PC 1/14/16
#5
(Distributed at hearing by staff)

Charlene Tim <charlene.tim@edcgov.us>

Dixon Ranch

Barbara Jensen <nick.jensen.edh@gmail.com> Wed, Jan 13, 2016 at 4:23 PM
To: Shawna Purvines <shawna.purvines@edcgov.us>, gary.miller@edcgov.us, tom.heflin@edcgov.us, dave.pratt@edcgov.us, lillian.macleod@edcgov.us, tiffany.schmid@edcgov.us, charlene.tim@edcgov.us

Dear Planning Personnel,

I am unable to attend the January 14, 2016 meeting on the above subject, so I am writing to share my thoughts.

I live on property which adjoins the Dixon Ranch. A little background:
We bought and moved onto this property in 1977 when it was all under the Williamson Act because we had a strong desire to live in the country. We lived in a trailer with 3 children for 19 months while we built a modest house. The first month we had no water and no electricity. We dug ditches by hand to lay pipes. During this drought time with rocky soil we all got a workout. These details are mentioned to demonstrate how much living here meant to us.

Now we are faced with the possibility that it will all be changed. The wildlife we view daily will no longer have a corridor in which to roam. Getting onto Green Valley Road will be a challenge - forget making a left turn there! (It is hard enough now at certain hours.) Being on a well and using as little as possible (the lawn is no longer with us) water is a huge concern. Even if the project uses EID water, rumor has it that wells will still be drilled for open space and ponds.

I was impressed at the December 10 Planning Commission meeting when the Dollar Store in Georgetown was discussed. Mention was made of wanting to retain the character of Georgetown, and to consider what the residents would like to see. I hope you will use that same philosophy for those of us who moved here in order to enjoy the ambiance of rural life.

Thank you for your consideration,

Barbara Jensen
3163 Verde Valle Lane
El Dorado Hills, CA 95762
--
Barbara Jensen
nick.jensen.edh@gmail.com

14-1617 Public Comment
PC Rcvd 01-14-16

(Distributed at hearing by Ellen Van Dyke) PC 1/14/16 #5 2 pages

Dixon Ranch, file no. 14-1617, Planning Commission 1/14/16
Green Springs Ranch Borders Committee, Public Comment

Of the 100 parcels in Green Springs Ranch, we have about 10 that border the Dixon project. We understand the applicant has tried to reach private agreements with a few of those property owners in an effort to make this project more palatable to them. However, the minor changes proposed to placate a couple of homeowners do not address the serious concerns of the remainder of our residents.

Last year, the County paid $150K for the Green Valley corridor traffic study, and identified deficiencies specifically related to the multiple direct access driveways on Green Valley Rd. Those deficiencies cause accidents routinely along the corridor under the existing traffic load. Yet Dixon Ranch proposes to increase traffic volume by *50%* with no change to those driveways. It will add nearly 5,000 vehicle trips daily from the project site with sole access from Green Valley Rd .

We don't expect the Dixon property to remain undeveloped. But any development that goes there needs to be safe, and it needs to not destroy the rural nature that *we* moved here for. We ask you, Commissioners, to please consider the following:

- The EIR includes a Reduced Build Alternative that would significantly reduce the traffic added to Green Valley Rd, and should not be dismissed for the sake of the developers profit.
- The Lima Way Non-Gated Alternative may have safety issues with 605 lots proposed, but at some significantly reduced number, it becomes acceptable. What is that number?
- The deficiencies in line of sight, as identified in the Corridor traffic study, must be corrected before adding *any* additional traffic (excerpt from study attached)
- The proposed Class II bike lane on Green Valley should be upgraded to a Class I.
- Minimum 5-acre parcels should form the border of Dixon Ranch, to provide the density buffer and transition that the surrounding rural neighborhoods would expect.
- Public water is likely to be supplied through our neighborhood; fire hydrants could be added along that route, and stubs for future expansion of EID into our neighborhood.

We have been looking for compromise since the project was first proposed, and most of those options will cost the applicant some of his profit. But as it stands, that profit is coming at the expense of residents in surrounding neighborhoods, and anyone who uses Green Valley Rd.

We urge the Commission to not approve the project as proposed, but instead require the applicant to come back with a reduced-build plan that is safe for BOTH Green Valley Rd and Lima Way; a plan that protects the rural character of the surrounding area. This kind of compromise (profit-infringing...) will not happen by choice and we are depending on you to place our residents' safety and quality of life over the interest of developer profits.

Ellen Van Dyke, on behalf of the GSR Border Committee

Green Springs Ranch is the rural subdivision immediately adjacent to the Dixon Ranch project.

Excerpts of some of the line of sight deficiencies noted in the Green Valley Corridor Traffic Study, Oct 2014, in the immediate project area:

Rocky Springs Rd:

"Due to the horizontal curvature of the roadway and overgrown foliage, the Rocky Springs Road approach has limited intersection sight distance looking east and west."

Malcolm-Dixon Rd:

"Due to the wide curve combined with an upgrade on Malcolm Dixon Road, vehicles typically slow down to make a left-turn onto Malcolm Dixon Road. This can present safety issues for the trailing motorists "

Lexi Way:

"ISD [intersection site distance] to the east is restrictive due to the vertical crest in the roadway."

Green Valley Road Home and Eastern Strawberry Entrance:

"Line of sight to the west from both the 1840 Green Valley Road home access and the second entrance to the strawberry stand (coming from the west) is limited due to vegetation but could be improved with tree removal by the private property owner. ISD to the east is limited from the home driveway due to the vertical crest of the road."

1855 Green Valley Rd:

"ISD is limited in both directions due to vegetation to the west and vertical curvature to the east. ISD to the west for the unmarked access across the street is also limited due to vertical curvature."

1870 Green Valley Rd:

" ISD to the east was extremely limited due to the vertical crest in the roadway."

Complete list submitted with Van Dyke public comments 2/6/15, attachment 8.

(Distibuted at hearing by Tenley Martinez)

PC 1/14/16
#5
2 pages

To Planning Commissioners
El Dorado County

My name is Tenley Martinez, 32 year resident of Green Springs Ranch, retired educator of 37 years in Buckeye School District and owner of Sea Dreams Lavender Farm at 2021 Marden Dr, Rescue California in Green Springs Ranch.

It is with great respect for the good work you do as planners that I stand here today and voice my concern about the proposed Dixon Ranch Project.

My concerns are as follows:

* The high density of the development with regards to traffic safety on Green Valley Road

*The proximity of homes to be built adjacent to the 5 acre parcels in Green Springs Ranch and other existing homes surrounding the Dixon Ranch

* Use of ground water from existing wells for residential purposes

In Reviewing the response to my letter of Feb. 6,2015 submitted during Draft EIR
Public comment, response B23-6 states
"The two other wells will not be used and will be abandoned, following proper County procedures, upon completion of proposed project. No ground water will be used for pond maintenance, construction watering, or irrigation for common open space, landscaping or for park areas within project site."

My questions are

1. What is the date of the completion of the proposed project and will they be able to access those wells until then?
2. Will the developer be able to activate the existing wells and use ground water for residential purposes if drought conditions exist?

I rely heavily on my well water for personal and agricultural use related to Sea Dreams Lavender Farm. I am a Certified Producer in El Dorado County, cdfa State of California Department of Food and Agriculture. For the past three years I have been doing business at the El Dorado County Farmer's Markets in El Dorado Hills and South Lake Tahoe May through Sept.

My fear is that if my well's production decreases because of wells being used in proximity to my farm, I will not be able to afford alternative water sources such as EID. I will have to close my business, abandon my retirement dreams of an owner built log home and lavender farm that I have worked so hard to develop over the past 32 years.

I understand that development is important in El Dorado County. However, this high density development is not appropriate for the Dixon Ranch Property. In closing, I ask that you not approve this project as proposed.

Sincerely,

Tenley Martinez

Tenley Martinez

website currently in development

14-1617 Public Comment
PC Rcvd 01-14-16

(Distributed during hearing by Cheryl Langley)

Cheryl Langley
Shingle Springs Resident

Public Comment
Planning Commission Meeting
January 14, 2016
Agenda Item No.5
File No. 14-1617

46 pages

Planning Commissioners:

Thank you for the opportunity to comment on the **Dixon Ranch Project**. Because my interest is primarily oak resource protection, I have focused on this aspect of the project.

El Dorado County's oak resources are important; without question oaks play an important role in defining the County as "rural." This rural attribute looms large as a County asset; it is often cited as the reason residents live in—and enjoy—this County. And, the County's rural character is the basis for much of the County's tourism industry. Aesthetics matter; trees matter.

While attending meetings on the Biological Resources Policies Update & Oak Resources Management Plan (ORMP), I have heard some individuals say we have "plenty" of trees in the County—plenty to spare. I have heard oak regeneration rates proposed as mitigation for loss (which are in fact not adequate to offset losses of mature blue oaks).[1] And, I have heard El Dorado Hills presented as an example of an area where development has not impacted the oak woodlands "that much,"—indicating residents need not worry that approval of housing developments will mean a decline in our oak woodlands.

But the truth is far from that; the El Dorado Hills Specific Plan concludes nearly **700 acres** of blue oak/live oak woodland would be removed following plan completion **for that project area alone.**[2] The Dixon Ranch project—Phases 1 and 2—will remove approximately 20 acres of oaks—over 44 percent of the project site's existing blue, valley, black and interior live oaks. And this figure may be a low estimate. If Option B is approved following ORMP adoption, this number could increase.

Currently—under Phase 1—the project proponent proposes to remove just under the maximum amount of tree canopy currently allowed under Option A—*for the entire project, phases 1 and 2*—4.45 acres of the "allowable" 4.48 acres. Phase 2—because its inclusion is not possible at this time under Option A—awaits the eventual passing of a revised ORMP, which is likely to contain an Option B that will allow 100 percent removal of oaks, if desired.

Mitigating to "*Less-Than-Significant*"

The conclusion in the Dixon Ranch EIR is that the proposed mitigation measures reduce impacts to woodlands to a less-than-significant level. But there are problems with this conclusion.

In El Dorado County, attempts to mitigate oak removal have proven an abysmal failure, as you can see by the photos of the mitigation plantings adjacent to Serrano Village D2 in "tree shelters." (This village was built around 2001-2003.) Photos taken **June, 2015**.

---

[1] Fryer, Janet L. 2007. Quercus douglasii. In: *Fire Effects Information System*. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory.

[2] Jones & Stokes Associates, Inc. 1987. *Draft Environmental Impact Report, El Dorado Hills Specific Plan*. State Clearing House Number 86122912, October 1987, pages 12-25 and 12-27.

