	0	0	479
Montane Hardwood										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	794	0	21	0	0	0	1	0	0	816
SDVC	1,378	0	45	1	0	0	9	0	0	1,433
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	2,019	0	18	0	0	0	0	0	0	2,068
MIVC	28	0	0	0	0	0	0	0	0	28
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	4,219	0	84	1	0	0	10	0	0	4,345
Valley Oak Woodland										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	2	0	0	0	0	0	0	2
SDVC	0	0	4	0	0	0	0	0	0	4
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	6	0	0	0	0	0	0	6
Montane Riparian										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	0	0
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	0	3
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0	0	0	0	3
TOTAL	9,136	0	171	60	0	0	415	0	0	9,816

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-62 Acres of Verified Change in Tehama County by Cause and Conifer Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Douglas Fir	0									
LDVC	0	0	3	0	0	0	0	0	0	3
MDVC	3	0	2	0	0	0	0	0	0	5
SDVC	5	0	112	0	0	0	0	0	0	117
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	7	0	0	0	0	0	0	7
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	8	0	124	0	0	0	0	0	0	132
Lodgepole Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	0	0
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	14	0	14
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0	0	14	0	14
Montane Hardwood-Conifer										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	576	0	0	0	0	0	0	0	0	576
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	129	0	0	0	0	0	0	0	0	129
MIVC	9	0	0	0	0	0	0	0	0	9
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	714	0	0	0	0	0	0	0	0	714
Ponderosa Pine										
LDVC	315	0	1	0	0	0	0	0	0	316
MDVC	554	0	0	0	0	0	0	0	0	554
SDVC	591	0	146	64	0	0	1	0	0	802
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	1,195	0	33	5	0	0	0	489	0	1,722
MIVC	25	0	0	0	0	0	0	4	0	29
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	2,680	0	180	69	0	0	1	493	0	3,423

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-62 Acres of Verified Change in Tehama County by Cause and Conifer Cover Type
(continued)

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Red Fir										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	40	0	0	0	0	0	0	40
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	117	0	117
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	40	0	0	0	0	117	0	157
Sierran Mixed Conifer										
LDVC	311	0	97	0	0	0	0	0	0	408
MDVC	280	0	399	5	0	0	0	0	0	684
SDVC	456	0	5,470	703	0	0	1	0	0	6,630
NCH		0	2	0	0	0	0	0	0	2
SIVC	1,556	0	730	335	0	0	0	4,171	0	6,792
MIVC	44	0	3	0	0	0	0	91	0	138
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	2,647	0	6,701	1,043	0	0	1	4,262		14,654
White Fir										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	47	0	0	0	0	0	0	47
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	400	0	400
MIVC	0	0	0	0	0	0	0	2	0	2
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	47	0	0	0	0	402	0	449
TOTAL	6,049	0	7,092	1,112	0	0	2	5,288	0	19,543

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Yolo County Monitoring Data Map

See appendix F

Table C-63 Acres of Classified Change in Yolo County by Lifeform and Owner Class

	National Forest								Other Public							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	4	0	1	0	7	0	0	0
NCH	0	0	0	0	0	0	0	0	5,360	92	263	87	13,197	91	0	0
SIVC	0	0	0	0	0	0	0	0	463	8	1	0	1,284	9	0	0
MIVC	0	0	0	0	0	0	0	0	16	0	38	12	6	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0	0	0	5,844	100	303	100	14,494	100	0	0

	Private								All Owners							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
MDVC	3	0	1	6	1	0	0	0	4	0	1	0	1	0	0	0
SDVC	109	0	0	3	50	0	0	0	113	0	1	0	56	0	0	0
NCH	56,863	94	11	91	24,250	87	0	0	62,223	93	274	87	37,447	88	0	0
SIVC	3,330	5	0	0	3,479	12	0	0	3,793	6	1	0	4,763	11	0	0
MIVC	401	1	0	0	31	0	0	0	417	1	38	12	37	0	0	0
LIVC	29	0	0	0	2	0	0	0	29	0	0	0	2	0	0	0
NVG	42	0	0	0	36	0	0	0	42	0	0	0	37	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	60,778	100	12	100	27,848	100	0	0	66,622	100	315	100	42,342	100	0	0

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-64 Acres of Classified Change in Yolo County by Hardwood Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Blue Oak Woodland	0	0	0		0		0	
LDVC	0	0	0	0	1	0	1	0
MDVC	0	0	0	0	2	0	2	0
SDVC	0	0	0	0	63	0	63	0
NCH	0	0	2,074	93	47,030	94	49,104	93
SIVC	0	0	154	7	2,841	6	2,995	6
MIVC	0	0	13	1	314	1	328	1
LIVC	0	0	0	0	2	0	2	0
NVG	0	0	0	0	24	0	24	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	2,241	100	50,277	100	52,518	100
Montane Hardwood								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	1	0	1	0	2	0
SDVC	0	0	4	0	27	1	30	1
NCH	0	0	3,143	95	8,506	94	11,649	94
SIVC	0	0	172	5	460	5	632	5
MIVC	0	0	2	0	3	0	5	0
LIVC	0	0	0	0	10	0	10	0
NVG	0	0	0	0	5	0	5	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	3,322	100	9,012	100	12,334	100
Valley Oak Woodland								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	0	0	0	0	76	49	76	49
SIVC	0	0	0	0	13	8	13	8
MIVC	0	0	0	0	50	32	50	32
LIVC	0	0	0	0	17	11	17	11
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	156	100	156	100
Coastal Oak Woodland								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	5	0	5	0
NCH	0	0	144	98	1,238	98	1,382	98
SIVC	0	0	3	2	17	1	20	1
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	147	100	1,261	100	1,407	100
Valley Foothill Riparian								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	14	19	14	7
NCH	0	0	0	0	10	14	10	5
SIVC	0	0	134	100	0	0	134	65
MIVC	0	0	0	0	34	48	34	17
LIVC	0	0	0	0	0	1	0	0
NVG	0	0	0	0	13	18	13	6
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	134	100	71	100	205	100
TOTAL	0		5,844		60,776		66,620	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-65 Acres of Classified Change in Yolo County by Conifer Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Sierran Mixed Conifer	0	0						
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	38	100	0	0	38	100
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	38	100	0	0	38	100
Undetermined Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	1	6	1	0
SDVC	0	0	1	0	0	3	1	0
NCH	0	0	263	99	11	91	274	99
SIVC	0	0	1	0	0	0	1	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	266	100	12	100	278	100
TOTAL	0	0	303		12		315	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Yuba County Monitoring Data Map

See appendix F

Table C-66 Acres of Classified Change in Yuba County by Lifeform and Owner Class

	National Forest								Other Public							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	2	0	111	0	0	0	0	0	4	0	6	1	0	0	0	0
MDVC	3	0	380	1	0	0	7	0	7	0	79	10	1	0	0	0
SDVC	35	1	575	2	0	0	113	3	52	1	56	7	8	1	0	1
NCH	4,496	97	30,103	90	2	100	3,652	90	9,912	97	672	82	1,199	93	51	82
SIVC	81	2	1,751	5	0	0	280	7	157	2	7	1	74	6	10	16
MIVC	18	0	364	1	0	0	17	0	27	0	2	0	8	1	1	1
LIVC	0	0	0	0	0	0	0	0	14	0	1	0	2	0	0	0
NVG	0	0	5	0	0	0	4	0	1	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	4,634	100	33,289	100	2	100	4,074	100	10,175	100	823	100	1,292	100	62	100

	Private								All Owners							
	Hardwood		Conifer		Shrub		Chaparral		Hardwood		Conifer		Shrub		Chaparral	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
LDVC	178	0	385	1	8	0	6	0	184	0	502	1	9	0	6	0
MDVC	137	0	1,495	4	17	0	199	2	146	0	1,954	3	17	0	206	2
SDVC	1,078	1	2,294	6	163	1	699	8	1,165	1	2,924	4	170	1	812	6
NCH	101,486	96	30,826	85	11,106	93	6,935	82	115,894	96	61,601	88	12,307	93	10,637	84
SIVC	2,129	2	729	2	537	5	591	7	2,367	2	2,486	4	611	5	881	7
MIVC	324	0	322	1	35	0	36	0	368	0	688	1	42	0	54	0
LIVC	140	0	107	0	28	0	0	0	154	0	109	0	30	0	0	0
NVG	31	0	2	0	9	0	19	0	32	0	7	0	10	0	23	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	105,502	100	36,159	100	11,902	100	8,484	100	120,311	100	70,272	100	13,197	100	12,620	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow

Table C-67 Acres of Classified Change in Yuba County by Hardwood Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Blue Oak Woodland	0	0	0	0	0	0	0	0
LDVC	0	0	1	0	9	0	9	0
MDVC	0	0	0	0	5	0	6	0
SDVC	0	0	16	1	112	1	129	1
NCH	0	0	1,346	98	8,977	97	10,323	97
SIVC	0	0	6	0	66	1	73	1
MIVC	0	0	7	1	48	1	55	1
LIVC	0	0	2	0	12	0	14	0
NVG	0	0	1	0	6	0	7	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	1,379	100	9,236	100	10,615	100
Blue Oak/Foothill Pine	0	0	0	0	0	0	0	0
LDVC	0	0	0	0	6	0	6	0
MDVC	0	0	0	0	11	0	11	0
SDVC	0	0	8	0	99	2	107	1
NCH	0	0	2,579	97	4,335	94	6,914	95
SIVC	0	0	82	3	114	2	195	3
MIVC	0	0	2	0	24	1	26	0
LIVC	0	0	1	0	1	0	2	0
NVG	0	0	0	0	8	0	8	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	2,672	100	4,597	100	7,269	100
Montane Hardwood								
LDVC	2	0	3	0	161	0	166	0
MDVC	3	0	5	0	121	0	128	0
SDVC	35	1	28	0	836	1	899	1
NCH	4,496	97	5,988	98	84,549	96	95,032	96
SIVC	81	2	69	1	1,917	2	2,066	2
MIVC	18	0	18	0	228	0	264	0
LIVC	0	0	11	0	127	0	137	0
NVG	0	0	0	0	16	0	16	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	4,634	100	6,121	100	87,954	100	98,709	100
Valley Oak Woodland								
LDVC	0	0	0	0	2	1	2	1
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	0	0	0	0	275	99	275	99
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	278	100	278	100
Valley Foothill Riparian								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	2	77	0	0	2	0
SDVC	0	0	0	8	31	1	31	1
NCH	0	0	0	0	3,350	97	3,350	97
SIVC	0	0	0	15	32	1	33	1
MIVC	0	0	0	0	23	1	23	1
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	1	0	1	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	3	100	3,438	100	3,440	100
TOTAL	4,634		10,175		105,502		120,311	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-68 Acres of Classified Change in Yuba County by Conifer Cover Type and Owner Class

	National Forest		Other Public		Private		All Owners	
	Acres	%	Acres	%	Acres	%	Acres	%
Douglas Fir								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	0	0	0	0	2	100	2	100
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	2	100	2	100
Montane Hardwood-Conifer								
LDVC	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0
NCH	0	0	128	100	0	0	128	100
SIVC	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	0	0	128	100	0	0	128	100
Ponderosa Pine								
LDVC	30	0	6	2	112	1	148	1
MDVC	119	1	68	23	731	6	918	4
SDVC	179	2	25	8	778	7	982	4
NCH	10,123	95	191	64	10,214	86	20,527	90
SIVC	148	1	6	2	101	1	255	1
MIVC	41	0	2	1	6	0	49	0
LIVC	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	10,638	100	299	100	11,942	100	22,879	100
Sierran Mixed Conifer								
LDVC	81	0	0	0	235	1	315	1
MDVC	261	1	10	39	630	4	900	2
SDVC	396	2	12	48	1,154	7	1,562	4
NCH	19,974	88	3	13	13,710	82	33,688	86
SIVC	1,603	7	0	0	619	4	2,222	6
MIVC	323	1	0	0	281	2	604	2
LIVC	0	0	0	0	0	0	0	0
NVG	5	0	0	0	0	0	5	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	22,643	100	24	100	16,629	100	39,297	100
Undetermined Conifer								
LDVC	0	0	0	0	38	1	38	0
MDVC	1	15	1	0	134	2	136	2
SDVC	0	0	19	5	361	5	381	5
NCH	6	82	350	94	6,900	91	7,257	91
SIVC	0	0	0	0	9	0	9	0
MIVC	0	0	0	0	35	0	35	0
LIVC	0	0	1	0	107	1	108	1
NVG	0	3	0	0	1	0	2	0
CLD/SHA	0	0	0	0	0	0	0	0
TOTAL	8	100	372	100	7,585	100	7,965	100
TOTAL	33,289		823		36,159		70,272	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-69 Acres of Verified Change in Yuba County by Cause and Hardwood Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Blue Oak Woodland										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	0	0
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	2	0	2
MIVC	0	0	0	0	0	0	0	13	0	13
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0	0	15	0	15
Blue Oak/Foothill Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	0	0
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	6	0	6
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0	0	6	0	6
Montane Hardwood										
LDVC	0	0	77	0	0	0	0	0	0	77
MDVC	0	0	50	0	0	0	2	0	0	52
SDVC	1	0	98	0	0	0	41	0	0	140
NCH	0	0	0	0	0	0	0	0	0	
SIVC	33	0	0	0	0	0	0	73	0	106
MIVC	0	0	0	0	0	0	0	49	0	49
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	34	0	225	0	0	0	43	122	0	424
TOTAL	34	0	225	0	0	0	43	143	0	445