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

Note the low success rates for blue oak plantings, even with tre shelters

The tree shelters in this area (as seen in foreground) are mostly devoid of trees.

The County's track record for oak mitigation is unbelievably poor, and yet the project applicant expects those evaluating the project and its mitigation proposal to believe their proposal to plant saplings and acorns will be effective enough to mitigate the loss of mature woodland to a "less-than-significant" level.

Where is the "real world" proof that acorn plantings can effectively replace oak woodland within the County? To my knowledge, no county in the state has shown this method of mitigation to be efficacious, and yet, according to the Dixon Ranch Oak Site Assessment, *"The total number of acorns required for the mitigation on this site will be 2, 670, and 1,800 will be blue oak, and 870 will be interior live oak."*[3] The planting of acorns is not a proven mitigation strategy in El Dorado County. And, blue oak especially—the species the project proponent indicates will make up the bulk of replacement planting—are notoriously slow growers.

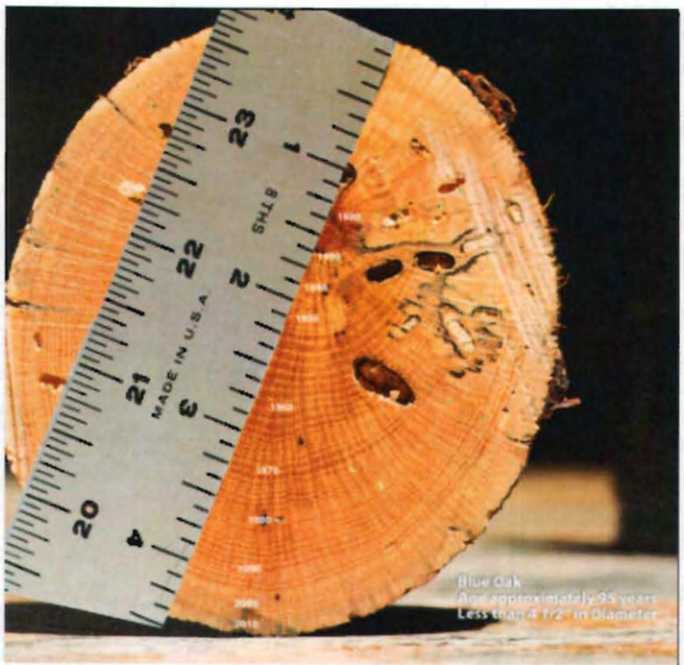
The blue oaks depicted on the next page are **10-16 years old.**[4]

---

[3] Gordon Mann. 2014. *Dixon Ranch Oak Site Assessment*. April 25, 2014, page 11.
[4] Phillips, R. L., et al. 1996. *Blue Oak Seedlings May be Older than they Look*. California Agriculture, May-June 1996.

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.

Below is a photo of a cross section of of a blue oak that is 4.5" dbh; it is estimated to be 95 years old.



4.5" dbh—approximately 95 years old

dbh=diameter at breast height:
4 '6" from ground level

Photo Source: Don & Ellen Van Dyke

And, large blue oaks are likely **153 to 390 years old.**[5] Given this growth rate, how many decades will it take to replace existing mature oak woodland? Well over 100 years?

[5] White, K.L. 1966. *Structure and Composition of Foothill Woodland in Central Coastal California*. Ecology 47:229-237.

Who here believes the planting of an acorn can replace the lost canopy of a mature tree in a "reasonable" amount of time, and thus reduce the impact to mature woodland to a less-than-significant level? Or would maximizing oak tree retention on-site be a better, more realistic option?
(**NOTE:** The performance standard under the Interim Interpretive Guidelines [IIG] requires canopy replacement in 15 years.)

Request for an Oak Tree Removal Mitigation Plan is Denied
A request for a specific landscape mitigation plan (namely an Oak Tree Removal Mitigation Plan) that would include the specific (mapped) location of oak plantings, oak sizes for those locations, details about maintenance (irrigation availability, irrigation duration) and monitoring, has been ignored. Instead, LSA repeated a litany of mitigation options, including the planting of trees grown in Deepot cells (1 year-old seedlings), and the possible planting of up to over 2,600 acorns. The where, the how of this strategy is unknown. And, LSA has indicated *"A detailed Oak Tree Removal Mitigation Plan has not been developed."* But the IIG requires just such a plan (IIG, page 11):

> Recommendations from the qualified professional shall include a minimum of: Site planting design; planting ratios to ensure success; any required acorn collection areas or nurseries; propagation measures; acorn and tree protection techniques; maintenance, monitoring and reporting requirements. The size of the designated replacement area shall equal at a minimum, the total area of the oak canopy cover that is proposed to be removed. An agreement to the satisfaction of County Counsel and the Director shall be required to ensure the long term maintenance and preservation of any replacement trees and/or acorns planted. Maintenance and monitoring shall be required for a minimum of 10 years after planting. Any trees that do not survive during this period of time shall be replaced by the property owner.

After all, how can the viability of mitigation be evaluated without a specific mitigation plan? This refusal to present a solid mitigation proposal equates to a deferral of mitigation, something that specifically violates the California Environmental Quality Act (CEQA). According to 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. Formulation of mitigation measures should not be deferred until some future time."*

But LSA presents the ***development*** of an Oak Tree Removal Mitigation Plan **as the mitigation that makes the impact less-than-significant.** (See attached mitigation measures BIO-2a and BIO-2b.) This is not mitigation—this is the preparation of ***a plan that may or may not be efficacious—that should be available for public review within an EIR****, a plan that could potentially be challenged.*

Just what could such a plan reveal? For instance, if acorn planting is planned and yet has been shown to be an ineffective mitigation strategy within the County, this mitigation proposal could be challenged and changed. Or, if the project proponent is unable to secure adequate off-site conservation easements or deed restrictions for off-site planting, that would be another sticking point that would mean mitigation could not be reduced to a less-than-significant level. This plan—and the selection of mitigation components—must be supported by substantial evidence and circulated for public review and input.

The second mitigation measure, BIO-2b, simply says the developer will comply with Option A for Phase 2, unless and until other options become available. Phase 2 development cannot meet Option A requirements; the only way Phase 2 will be developed is through the removal of about 15 more acres of existing oak woodland. **How do either of these measures effectively mitigate the impact to oaks?**

Needless to say, I ask that you deny this project. However, if this project is to proceed, I ask that prior to approving any of the matters before you today—before moving this project forward—you require the following:

- Require the project's two phases meet current Option A requirements *in total*. In other words, the entire project should meet *existing* requirements. The phasing of projects to "spread" the impacts over subsequent portions of the project is unacceptable, and conflicts with the spirit of CEQA.

  This phasing of the project—and the phasing of mitigation—enables the project to evade adequate cumulative impact analysis under CEQA. Phase 2 mitigations are "pending" based on the terms established under the yet-to-be-adopted ORMP, whose adoption—and/or the terms of adoption—are speculative. In addition, a new tentative map and development plan is pending for Phase 2; this plan is not known—or knowable ***at this time***—as is true of its impact or any mitigation measures that may be approved. Because the development plan is uncertain, so are its direct and cumulative impacts. This project needs to be evaluated ***in total*** prior to moving any portion forward (i.e., Phase 1).

- Reject the planting of acorns as a mitigation option.

- Require provision of a complete Oak Tree Removal Mitigation Plan *prior* to moving the project forward; enable the public to review this plan. Woodland restoration that will accomplish mitigation has not been defined; the project proponent's mitigation "plan" is nonspecific, and timing of mitigation has not been outlined. The comment that *"the proposed Phase 1 mitigation plan may be performed in multiple planting phases"* indicates that no specific plan has been established, as does *"the mitigation actions that will be performed for this project will be dependent upon the allowable mitigation measures to be conditioned for this project,"* and *"the project is submitted based on the expectation that the County of El Dorado Board of Supervisors may amend the General Plan policies..."* Specific tree size(s) to be planted, the location of plantings, and timing of plantings, the irrigation type and duration, the monitoring and replacement plan should all be defined. If other mitigation tools will be employed, that should be specified, too (such as off-site purchase of woodland conservation easements, or the establishment of deed restrictions). Any such conservation easement or deed restriction acquisitions should be "solid" commitments, and made public. The mitigation plan—in its entirety—needs to be established *prior* to moving the project forward. (That is, it needs to establish a less-than-significant impact, if the applicant believes this is feasible.) Require that the plan provide substantial evidence that the replacement methods proposed are *proven* to be effective (within the County, under real-world conditions, not simply under *research* [study] situations).

- If on-site planting is to occur, require the planting regime preserve the original diversity of the woodland removed. Black oak (*Quercus kelloggii*) and valley oak (*Quercus lobata*) are also components of the woodland proposed to be removed, and yet the project proponent proposes to replace only blue oak (*Quercus douglasii*) and interior live oak (*Quecus wislizeni).* This change in species composition impacts the diversity and quality of the reestablished woodland, especially in terms of its value to wildlife (which can be species dependent). Plus, valley oak has specifically been listed as "sensitive habitat," [6] and yet there are no plans to replace this species.

- Require the developer (Dixon Ranch Ventures, LLC) to commit to mitigation planting efficacy for the duration of the monitoring and maintenance period (10 years for trees; 15 years for acorns, (if used). Specify that such responsibilities cannot be turned over to a Home Owner's Association, or other "similar entity" as proposed in the EIR.[7]

- Require the Oak Tree Removal Mitigation Plan be prepared to the *"satisfaction and approval by a registered arborist,"* not simply, "to the satisfaction of the County," as is currently stated. (This plan must also be subsequently approved by the County, following arborist development.)

- Please require the project proponent to identify and implement the additional mitigation that will reduce to less-than-significant the impact of the project on oak woodlands, beyond the mitigation proposed to meet the requirements of 7.4.4.4 (Option A).

  According to the *Biological Resources Study and Important Habitat Mitigation Program,* page 8, if the project will impact the following: the density of oak canopy, the stand-age structure and understory, oak regeneration, eliminate snags, impact adjacent habitats or habitat buffers, result in sedimentation, decrease biological diversity, increase oak woodland fragmentation, etc., then (for discretionary projects), *"...**the impact may be considered significant under CEQA unless adequate mitigation is proposed <u>in addition to</u> compliance with the replacement requirements of Policy 7.4.4.4...**"*

- **Require the project proponent to satisfy the requirement of General Plan Policy 7.4.5.2:** *"It shall be the policy of the County to **preserve native oaks wherever feasible,** through the review of all proposed development activities where such trees are present on either public or private property, while at the same time recognizing individual rights to develop private property in a **reasonable manner.**"* This project does not represent "reasonable use." The density and intensity of the proposed uses will impact neighboring land owners. Impacts to water supply, traffic congestion, traffic safety, air quality, and community aesthetics will equal a reduction in the overall quality of living conditions in the neighborhood, and may adversely impact property values.