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table C-70 Acres of Verified Change in Yuba County by Cause and Conifer Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Ponderosa Pine										
LDVC	0	0	89	0	0	0	0	0	0	89
MDVC	0	0	627	0	0	0	0	0	0	627
SDVC	0	0	399	0	0	0	0	0	0	399
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	5	0	0	0	0	139	0	144
MIVC	0	0	0	0	0	0	0	42	0	42
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	1,120	0	0	0	0	181	0	1,301
Sierran Mixed Conifer										
LDVC	0	0	212	0	0	0	0	0	0	212
MDVC	0	0	581	0	0	0	0	0	0	581
SDVC	2	0	689	0	0	0	0	0	0	691
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	14	0	0	0	0	0	0	1,654	0	1,668
MIVC	0	0	0	0	0	0	0	562	0	562
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	16	0	1,482	0	0	0	0	2,216	0	3,714
Undetermined Conifer										
LDVC	0	0	13	0	0	0	0	0	0	13
MDVC	0	0	15	0	0	0	0	0	0	15
SDVC	0	0	44	0	0	0	1	0	0	45
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	1	0	1
MIVC	0	0	0	0	0	0	0	2	0	2
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	72	0	0	0	1	3	0	76
TOTAL	16	0	2,674	0	0	0	1	2,400	0	5,091

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

NATIONAL FOREST TABLES

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2. Acres of Classified Change by Lifeform and National Forest
3. Acres of Classified Change by Hardwood Cover Type and National Forest
4. Acres of Classified Change by Conifer Cover Type and National Forest
5. Acres of Verified Change in the Eldorado National Forest by Cause and Hardwood Cover Type
6. Acres of Verified Change in the Eldorado National Forest by Cause and Conifer Cover Type
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8. Acres of Verified Change in the Lassen National Forest by Cause and Hardwood Cover Type
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10. Acres of Verified Change in the Modoc National Forest by Cause and Conifer Cover Type
11. Acres of Verified Change in the Plumas National Forest by Cause and Hardwood Cover Type
12. Acres of Verified Change in the Plumas National Forest by Cause and Conifer Cover Type
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14. Acres of Verified Change in the Tahoe National Forest by Cause and Conifer Cover Type

ElDorado National Forest Monitoring Data Map

See appendix F

LTBMU County Monitoring Data Map

See appendix F

Lassen National Forest Monitoring Data Map

See appendix F

Modoc National Forest Monitoring Data Map

See appendix F

Plumas National Forest County Monitoring Data Map

See appendix F

Tahoe National Forest Monitoring Data Map

See appendix F

Table F-1 Acres of Classified Change by Lifeform and National Forest

	Eldorado		Lake Tahoe Basin Management Unit		Lassen		Modoc		Plumas		Tahoe		All Forests	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Hardwood														
LDVC	0	0	0	0	0	0	0	0	30	0	92	0	122	0
MDVC	12	0	2	0	818	2	0	0	95	0	76	0	1,003	1
SDVC	122	1	28	4	1,929	5	64	1	447	1	741	1	3,332	2
NCH	9,890	98	496	71	35,006	87	4,282	82	76,249	97	62,785	98	188,707	95
SIVC	22	0	170	24	2,625	6	574	11	1,749	2	312	0	5,452	3
MIVC	2	0	0	0	32	0	301	6	95	0	63	0	492	0
LIVC	0	0	0	0	0	0	29	1	0	0	0	0	29	0
NVG	3	0	0	0	2	0	1	0	32	0	279	0	318	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	10,052	100	696	100	40,412	100	5,251	100	78,698	100	64,347	100	199,454	100
Conifer														
LDVC	43	0	0	0	2,238	0	1,052	0	694	0	377	0	4,404	0
MDVC	7,255	2	85	0	4,049	1	5,081	1	1,537	0	7,384	1	25,390	1
SDVC	11,033	2	297	0	38,106	5	15,043	2	14,265	2	28,652	5	107,396	3
NCH	435,746	92	71,110	98	717,205	90	814,244	96	692,419	89	454,495	87	3,185,220	91
SIVC	15,846	3	1,015	1	29,549	4	8,591	1	65,341	8	26,543	5	146,884	4
MIVC	162	0	4	0	1,418	0	669	0	6,667	1	2,974	1	11,894	0
LIVC	0	0	0	0	0	0	1	0	0	0	0	0	1	0
NVG	990	0	69	0	7	0	79	0	84	0	702	0	1,931	0
CLD/SHA	658	0	0	0	0	0	0	0	0	0	0	0	658	0
TOTAL	471,734	100	72,579	100	792,573	100	844,760	100	781,007	100	521,127	100	3,483,779	100
Shrub														
LDVC	0	0	0	0	0	0	33	0	2	0	13	0	48	0
MDVC	0	0	0	0	8	0	81	0	674	1	230	1	993	0
SDVC	2	0	27	1	21	0	2,258	0	1,159	2	2,004	7	5,470	1
NCH	1,411	67	3,094	91	59,375	97	661,241	98	71,832	94	26,899	90	823,853	97
SIVC	511	24	242	7	956	2	9,315	1	2,698	4	716	2	14,437	2
MIVC	0	0	0	0	230	0	514	0	104	0	6	0	854	0
LIVC	0	0	0	0	0	0	4	0	0	0	0	0	5	0
NVG	168	8	48	1	478	1	1,399	0	20	0	79	0	2,192	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2,092	100	3,411	100	61,067	100	674,847	100	76,489	100	29,946	100	847,852	100
Chaparral														
LDVC	29	0	0	0	0	0	3	0	3	0	186	0	221	0
MDVC	43	0	10	0	279	0	21	0	186	0	808	1	1,347	0
SDVC	318	1	134	1	1,325	1	310	1	1,000	1	4,105	3	7,191	1
NCH	21,731	95	16,423	91	112,134	94	50,513	94	140,521	95	124,097	91	465,419	93
SIVC	599	3	1,343	7	5,683	5	2,831	5	6,138	4	5,461	4	22,054	4
MIVC	1	0	0	0	181	0	28	0	195	0	60	0	466	0
LIVC	0	0	0	0	0	0	0	0	1	0	0	0	1	0
NVG	54	0	49	0	87	0	56	0	189	0	1,672	1	2,108	0
CLD/SHA	109	0	0	0	0	0	0	0		0		0	109	0
TOTAL	22,884	100	17,960	100	119,688	100	53,762	100	148,233	100	136,390	100	498,916	100
TOTAL	506,760		94,646		1,013,740		1,578,619		1,084,427		751,809		5,030,001	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow

Table F-2 Acres of Classified Change by Hardwood Cover Type and National Forest

	Eldorado		Lake Tahoe Basin Management Unit		Lassen		Modoc		Plumas		Tahoe		All Forests	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Blue Oak Woodland														
LDVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	125	1	0	0	0	0	0	0	126	1
SDVC	5	6	0	0	635	3	0	0	0	0	0	0	639	3
NCH	76	93	0	0	16,900	90	0	0	0	0	41	94	17,017	90
SIVC	1	1	0	0	1,144	6	0	0	0	0	2	4	1,146	6
MIVC	0	0	0	0	4	0	0	0	0	0	0	0	4	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0	1	2	1	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	81	100	0	0	18,808	100	0	0	0	0	43	100	18,933	100
Blue Oak/Foothill Pine														
LDVC	0	0	0	0	0	0	0	0	0	0	0	0		
MDVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SDVC	0	4	0	0	0	0	0	0	0	0	0	0	0	0
NCH	4	82	0	0	4	86	0	0	0	0	0	0	0	2
SIVC	1	14	0	0	1	14	0	0	0	0	0	0	8	84
MIVC	0	0	0	0	0	0	0	0	0	0	0	0	1	14
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	5	100	0	0	5	100	0	0	0	0	0	0	0	0
Montane Hardwood													10	100
LDVC	0	0	0	0	0	0	0	0	30	0	92	0		
MDVC	12	0	0	0	692	3	0	0	95	0	73	0		
SDVC	116	1	0	0	1,288	6	0	0	436	1	717	1	122	0
NCH	9,551	98	0	0	17,206	84	44	99	73,683	97	59,220	98	872	1
SIVC	15	0	0	0	1,157	6	0	1	1,285	2	257	0	2,557	2
MIVC	2	0	0	0	17	0	0	0	76	0	63	0	159,703	96
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	2,714	2
NVG	3	0	0	0	2	0	0	0	28	0	266	0	157	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	9,699	100	0	0	20,362	100	44	100	75,633	100	60,687	100	299	0
Aspen													0	0
LDVC	0	0	0	0	0	0	0	0	0	0	0	0	166,425	100
MDVC	0	0	2	0	0	0	0	0	0	0	0	0		
SDVC	0	0	28	4	4	1	61	1	3	1	15	11		
NCH	0	0	496	71	502	71	3,834	81	228	73	117	89	0	0
SIVC	0	0	170	24	191	27	528	11	73	23	0	0	2	0
MIVC	0	0	0	0	9	1	281	6	9	3	0	0	110	2
LIVC	0	0	0	0	0	0	28	1	0	0	0	0	5,177	79
NVG	0	0	0	0	0	0	1	0	0	0	0	0	962	15
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	299	5
TOTAL	0	0	696	100	705	100	4,733	100	313	100	132	100	28	0
Montane Riparian													1	0
LDVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	1	0	0	0	0	0	3	0	6,579	100
SDVC	1	0	0	0	3	1	4	1	8	0	9	0		
NCH	260	98	0	0	447	76	404	85	2,338	85	3,407	98		
SIVC	5	2	0	0	138	23	46	10	392	14	53	2	0	0
MIVC	0	0	0	0	2	0	19	4	10	0	0	0	3	0
LIVC	0	0	0	0	0	0	1	0	0	0	0	0	25	0
NVG	0	0	0	0	0	0	0	0	4	0	13	0	6,855	91
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	634	8
TOTAL	266	100	0	0	592	100	473	100	2,752	100	3,484	100	32	0
TOTAL	10,052		696		40,412		5,251		78,698		64,347		1	0

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table F-3 Acres of Classified Change by Conifer Cover Type and National Forest

	Eldorado		Lake Tahoe Basin Management Unit		Lassen		Modoc		Plumas		Tahoe		All Forests	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Juniper														
LDVC	0	0	0	0	0	0	4	0	0	0	0	0	4	0
MDVC	0	0	0	0	0	0	316	0	0	0	0	0	316	0
SDVC	0	0	0	0	88	1	881	0	0	0	0	0	969	0
NCH	0	0	0	0	6,996	96	279,051	99	0	0	0	0	286,047	99
SIVC	0	0	0	0	189	3	542	0	0	0	0	0	731	0
MIVC	0	0	0	0	1	0	169	0	0	0	0	0	170	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	25	0	0	0	0	0	25	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	7,273	100	280,988	100	0	0	0	0	288,261	100
Closed-Cone Pine-Cypress														
LDVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NCH	0	0	0	0	8	88	0	0	0	0	118	100	126	99
SIVC	0	0	0	0	1	12	0	0	0	0	0	0	1	1
MIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	9	100	0	0	0	0	118	100	127	100
Douglas Fir														
LDVC	0	0	0	0	2	0	0	0	0	0	0	0	2	0
MDVC	0	0	0	0	6	0	0	0	0	0	0	0	6	0
SDVC	0	0	0	0	18	1	0	0	0	0	0	0	18	1
NCH	0	0	0	0	1,187	97	0	0	3	5	0	0	1,190	93
SIVC	0	0	0	0	10	1	0	0	25	40	0	0	35	3
MIVC	0	0	0	0	0	0	0	0	35	55	0	0	35	3
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	1,223	100	0	0	63	100	0	0	1,285	100
Eastside Pine														
LDVC	0	0	0	0	29	0	156	0	0	0	0	0	185	0
MDVC	0	0	0	0	284	0	1,396	0	0	0	0	0	1,680	0
SDVC	0	0	0	0	9,344	5	6,004	2	3	12	2	3	15,352	3
NCH	0	0	0	0	179,530	93	318,767	96	19	88	47	97	498,364	95
SIVC	0	0	0	0	4,257	2	6,411	2	0	0	0	0	10,669	2
MIVC	0	0	0	0	268	0	349	0	0	0	0	0	617	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	12	0	0	0	0	0	12	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	193,712	100	333,096	100	22	100	49	100	526,879	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table F-3 Acres of Classified Change by Conifer Cover Type and National Forest