  While LSA Associates writes that this policy does *"...not apply to the proposed project...because an Oak Tree Preservation Ordinance...has not yet been adopted."* [8] I beg to differ; I believe the policy does apply, and the project proponent needs to make a good faith effort to comply.

---

[6] El Dorado County. 2015. *Draft Oak Resources Management Plan, Revised November 2015 (Clean Version).* Page 3.
[7] LSA Associates, Inc. 2015. *Dixon Ranch Residential Project EIR Response to Comments Document.* Comments and Responses, November, 2015. Response B34-24, page 348.
[8] LSA Associates, Inc. 2015. *Dixon Ranch Residential Project EIR Response to Comments Document*, November, 2015, Response B34-50, page 356.

- Require the project proponent to identify and establish mitigation for **lost agricultural land**. Not only does this project convert agricultural land to non-agricultural (urban/residential) land uses, it impacts the amount of water available to agricultural operations. The California Land Evaluation and Site Assessment Model (LESA) system requires that for projects found to have a significant impact on agricultural lands, mitigation shall include 1:1 replacement or conservation for loss of agricultural land that is either in active production, or identified as suitable for agricultural production. Because the Dixon Ranch site is a viable agricultural unit (cattle grazing), its loss requires mitigation. Therefore, the project proponent must identify where this mitigation is to occur.

In closing,
I ask that you deny the project. The proposed project will have a significant impact on oak woodlands that cannot be adequately mitigated. The project proponent understates the project's harm to the environment, and exaggerates project benefits and the viability of mitigations.

AHACHMENT 1 OF 4

Proposed Mitigation Measures
Dixon Ranch Project

Mitigation Measures BIO-2: The project applicant shall implement the following two-part measure:

- BIO-2a: The project applicant shall comply with County oak tree mitigation requirements to the satisfaction of the Development Services Division, ~~and per~~in compliance with the requirements of Option A ~~of~~ under Policy 7.4.4.4. As a condition of approval, ~~P~~prior to providing any permits for the project, the project applicant shall prepare and submit an Oak Tree Removal Mitigation Plan to the satisfaction of and approval by the County. ~~Per~~ Pursuant to the Arborist Report for Phase 1 of the project, mitigation for oak tree removal will ~~generally~~ consist of planting up to 4.48 acres of oak ~~trees~~ canopy area at a 1:1 ratio ~~per~~ for the acres actually removed, up to the allowable 10 percent canopy ~~reduction~~ removal area. The Mitigation Plan shall identify the locations for all on-site and off-site planting areas as well as all conditions associated with the planting. At a minimum, all tree planting for this mitigation measure will comply with the County's target density of 200 trees per acre and other guidelines set forth under Option A, as well as the project tree planting specifications summarized in the Dixon Ranch Oak Site Assessment Report and further detailed in the Oak Tree Removal Mitigation Plan. The Mitigation Plan shall also identify measures to protect oak trees adjacent to the construction areas that will not be removed.
- BIO-2b: ~~The project applicant shall provide a tentative map and development plan for Phase 2 of the project. Phase 2 of the project will undergo additional CEQA review (as necessary) and must adhere to all provisions and mitigations outlined in the Option B Oak Tree Removal Mitigation Plan.~~ Phase 2 development shall be subject to the requirements of Option A under Policy 7.4.4.4. If in the future, Option B becomes available, the project will undergo additional CEQA review as necessary, and must adhere to all provisions and mitigations outlined in the Option B adopted policy amendments, associated CEQA clearance document, and Oak Tree Removal Mitigation Plan. Option B mitigations and measures may include the following: prepar~~e~~ation of an Oak Tree Removal Mitigation Plan, to the satisfaction of and approval by the County; payment of a mitigation fee to the County~~,~~ for offsite permanent preservation and/or dedication ~~per~~ towards an easement of oak woodlands; inclusion and permanent protection of additional oak woodlands as part of the project to offset ~~tree~~ woodland removal~~s~~; or other feasible measures identified by and to the satisfaction of and approval of the County. Because it is not known at this time what the updated General Plan will require, at a minimum, the Oak Tree Removal Mitigation Plan shall require oak woodland of comparable quality is conserved, created, or restored at a ratio of two acres of oak woodland canopy area conserved for every one acre of oak canopy area removed (2:1).

14-1617 Public Comment
PC Rcvd 01-14-16

ATTACHMENT 2 of 4

Response B25-13:

...

Policy 8.1.3.4 is an action directing the establishment of a threshold of significance and is not a policy for which consistency of a development project needs to be determined. General Plan Policy 8.1.4.1 requires that the County Agricultural Commission review all discretionary development applications involving land zoned for or designated agriculture, or lands adjacent to such lands, and to make a recommendation to the reviewing authority, in this case Development Services Planning Division. On November 9, 2011, at a regularly scheduled meeting, the County Agricultural Commission considered the applicant's request for a rezone from Exclusive Agriculture (AE). The Commission unanimously approved the rezone request. In conjunction with that approval, the Commission made three findings: (A) the proposed project will not intensify existing conflicts or add new conflicts between adjacent residential areas and agricultural activities; (B) the proposed project will not create an island effect wherein agricultural lands located between the project site and other non-agricultural lands will be negatively affected; and (C) the proposed project will not significantly reduce or destroy the buffering effect of existing large parcel sizes adjacent to agricultural lands.

The motion to approve also included a requirement that all necessary considerations for adjacent agriculture on adjoining lands be taken into account when zoning and environmental impacts are considered. The Draft EIR evaluates potential environmental impacts in accordance with this requirement. Because no significant impacts were identified, replacement or mitigation for agricultural acreage is not required. No revisions to the Draft EIR are necessary as a result of this comment.

Excerpt from pages:

231

14-1617 3H 235 of 444

232

14-1617 3H 236 of 444

ATTACHMENT 3 OF 4

Quercus douglasii

INTRODUCTORY

Blue oak savanna. Mark W. Skinner @ USDA-NRCS PLANTS Database.

AUTHORSHIP AND CITATION:
Fryer, Janet L. 2007. Quercus douglasii. 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 9].

FEIS ABBREVIATION:
QUEDOU

NRCS PLANT CODE [242]:
QUDO

COMMON NAMES:
blue oak

TAXONOMY:
The scientific name of blue oak is *Quercus douglasii* Hook. & Arn. (Fagaceae). It is in the white oak (Lepidobalanus) subgenus [72,114,134,157,239].

Blue oak hybrids are:

Quercus × *alvordiana* Eastwood (*Q. douglasii* × *Q. john-tuckeri* Tucker) [72,98,114,157,239]
Quercus × *kinselae* (C. H. Muller) Nixon (*Q. douglasii* × *Q. dumosa* Nutt.) [72,98,239]
Quercus × *eplingii* C. H. Mull. (*Q. douglasii* × *Q. garryana* Dougl. ex Hook.) [98,114,157,239,240]
Quercus × *jolonensis* Sarg. (*Q. douglasii* × *Q. lobata* Nee) [61,98,114,157,239]

SYNONYMS:

14-1617 Public Comment
PC Rcvd 01-14-16

None

LIFE FORM:
Tree

FEDERAL LEGAL STATUS:
No special status

OTHER STATUS:
Over 100 cities and counties in California have ordinances providing some level of protection for oaks. At the state level, the Integrated Hardwood Range Management Program, a collaborative effort between the University of California and the California Division of Forestry, is monitoring blue oak populations to provide recommendations for future legal protection [70]. Information on state-level protection status of blue oak is available at Plants Database.

DISTRIBUTION AND OCCURRENCE

SPECIES: Quercus douglasii

- GENERAL DISTRIBUTION
- HABITAT TYPES AND PLANT COMMUNITIES

GENERAL DISTRIBUTION:
Blue oak is native and endemic to California [98,114,116,188,196]. It is very common within its narrow range, dominating almost half of California's oak woodlands [196]. It occurs in valleys and on low slopes of the Coast Ranges and on low foothills of the Sierra Nevada. The core area of blue oak distribution almost completely encircles the Central Valley, from Shasta County in the north to Los Angeles County in the south [98,114,116,188]. Some blue oak populations extend into the Central Valley. Blue oak reaches its northernmost distribution in Del Norte County and its southernmost distribution in Riverside County. Isolated populations occur in the Siskiyou, Klamath, and Trinity mountains, east of the Cascade Range, and on Santa Cruz and Santa Catalina islands [98]. Populations in coastal southern California and on the Channel Islands consist of small stands or solitary individuals, and some doubt exists as to whether some or all of those populations are natural stands or are historical introductions near Native American settlements [72]. The Jepson Flora Project provides a distributional map of blue oak.

Quercus × *alvordiana* is the most common of the blue oak hybrids and frequently forms hybrid swarms. The *Q.* × *alvordiana* complex is a variable group of semideciduous oaks that are a "conspicuous part" of the vegetation on the inner Coast Ranges from Carmel Valley in Monterey County south to the Tehachapi Mountains. *Q.* × *alvordiana* displaces blue oak as the dominant foothills oak in parts of that range. Although Griffin and Critchfield [98] describe *Q.* × *alvordiana* as an "unsatisfactory" taxonomic unit, they concede that these "problem oaks should be considered if the southern distribution of blue oak is to be fully understood." The Jepson Flora Project provides a distributional map of *Q.* × *alvordiana*.

HABITAT TYPES AND PLANT COMMUNITIES:

Blue oak woodlands and savannas dominate many of California's lower foothills. Along low western slopes of the Cascade-Sierra Nevada ranges, blue oak types either 1) lie between chaparral or mixed-conifer forest above and annual grassland or valley oak (*Quercus lobata*) woodland below [95,102] or 2) form a mosaic with chaparral and annual grassland. Blue oak savannas generally occur near the Central Valley floor, on shallow soils, and/or low-elevation, south-facing foothills. Blue oak woodlands occur further upslope, sometimes closing to a nearly continuous overstory on moist sites [256]. At midelevation, oak woodland, annual grassland, and chaparral ecotones may be dynamic [58], with type shifts dependent on differences in soil, aspect, grazing patterns, and/or fire history [45]. On the Coast Ranges, blue oak woodlands and mixed-oak woodlands with a blue oak component typically lie within a mosaic that includes annual grassland, coastal sage scrub, chaparral, redwood (*Sequoia sempervirens*), and/or coast Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*) communities. Blue oak woodlands finger into singleleaf pinyon-California juniper (*Pinus monophylla-Juniperus californica*) woodlands at the ecotones of the Great Basin and Mojave deserts [18,80,95,125].

Blue oak woodland. Mark W. Skinner @ USDA-NRCS PLANTS Database.

Blue oak-dominated communities are highly variable in composition. Blue oak frequently codominates with gray pine (*Pinus sabiniana*) [88,95]. It also occurs in monospecific stands or codominates with valley oak, Oregon white oak (*Q. garryana*), coast live oak (*Q. agrifolia*), and/or interior live oak (*Q. wislizenii*) [95,196]. In Annadel State Park, oak woodlands with various mixtures of blue oak, valley oak, California black oak (*Q. kelloggii*), and interior live oak form a mosaic with mixed-evergreen forest and redwood groves [71]. Blue oak is a component of some low-elevation riparian communities. A vegetation survey along watercourses of the Central Valley found blue oak grew in association with Fremont cottonwood (*Populus fremontii*), California sycamore (*Platanus racemosa*), northern California black walnut (*Juglans californica* var. *hindsii*), and valley oak [250].

The herbaceous ground layer in blue oak communities and annual grasslands is dominated by nonnative annual species. California grasslands were probably historically dominated by perennial bunchgrasses such as purple needlegrass (*Nassella pulchra*) and bottlebrush squirreltail (*Elymus elymoides*) [22,55,204,211,251]. The type shifts from blue oak/perennial bunchgrass to blue oak/annual grassland and from perennial bunchgrass to annual grassland are irreversible [139]. Groundlayer diversity is probably higher since invasion of nonnative annuals than when blue oak communities supported a ground layer of native perennial grasses [139]. Keeley [138] conducted an inventory of groundlayer vegetation in blue oak woodlands in and near Sequoia-Kings Canyon National Park. He found nonnative annuals comprised about three-fourths of the groundlayer species present at the smallest scale (1 m^2) and about one-half the species at the largest scale (1,000 m^2) [138].

The following vegetation typings describe blue-oak dominated communities. Typings are listed from north to south, with general, statewide typings below.

- blue oak phase in the Cascade Range [95]
- blue oak associations of the North Coast Ranges of California [56]
- blue oak phase in the Coast Ranges [95]
- blue oak savanna and woodland phases on the Hasting Natural History Reservation [94]
- blue oak woodlands of Pinnacles National Monument [107]
- blue oak/annual grassland savanna in the Central Valley [95]
- gray pine-blue oak woodland phase in the Sierra Nevada foothills [88,95]
- mixed-oak/California buckeye (*Aesculus californica*) foothill woodlands of southern California [231]
- blue oak series in the Liebre Mountains [39]
- blue oak plant communities of southern San Luis Obispo and northern Santa Barbara counties:
    - blue oak/foxtail barley-Johnny-jump-up (*Hordeum murinum* ssp. *leporinum-Viola pedunculata*)
    - blue oak/Chilean bird's-foot trefoil (*Lotus wrangelianus*)-purple needlegrass
    - blue oak/warty spurge-goldback fern (*Euphorbia spathulata-Pityrogramma triangularis*)
    - blue oak/phloxleaf bedstraw-bajada lupine (*Galium andrewsii-Lupinus concinnus*)
    - blue oak/white-stemmed filaree (*Erodium moschatum*)-foxtail barley
    - blue oak/San Bernardino larkspur-imbricate phacelia (*Delphinium parryi-Phacelia imbricata*)
    - blue oak/bajada lupine-foothill clover (*Trifolium ciliolatum*)
    - blue oak-interior live oak/mission woodland-star (*Lithophragma cymbalaria*)
    - blue oak/common fiddleneck-rusty popcornflower (*Amsinckia menziesii* var. *intermedia-Plagiobothrys nothofulvus*)
    - blue oak/longstem buckwheat (*Eriogonum elongatum*)-Chilean bird's-foot trefoil-dotseed plantain (*Plantago erecta*)
    - blue oak/blue-eyed Mary-wireweed (*Collinsia sparsiflora-Rigiopappus leptocladus*)
    - blue oak/birchleaf mountain-mahogany/hoary bowlesia-San Francisco woodland-star (*Cercocarpus montanus* var. *glaber/Bowlesia incana-Lithophragma affine*)
    - blue oak/hillside gooseberry/ripgut brome (*Ribes californicum/Bromus diandrus*) [36]
- blue oak-valley oak woodland formation on the Los Padres National Forest [125]
- Great Basin transition woodland, blue oak-California juniper phase [95]

General typings:

- blue oak/grass woodland [10,116,197]
- blue oak/blue oak/grass woodland [10]
- blue oak-valley oak/grass woodland
- blue oak-valley oak-coast live oak/grass woodland
- blue oak-coast live oak/grass woodland
- blue oak-interior live oak/grass woodland
- interior live oak-blue oak-gray pine woodland [10,12]
- blue oak-gray pine SAF forest cover type [191]
- blue oak-gray pine/grass cover type
- blue oak-gray pine/whiteleaf manzanita (*Arctostaphylos viscida*)/grass cover type
- blue oak/narrowleaf goldenbush (*Ericameria linearifolia*) cover type

- blue oak-gray pine/wedgeleaf ceanothus (*Ceanothus cuneatus*)/grass cover type
- blue oak-gray pine/wedgeleaf ceanothus-birchleaf mountain-mahogany cover type [10,12]

BOTANICAL AND ECOLOGICAL CHARACTERISTICS

SPECIES: Quercus douglasii

@ USDA-NRCS PLANTS Database

GENERAL BOTANICAL CHARACTERISTICS:
This description provides characteristics that may be relevant to fire ecology, and is not meant for identification. Keys for identification are available (for example, [72,114]).

Blue oak is a medium-sized, fall- and drought-deciduous tree [109,168,188,196]. It may retain its leaves year-round on moist sites [196] or show a flush of new leaves after heavy rains [100]. It is generally short and straight, from 20 to 66 feet (6-20 m) in height and 14 to 24 inches (36-60 cm) in DBH [173]. Blue oak typically has a single trunk, although some trees have few to several trunks [72]. The trunk is seldom more than 2 feet (0.6 m) in diameter. The bark is thin and flaky [66,235]. The canopy is compact, round, and supported by many crooked branches [196]. Leaves are sparse [235], 1 to 3 inches (2.5-8 cm) long, and have wavy, spineless margins. They are bluish-green, waxy, and thick [1,72]. The bluish-green color becomes most pronounced with drought [196]. Blue oak's leaf canopy is proportionately smaller than canopies of other, less drought-tolerant oaks [196]. The fruit is a nut, commonly called an acorn, that is 5 to 10 mm long × 10 to 15 mm wide [72,188]. Pavlik and others [196] state that the mature root system is "not particularly deep or extensive"; however, shallow roots are probably only characteristic of blue oaks on shallow soils [42,47]. Blue oak roots are often extensive, growing through fractured and jointed rock to a depth of 80 feet (24 m) or more to tap groundwater reserves [155]. Blue oak tends to produce more fine roots on sites were the taproot does not reach the water table [48]. Milikin and others [179] present preliminary regression equations for estimating blue oak root biomass based on DBH.

Stand and age class structure: Blue oak types vary in physiognomy from widely spaced blue oak savannas with a grass and forb understory to partially-closed or closed-canopy woodlands [18,88]. Stands in late succession may have an understory of drought-hardy trees and/or chaparral shrubs [18]. There are usually blue oak seedlings in the understory but few sapling or pole-sized trees (see Regeneration Processes). On the Central Coast Ranges, blue oak stand density ranged from open stands with means of 25 trees/ha and 14 inches (36 cm) DBH to dense stands of 163 trees/ha and 7 inches (18 cm) DBH [252]. Trees in mature stands are typically 90 to 100 years old [18,66]. The oldest known blue oak, in Sequoia National Park, is about 400 years old [173]. McClaran and Bartolome [164,166] found blue oak tree height and DBH were poor indicators of age on sites in the Sierra Nevada, and stated that analysis of blue oak age class structure requires direct age measurements.

It is difficult to reconstruct recruitment dates of true blue oak seedlings as opposed to blue oak sprouts, and most blue oak recruitment studies either do not distinguish between true seedlings and sprouts or define "seedling" as a size class, not an age class (for example, [101,177]). Tree-ring data sometimes show sprout recruitment dating from the last stand-replacing fire [176,177]. In this review, "seedling" refers to a size class unless otherwise stated.

Karlik and McKay [133] provide leaf area index and leaf mass density measurements for a blue oak stand at California Hot Springs near Bakersfield.

Physiological adaptations: Blue oak is the most drought tolerant of California's deciduous oaks. Adaptations to drought include thick leaves and bluish-green color [1], high water-use efficiency [43,142,182], deciduous habit with summer drought, plasticity in leaf development, and plasticity in early root development. During leaf development, leaves on droughty sites may gain more leaf mass than trees on mesic sites in spring but lose more leaf mass and reduce their photosynthetic rates in summer. In early root development, root growth is directed toward either upper or lower soil-layer water sources, depending on water availability (see Seedling establishment/growth for further details) [46].

RAUNKIAER [203] LIFE FORM:
Phanerophyte

REGENERATION PROCESSES:
Blue oak regenerates from seed and vegetatively.

14-1617 Public Comment
PC Rcvd 01-14-16

Pollination: Blue oak is wind pollinated [34].

Breeding system: Blue oak is monoecious and rarely self fertile. Since blue oak is mostly outcrossing [34] and its acorns are dispersed by animals [96], genetic diversity is probably greater among than within blue oak populations [151]. For example, studies have found more variation in water-use efficiency among than within blue oak populations [162,206], and a common garden study found high genetic variation in stem growth, phenology, and mineral accumulation among blue oak populations [163]. Reciprocal transplant and common garden studies show between-population differences and local adaptation in seedling emergence, survivorship, and growth traits, however [205,208]. For information on gene flow among blue oak populations, see Riggs and others [209].

Seed production: Blue oak is a masting species [144,147,164]. Catkins develop from flower buds formed in the previous growing season, although flower buds may not develop in drought years [19]. The acorns mature in 1 year [34,51,114]. A 10-year study on the Hastings Natural History Reservation in Carmel Valley found mast years occurred approximately every 3 years for blue oak [144]. Abundant crops are generally produced every 2 to 3 years, with bumper crops every 5 to 8 years [193]. Masting is apparently tied to climate cycles, not endogenous cycles. A mast year is often followed by a year of low acorn production (review by [90]). Warm April temperatures and hot summer temperatures result in the largest blue oak acorn crops [147]. Acorn production can vary widely among trees in a stand [89]. One 38-foot (11.6 m) blue oak in Shasta County produced 3,750 acorns during a favorable season [173].