(continued)

	Eldorado		Lake Tahoe Basin Management Unit		Lassen		Modoc		Plumas		Tahoe		All Forests	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Jeffrey Pine														
LDVC	0	0	0	0	0	0	0	0	6	0	2	0	9	0
MDVC	1	0	7	0	0	0	0	0	315	0	475	1	799	0
SDVC	8	1	56	1	0	0	0	0	2,181	2	4,057	8	6,301	3
NCH	1,015	98	5,120	97	0	0	0	0	103,115	81	40,900	82	150,150	82
SIVC	15	1	102	2	0	0	0	0	19,113	15	4,155	8	23,384	13
MIVC	0	0	0	0	0	0	0	0	1,795	1	114	0	1,909	1
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	11	0	0	0	0	0	23	0	6	0	40	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1,039	100	5,296	100	0	0	0	0	126,548	100	49,710	100	182,593	100
Lodgepole Pine														
LDVC	0	0	0	0	6	0	0	0	0	0	0	0	6	0
MDVC	0	0	0	0	4	0	22	0	0	4	29	1	55	0
SDVC	0	0	0	0	752	3	8	0	0	0	140	3	900	2
NCH	1	100	0	0	22,990	93	16,805	99	5	88	4,582	95	44,383	95
SIVC	0	0	0	0	864	3	160	1	0	8	52	1	1,077	2
MIVC	0	0	0	0	170	1	21	0	0	0	0	0	191	0
LIVC	0	0	0	0	0	0	1	0	0	0	0	0	1	0
NVG	0	0	0	0	0	0	4	0	0	0	4	0	8	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1	100	0	0	24,785	100	17,022	100	5	100	4,807	100	46,620	100
Montane Hardwood-Conifer														
LDVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0	8	2	8	1
SDVC	0	0	0	0	134	21	0	0	0	0	31	7	165	15
NCH	0	0	0	0	436	68	0	0	0	0	424	92	860	78
SIVC	0	0	0	0	62	10	0	0	0	0	0	0	62	6
MIVC	0	0	0	0	5	1	0	0	0	0	0	0	5	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	637	100	0	0	0	0	463	100	1,100	100
Pinyon-Juniper														
LDVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	7	1	0	0	7	1
NCH	0	0	0	0	0	0	0	0	1,045	94	0	0	1,045	94
SIVC	0	0	0	0	0	0	0	0	60	5	0	0	60	5
MIVC	0	0	0	0	0	0	0	0	1	0	0	0	1	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0	0	0	1,113	100	0	0	1,113	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table F-3 Acres of Classified Change by Conifer Cover Type and National Forest
(continued)

	Eldorado		Lake Tahoe Basin Management Unit		Lassen		Modoc		Plumas		Tahoe		All Forests	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Ponderosa Pine														
LDVC	15	0	0	0	17	0	0	0	193	0	6	0	231	0
MDVC	892	1	0	0	284	2	0	0	296	0	79	1	1,551	1
SDVC	2,653	3	0	0	574	3	0	0	1,156	1	253	2	4,636	2
NCH	71,382	94	0	0	14,643	87	0	0	78,400	94	10,707	96	175,132	93
SIVC	1,171	2	0	0	1,327	8	0	0	2,828	3	89	1	5,414	3
MIVC	104	0	0	0	25	0	0	0	264	0	13	0	406	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	3	0	0	0	21	0	2	0	26	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	76,217	100	0	0	16,873	100	0	0	83,157	100	11,149	100	187,397	100
Red Fir														
LDVC	0	0	0	0	91	0	0	0	3	0	1	0	95	0
MDVC	223	0	5	0	165	0	53	0	77	0	690	1	1,212	0
SDVC	1,055	1	57	0	1,573	3	56	0	738	1	2,289	2	5,769	2
NCH	83,063	95	19,655	97	46,427	91	20,650	99	49,357	92	112,630	94	331,782	94
SIVC	2,202	3	542	3	2,651	5	49	0	3,640	7	3,863	3	12,947	4
MIVC	0	0	2	0	270	1	1	0	73	0	0	0	346	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	31	0	19	0	0	0	0	0	13	0	617	1	680	0
CLD/SHA	558	1	0	0	0	0	0	0	0	0	0	0	558	0
TOTAL	87,133	100	20,280	100	51,176	100	20,809	100	53,901	100	120,089	100	353,389	100
Subalpine Conifer														
LDVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MDVC	7	0	0	0	0	0	0	0	0	0	6.22706	0	13	0
SDVC	263	1	6	0	8	1	3	0	0	0	14.90047	1	294	1
NCH	37,605	91	4,721	96	754	99	5,297	98	0	0	2018.902	96	50,396	93
SIVC	2,387	6	133	3	0	0	95	2	0	0	16.67963	1	2,632	5
MIVC	0	0	0	0	0	0	12	0	0	0	0	0	12	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	959	2	38	1	0	0	6	0	0	0	46.92535	2	1,051	2
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	41,220	100	4,899	100	762	100	5,414	100	0	0	2103.634	100	54,398	100
Sierran Mixed Conifer														
LDVC	28	0	0	0	1,995	0	702	1	492	0	367	0	3,584	0
MDVC	6,131	2	73	0	3,178	1	2,609	2	848	0	6,086	2	18,925	1
SDVC	7,019	3	178	0	23,575	5	6,820	5	10,123	2	21,849	7	69,565	4
NCH	241,796	91	41,613	99	395,859	89	127,701	92	459,152	89	282,557	85	1,548,676	89
SIVC	10,066	4	238	1	18,258	4	1,055	1	39,659	8	18,364	6	87,640	5
MIVC	58	0	1	0	650	0	103	0	4,499	1	2,845	1	8,156	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	4	0	14	0	27	0	27	0	72	0
CLD/SHA	100	0	0	0	0	0	0	0	0	0	0	0	100	0
TOTAL	265,198	100	42,103	100	443,519	100	139,004	100	514,800	100	332,094	100	1,736,719	100

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table F-3 Acres of Classified Change by Conifer Cover Type and National Forest
(continued)

	Eldorado		Lake Tahoe Basin Management Unit		Lassen		Modoc		Plumas		Tahoe		All Forests	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
White Fir														
LDVC	0	0	0	0	99	0	190	0	0	0	0	0	289	0
MDVC	0	0	0	0	128	0	685	1	0	0	0	0	813	1
SDVC	2	4	0	0	2,042	4	1,270	3	58	4	0	0	3,372	3
NCH	49	96	1	100	48,375	92	45,973	95	1,318	95	12	98	95,728	93
SIVC	0	0	0	0	1,929	4	278	1	15	1	0	2	2,223	2
MIVC	0	0	0	0	29	0	14	0	0	0	0	0	44	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	16	0	0	0	0	0	16	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	51	100	1	100	52,602	100	48,427	100	1,391	100	12	100	102,485	100
Undetermined Conifer														
LDVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	1	18	11	2	12	1
SDVC	32	4	0	0	0	0	0	0	0	0	16	3	48	3
NCH	836	96	0	0	0	0	0	0	5	82	499	94	1,339	95
SIVC	6	1	0	0	0	0	0	0	0	0	3	1	9	1
MIVC	0	0	0	0	0	0	0	0	0	0	2	0	2	0
LIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	874	100	0	0	0	0	0	0	6	100	531	100	1,412	100
TOTAL	471,733		72,579		792,573		844,760		781,007		521,127		3,483,779	

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table F-4 Acres of Verified Change in the Eldorado National Forest by Cause and Hardwood Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Blue Oak/Foothill Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	0	0
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	1	0	0	0	0	1
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	1	0	0	0	0	1
Montane Hardwood										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	5	0	1	0	0	0	0	0	0	6
SDVC	13	0	7	0	0	0	0	0	0	20
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	5	0	5
MIVC	0	0	0	0	0	0	0	2	0	2
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	18	0	8	0	0	0	0	7	0	33
TOTAL	18	0	8	0	1	0	0	7	0	34

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table F-5 Acres of Verified Change in the Eldorado National Forest by Cause and Conifer Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Jeffrey Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	2	0	0	0	0	0	0	2
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	12	0	12
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	2	0	0	0	0	12	0	14
Ponderosa Pine										
LDVC	0	0	15	0	0	0	0	0	0	15
MDVC	485	0	228	0	0	0	1	0	0	714
SDVC	450	11	241	11	0	0	5	0	0	718
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	1	0	0	0	0	1,028	0	1,029
MIVC	0	0	0	0	0	0	0	95	0	95
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	935	11	485	11	0	0	6	1,123	0	2,571
Red Fir										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	184	0	0	0	0	0	0	184
SDVC	0	0	35	0	0	0	0	0	0	35
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	826	0	826
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	558	0	558
TOTAL	0	0	219	0	0	0	0	1,384	0	1,603
Sierran Mixed Conifer										
LDVC	0	0	28	0	0	0	0	0	0	28
MDVC	5,067	0	895	0	0	0	0	3	0	5,965
SDVC	2,960	36	1,276	2	0	25	0	0	0	4,299
NCH	0	0	0	0	0	0	0	1	0	1
SIVC	251	0	5	0	0	0	0	8,750	0	9,006
MIVC	0	0	0	0	0	0	0	58	0	58
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	100	0	100
TOTAL	8,278	36	2,204	2	0	25	0	8,912	0	19,457
Undetermined Conifer										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	15	0	0	0	0	0	0	15
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	1	0	0	0	0	1
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	15	0	1	0	0	0	0	16
TOTAL	9,213	47	2,925	13	1	25	6	11,431	0	23,661

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table F-6 Acres of Verified Change in the Lake Tahoe Basin Management Unit by Cause and Conifer Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Jeffrey Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	4	0	0	2	0	0	0	6
SDVC	0	0	23	0	0	33	0	0	0	56
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	27	0	0	35	0	0	0	62
Red Fir										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	2	0	0	0	0	0	0	2
SDVC	0	0	0	0	0	13	0	0	0	13
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	2	0	0	13	0	0	0	15
Subalpine Conifer										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	2	0	0	0	2
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	2	0	0	0	2
Sierran Mixed Conifer										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	65	0	0	6	0	0	0	71
SDVC	0	0	09	0	0	46	0	0	0	144
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	163	0	0	52	0	0	0	215
TOTAL	0	0	192	0	0	102	0	0	0	294

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table F-7 Acres of Verified Change in the Lassen National Forest by Cause and Hardwood Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Blue Oak Woodland										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	125	0	0	0	0	0	0	0	0	125
SDVC	578	0	0	0	0	0	0	0	0	578
NCH		0	0	0	0	0	0	0	0	0
SIVC	947	0	0	0	0	0	0	0	0	947
MIVC	4	0	0	0	0	0	0	0	0	4
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	1,654	0	0	0	0	0	0	0	0	1,654
Montane Hardwood										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	681	0	3	0	0	0	0	0	0	684
SDVC	1,205	6	10	0	0	0	0	0	0	1,221
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	802	0	3	0	0	0	8	47	0	860
MIVC	10	0	0	0	0	0	0	3	0	13
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	2,698	6	16	0	0	0	0	0	0	2,778
Montane Riparian										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	2	0	0	0	0	0	0	2
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	16	0	16
MIVC	0	0	0	0	0	0	0	2	0	2
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	2	0	0	0	0	0	0	20
TOTAL	4,352	6	18	0	0	0	8	68	0	4,452

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table F-8 Acres of Verified Change in the Lassen National Forest by Cause and Conifer Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Douglas Fir										
LDVC	2	0	0	0	0	0	0	0	0	2
MDVC	3	0	2	0	0	0	0	0	0	5
SDVC	3	0	11	0	0	0	0	0	0	14
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	1	0	0	0	0	0	0	1
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	8	0	14	0	0	0	0	0	0	22
Eastside Pine										
LDVC	0	0	7	0	0	0	0	0	0	7
MDVC	88	0	139	0	0	0	0	0	0	227
SDVC	429	0	2,849	2,036	0	0	0	0	0	5,314
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	1,847	0	40	0	0	0	0	745	0	2,632
MIVC	141	0	10	0	0	0	0	37	0	188
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	2,505	0	3,045	2,036	0	0	0	782	0	8,368
Juniper										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	4	0	1	0	0	0	0	0	0	5
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	146	0	0	0	0	0	0	0	0	146
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	150	0	1	0	0	0	0	0	0	151
Lodgepole Pine										
LDVC	0	0	4	0	0	0	0	0	0	4
MDVC	0	0	3	0	0	0	0	0	0	3
SDVC	34	0	177	15	0	0	0	0	0	226
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	3	0	66	0	0	0	0	110	0	179
MIVC	0	0	10	0	0	0	0	1	0	11
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	37	0	260	15	0	0	0	111	0	423

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table F-8 Acres of Verified Change in the Lassen National Forest by Cause and Conifer Cover Type (continued)

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Montane Hardwood-Conifer										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	131	0	0	0	0	0	0	0	0	131
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	47	0	0	0	0	0	0	0	0	47
MIVC	5	0	0	0	0	0	0	0	0	5
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	183	0	0	0	0	0	0	0	0	183
Ponderosa Pine										
LDVC	17	0	0	0	0	0	0	0	0	17
MDVC	245	2	12	0	0	0	0	0	0	259
SDVC	339	0	25	0	0	0	9	0	0	373
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	596	0	16	0	0	0	2	186	0	800
MIVC	20	0	0	0	0	0	0	4	0	24
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	1,217	2	53	0	0	0	11	190	0	1,473
Red Fir										
LDVC	0	0	70	0	0	0	0	0	0	70
MDVC	0	0	110	0	0	0	0	0	0	110
SDVC	20	0	728	0	0	0	0	0	0	748
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	3	0	0	0	0	0	0	1,683	0	1,686
MIVC	0	0	1	0	0	0	0	236	0	237
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	23	0	909	0	0	0	0	1,919	0	2,851
Sierran Mixed Conifer										
LDVC	1,129	0	582	0	0	0	0	0	0	1,711
MDVC	1,322	0	1,389	13	0	0	0	0	0	2,724
SDVC	440	11	14,257	112	0	0	10	0	0	14,830
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	590	0	221	0	0	0	0	8,133	0	8,944
MIVC	1	0	5	0	0	0	0	491	0	497
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	3,482	11	16,454	125	0	0	10	8,624	0	28,706
White Fir										
LDVC	0	0	98	0	0	0	0	0	0	98
MDVC	0	0	119	0	0	0	0	0	0	119
SDVC	0	0	903	0	0	0	0	0	0	903
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	24	0	0	0	0	889	0	913
MIVC	0	0	0	0	0	0	0	21	0	21
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	1,144	0	0	0	0	910	0	2,054
TOTAL	7,605	13	21,880	2,176	0	0	21	12,536	0	44,231

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table F-9 Acres of Verified Change in the Modoc National Forest by Cause and Conifer Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Eastside Pine										
LDVC	8	0	135	0	0	0	0	0	0	143
MDVC	171	0	817	14	0	25	0	5	0	1,032
SDVC	4	0	2,711	191	0	119	0	7	0	3,032
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	50	0	4	0	0	0	0	5,566	0	5,620
MIVC	45	0	0	0	0	0	0	233	0	278
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	278	0	3,667	205	0	144	0	5,811	0	10,105
Juniper										
LDVC	0	0	4	0	0	0	0	0	0	4
MDVC	0	0	4	0	0	0	0	0	0	4
SDVC	58	0	53	0	0	0	0	0	0	111
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	11	0	1	0	0	0	0	3	0	15
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	69	0	62	0	0	0	0	3	0	134
Lodgepole Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	15	0	0	0	0	0	0	15
SDVC	0	0	3	0	0	0	0	0	0	3
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	1	0	0	0	0	0	0	1
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	19	0	0	0	0	0	0	19
Red Fir										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	0	0
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	42	0	42
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0	0	42	0	42

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow

Refer to Appendix D for WHR type descriptions.

Table F-9 Acres of Verified Change in the Modoc National Forest by Cause and Conifer Cover Type (continued)

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Sierran Mixed Conifer										
LDVC	0	0	585	0	0	3	0	0	0	588
MDVC	1	0	2,244	29	0	24	0	0	0	2,298
SDVC	16	0	4,621	204	0	375	0	0	0	5,216
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	42	0	1	0	0	0	0	783	0	826
MIVC	33	0	0	0	0	0	0	55	0	88
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	5	0	5
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	92	0	7,451	233	0	402	0	843	0	9,021
White Fir										
LDVC	0	0	175	0	0	0	0	0	0	175
MDVC	29	0	534	0	0	0	0	0	0	563
SDVC	14	0	804	0	0	37	0	0	0	855
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	17	0	5	0	0	0	0	104	0	126
MIVC	2	0	0	0	0	0	0	9	0	11
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	6	0	0	0	0	0	0	6
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	62	0	1,524	0	0	37	0	113	0	1,736
TOTAL	501	0	12,723	438	0	583	0	6,812	0	21,057

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table F-10 Acres of Verified Change in the Plumas National Forest by Cause and Hardwood Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Montane Hardwood										
LDVC	0	0	19	0	0	0	0	0	0	19
MDVC	0	0	12	0	0	0	0	0	0	12
SDVC	9	0	41	0	0	0	0	0	0	50
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	4	0	4	0	0	0	0	340	0	348
MIVC	0	0	0	0	0	0	0	58	0	58
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	13	0	76	0	0	0	0	398	0	487
Aspen										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	1	0	0	0	0	0	0	0	0	1
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	2	0	0	0	0	0	0	62	0	64
MIVC	9	0	0	0	0	0	0	0	0	9
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	12	0	0	0	0	0	0	62	0	74
Montane Riparian										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	0	0
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	4	0	0	0	0	0	0	30	0	34
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	4	0	0	0	0	0	0	30	0	34
TOTAL	29	0	76	0	0	0	0	490	0	595

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table F-11 Acres of Verified Change in the Plumas National Forest by Cause and Conifer Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Douglas Fir										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	0	0
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	25	0	0	0	0	0	0	0	0	25
MIVC	35	0	0	0	0	0	0	0	0	35
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	60	0	0	0	0	0	0	0	0	60
Jeffrey Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	198	0	2	0	0	0	0	0	0	200
SDVC	404	0	170	0	0	0	0	0	0	574
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	7,264	0	0	0	0	0	0	7,665	0	14,929
MIVC	1,161	0	0	0	0	0	0	514	0	1,675
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	1	0	0	0	0	0	0	0	0	1
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	9,028	0	172	0	0	0	0	0	0	17,379
Pinyon-Juniper										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	7	0	0	0	0	0	0	0	0	7
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	59	0	0	0	0	0	0	1	0	60
MIVC	1	0	0	0	0	0	0	0	0	1
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0	0	1	0	68
Ponderosa Pine										
LDVC	0	0	65	0	0	0	0	0	0	65
MDVC	0	0	150	0	0	0	0	0	0	150
SDVC	0	0	147	0	0	0	13	0	0	160
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	93	0	7	0	0	0	0	1,098	0	1,198
MIVC	7	0	0	0	0	0	0	194	0	201
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	100	0	369	0	0	0	13	1,292	0	1,774
Red Fir										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	12	0	0	0	0	0	0	12
SDVC	0	0	36	0	0	0	0	0	0	36
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	4	0	0	0	0	0	0	1,438	0	1,442
MIVC	0	0	0	0	0	0	0	30	0	30
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	4	0	48	0	0	0	0	1,468	0	1,520

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table F-11 Acres of Verified Change in the Plumas National Forest by Cause and Conifer Cover Type (continued)

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Sierran Mixed Conifer										
LDVC	4	0	232	0	0	0	0	0	0	236
MDVC	18	0	256	0	0	0	0	0	0	274
SDVC	164	0	1,388	0	0	0	0	0	0	1,552
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	2,946	0	12	0	0	0	0	22,462	0	25,420
MIVC	1,214	0	0	0	0	0	0	3,056	0	4,270
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	1	0	1
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	4,346	0	1,888	0	0	0	0	25,519	0	31,753
White Fir										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	15	0	0	0	0	0	0	15
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	15	0	0	0	0	0	0	15
TOTAL	13,605	0	2,492	0	0	0	13	36,459	0	52,569

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table F-12 Acres of Verified Change in the Tahoe National Forest by Cause and Hardwood Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Montane Hardwood										
LDVC	0	0	70	0	0	0	3	7	0	80
MDVC	0	0	38	0	0	0	1	3	0	42
SDVC	21	0	107	0	0	0	8	2	0	138
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	39	0	1	0	0	0	0	135	0	175
MIVC	3	0	1	0	0	0	0	40	0	44
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	1	0	0	0	0	0	0	0	0	1
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	64	0	217	0	0	0	12	187	0	480
Aspen										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	15	0	0	0	0	0	0	0	0	15
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	15	0	0	0	0	0	0	0	0	15
Montane Riparian										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	2	0	0	0	0	0	0	2
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	7	0	7
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	2	0	0	0	0	0	0	9
TOTAL	79	0	219	0	0	0	12	194	0	504

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table F-13 Acres of Verified Change in the Tahoe National Forest by Cause and Conifer Cover Type

	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Eastside Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	1	0	0	0	0	0	0	0	0	1
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	0	0	0
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	1	0	0	0	0	0	0	0	0	1
Jeffrey Pine										
LDVC	2	0	0	0	0	0	0	0	0	2
MDVC	392	0	48	0	0	0	0	0	0	440
SDVC	2,786	0	457	0	0	0	0	0	0	3,243
NCH		0	0	0	0	0	0	0	0	0
SIVC	47	0	0	0	0	0	0	3,110	0	3,157
MIVC	0	0	0	0	0	0	0	112	0	112
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	2	0	2
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	3,227	0	505	0	0	0	0	3,224	0	6,956
Lodgepole Pine										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	1	0	0	0	0	0	0	1
SDVC	0	0	0	0	0	0	0	0	0	0
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	18	0	18
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	1	0	0	0	0	18	0	19
Ponderosa Pine										
LDVC	0	0	6	0	0	0	0	0	0	6
MDVC	0	0	28	0	0	0	0	0	0	28
SDVC	1	0	18	0	0	0	1	10	0	30
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	5	0	0	0	0	0	0	47	0	52
MIVC	0	0	0	0	0	0	0	9	0	9
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	6	0	52	0	0	0	1	66	0	125
Red Fir										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	315	0	0	0	0	0	0	315
SDVC	0	0	543	0	0	1	0	0	0	544
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	30	0	0	0	0	0	0	2,619	0	2,649
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	30	0	858	0	0	1	0	2,619	0	3,508

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

Table F-13 Acres of Verified Change in the Tahoe National Forest by Cause and Conifer Cover Type (continued)

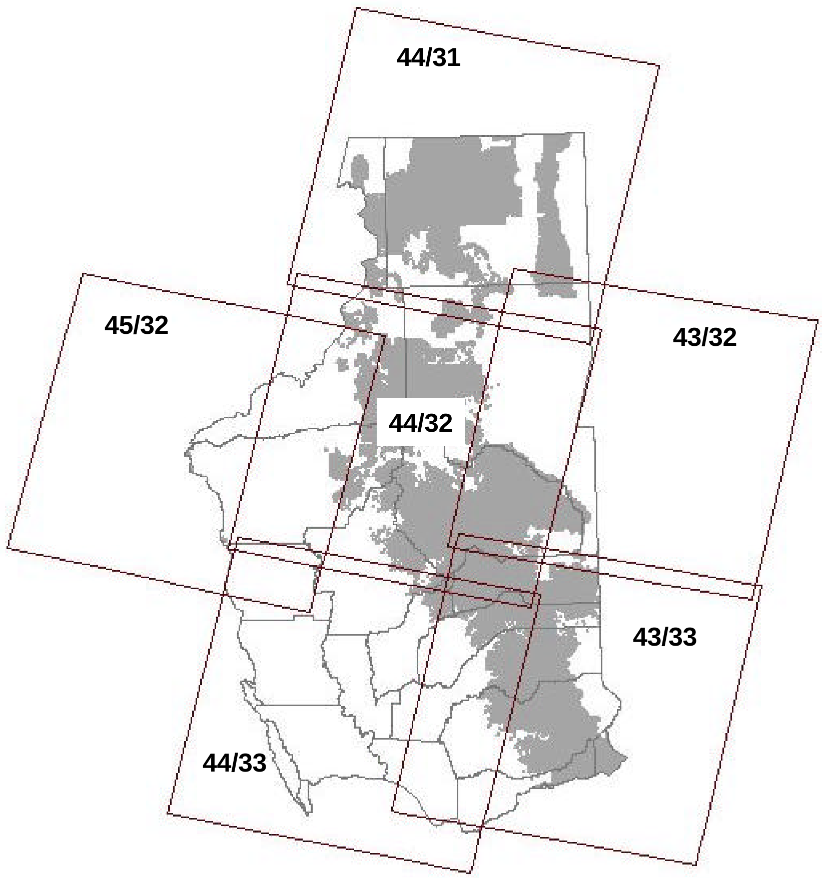
	Wildfire	Prescribed Burn	Harvest	Thinning	Brushing for Fuel Reduction	Mortality	Development	Regeneration	Other	Total Verified
Subalpine Conifer										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	0	0	0	0	0	0	0	0
SDVC	0	0	0	0	0	0	0	0	0	0
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	2	0	2
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0	0	2	0	2
Sierran Mixed Conifer										
LDVC	25	0	326	0	0	0	0	1	0	352
MDVC	4,161	0	1,354	0	0	0	7	12	0	5,534
SDVC	12,572	0	1,872	20	0	0	57	12	0	14,533
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	3,727	0	40	0	0	0	0	13,350	0	17,117
MIVC	945	0	20	0	0	0	0	1,834	0	2,799
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	2	0	0	0	0	0	0	2	0	4
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	21,432	0	3,612	20	0	0	64	15,211	0	40,339
Undetermined Conifer										
LDVC	0	0	0	0	0	0	0	0	0	0
MDVC	0	0	4	0	0	0	0	0	0	4
SDVC	0	0	9	0	0	0	1	0	0	10
NCH	0	0	0	0	0	0	0	0	0	0
SIVC	0	0	0	0	0	0	0	1	0	1
MIVC	0	0	0	0	0	0	0	0	0	0
LIVC	0	0	0	0	0	0	0	0	0	0
NVG	0	0	0	0	0	0	0	0	0	0
CLD/SHA	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0	13	0	0	0	1	1	0	15
TOTAL	24,696	0	5,041	20	0	1	66	21,141	0	50,965

LDVC – large decrease in vegetation cover; MDVC – moderate decrease in vegetation cover; SDVC – small decrease in vegetation cover; NCH – little to no change in vegetation cover; SIVC – small increase in vegetation cover; MIVC – moderate increase in vegetation cover; LIVC – large increase in vegetation cover; NVG – non-vegetation change; CLD/SHA – cloud or shadow
Refer to Appendix D for WHR type descriptions.