Seed dispersal: Acorns are disseminated by various animals. Magpies, scrub jays, and various rodents bury blue oak acorns in caches, resulting in high rates of emergence compared to uncached acorns [96].

Seed banking: Given blue oak's lack of seed dormancy [34,196], the palatability of the acorns to wildlife (see Palatability/nutritional value), and the many diseases that infect acorns (see Germination), it is unlikely that blue oak forms a persistent seed bank.

Germination: Since they are not dormant, blue oak acorns germinate rapidly when cool October rains begin [34,196]. In various Sierra Nevada locations, germination was initiated at the first rainfall and slowly continued through winter [160]. Germination may be epigeal or hypogeal, with buried acorns showing more recruitment than acorns on the soil surface [38]. Some blue oak acorns begin germinating before they fall from parent trees [92]. Fresh acorns collected by Mirov and Kraebel [180] from various locations around the state averaged 72% viability.

Although fall moisture is required for germination, too much rainfall in winter and spring can reduce seedling establishment on woodland sites [92]. Blue oak germinants are highly susceptible to fungal infection in cool, moist weather, so many acorns and germinants rot over winter [160]. A study in Berkeley and Mendocino counties found that emergence was greatest at 75% of normal rainfall, with above-normal rainfall resulting in high rates of germinant death due to damping-off fungi [164]. However, above-average rainfall may increase blue oak establishment in annual grassland [92].

Aspect can influence blue oak germination and seedling survival. In a 3-year Carmel Valley study, acorns on mineral soil showed higher rates of emergence on north-facing woodland slopes than south-facing woodland slopes. Emergence rates were similar on north- and south-facing woodland slopes when acorns were buried; however, first-year seedlings on south-facing, open grassy slopes had high rates of mortality except in wet years [92].

Seedling establishment/growth: Blue oaks show rapid, early root elongation prior to shoot development [161,196]. Blue oak seedlings generally produce more root than shoot compared to associated oaks, and maintain this growth habit through sapling and mature stages of life [196]. Seedlings with access to deep soil layers tend to grow deep taproots [42]. When supplied with a deep water source in the greenhouse, blue oak seedlings rapidly grew a taproot but not an extensive lateral root system. When water was only available in the upper soil layer, however, the seedlings grew many lateral roots [48]. In field and greenhouse experiments, shaded seedlings elongated their taproots faster than seedlings in the open [43].

Blue oaks beneath their parents' canopies may show higher establishment and growth rates than seedlings in the open. Blue oak's deciduous habit allows nearly full-sunlight penetration to the ground in some seasons, and blue oak canopies are usually sparse and diffuse in all seasons [43], so light does not usually limit blue oak establishment beneath blue oak canopies. Surveys in north-central California suggest that blue oak seedlings may persist beneath their parents' canopies for decades before release by death of the parent trees [224,226].

Blue oak top-growth may be rapid when mesic conditions foster rapid, early root growth. On the Sierra Foothill Range and Field Station on the east side of the Sacramento Valley, planted blue oak seedlings were irrigated their first year in the field but not thereafter. The seedlings grew an average of 9.8 inches (25 cm) in their first field season. Annual growth rate for the next 3 years averaged 27 inches (68 cm) [170].

Seedlings that survive 10 or more years have the greatest chance of surviving in subsequent years, although growth rate of older seedlings may be very slow. In Kern County, blue oak seedlings ≥10 years old showed reduced mortality compared to younger seedlings. However, older seedlings tended to die back more during drought compared to younger seedlings, so relative growth rate was slower for older seedlings compared to seedlings <10 years old. Mean change in height over a 4-year period was a gain of 0.96 inch (2.4 cm) for young seedlings and a loss of 1 inch (2.5 cm) for seedlings 10 or more years old [198].

Barriers to regeneration: Blue oak is regenerating poorly in some areas of its distribution [69,85,165,186]. Causes for this failure include most environmental and managerial influences [25,164]. Ungulate herbivory, rodent herbivory, acorn predation, annual grass interference, and drought are barriers to successful establishment on many sites [4,5,65,104,106,164]. Cattle, mule deer, and/or northern pocket gopher browsing have all seriously reduced blue oak seedling and sapling recruitment [65,106,176].

Seedling recruitment: Fire or flood prior to acorn dispersal can reduce acorn predator populations. Fire kills the larvae of ground-dwelling beetle larvae that damage blue oak acorns [15]. On The Nature Conservancy's Kaweah River Preserve, a large blue oak acorn crop was followed by a wet winter that flooded the Preserve and killed many ground-dwelling, acorn predator insects. The Preserve now supports many saplings that date back to the flood year [196].

Seedlings do not compete well with annual grasses [3,65,86]. Radicles of unburied acorns often fail to reach the soil surface before desiccation

14-1617 Public Comment
PC Rcvd 01-14-16

when growing through annual grass thatch. Additionally, annual grasses often outcompete blue oak seedlings for space, water, and light [37,85,86,182]. In a study on the competitive effects of ripgut brome and cutleaf filaree (*Erodium cicutarium*) on blue oak seedlings, Gordon and others [85] concluded that "competition for soil water with introduced annual species contributes to the increased rate of blue oak seedling mortality currently observed in California woodland systems."

A 4-year study across blue oak's range found growth interference from annual grasses limited establishment of true blue oak seedlings more than herbivory. Blue oak emergence increased significantly when herbaceous species were controlled with herbicides and hoeing (50% increase from uncontrolled plots, P=0.01). Herbivory exclosures significantly increased first-year blue oak seedling survivorship another 18% over unprotected seedlings. Interactive effects of protection from annual grasses and herbivory were not significant [4,5]. However, grazing sometimes favors young blue oaks by reducing the fuel load in blue oak ecosystems, so fires are not as severe and are less likely to kill seedlings and saplings [153].

Nonnative annuals may have irreversibly altered the seasonal availability of soil moisture to blue oak seedlings [27]. An experiment using exclosures and herbicides on 6 sites across blue oak's distribution showed that when confounding effects of ungulate herbivory were removed, growth interference from annual grasses reduced blue oak seedling emergence. Emergence was 45% on plots where grasses were controlled with herbicides and hoeing compared to 29% on plots without grass control. After 3 years, blue oak seedling survivorship was significantly less on uncontrolled plots compared to plots with grass control ($P \leq 0.01$) [3]. On sites in Santa Barbara and Monterey counties, Callaway [43] found blue oak seedling establishment was least frequent in open annual grassland and most frequent beneath coastal sage scrub species. Causes of recruitment failure differed between annual grassland sites and sites with shrubs. Blue oak seedling mortality from drought was most common in annual grassland, whereas acorn predation was the most common reason for blue oak recruitment failure under shrubs [43].

Blue oak is regenerating successfully on some sites despite competition from nonnative annuals. A 1990 resurvey of plots in San Benito and Monterey counties, originally inventoried in 1932, showed net gains in blue oak basal area and small tree density (4-11 inches (10-28 cm) DBH). Blue oak/annual grass and blue oak-gray pine/annual grass communities had significant increases in both blue oak basal area and cover of annual grasses (for example, ripgut brome and wild oat (*Avena fatua*), while blue oak basal area and grass cover in interior live oak-blue oak/perennial bluegrass (*Poa* spp.) communities were similar to the original survey [122]. Some blue oak establishment may occur in annual grassland even with drought. At the Hastings Natural History Reservation, unirrigated blue oak seedlings in annual grassland showed 33% survivorship 1.5 years after acorn plantings. The area was experiencing a severe, prolonged drought [184,185].

Annual recruitment of seedlings is not necessary for a long-lived species such as blue oak [18]. Because of a flush of blue oak establishment that occurred statewide from 1850 to 1900 [177,244,252], some suggest that recruitment of this species occurs in episodic bursts [19,81,196,244,252]. Episodic bursts may only occur when many factors favoring blue oak establishment coincide: high acorn production, low acorn predation, protection from desiccation during germination, above-average fall precipitation, low competition from neighboring plants, and limited seedling and sapling browsing [164]. A convergence of favorable conditions may occur only once or twice in a century but still be sufficient for successful recruitment in a long-lived species such as blue oak. Since blue oak can live for 200+ years, sporadic, sometimes widely spaced recruitment pulses are probably enough to replace aging trees [92,196]. While episodic bursts in recruitment have occurred on some sites, however, other sites show an historic pattern of steady recruitment over decades [169,176,177]. Tree-ring age analysis of trees in Kern County showed blue oak recruitment was fairly continuous from 1570 to 1850, when a seedling flush occurred [176,177]. It is unclear if episodic recruitment was historically the norm or if blue oak relied on both episodic establishment pulses and steady recruitment [196]. McCreary [169] calls for research on blue oak stand dynamics, including mortality rates for all size classes, to determine if there are "enough" seedlings and saplings for adequate blue oak regeneration.

Sapling and pole recruitment: Although blue oak seedlings are plentiful on many sites, saplings and pole-sized trees are generally rare [169,199,219,226]. Even seedling regeneration is poor in some areas [33,164], and there is concern that there will not be enough juvenile replacements when mature blue oaks die [169]. Lack of sapling and pole recruitment has been attributed to livestock [73,105,219], mule deer [92,158,165], and pocket gopher [7,92] herbivory, drought [199], interference from nonnative annual grasses [7], fire [17,41,244], and/or fire exclusion [176]. McClaran and Bartolome [165] found that blue oak requires 10 to 30 years to transition from the seedling to sapling stage.

Causes of blue oak recruitment failure vary spatially and temporally. At the San Joaquin Experimental Range, few blue oak have reached sapling size despite cessation of livestock grazing since 1934: Lack of sapling recruitment there is attributed to wildlife herbivory [69]. McClaran and Bartolome [165] suggest that seedlings must grow quickly enough to surpass the browse line in 10 to 13 years for blue oak sapling recruitment, and that this may not be possible during periods of prolonged drought. A study monitoring ages and growth rates of blue oak seedlings in southern California was undertaken during a period of extended drought. The study found 68.5% survivorship and a mean total growth rate of 0.02 inch (0.5 mm) of blue oak seedlings over 6 years. Many blue oak seedlings died back to their root crowns in summer. Slow growth (and hence, lack of recruitment to the sapling stage) was attributed to the 6-year drought. Blue oak seedling age ranged from 1 to 26+ years, with most seedlings <10 years old [199].