APPENDIX A - DATA SOURCES

Image Data

TM imagery provides the base data for deriving changes in vegetation cover. Project area coverage requires six TM image pairs (12 TM images). Images for each year are selected as close to the same month as possible to minimize differences in vegetation moisture content and shadow effects. Images are also selected for minimal cloud coverage. TM imagery consists of thousands of pixels, each having a spatial resolution of $30m^2$ or approximately 1/5 of an acre. Figure 1a shows the extent of TM image coverage and lists all imagery for the project area by path/row and date.



Path/Row	Dates	
44/31	8/26/91	8/07/96
45/32	6/27/90	8/14/96
44/32	8/26/91	8/07/96
43/32	8/16/90	7/31/96
44/33	6/20/90	8/07/96
43/33	7/02/91	7/31/96

Figure 1a. TM Imagery Extent and Dates for the Northeastern California Project Area.

Vegetation Data

Vegetation data are used to determine which lifeforms and WHR types (Appendix D) are experiencing various magnitudes of change. The best available vegetation data are collected for the project area and combined into a single layer (Table 2a). In areas that overlap, the most current and accurate vegetation data are used. Vegetation layers not in the WHR classification (Mayer and Laudenslayer, 1988) are modeled to this classification. The LCMMP has completed vegetation data for most of the project area. The exceptions are the low elevation hardwood rangelands that the hardwood data cover and the northern portion of the Sacramento Valley that the GAP data cover.

Table 1a. Vegetation Data for the Northeastern California Project Area

Name	Classification	Source	Scale	Extent	% Of Project Area
CA Mapping & Monitoring Program Vegetation Data	CALVEG / WHR	1991 TM imagery	2.5 acre mmu*	Modoc bioregion, Plumas NF, Eldorado NF, Tahoe NF, LTBMU**	64
Hardwood Rangelands	WHR	CDF, updated 1990	25^2 meter pixels	Hardwood rangelands below 5000 ft. elevation	23
GAP Analysis 1990	WHR used	Varies; TM imagery, Field data	100 hectares (~250 acres)	Statewide	13

*mmu - minimum mapping unit.
**Lake Tahoe Basin Management Unit.

Other Data

Table 3a describes data layers that supplement our monitoring program. These layers are used to stratify change areas, verify causes and correlate change to mortality levels.

Table 2a. Supplemental Data for Northeastern California Project Area

Name	Description	Data Type	Scale	Source	Extent
Ownership	Local, state federal, private	Polygon	1:100,000	Teale Data Center	Statewide
County	County boundaries	Polygon	1:24,000	Teale Data Center	Statewide
Fire Perimeters	Recent and past fires	Regions (polygon)	Varies; 1:24,000 to 1:100,000	Maintained by CDF and FS	Statewide
Harvest / Plantation	Silvicultural practices	Polygon	1:24,000	FS	National Forest lands
NHFEU* Boundaries	Ecological subsection boundaries	Polygon	1:7,500,000	FS	Statewide
Aerial Photos	9" x 9"	Print photograph	1:15,840 nominal	FS	National Forest lands
Field Plots	Variable & fixed radius	Ground measures	⅛ ac., ¼ ac., 40 BAF	CA Mapping & Monitoring Program	Selected sites within project area

*National Hierarchical Framework of Ecological Units.

APPENDIX B - METHODOLOGY

Database Building

In this procedure, TM imagery is prepared for processing and a single vegetation layer is assembled. The first step in preparing the TM imagery is to register the early date TM image to the later date TM image that are in the same path and row. Registration begins by identifying common features throughout both images on-screen (e.g., road intersections). These features are used in a nearest neighbor resampling technique to assign the early date pixel values to the later date pixel locations. These new pixel locations must be within ½ pixel of the later date pixels to eliminate any false changes. The images are then radiometrically corrected to account for differences in atmospheric conditions (e.g., haze and water vapor). This process selects dark and light groups of pixels in each image date and applies a regression-based correction to the early image date to effectively remove differences in atmospheric conditions (Schott et al., 1988).

Another part of database building is assembling a single vegetation layer. A complete vegetation layer for the project area does not currently exist, so the best available vegetation layers are mosaicked together (Table 2a). Layers that are in a polygon format are converted to a pixel format. In the mosaic process, precedence is given to the LCMMP vegetation layers, then the hardwood layer and finally the GAP data, which fills in any remaining areas. GAP data is usually a small component of the vegetation layer and is mainly used to cover the low elevation valley areas. The WHR classification system is used for the final vegetation layer. Vegetation layers not in this classification system, such as CALVEG (USDA Forest Service Regional Ecology Group, 1981), are classified to it.

Change Processing

The TM imagery co-registered and radiometrically corrected in the database building process is analyzed for change in this step. This process begins by applying a Kauth-Thomas transformation to both dates of imagery (Kauth and Thomas, 1976). This transformation uses model coefficients to produce a new image depicting changes in brightness, greenness, and wetness components (Crist and Cicone, 1984). Brightness identifies variation in reflectance, greenness is related to the amount of green vegetation present in the scene, and wetness correlates to canopy and soil moisture. The Kauth-Thomas transformation produces an image with so much information (each pixel contains values for brightness, greenness and wetness changes), that it is necessary to aggregate areas of similar pixel values into regions. Regions are based on pixel groupings from two TM bands (3 and 4) and a texture band, which is a spatial component that enhances subtle edges, from the later date TM image (Ryherd and Woodcock, 1990). These regions are then used to aggregate the pixels of brightness, greenness, and wetness changes and effectively reduce the number of unique information types.

Change Labeling

Change labeling is a multi-step process that converts the change image to a change map that identifies decreases and increases in vegetation cover. The change image is subset into individual lifeform type (e.g., conifer, hardwood and shrub) by overlaying the vegetation layer and selecting those areas in the change image that have the same lifeform. An unsupervised classification is performed on the individual lifeform change images resulting in groups of similar levels of brightness, greenness and wetness. These groupings are assigned to one of nine change classes (Figure 1b). Image appearance, photo interpretation, vegetation and topographic

- **Large Decrease in Vegetation Cover**
- **Moderate Decrease in Vegetation Cover**
- **Small Decrease in Vegetation Cover**
- **Little or No Change in Vegetation Cover**
- **Small Increase in Vegetation Cover**
- **Moderate Increase in Vegetation Cover**
- **Large Increase in Vegetation Cover**
- **Non-Vegetation Change**
- **Cloud or Shadow**

Figure 1b. Classes of vegetation cover change.

maps and bispectral plots (e.g., greenness vs. wetness) aid in assigning the change classes. Each individual lifeform change image is then assembled into one project area change map.

The decrease and increase change classes represent relative changes in vegetation cover. For example, a small decrease will have less vegetation cover loss than a moderate or large decrease (e.g., a thinning compared to a clearcut). The little or no change class indicates that change did not occur or that change was so slight that it could not be detected. The non-vegetation change class accounts for variations in lake or reservoir water levels and snow pack in the higher elevations. The cloud or shadow class accounts for clouds in the imagery and shadows in the mountainous areas that obscure ground cover and make it not possible to determine whether the vegetation had changed or remained stable in these areas.

Cause Verification

Once the final change map is complete, the attempt is made to verify cause on all change areas. GIS overlay, fieldwork and photo interpretation are used to determine the causes of change areas. The CDF forest practices database, the FS stand record system database and the CDF fire history database are overlaid onto the change map to attribute changes caused by harvests, regeneration and wildfires. FS resource managers interpret change maps by applying local knowledge and fieldwork to identify sources of change on national forest lands. Similarly, UC Integrated Hardwood Rangeland Management Program (IHRMP) personnel consult private landowners to identify sources of change in hardwood rangelands. Areas without a causal agent identified through the above processes become the focus of further field efforts and aerial photo interpretation. Despite all these efforts, full coverage of cause verification is not always possible due to the large number of change areas, insufficient information and inaccessible lands.

APPENDIX C - DATA ACCURACY

To assess the accuracy of the change map, 300 randomly selected change areas were compared with known reference information of the same areas. All change classes were represented with sites based on the acreage amount of change (e.g., the little or no change class has the largest acreage, thus contains the most sites). Sites were selected by creating polygons out of the change areas, then randomly selecting change polygons between 10 and 30 acres. These areas were interpreted for change using color aerial photography at a scale of 1:15,840, TM imagery and field collected data. Because the decreasing and increasing change classes are relative to each other (large decrease has more relative change than moderate decrease), the interpretation of the photo or image was subjective based on the degree of interpreted change.

Table 1c displays the error matrix for the Northeastern CA project area. The overall accuracy of the change map is 89.3%. This means that of the 300 sample sites, 268 were correctly classified (the reference and classified classes are the same). Errors of commission (reference class included in the wrong classified class) and omission (reference class excluded from the correct classified class) are also evident. For example, in Table 1c one site is classified as LDVC when the reference class shows it was actually MDVC. Therefore, one area was omitted from the

Table 1c. Change Map Accuracy Assessment for the Northeastern CA Project Area

Reference Class (columns); Classified As (rows)

	LDVC*	MDVC	SDVC	NCH	SIVC	MIVC	LIVC	NVG	**TOTAL**
LDVC	8	1							**9**
MDVC	1	12	7						**20**
SDVC	1	2	30						**33**
NCH			8	150	5			3	**166**
SIVC					38	1	1		**40**
MIVC					2	14			**16**
LIVC							9		**9**
NVG								7	**7**
TOTAL	**10**	**15**	**45**	**150**	**45**	**15**	**10**	**10**	**300**

Producer's Accuracy

LDVC	8/10	80%
MDVC	12/15	80%
SDVC	30/45	67%
NCH	150/150	100%
SIVC	38/45	84%
MIVC	14/15	93%
LIVC	9/10	90%
NVG	7/10	70%

User's Accuracy

LDVC	8/9	89%
MDVC	12/20	60%
SDVC	30/33	91%
NCH	150/166	90%
SIVC	38/40	95%
MIVC	14/16	88%
LIVC	9/9	100%
NVG	7/7	100%

* LDVC - large decrease in vegetation cover; MDVC - moderate decrease in vegetation cover; SDVC - small decrease in vegetation cover; NCH - little or no change in vegetation cover; SIVC - small increase in vegetation cover; MIVC - moderate increase in vegetation cover; LIVC - large increase in vegetation cover; NVG - non-vegetation change; CLD/SHA - cloud or shadow

correct MDVC class and committed to the incorrect LDVC class. The producer's accuracy for each change class ranged from 67% to 100% and the user's accuracy ranged from 60% to 100%. Producer's accuracy represents how well the reference data of each change class is classified. User's accuracy indicates the probability that a given change class actually represents that same change on the ground.

The accuracy assessment also shows how well the methods classify decreases and increases. Areas classified as a decrease were always a decrease, although the correct class was not always assigned. The same is true for the areas classified as an increase. Also, a decrease site is not classified into an increase class and an increase site is not classified into a decrease class. The small decrease and increase classes have sites classified into the little to no change class (eight and five out of 45, respectively). This is expected, however, as this type of change can be very subtle and the methods will have difficulty detecting it.

APPENDIX D - WHR TYPE DESCRIPTIONS

Species Compositions for Major Hardwood, Conifer and Shrub / Chaparral WHR Types; Species in bold are dominant and species in non-bold are associates.
Source: Mayer and Laudenslayer, 1988.

BLUE OAK WOODLAND	BLUE OAK/ FOOTHILL PINE	MONTANE HARDWOOD
blue oak	**blue oak** **foothill pine**	**CA black oak** **Pacific madrone** **tanoak** **alder** **interior live oak** **canyon live oak**
interior live oak coast live oak buckeye juniper canyon live oak valley oak ponderosa pine	coast live oak interior live oak canyon live oak	Oregon white oak coast live oak California laurel valley oak blue oak foothill pine ponderosa pine

SIERRAN MIXED CONIFER	EASTSIDE PINE	JUNIPER	PONDEROSA PINE	RED FIR	JEFFREY PINE
white fir **Douglas fir** **ponderosa pine** **sugar pine** **incense cedar**	**ponderosa pine**	**juniper**	**ponderosa pine**	**red fir**	**Jeffrey pine**
giant sequoia	Jeffrey pine lodgepole pine white fir incense cedar Douglas fir California black oak western juniper	white fir Jeffrey pine ponderosa pine whitebark pine singleleaf pinyon	white fir incense cedar Coulter pine Jeffrey pine sugar pine Douglas fir bigcone Douglas fir		ponderosa pine Coulter pine sugar pine lodgepole pine white fir red fir limber pine incense cedar

MIXED CHAPARRAL	MONTANE CHAPARRAL	SAGEBRUSH
oaks **ceanothus** **manzanita**	**ceanothus** **manzanita** **bitter cherry**	**sagebrush** **rabbitbrush** **gooseberry**
chamise mountain mahogany buckeye sumac buckthorn California fremontia		

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APPENDIX F – Map Atlas Document

The county monitoring maps have been removed from this document and assembled into a separate map atlas document. The purpose of this is to minimize the file size of the document. The map atlas document is located at:
http://frap.cdf.ca.gov/projects/land_cover/monitoring/pdfs/necdp_county_atlas.pdf
Warning the file size is large, so please be patient.

California Wildlife Habitat Relationships System
California Department of Fish and Game
California Interagency Wildlife Task Group

Blue Oak-Foothill Pine

Jared Verner

Vegetation

Structure-- This habitat is typically diverse in structure both vertically and horizontally, with a mix of hardwoods, conifers, and shrubs. The shrub component is typically composed of several species that tend to be clumped, with interspersed patches of Annual Grassland. Woodlands of this type generally have small accumulations of dead and downed woody material and relatively few snags, compared with other tree habitats in California. Most existing stands of this type are in mature stages, with canopy cover ranging from 10 to 59 percent, and dbh ranging from 2.5 to 30 cm (1 to 12 in). Size class 6 depends on a sparse overstory of foothill pine above a lower canopy of oaks, as canopies of blue oak seldom exceed 15 m (50 ft) in height. Individual trees seldom exceed 125 cm (49 in) dbh, and exceptionally may reach 30 m (100 ft) in height.

Composition-- Blue oak and foothill pine typically comprise the overstory of this habitat, with blue oak usually most abundant. Stands dominated by foothill pine tend to lose their blue oak, which is intolerant of shade (P. M. McDonald, pers. comm.). In the foothills of the Sierra Nevada, tree species typically associated with this habitat are interior live oak and California buckeye. In the Coast Range, associated species are the coast live oak, valley oak, and California buckeye (Griffin 1977). Interior live oak sometimes dominates the overstory, especially in rocky areas and on north-facing slopes at higher elevations (Neal 1980).

At lower elevations, where blue oaks make up most of the canopy, the understory tends to be primarily annual grasses and forbs. At higher elevations where foothill pines and even interior live oaks sometimes comprise the canopy, the understory usually includes patches of shrubs in addition to the annual grasses and forbs. Shrub species include Ceanothus spp. Mariposa manzanita, whiteleaf manzanita, Parry manzanita redberry, California coffeeberry, poison-oak, silver lupine, blue elder, California yerba-santa, rock gooseberry, and California redbud.

Other Classifications-- This type is referred to as Blue Oak-Foothill Pine by the Society of American Foresters (Eyre 1980) and Parker and Matyas (1981), and as Blue Oak-Foothill Pine Forest by Küchler (1977). Neal (1980) gives an excellent, short description of the type, and a more complete description can be gleaned from Griffin (1977) in his discussion of California's oak woodlands.

Habitat Stages

Vegetation Changes-- 2-5:S-D;6. Succession presumably proceeds from annual grasslands directly to tree stages at lower elevations, where a shrub layer is usually sparse or absent. At higher elevations, shrubs and trees regenerate together.

Duration of Stages-- Secondary succession beginning with disturbed soil is rapid during early stages, with annual grasslands giving way to shrubs within 2 to 5 years. However, stands of mature shrubs adequate to provide habitat for those wildlife species requiring them take longer to develop approximately 10 to 15 years. The conifers grow more rapidly than the hardwoods, maturing into relatively large trees even within 30 to 40 years, judging from the photo series taken at the San Joaquin Experimental Range in Madera County (Woolfolk and Reppert 1963). Most of the meager information on growth rates of blue oaks comes from sites in northern and central California. They generally grow slowly at all ages. Blue oaks in Nevada, Shasta, and Placer Counties showed little or no growth in height after they reached 65 cm (26 in) dbh (McDonald 1985)(No McDonald 1985 in Habitat Lit Cite.). The age at which they normally begin producing acorn crops is unknown (M. McClaran, pers. comm.), but it likely takes several decades. Concern has been expressed for the long-term existence of this habitat (Holland 1976), because "little regeneration has occurred since the late 1800s, as livestock, deer, birds, insects, and rodents consume nearly the entire acorn crop each year. Of the few seedlings that become established a large proportion are eaten by deer" (Neal 1980:126). Furthermore, the absence of grazing livestock does not generally result in regeneration (White 1966), because many other animals eat acorns and seedling oaks. Moreover, introduced grasses are subject to burning, may compete directly with seedling oaks for light and nutrients, and may be allelopathic to the oaks. The general absence of secondary successional stages of these woodlands has precluded detailed study of their composition or rates of change.

Biological Setting

Habitat-- As Griffin (1977:386) points out, "oak woodland seldom forms a continuous cover over large areas. It is a major item in a mosaic including valley grassland...and chaparral...with strips of riparian forest." This mosaic is reflected in the character of the understory in stands of BOP woodlands. At lower elevations, these woodlands merge with Annual Grasslands, Blue Oak Woodlands, and Valley Oak Woodlands. The Annual Grasslands actually extend into the woodlands as a ground cover where not shaded by shrubs. The Blue Oak Woodlands differ from the BOP type in lacking a conifer component and usually in lacking a shrub component.

At upper elevations, BOP habitats merge with extensive stands of Mixed Chaparral in most localities, although in some places the Ponderosa Pine type grows at an elevation low enough to form a mixed ecotone with Mixed Chaparral and BOP.

Wildlife Considerations-- BOP woodlands provide breeding habitats for a large variety of wildlife species, although no species is totally dependent on them for breeding, feeding, or cover. In the western Sierra Nevada, for example, 29 species of amphibians and reptiles, 79 species of birds, and 22 species of mammals find mature stages of this type suitable or optimum for breeding, assuming that other special habitat requirements are met (Verner and Boss 1980).

Most species breed during late winter and early spring a factor to consider when planning management activities. Snags are less common, and hence less critical to wildlife, in this than in other forest types. Most species of cavity-nesting birds, for example, use living oaks. The cavities are often in scars where limbs have broken from the trunk or a main branch and have developed a level of decay that makes them more easily excavated by primary cavity nesters.

According to Olson (1974), blue oaks produce an abundant seed crop every 2 to 3 years and bumper crops every 5 to 8 years; however, McClaran (pers. comm.) questions that such a clear cycle of acorn production has been confirmed. In any case, acorns are an important food resource for many species of birds (Verner 1980a.) and mammals (Barrett 1980).

Physical Setting

The habitat occurs in a typically Mediterranean climate hot, dry summers and cool, wet winters. Most precipitation falls as rain from November through April, averaging from 51 to 102 cm (20 to 40 in) within the primary range of blue oak (McDonald 1985). The frost-free growing season ranges from 150 to 300 days, with January minima averaging 1 C (30 F) and July maxima averaging 32 C (90 F) (McDonald 1985). Soils are from a variety of generally well-drained parent materials, ranging from gravelly loam through stony clay loam. Soils rich in rock fragments are typical (McDonald 1985).

Distribution

The range of this habitat (well described by Neal, 1980) generally rings the foothills of the Central Valley, between 150 and 915 m (500 and 3000 ft) in elevation. The Pit River drainage in the Cascade Range and the foothills of the Klamath Mountains mark the approximate northern limit. The habitat is nearly continuous in the western foothills of the Sierra Nevada, except for a gap of 96 km (60 mi) between the Kings and Kern Rivers, where foothill pine is missing. The distribution extends south into the Liebre Mountains of northern Los Angeles County and the drainages of Piru Creek and Santa Clara River in Ventura County. It is discontinuous in the Coast Range west of the Central Valley from Ventura to Mendocino Counties. And it extends westward to within 16 km (10 mi) of the coast in a few places (Griffin 1977, Neal 1980).

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Blue Oak-Foothill Pine

Jared Verner

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Composition-- Blue oak and foothill pine typically comprise the overstory of this habitat, with blue oak usually most abundant. Stands dominated by foothill pine tend to lose their blue oak, which is intolerant of shade (P. M. McDonald, pers. comm.). In the foothills of the Sierra Nevada, tree species typically associated with this habitat are interior live oak and California buckeye. In the Coast Range, associated species are the coast live oak, valley oak, and California buckeye (Griffin 1977). Interior live oak sometimes dominates the overstory, especially in rocky areas and on north-facing slopes at higher elevations (Neal 1980).

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Habitat Stages

Vegetation Changes-- 2-5:S-D;6. Succession presumably proceeds from annual grasslands directly to tree stages at lower elevations, where a shrub layer is usually sparse or absent. At higher elevations, shrubs and trees regenerate together.

Duration of Stages-- Secondary succession beginning with disturbed soil is rapid during early stages, with annual grasslands giving way to shrubs within 2 to 5 years. However, stands of mature shrubs adequate to provide habitat for those wildlife species requiring them take longer to develop approximately 10 to 15 years. The conifers grow more rapidly than the hardwoods, maturing into relatively large trees even within 30 to 40 years, judging from the photo series taken at the San Joaquin Experimental Range in Madera County (Woolfolk and Reppert 1963). Most of the meager information on growth rates of blue oaks comes from sites in northern and central California. They generally grow slowly at all ages. Blue oaks in Nevada, Shasta, and Placer Counties showed little or no growth in height after they reached 65 cm (26 in) dbh (McDonald 1985)(No McDonald 1985 in Habitat Lit Cite.). The age at which they normally begin producing acorn crops is unknown (M. McClaran, pers. comm.), but it likely takes several decades. Concern has been expressed for the long-term existence of this habitat (Holland 1976), because "little regeneration has occurred since the late 1800s, as livestock, deer, birds, insects, and rodents consume nearly the entire acorn crop each year. Of the few seedlings that become established a large proportion are eaten by deer" (Neal 1980:126). Furthermore, the absence of grazing livestock does not generally result in regeneration (White 1966), because many other animals eat acorns and seedling oaks. Moreover, introduced grasses are subject to burning, may compete directly with seedling oaks for light and nutrients, and may be allelopathic to the oaks. The general absence of secondary successional stages of these woodlands has precluded detailed study of their composition or rates of change.

Biological Setting

Habitat-- As Griffin (1977:386) points out, "oak woodland seldom forms a continuous cover over large areas. It is a major item in a mosaic including valley grassland...and chaparral...with strips of riparian forest." This mosaic is reflected in the character of the understory in stands of BOP woodlands. At lower elevations, these woodlands merge with Annual Grasslands, Blue Oak Woodlands, and Valley Oak Woodlands. The Annual Grasslands actually extend into the woodlands as a ground cover where not shaded by shrubs. The Blue Oak Woodlands differ from the BOP type in lacking a conifer component and usually in lacking a shrub component.

At upper elevations, BOP habitats merge with extensive stands of Mixed Chaparral in most localities, although in some places the Ponderosa Pine type grows at an elevation low enough to form a mixed ecotone with Mixed Chaparral and BOP.

Wildlife Considerations-- BOP woodlands provide breeding habitats for a large variety of wildlife species, although no species is totally dependent on them for breeding, feeding, or cover. In the western Sierra Nevada, for example, 29 species of amphibians and reptiles, 79 species of birds, and 22 species of mammals find mature stages of this type suitable or optimum for breeding, assuming that other special habitat requirements are met (Verner and Boss 1980).