Protection from browsing may promote blue oak sapling recruitment. A study on a Shasta County ranch found nonnative Himalayan blackberry (*Rubus discolor*) presence increased the number of blue oaks recruited to the sapling stage. Blue oak seedlings and saplings grew in Himalayan blackberry thickets more often than expected based on area covered by the thickets (P=0.01). Blue oak seedlings and saplings in thickets were significantly taller and thicker in basal diameter compared to open-grown blue oaks (P=0.05). The researchers attributed the differential survivorship and growth to absence of cattle browsing in Himalayan blackberry thickets [255].

In a statewide study, blue oak sapling establishment varied with geographical location and site characteristics. In the northern Sierra Nevada, the steepest slopes supported the greatest number of saplings. Along the Sacramento and San Joaquin deltas and in the Central Coast Ranges, saplings were more frequent on mesic slopes. In the southern Sierra Nevada, sapling frequency was greatest where shrub cover was low [186]. In a survey in the southern Sierra Nevada, presence of blue oak seedlings and saplings was positively associated with tree cover ($P<0.01$). Seedling recruitment was negatively associated with grazing ($P<0.01$), but grazing was nonsignificant for saplings [218]. Standiford and others [219] found blue oak saplings in Madera and Kern counties were more common on relatively high-elevation sites than on low-elevation sites that received less rain, and suggested that moisture may limit blue oak sapling recruitment on dry, low-elevation sites. In a 13-county survey, Swiecki and others [226] found blue oak sapling recruitment was positively associated with fire, canopy gaps, presence of shrubs, insolation, and altitude, and negatively associated with grazing. The majority of sites surveyed had few or no blue oak saplings, although seedlings were numerous. The researchers concluded that current blue oak sapling recruitment was insufficient to offset losses of mature blue oaks [225,226].

Climate effects: Effects of long-term climate patterns on blue oak are unclear. A state-wide study of blue oak acorn production and growth patterns found synchrony over large geographic scales, suggesting that large-scale climate patterns are important in determining rates of blue oak reproduction and growth [146]; however, a tree-ring chronology study in the Tehachapi Mountains found that precipitation was not correlated to blue oak stem recruitment [81]. See Climate for further details of the Tehachapi Mountains study.

Vegetative regeneration: Blue oak produces root crown or bole sprouts after top-kill by cutting or burning [21,172,173]. Sprouting ability varies with tree age, site, postdisturbance precipitation, and—when the disturbance was fire—fire severity (see Plant Response to Fire). Consequently, blue oaks may fail to sprout on some sites [66,102]. Some root crowns initially support more sprouts than others, but number of sprouts/root crown generally equalizes within a few postdisturbance years. Pruning or light browsing may initially encourage growth but probably makes no long-term impact on sprout growth. In a study to determine pruning effects on growth rates of sprouts on harvested blue oaks, sprouts of stumps pruned to 2 sprouts/root crown showed increased growth rate for 2 postharvest years compared to sprouts of unpruned root crowns. After that, sprout growth rates were similar on pruned and unpruned stumps [21]. Sprout growth is often rapid, so blue oak sprouts have a higher probability of survival to sexual maturity than true seedlings [165]. At the University of California's Sierra Foothill Range and Field Station, coppice sprouts grew rapidly from experimentally-cut trees measuring 4 to 36 inches (10-91 cm) in diameter. Seventeen years after cutting, sprouts averaged 13 feet (4 m) in height, ranging from 9 to 17 feet (3-5 m) tall [135]. Frequent top-kill, however, may result in bushlike or stunted trees [66].

Blue oaks that retain some live bole tissue may show a stronger sprouting response than blue oaks that are killed back to the root crown. In an across-state harvesting experiment, the percentage of blue oaks that sprouted after cutting was significantly greater for trees cut 35 inches (90 cm) above ground ($\bar{x}$=75%) compared to trees cut at ground level ($\bar{x}$=45%). Stumps of small-diameter trees (≤6.1 inches (15.5 cm)) produced significantly more sprouts than stumps of large-diameter trees. Harvest date (winter, spring, summer, or fall) did not affect the number of sprouts produced, although stumps of trees cut in spring produced significantly shorter sprouts than stumps of trees cut in other seasons ($P<0.05$ for all measures) [172]. Mensing [175] stated that winter cutting or burning generally results in faster sprout growth than tree removal in other seasons.

Sprouting ability declines with age. Mature trees produce more bole than root crown sprouts. Bole sprouts grow more slowly and have higher mortality rates than root crown sprouts [96]. Very old trees either do not sprout or produce only bole sprouts [173].

SITE CHARACTERISTICS:
Blue oak grows on low-elevation slopes and foothills [114]. It is usually restricted to dry sites [93,114], although it occasionally grows on spring-fed and other moist soils [13]. It is reported as flood intolerant [129] to intermediate in flood tolerance [188,249]. Flood tolerance may depend on depth of the root system and/or soil depth. When the water level of Black Butte Reservoir was raised for 50 to 98 days, flooding both alluvial and shallow soils, blue oaks on alluvial soils suffered little mortality. Blue oaks on shallow soils suffered 50% mortality [109].

Soils: Blue oak grows in soils derived from a variety of parent materials. Soils are characteristically shallow, skeletal, infertile, thermic, and moderately to excessively well drained. Soil textures range from gravelly loam to clay [80,173]. Blue oak can grow over hardpans [126]. A study in Sequoia National Park found blue oak woodland soils were lower in nitrogen, phosphorus, and organic matter content compared to soils of an adjacent mixed-evergreen woodland [18]. In a San Luis Obispo County study comparing soils on sites dominated by blue oak and sites dominated by coast live oak, blue oak occupied erosional soils that were relatively more acidic and had finer textures than soils with coast live oak. Subsoil pH on blue oak sites ranged from 3.9 to 7.9 [67].

Climate: Blue oak occurs in a mediterranean climate, with hot, dry summers and cool, wet winters. In summer, midday temperatures in blue oak woodlands can exceed 100 °F (38 °C) for weeks at a time [196]. The mean maximum July temperature is 90 °F (32 °C); the mean minimum January temperature is 30 °F (-1 °C). The frost-free growing season varies from 150 to 300 days. Annual precipitation ranges from 20 to 40 inches (510-1,020 mm), with most occurring between November and April [173]. Using blue oak tree-ring chronologies from the 18th, 19th, and 20th centuries, Gervais [81] found blue oaks in the Tehachapi Mountains experienced "disproportionately" long periods of both extreme drought and heavy precipitation, with "normal" or mean precipitation poorly representing the extreme ranges. For example, there was 10-year drought in the 1770s, while the 1790s was an extremely wet decade [81].

Elevation: Blue oak typically occurs below 3,900 feet (1,200 m) elevation [114]. Its elevational range is from sea level on the Central Valley floor to 5,900 feet (1,800 m) in its southernmost distributional limits [72,173]. In Sequoia National Park, blue oak occurs from 2,000 to 3,000 feet (600-800 m) on south-facing slopes and below 1,600 feet (500 m) on north-facing slopes [18].

SUCCESSIONAL STATUS:
Blue oak is moderately shade tolerant [116,186,191]. Seedings and saplings can persist in shade but require release to become pole-sized trees [169,226].

Oak woodland to other types: Blue oak woodland, chaparral, and annual grassland boundaries are dynamic, and mechanisms causing shifts from one type to another are not fully understood. Field and greenhouse experiments show that chaparral shrubs are sometime nurse plants to blue oak, facilitating blue oak seedling establishment and probably, as blue oaks grow and shade out the shrubs, eventual conversion of shrub-dominated sites to blue oak woodlands [43]. Callaway and Davis's [45] study of shifts in coast live oak woodland coverage may also apply to blue oak woodlands. Using GIS layers to analyze vegetation shifts at Gaviota State Park, they found coast live oak, coastal sage scrub, and annual grassland types were relatively stable on undisturbed landscapes, with each type losing little total cover over 42 years (1947-1989). Fire or grazing generally lowered transitional rates among these types, but fire resulted in a high conversion rate from coast live oak woodland to annual grassland and from coastal sage scrub to annual grassland. Transition rates varied with topographical position and soil substrate. Callaway and Davis concluded that fire, grazing, and site interactions determine type-shift rates among coast live oak woodland, coastal sage scrub, and annual grassland. At the landscape level, only portions of these types shifted, with some patches undergoing rapid transitions with fire or grazing, and other patches remaining static as edaphic or topographic climax communities [45]. Similar studies are needed to determine type shifts and successional patterns among blue oak woodlands, chaparral, and annual grasslands.

Old fields: In an old-field succession study on the Hastings Natural History Reservation, blue oak was present on untilled rangeland but did not appear on old fields until 29 years after field abandonment [252].

Fire exclusion has resulted in unprecedented, dense basal areas in some blue oak woodlands. In Annadel State Park, coast Douglas-fir is invading blue oak-California black oak-coast live oak communities, changing what was historically a savanna to a densely canopied woodland [20]. In Sequoia National Park, a comparison of contemporary blue oak woodland structure with that noted in historical records from the settlement period showed a large increase in blue oak cover and density. Vankat and Major [244] suggest that increased density of blue oak woodlands is due to a combination of fire exclusion and past livestock grazing. For example, the blue oak-California buckeye phase of the blue oak woodland type is characterized by a partially-closed canopy, and frequent surface fires probably maintained blue oak as the canopy dominant. In the absence of fire or other top-killing disturbances, California buckeye is successionally replacing blue oak on some sites in Sequoia National Park, with the blue oak woodland communities succeeding to closed-canopy California buckeye-blue oak forests [18].