Most species breed during late winter and early spring a factor to consider when planning management activities. Snags are less common, and hence less critical to wildlife, in this than in other forest types. Most species of cavity-nesting birds, for example, use living oaks. The cavities are often in scars where limbs have broken from the trunk or a main branch and have developed a level of decay that makes them more easily excavated by primary cavity nesters.

According to Olson (1974), blue oaks produce an abundant seed crop every 2 to 3 years and bumper crops every 5 to 8 years; however, McClaran (pers. comm.) questions that such a clear cycle of acorn production has been confirmed. In any case, acorns are an important food resource for many species of birds (Verner 1980a.) and mammals (Barrett 1980).

Physical Setting

The habitat occurs in a typically Mediterranean climate hot, dry summers and cool, wet winters. Most precipitation falls as rain from November through April, averaging from 51 to 102 cm (20 to 40 in) within the primary range of blue oak (McDonald 1985). The frost-free growing season ranges from 150 to 300 days, with January minima averaging 1 C (30 F) and July maxima averaging 32 C (90 F) (McDonald 1985). Soils are from a variety of generally well-drained parent materials, ranging from gravelly loam through stony clay loam. Soils rich in rock fragments are typical (McDonald 1985).

Distribution

The range of this habitat (well described by Neal, 1980) generally rings the foothills of the Central Valley, between 150 and 915 m (500 and 3000 ft) in elevation. The Pit River drainage in the Cascade Range and the foothills of the Klamath Mountains mark the approximate northern limit. The habitat is nearly continuous in the western foothills of the Sierra Nevada, except for a gap of 96 km (60 mi) between the Kings and Kern Rivers, where foothill pine is missing. The distribution extends south into the Liebre Mountains of northern Los Angeles County and the drainages of Piru Creek and Santa Clara River in Ventura County. It is discontinuous in the Coast Range west of the Central Valley from Ventura to Mendocino Counties. And it extends westward to within 16 km (10 mi) of the coast in a few places (Griffin 1977, Neal 1980).

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Initial mortality and root and shoot growth of oak seedlings planted as seeds and as container stock under different irrigation regimes

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ABSTRACT

Valley Oak (*Quercus lobata*) is a tree commonly used in restoration in the Central Valley of California. We tested initial growth and survivorship of oaks either a) planted as acorns, b) planted out after growing in small containers for three months, c) same as b) but transplanted into larger containers for the last six weeks before planting out, and d) planted out after growing in small containers for one year (commercial stock). We subjected each of these to three different watering regimes, in a stratified random experiment. The oaks were either a) not irrigated, b) drip irrigated or c) overhead irrigated. Water to half of the irrigated oaks was stopped after the first year. Oaks grown from seeds had significantly greater survivorship than oaks planted from containers in non-irrigated plots. Across stock type (acorns, plants of different ages) initial differences in plant height remained after 18 months of growth, but growth rates were similar. Plants grown from pots usually had more branched and more distorted roots systems, but all stock types successfully produced deep roots. It appears that direct seeding may be preferable to using container stock, at least in non-irrigated sites. These oak saplings showed a strong ability to survive sometimes severe initial browsing by hares, which preferentially attacked larger plants. Irrigated plants grew faster than non-irrigated plants, but those weaned from irrigation did no worse in their second year than those that were never irrigated.

INTRODUCTION

The successful propagation and establishment of seedlings is an important component of many restoration efforts. Many of the woody plants planted for restoration in upland habitats in the western United States are xeric tap-rooted species, including several oak species. There have been problems with the establishment of native oaks, both naturally and at restoration sites (Adams *et al.* 1992). Lack of natural recruitment seriously hinders restoration efforts, which often attempt to establish oak seedlings through either direct seeding or planting of seedlings initially established in containers.

The planting of container stock in preference to direct seeding appears to be a standard practice in restoration. In a survey of six restoration projects in Yolo County, CA where Valley oaks are being planted, four have been planting container stock and four direct seeded (two sites did both; TPY, unpublished data). Propagation in pots may restrict taproot growth (Moore 1985), and this can hinder the growth and survivorship of tap-rooted species including Valley oaks (see below). The growth of a deep taproot may be vital to the long-term success of oaks in non-irrigated landscapes and restoration sites.

There have been numerous studies on how containers affect the development of seedlings, in terms of both root and shoot growth (Halter *et al.* 1993; Gilman & Beeson 1996; Mughal 1996; McCreary & Lippitt 1997; Van Iersel 1997; Maejima *et al.* 1997; Marshall & Gilman 1997; Ray & Sinclair 1998; Wu *et al.* 1998). If plants remain in the containers for too long, all types of roots can circle and become deformed. More importantly for xeric restoration, there is growing evidence that tap-rooting species grown in containers lose their taproots permanently (Moore 1985), and this may account for their poor growth and survival when planted into xeric sites (Halter *et al.* 1993; McCreary 1995, 1996; Welch 1997; see review in Young & Evans 2001).

Container size also affects seedling growth. Non-tap-rooting plants grown in larger containers are taller than plants grown in smaller containers (Wu *et al.* 1998), because they grow faster (Van Iersel 1997). However, we still do not know how container size affects the establishment of tap-rooted species.

Irrigation is an expensive and common amendment in restoration settings. Although it can increase initial survival of planted species, its use is not without problems. Irrigation layouts can cost several times the value of the land itself. Irrigation can favor undesirable species, or one planted species over others (Padgett *et al.* 2000). In addition, some species that thrive under irrigation in restoration sites die shortly after the irrigation is removed (Hershey 1999). It is not usually known whether this is due to unsuitable plantings in the first place, or to the plant's inability to adapt to xeric sites while being irrigated.

The research reported here examines how propagation techniques affect the establishment of Valley Oaks (*Quercus lobata*) in a simulated restoration setting. Our data indicate that in non-irrigated situations, seedlings grown from acorns have similar growth rates and significantly higher survival rates than oaks planted as container stock. Irrigated plants grew faster than non-irrigated plants, but those weaned from irrigation did no worse in their second year than those that were never irrigated.

STUDY SPECIES AND SITE

Valley Oak (*Ouercus lobata*) is a California endemic that grows up to 30m tall. It occurs sporadically throughout the state at elevations below 1700m (though not in deserts), and on the Channel Islands. It can be locally abundant along rivers, but it also found on mesic slopes, Valleys, and savannas. The acorn is usually 30-50mm long and 12-20mm wide (Hickman 1993). It is perhaps the most commonly planted tree species in riparian restoration projects in the Central Valley of California.

This research was carried out in a tilled research field of the University of California at Davis. The area experiences a Mediterranean climate with mean annual rainfall of 400 mm, most of which falls November-June.

METHODS

In an experimental field, we set up a random stratified experiment on the effects of plant provenance and watering regime on the success of Valley Oak seedlings. Nine strips of land 3m x 30m were grouped into three blocks. Within each block, one strip was assigned to each of three watering treatments. Within each strip, there were six plots, each an array of nine plants in a 3 x 3 grid, 2m apart. Two of these plots were assigned either seeds, 3-month-old seedlings from containers, or one-year-old seedlings from containers. There were therefore six replicate plots (54 plants) for each of the nine combinations of plant provenance and irrigation regime (486 plants total). We purchased one-year-old Valley Oak seedlings that had been grown in standard potting soil in 6x6x25 cm pots at a local native plant nursery. These were planted into their assigned grids in January 1998 (n = 162). There was initial damage to some shoots through hare herbivory (see below), but only two plants died of this. Thereafter, we put up a protective fence around the entire field, and browsing by hares dropped dramatically.

We obtained approximately 500 *Ouercus lobata* seeds from a commercial source (Mistletoe Seeds) collected near Los Robles, California in October 1998. The acorns were placed into cool storage until January 1999, when radicals began to emerge. Selected randomly, 162 acorns were planted into their assigned grid locations in the field experiment, and covered with a thin layer of soil (-1cm).

In a lath house, 272 acorns were placed onto the surface of standard potting soil in 6x6x25 cm pots, placed on benches, and watered regularly. On 25 February (week 5) half of the lath house seedlings were randomly selected and transplanted into larger pots (15x15x40 cm). In late March, 162 of these 3-month old seedlings (randomly selecting 81 from each of the two container sizes) were planted into the experiment outlined above. The seedlings from small and large containers were alternated within each plot. The plants from larger pots were by this time nearly three times taller than plants from smaller pots (see also Hobbs & Young 2000).

These plants received only natural precipitation throughout the winter rains. In May 1999, we began to irrigate some of the plots. The three strips designated “Drip” received weekly water through a drip system with 2 gph emitters. The volume applied (4L per plant per week) was sufficient to replace reference evapotranspiration for a 1000 cm^2 area around each plant. The three strips designated “Overhead” got water applied over the entire strip through spray sprinklers in quantities similar to that provided by drip irrigation. We adjusted the overhead sprinkler irrigation so that the entire plot received the same amount of water per unit area as in the area around each drip-irrigated plant. The last three strips received no irrigation. In the second year, we ceased irrigation on half of the irrigated plots within each irrigated strip to test weaning responses. We chose not to keep all weeds out of the plots to better simulate a restoration setting. However, we did weed within 40 cm of each oak, and did general weed control when the weeds got thick.

All plants were surveyed regularly for growth and mortality over the next two years. When no seedling appeared above ground for planted acorns, the site was excavated to see if the acorn was still there. For the other oaks, the height of the highest stem tip (not leaf blade) was measured to the nearest cm. Conditions of dead and apparently dying oaks were recorded.

In March 2001, we excavated the root systems of 28 trees, using a backhoe and a power-blower. Trees were chosen to sample representative individuals from all stock and irrigation treatment combinations. We followed all roots as far as possible, usually until they where less than 2mm in diameter. After excavation, we measured the length of the deepest root (standardized to the depth at which the roots tapered to less than 2mm). We counted the number of roots that were greater than 5mm in diameter at 20cm depth, and the number greater than 2mm at 40cm depth. The presence and depths of branch points and contortions ("kinks") of the roots were also recorded. We measured the wet and dry biomass of the roots and the shoots of each excavated plant, and calculated root/shoot ratios.

On 13 August 2001, we measured the field water potentials of the remaining trees. None had been irrigated since the previous year. We used a standard pressure bomb (Soil Moisture Equipment Corp., Goleta, CA) on one leaf from each of four or five plants from each combination of irrigation type and stock source (42 plants total).

Statistical analysis

Mortality rates were calculated for each combination of plant age and watering regime in each of the three blocks. Height data were square root transformed to achieve normality for analysis, but the results presented in the figures are from untransformed data. The effects of block, watering regime, and plant provenance on growth, mortality and root data were analyzed using ANOVAs**.** A posteriori tests were used to distinguish which aspects of watering regime or plant age contributed to significant effects. We separately tested the effects of early hare browsing on one-year-old stock and the effects of pot size on three-month-old plantings with separate one-way analyses of variance. We examined the effects of plant height on the probability of later hare browsing with logistic regression, and the effects of early browsing on late browsing with a chi- square analysis.

RESULTS

Mortality

Within two weeks of planting the one-year-old container plants, hares had nipped the stems of 114 of the 162 oaks, leaving on average 10cm of stem. Subsequently we erected a protective fence around the plots. The only two oaks nipped to less than 2 cm from the ground died. However, overall mortality rates were -10% for both browsed and unbrowsed oaks, and independent of the degree of herbivory (Table 1). Our exclosures decreased, but did not eliminate, hare browsing. We conservatively estimated plants that lost at least 2cm between September 1999 and May 2000 had been browsed by hares (16% of all plants). Overall, taller plants were significantly more likely to be browsed during this later period than were shorter plants (Logistic regression; $X^2 = 17.80$, $P < 0.001$). However, the tallest plants appeared to be escaping by height from hare browsing (Table 2). One-year-old plants browsed in January 1999 were significantly less likely to be browsed later than were plants not browsed early (16% vs. 50%, $X^2 = 15.94$ $p < 0.001$). Approximately 40% of the field-planted acorns disappeared in the first two months after planting, probably taken by ground squirrels or other seed predators. Of the remainder, 90% successfully germinated (see also Hobbs & Young 2000). The mortality reported below is for those oaks that both survived this predation and successfully germinated.

Table 1. Mortality (from February 1999 to May 2000) of one-year-old container Valley oaks planted out in January 1999 and suffering (naturally) differing amounts of hare herbivory in the next four weeks. The only mortality within three weeks of herbivory was of the two oaks with less than 2 cm of stem (in parentheses), all other mortality occurred over the next 16 months.