SEASONAL DEVELOPMENT:
Blue oak acorns germinate in fall and emerge in winter. Acorns planted at the Hastings Natural History Reservation emerged from late February to late March [95]. Most active growth occurs from March through May, when soil moisture and blue oak water uptake are high and air temperatures are warm [18]. On the Hasting Natural History Reservation, leaves expanded from late March to 26 April and abscised in October [46]. In Sequoia National Park, leaf expansion occurred simultaneously with stem elongation on 1 site but began when stem elongation slowed on 2 other sites [18]. Blue oak flowers in late winter or early spring [72]. Baker and others [18] found blue oak failed to flower following a 2-year drought, even though precipitation was above normal in the spring of study. Acorns disperse from late summer to late fall [169]. Phenological development of blue oaks in Sequoia National Park was as follows [18,19]:

leaf buds swell: January to mid-May
stem elongation: February to mid-May
new leaves appear: mid-March to May
catkins emerge: March to mid-June
leaves fall: August to mid-November

Blue oak undergoes premature leaf abscission during summer drought [1,168,173,188]. When blue oaks drop their leaves in response to summer drought, the trees go partially dormant until soil moisture increases in spring, when blue oaks produce a flush of new leaves [18,196]. Trees that drop their leaves in summer usually continue to develop and fill their acorns [196]. On the Hastings Natural History Reservation, blue oaks began leaf drop in late August in a dry year and in late November in a wet year [93]. Site characteristics and stand structure influence degree of leaf drop. On the Sierra Foothill Range and Field Station, blue oaks dropped leaves for 2 successive years in mid-August in response to drought. Trees on shallow, rocky soils or south-facing slopes lost more leaves than trees on valleys or swales, and trees growing in clumps lost more leaves than trees growing alone. Trees that defoliated in summer leafed out earlier in spring than trees that did not defoliate in summer (r=0.42). In this 3-year study, summer leaf fall had no short-term effect on tree mortality [168].

FIRE ECOLOGY

SPECIES: Quercus douglasii

- FIRE ECOLOGY OR ADAPTATIONS
- POSTFIRE REGENERATION STRATEGY

Photo courtesy of Univ. of CA, Davis, Agricultural Experiment & Cooperative Extension.

FIRE ECOLOGY OR ADAPTATIONS:
Fire adaptations: Blue oak sprouts from the root crown and/or bole after top-kill by low- to moderate-severity surface fire [28,103,154,165,173,176,176,235,236,253]. Young blue oaks are best adapted to sprout after top-kill [235,236]. Blue oak probably establishes from acorns after fire, likely from several sources including animal-dispersed acorns and acorns dropping from surviving parent trees.

Ability to sprout decreases with blue oak age [130,235]. Bark of mature blue oak bark is thin compared to bark of most mature, associated oaks, and it tends to flake off as trees age [235], so blue oaks are less insulated against fire than associated oaks. Longhurst [159] noted blue oaks on the Hopland Field Station sprouted less "vigorously" as they aged, with seedlings showing the most vigorous sprouting after top-kill. In a 13-county study, blue oak sapling recruitment was positively associated with fire ($P \geq 0.01$) [226].

Blue oak's ability to withstand extreme drought by dropping leaves under water stress and producing a flush of new leaves when wet weather returns probably also aids in blue oak's postfire recovery. In wet years, crown-scorched blue oaks may produce a flush of new leaves soon after fire [100].

Fire regimes:

Ignition sources—In contrast to higher-elevation ecosystems, lightning ignitions are relatively rare in California's oak woodlands [95,204]. For example, a mean of 23 lightning strikes/million acres occurred over 10 years in a mixed-oak woodland spanning Amador and El Dorado counties. Strike rate in higher-elevation conifer sites on the El Dorado National Forest was 148 lightning strikes/million acres [137]. People may have historically been, and continue to be, the primary cause of ignitions in blue oak woodlands [221]. Lightning must have ignited some fires in prehistoric blue oak woodlands, though. Fire spread from more fire-prone adjacent ecosystems, such as chaparral and low-elevation ponderosa pine woodlands, was likely before fire exclusion [35]. Even given the low number of lightning strikes in blue oak ecosystems, lightning fires probably burned considerable acreage. A history of lightning-ignited fires in the lower foothill region found that in 1936, 11 lightning-ignited wildfires burned about 10 square miles before the fires were suppressed. It is likely that total acreage burned would have been much larger had the fires been allowed to spread [204]. The low incidence of lightning in blue oak and low low-elevation woodlands, however, may have increased the relative impact of Native American-set fires in blue oak woodlands [256].

Historic fire regimes— Blue oak woodlands historically had a regime of frequent summer and fall surface fires, fueled by groundlayer perennial bunchgrasses and forbs and downed woody debris [8,101,164,165,176,212]. In 1902, Leiberg [154] noted that wildfires were "extensive" in blue oak-gray pine communities in the foothills of the Sierra Nevada, and that blue oak sprouted from the root crown or stump after wildfire or cutting. Blue oak ecosystems have experienced 3 periods with differing fire regimes: the presettlement, settlement (approximately 1850-1920), and postsettlement periods (after 1920). Presettlement and settlement fire regimes were most favorable to blue oak populations.

Presettlement period: Surface fires occurred about every 8 to 10 years in presettlement blue oak ecosystems. In the foothills of the northern Sierra Nevada, median fire-return interval in the presettlement era was 8 years, with minimum and maximum intervals of 2 and 49 years, respectively [165]. In a fire history study on 2 blue oak woodland sites on the Sierra Foothill Range and Field Station, McClaran [164] found blue oak woodlands historically experienced frequent surface fires. Percentage of blue oaks with fire scars ranged from 10% to 65% across sites. Fire frequency increased from presettlement intervals after the Gold Rush (1852), then dropped again in the late 1940s. Mean fire-return intervals on the 2 sites were 8.3 and 7.7 years from 1890 to 1948. No fires were detected from 1948 to 1958. There was a strong positive relationship between fire and subsequent successful blue oak establishment on both sites ($P<0.025$) [164].

A fire history study of isolated redwood groves in Annadel State Park found fire-return intervals ranged from 6.2 to 23.0 years before the early 1800s, with 67% of the intervals between 2 and 10 years. The redwood groves were small and surrounded by oak woodlands where blue oak was common to dominant, and by mixed-evergreen forests where coast Douglas-fir was common to dominant. Finney and Martin [71] concluded that the fire history recorded in the redwood groves probably reflected the fire regime of surrounding oak woodlands and mixed-evergreen forests. As of 1990, the Park had experienced 2 fires since fire exclusion began in the 1900s. In the absence of frequent surface fires, coast Douglas-fir was invading the oak woodlands but not the redwood groves [71].

Native American use of fire: There is high probability that Native American use of fire had important effects on foothills vegetation [256], although historical accounts of Native American use of fire in blue oak woodlands are inconclusive [156]. Based on sparse historical records, Sampson [212] concluded in a 1944 report that Native American use of fire in blue oak woodlands was negligible, with "the most extensive and destructive fires occurring since the coming of the white man." Lewis [156] proposed that Native American use of fire may have been important, but acknowledged a dearth of conclusive information. Early pioneers' accounts of Native American use of fire rarely distinguished between fires in the very low-elevation California prairie and the slightly higher-elevation blue oak savannas and woodlands [156]. It is likely, however, that Native Americans set frequent, low-severity fires in blue oak woodlands. Although blue oak acorns were not preferred for making meal, the abundance of blue oaks in the lower foothills made blue oak acorns an important food source for Native Americans. Native Americans used surface fire in blue oak woodlands to kill acorn weevils, which damage acorn crops [15]. A Mono tribeswoman specified blue oak as one of the species intentionally burned to produce sprouts for basketry (Turner, personal communication in [14]). Jepson [131] stated it was likely that Native American burning helped keep blue oak woodlands adjacent to chaparral or ponderosa pine woodlands from shrub and ponderosa pine invasion. Greenlee and Moldenko [91] suggested Native Americans burned low-elevation oak woodlands every 1 to 2 years, so fire severity would have been very low. Agee and Biswell [8] surmised that Native Americans set low-severity surface fires in spring or late fall in the blue oak woodlands of what is now Pinnacles National Monument.

Settlement fire regimes: Fire frequency increased during the settlement period due to rangeland burning by ranchers and wildfires in the gold fields [165]. A fire history study on 3 blue oak woodland sites in the Tehachapi Mountains found that prior to European settlement around 1856, blue oak recruitment occurred at a relatively steady rate, and the woodland had open structure. Mean fire-return interval in the presettlement period was 10 years. A burst of blue oak recruitment occurred in the 1850s and 1860s, when fire frequency increased during the settlement period ($\bar{x}$=4.5-year return interval). Since the 1860s, the blue oak woodland had been used as livestock rangeland. Fires were suppressed, with only a single fire that occurred in the 1920s. The blue oak woodland had increased in density compared to presettlement times, and there was almost no blue oak regeneration with cattle grazing and fire exclusion [176]. Repeat photography studies near Sequoia-Kings Canyon National Park showed a "large increase" in blue oak cover and density beginning in the late 1800s, when Native American fires ceased and livestock grazing began. In 1981, most blue oaks were 60 to 100 years old, with few young trees [99].

The policy of fire exclusion began in higher-elevation forests before it was practiced in blue oak woodlands. Fire exclusion was officially adopted as policy in California 1905, but active fire suppression in blue oak woodlands only began in the 1930s [54]. Prior to the 1930s and 1940s, many ranchers used frequent prescribed surface fire to increase forage production in blue oak woodlands [154,164,212]. A fire history study of a mixed oak-foothills pine-ponderosa pine community was conducted in El Dorado County, using stumps of logged ponderosa pine. The site was logged in 1952, and the fire history spanned the settlement and postsettlement periods from 1850 to 1952. Blue oak was not a dominant oak but was a component of the vegetation. The study found fire-return intervals ranging from 2 to 18 years, with a mean of 7.7 years. Stephens [221] suggested that ranchers set most of the fires in the early settlement period, and that the fires were of low severity. Ranchers continued to burn blue oak rangelands in 8- to 15-year intervals until fire exclusion began in the 1940s [154,212].

In a fire history study on 2 Sierra Foothill Range and Field Station sites, McClaran and Bartolome [165] found that fire frequency increased from 1848 to 1940 compared to earlier and later times, with a peak of fire activity around 1848. Gold mining and ranching began in the area in 1848, and fire exclusion began in 1940. Cattle had grazed the site for over a hundred years at the time of study (1982-1983). For one of the study sites, the researchers selected a site that was relatively inaccessible to cattle and had no free-standing water, so it was only lightly grazed. The other site has heavily grazed. Probably due to tree harvest, there were few trees on the lightly grazed site older than 150 years. Blue oak recruitment had been sparse since fire exclusion was implemented. McClaran and Bartolome found a positive association between blue oak ages and fire dates, while cattle grazing was negatively associated with blue oak recruitment (P>0.01). Most blue oak recruitment occurred during the period of high fire frequency in the mid-1800s. McClaran and Bartolome suggested blue oak recruitment at that time was due to rapid growth of blue oak sprouts after fire. Comparing recent blue oak recruitment on heavily and lightly grazed plots, they found blue oaks sprouts were able to grow above the browse line only on lightly grazed plots. They suggested that blue oak sprouts required about 10 to 13 years to surpass the cattle browse line, while true seedlings may require 18 to 20 years [165].