	Cm of stem left above ground after hare browsing			
	(0-)2-5 cm	6-10	11-17	Unbrowsed
# died	0 (2)	5	5	5
Total number	10 (12)	49	48	41
% mortality	0 (17)	10.2	10.4	12.2

Watering regime had a significant effect on plant mortality across all plant provenances ($F = 36.5$, $P < 0.001$). This was due to the higher mortality of the non-irrigated plants (Figure 1). Mortality rates were similar for the drip and overhead watering regimes.

Table 2. Rates of browsing by hares between September 1999 and May 2000 on oak seedlings of differing heights in September 1999.

Height (cm)	0-9.9	10-19.9	20-29.9	30-39.9	40-49.9	50-59.9
Total	22	110	65	65	38	37
Browsed	1	8	11	19	15	8
%browsed	4.5	7.3	16.9	29.2	39.5	21.6

There were also significant differences in mortality of plants planted at different ages (F = 3.51, P = 0.05). Oaks grown from planted acorns had half as much mortality as oaks planted from 3 mo or 12 mo containers, and this was almost entirely due to differences in the non-irrigated plots (Figure 1). Among the oaks grown from 3 mo containers, those grown in smaller pots had nearly twice as much mortality as those that were transplanted into larger pots six weeks before planting (18/81 vs. 10/81), but this difference was not statistically significant ($X^2 = 2.15$, $P < 0.15$).

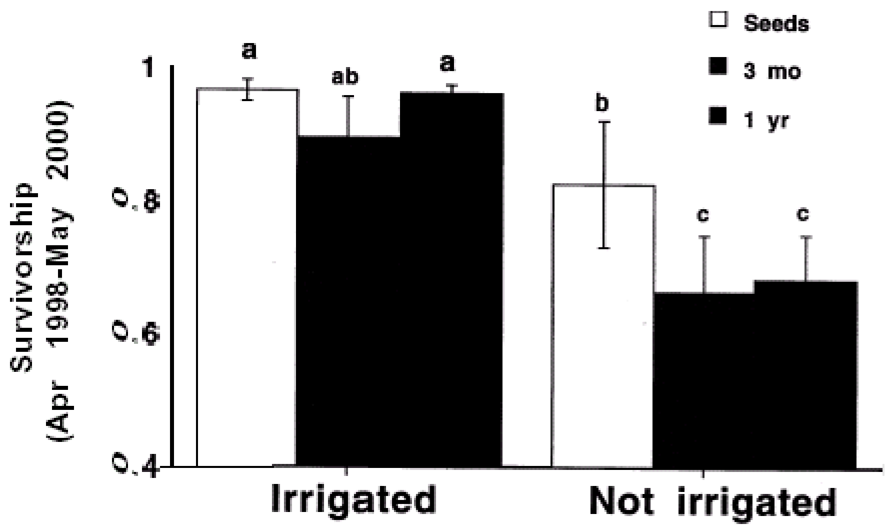

Figure 1. Survivorship rates of different kinds of Valley oak plantings in irrigated and non-irrigated plots. Bars represent standard errors, which are large because of large block effects, which were controlled for in the ANOVA and because these data are not log-transformed. Bars sharing a letter are not significantly different, based on separate a posteriori analyses of irrigated and non-irrigated plants (N = 3 blocks).

There were no differences in mortality among oaks from different sources in the second year of the experiment. Plants that were irrigated the first year, but not the second, had no greater mortality than the plants that had not been irrigated in either year. Smaller plants were more likely to die in the second year than larger plants.

Plant height

There were significant effects on plant height of block, planting age, and irrigation regime, based on a three-way ANOVA (Table 3). Watered plants were significantly taller than non-irrigated plants, and those watered with overhead sprinklers were taller than those on drip irrigation (Table 4**).**

Table 3. Results of analysis of variance of May 2000 height (on ln transformed data). All surviving plants included.

Source	d.f.	Sum of squares	Mean square	F	P
Block	2	41.5	20.8	9.35	0.001
Irrigation regime	2	15.6	7.8	3.51	0.031
Stock	2	171.3	85.6	38.55	<0.001
Stock * Irrigation	4	4.4	2.2	0.50	0.74
Error	353	784.2	2.22		

Plants grown from seed were 23% smaller than oaks planted as three-month-old container stock, which were 28% smaller than oaks planted from one year-old container stock. Within the three-month container stock, oaks planted from smaller containers were 20% smaller than those planted from larger containers, and were virtually the same size as plants grown from seed (Table 4). There was no significant interaction between irrigation regimes and planting age (Table 3).

Table 4. Height (in May 2000) of oaks from different planting stock and irrigation regimes (+/- one standard error. Numbers in parentheses are sample sizes. Included both browsed and unbrowsed plants.

	Irrigation regime			
Stock	None	Drip	Overhead	Mean
Seed	17.4 ± 2.4 (25)	25.1 ± 2.6 (40)	27.5 ± 2.7 (33)	23.9 ± 1.6 (98)
3 mo (small)	17.5 ± 2.3 (17)	21.5 ± 3.2 (22)	32.9 ± 5.1 (24)	24.8 ± 2.4 (63)
3 mo (large)	33.1 ± 2.9 (19)	36.0 ± 3.4 (25)	41.5 ± 4.7 (24)	37.2 ± 2.2 (68)
3 mo (all)	25.8 + 2.3 (36)	29.3 ± 2.6 (47)	37.2 ± 3.5 (48)	31.2 ± 1.7 (131)
12 mo (browsed)	31.1 ± 2.9 (23)	45.9 ± 3.7 (32)	49.1 ± 3.2 (40)	43.7 + 2.1 (95)
12 mo (unbrowsed)	36.6 ± 5.8 (8)	43.8 ± 3.4 (20)	47.2 ± 5.3 (12)	43.4 ± 2.6 (40)
12 mo (all)	32.5 ± 2.6 (31)	45.1 ± 2.6 (52)	48.7 ± 2.8 (52)	43.6 + 1.7 (135)
Mean	25.8 ± 1.5 (92)	34.0 ± 1.7 (139)	40.6 ± 2.0 (125)	33.8 + 1.06 (364)

The average size in May 2000 of plants browsed by hares in early 1999 was similar to plants that were not browsed, even though the browsed plants lost on average half their initial height (Table 4). However, this effect was mostly due to the inclusion of plants that were also browsed between September 1999 and May 2000 (change in height <-2cm). When these plants were excluded, height growth was similar for plants browsed in early 1999 and those not browsed. After excluding the plants browsed between September 1999 and May 2000 (change in height <-2cm), height growth was essentially the same for all planting stocks ($F = 0.42$, $p = 0.65$; Figure 2) and pot sizes ($F = 0.04$, $p = 0.84$). The height advantage of having been initially grown in a larger pot gradually decreased over the first 18 months of the experiment, and was relatively small by November 2000 (Figure 3).

Root excavations and water potentials

Roots on all excavated trees went very deep after only two years of growth. Roots at least 2mm in diameter were always found at 2m depth. There were no significant differences in rooting depth or root/shoot ratios among different provenances or among different irrigation regimes. However, plants transplanted from pots were significantly more likely to have branched root systems than direct-seeded plants. Plants grown from transplants often had branches at the depths of their corresponding pots, and were often grossly contorted ("kinked") at these depths (Table 5, Figure 4). There were no significant effects of watering regime or stock type on root/shoot ratios. There were no significant differences in leaf water potentials in 2001, based on either irrigation history or stock type.

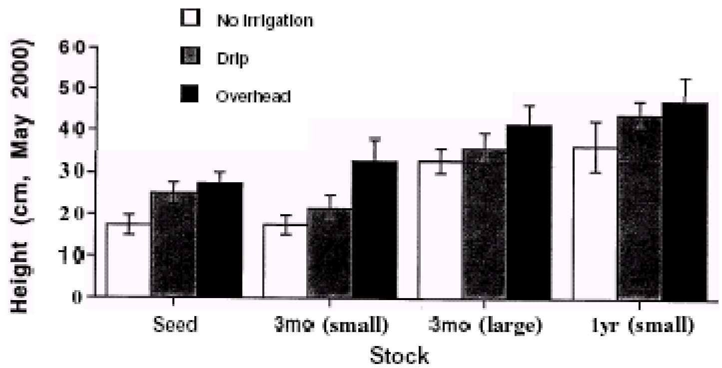

Figure 2. Height growth of Valley oaks planted at different ages, averaged across irrigation regimes. Does not include oaks that were browsed September 1999 and May 2000 (see text). Error bars are one standard error (N = 3 blocks).

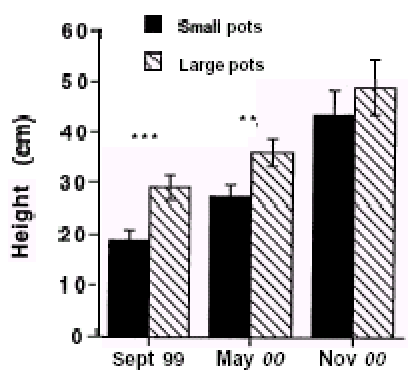

Figure 3. Height though time of Valley oaks planted at 3 months, from either large or small pots, averaged across irrigation regimes. Error bars are one standard error (N = 3 blocks).

DISCUSSION

Herbivory of seedlings is often a limiting factor for oak species, both in natural and restoration settings (Hall *et al.* 1992, McPherson 1993, Bonfil 1998). On our site, hares were initially a major source of herbivory, and likely would have limited recruitment had we not protected the plants (see also Hull & Quiroz-Nietzen 1999). Once protected, however, these oak seedlings were able to recover from severe herbivory. Acorns planted into the field suffered nearly 40% loss before germination, most likely from ground squirrels or other rodents. Cages around planting sites would likely prevent both forms of mortality.

The greater initial mortality of container-grown oaks than field planted acorns may seem surprising, but several other studies have shown similar patterns. Saplings of lodgepole pine (*Pinus contorta*) grown from seed fared better than did container stock even after 11 years (Halter *et al.* 1993). Young blue oaks (*Ouercus douglasii*) had higher survivorship and growth rates than did container stock (McCreary 1995). Just two years after planting, plants of big sagebrush (*Artemisia tridentata*) were larger and had higher survivorship and reproduction than plants planted from container stock (Welsh 1996).

These patterns have been attributed to root problems in containers. Root circling and taproot loss are both symptoms of plants kept too long in containers. In our study, even plants grown in large containers for as little as three months still fared more poorly than plants that were seeded directly. The fact that this effect was most pronounced in the non-irrigated plots suggests a root problem. It is not known if this result can be generalized to a wider array of restoration species. In any case, restoration ecologists may find in these results further justification for direct seeding, at least of large-seeded tap-rooting species. The fact that these difficulties appear only in non-irrigated plots may explain why they have received little attention in traditional horticulture, where most landscape plantings receive supplemental water.

Table 5. Effects of stock provenance on root characteristics, measured 2 years after planting out. P values are for comparison between direct seeded plants and plants initially grown in pots (3 mo and 1 yr combined). ANOVA tests for quantitative traits (mean and s.e.), Chi-square tests for categorical traits.

Provenance	Seed	3 mo pots	1 yr pots	P
Rooting depth (2mm diam)	272 ± 36	218 ± 21	288 ± 19	0.51
Root/shoot ratio	4.16 ± 1.01	4.33 ± 0.62	6.50 ± 1.94	0.48
# of 5mm roots @ 20cm depth	1.11 ± 0.26	2.00 ± 0.54	2.25 ± 0.37	0.066
# of 2mm roots @ 40cm depth	1.78 ± 0.40	3.18 ± 0.71	4.25 ± 0.75	0.035
Roots kinked?	0 out of 9	11 out of 11	5 out of 8	0.001
Roots branched?	3 out of 9	10 out of 11	8 out of 8	0.002

Although the larger oak plantings were still larger after a year and a half of growth, their growth rates were similar and it appears that this initial height advantage does not translate into a growth advantage (Figure 2). This was true even after controlling for the fact that taller plants were more likely to be browsed than shorter plants. Not only does older stock and stock in larger containers cost more to produce or purchase, but these also require more time to plant than individual acorns. Again, it appears that the greater time and energy that goes into older and larger Valley Oak stock may not be justified by greater field performance.

Figure 4. Representative roots of Valley Oaks planted from (left to right) seed, 3-month-old or l-year-old container stock. Note branching and kinks in the roots of the container stock at the depth of the containers (20cm).

It is not surprising that irrigated plants had higher growth and survivorship rates. The higher growth rates of overhead watering compared to drip irrigation were likely due to the fact that these plots received more water overall. Faster growth rates did serve to help plants “escape by height” from hare herbivory. Although the greater individual growth and survivorship rates associated with irrigation may help to fulfill contractual obligations or values, it has been suggested that there may be a “weaning” cost of irrigation, where previously irrigated plants suffer from the removal of the irrigation. Our data do not support such a view, at least for Valley oaks. Irrigated plants had roots that grew at least as deeply as non-irrigated plants, and suffered no greater mortality when eventually deprived of irrigation.

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