Fire exclusion in the postsettlement period: It is difficult to assess the impact of fire exclusion on blue oak ecosystems. Besides fire exclusion, so many other human-caused changes have occurred in blue oak ecosystems that it is impossible to isolate the effects of any 1 change. Type conversion to a nonnative annual grassland understory, decline of rodent predators such as foxes and bobcats, loss of the top carnivore (the California grizzly bear), moderate to heavy livestock grazing in an ecosystem that evolved with only light grazing, a rapidly lowering water table, and urban development have all probably influenced the response of blue oak populations to fire [214].

Fuels: Surface fuels in blue oak woodlands are mostly comprised of nonnative annual grasses and downed woody debris. Without grazing, herbaceous fuels are continuous and can carry surface fires [71].

The type change from blue oak/perennial bunchgrass to blue oak/annual grass has probably altered fuels and fire behavior in blue oak ecosystems. Since there are few descriptions of pristine California oak woodland vegetation, it is difficult to compare groundlayer fuel loads in presettlement and contemporary blue oak woodlands. The perennial bunchgrass groundlayer was thought to be a southern extension of northern palouse prairie vegetation, which consists of spaced bunchgrass clumps with some forbs, soil crust organisms, and/or bare ground between grass clumps. Groundlayer vegetation was probably even sparser in California oak woodland understories than in palouse prairie due to reduced precipitation around the Central Valley compared to farther north [22]. In contrast to perennial bunchgrasses, annual grasses are usually closely spaced, creating a more continuous horizontal fuelbed [221]. Annual grass fuels are usually drier than bunchgrass fuels. California's perennial bunchgrasses generally stop growing, go dormant, and start drying after early June rains [128], while the annual grasses are generally dead and dry by early May [22,112]. In ungrazed blue oak ecosystems, changes in fuel loads caused by annual grass invasion have probably increased fire spread rate and altered fire seasonality.

Most blue oak/annual grass types are on private rangelands, and livestock grazing often reduces annual grass fuels. This reduction can be enough to stop fire spread, depending upon livestock utilization; however, fuel loads may be heavy where livestock are excluded [214] (see Discussion and Qualification of Plant Response).

Standiford [215] provides models to predict blue oak crown cover and height. Tietje and others [232,236] provide inventories of coarse woody debris size and volume in blue oak and other hardwood woodlands.

The following table provides fire regime information that may be relevant to blue oak. 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 regime information on vegetation communities in which blue oak may occur. For each community, fire regime characteristics are taken from the LANDFIRE Rapid Assessment Vegetation Models [150]. These vegetation models were developed by local experts using available literature, local data, and/or expert opinion as documented in the PDF file linked from the name of each Potential Natural Vegetation Group listed below. Cells are blank where information is not available in the Rapid Assessment Vegetation Model.

- California Grassland
- California Shrubland
- California Woodland

Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics			
		Percent of fires	Mean interval (years)	Minimum interval (years)	Maximum 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

14-1617 Public Comment
PC Rcvd 01-14-16

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		

*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.
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.
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 [108,149].

POSTFIRE REGENERATION STRATEGY [223]:
Tree with adventitious buds, a sprouting root crown, sobols, and/or root suckers
Crown residual colonizer (on site, initial community)
Initial off-site colonizer (off site, initial community)
Secondary colonizer (on-site or off-site seed sources)

FIRE EFFECTS

SPECIES: Quercus douglasii

- IMMEDIATE FIRE EFFECT ON PLANT
- DISCUSSION AND QUALIFICATION OF FIRE EFFECT
- PLANT RESPONSE TO FIRE
- DISCUSSION AND QUALIFICATION OF PLANT RESPONSE
- FIRE MANAGEMENT CONSIDERATIONS

IMMEDIATE FIRE EFFECT ON PLANT:
Low- or moderate-severity fire generally top-kills blue oak seedlings and saplings [78,124,165,173,176]. The bark of young blue oaks catches fire and burns easily, providing little protection from fire [173]. Mature trees are resistant to top-kill by low-severity surface fires and most moderate-severity surface fires, but are top-killed or killed by severe fires or the sustained heat of most chaparral fires [173,200]. Because the bark is thin [66,235], the boles of mature blue oaks scar easily. Wildfires in Sequoia National Park have scarred large blue oaks even where fire severity was low [100,200] (see Plant Response to Fire).

Because summer and early fall wildfires occur during periods of high air temperatures and are more severe, they generally kill more blue oaks than prescribed fires, which are usually of low severity [11,192,214,235].

DISCUSSION AND QUALIFICATION OF FIRE EFFECT:
Prescribed October fires on a cattle ranch in Madera County had little effect on mature blue oaks (>4 inches (10 cm) DBH) with an annual grass ground layer, but cover of mature blue oaks was reduced from prefire levels when a chaparral understory was present. The site was a mosaic of interior live oak/chaparral, blue oak woodland/chaparral transition (blue oak with minor amounts of chaparral and shrubby interior live oak), and blue oak-interior live oak/annual grass communities. Interior live oaks were selectively crushed prior to prescribed burning. This prefire site preparation reduced blue oak cover only in interior live oak/chaparral communities. The fire management objective was to reduce woody cover on sites with a chaparral understory and increase herbaceous production in all 3 plant communities. Prescribed burning reduced blue oak seedling density in all 3 communities compared to prefire numbers [174,235,235].

Blue oak canopy cover (%) before and after site preparation and prescribed fire in plant communities with varying woody fuels [174,235]

Community	Pretreatment (1986)	Postcrush treatment (1987)	Postfire month 2 (1987)	Postfire year 1 (1988)	Postfire year 2 (1989)	Postfire year 8 (1995)
interior live oak/chaparral	15a*	15a	3b	1b	10a	2b
transition	37a	40a	35a	35a	28a	35a
blue oak-interior live oak/grass	23a	23a	24a	29a	22a	23a

Blue oak seedling densities (trees/acre) before and after site preparation and prescribed fire [235]						
interior live oak/chaparral	23	17	0	7	---**	---
transition	54	51	0	6	---	---
blue oak-interior live oak/grass	1	18	0	0	---	---
Changes in blue oak wood production (cords/0.2 acre) in blue oak transition communities [174,235]						
interior live oak/chaparral	1.21	0.72	0.72	---	---	---
transition	0.80	0.80	0.80	---	---	---
blue oak-interior live oak/grass	2.56	2.56	2.56	---	---	---
*Values in a row followed by a different letter are significantly different (P>0.05).						
**No data.						

Pre- and postfire growth of 24 small blue oaks on the cattle ranch was monitored with and without cattle and mule deer browsing until postfire year 13. At that time, there was no evidence that burning had stimulated blue oak growth: greatest growth gain occurred on unburned, unbrowsed sites. Browsing reduced blue oak growth rate more than fire. On browsed sites, the browse line extended to 60 inches (150 cm) above ground, with 80% of meristems on marked trees getting browsed. Some blue oaks on burned, browsed sites grew above the browse line [24].

Mean height (cm) of blue oak saplings in postfire year 13 [24]		
	Browsed	Unbrowsed
Burned	150	260
Unburned	175	275

PLANT RESPONSE TO FIRE:
Blue oak sprouts from the root crown or bole after top-kill by fire [21,78,172,173,200]. Postfire sprouting occurs even in drought years [100,124]. Large trees that have developed a relatively thick bark layer are likely to survive low- and moderate-severity fires with crown scorch, bole scars, or no damage. Mature blue oaks with severe crown scorch usually produce bole sprouts after fire [100,200]. Although moderate-severity fire usually leaves basal scarring, blue oaks generally grow bark over small fire scars within a few postfire years. Mature blue oaks often show no evidence of internal fire scars, which get covered as bark grows around them [100].

Top-killed blue oak seedlings and saplings sprout during the first postfire growing season following low-severity fire: Even first-year seedlings can sprout. Sprouts may grow above the browse line more rapidly than true seedlings, and therefore have a greater probability of survival to maturity [164,165]. However, this response is variable and depends on physical and biological site characteristics and pre- and postfire site management. Bartolome and others [24] found prescribed fire and livestock grazing reduced blue oak growth compared to blue oaks on unburned, ungrazed sites.

Blue oak shows rapid postfire height gain on favorable sites. In a dendrochronology study, McClaran [167] reported that 70% to 85% of blue oaks in stands on the Sierra Foothill Range and Field Station probably originated as sprouts that emerged within 1 year of fire. Growth rates of blue oaks establishing within 1 year of fire were significantly greater than growth rates of blue oaks establishing at other times (P<0.01) [167].

Vertical growth rates of blue oak establishing on the Sierra Field Station within 1 year after fire vs. trees establishing at other times [167]		
Tree height (cm)	Mean growth rate (cm/year)	
	Trees establishing within 1 year after fire	Trees establishing in nonfire years
0-60	33.9a*	16.5b
60-135	13.8c	10.1d
*Values followed by different letters are significant at P<0.01.		

However, McClaran found a flush of blue oak establishment did not follow every fire, and about 10% to 30% of blue oaks on the Sierra Field Station established in nonfire years. Many factors may combine to suppress blue oak establishment after fire [167] (see Barriers to regeneration).

Effects on recruitment: Although it is widely accepted that blue oak woodlands evolved under a regime of frequent surface fires [8,101,164,165,212], there is little consensus regarding the effects of fire on contemporary blue oak populations, which encounter environmental conditions severely altered from historic times (see Fire exclusion in the postsettlement period). Some studies found that prescribed burning benefited blue oak populations. For example, McClaran [164] found small-diameter blue oaks grew taller after fire compared to unburned small-diameter blue oaks. Based on fire modeling, Anderson and Pasquinelli [17] concluded that periodic prescribed fire benefited blue oak regeneration, but that wildfires tended to reduce blue oak regeneration. Other studies, however, found negative effects of frequent fire on blue oak populations. Bartolome and others [24] and Swiecki and others [225,226] found frequent fire reduced blue oak seedling and sapling numbers, while infrequent fire had a neutral to positive effect on seedling and sapling density.

The interactive effects of prescribed fire, livestock grazing, site quality, and other factors affecting blue oak survivorship and growth are complex and not completely understood. Harvey [110] concluded that a history of fire, or lack of fire, did not explain differences in blue oak recruitment on his study sites in San Luis Obispo and Santa Barbara counties.

Sapling response— Blue oak saplings are well adapted to survive moderate-severity fires. Top-kill and subsequent sprouting after fire can prolong the juvenile period, however, which may reduce pole recruitment [228,241]. In a state-wide survey, Swiecki and others [225] found frequent fire was negatively associated with sapling recruitment, while infrequent fire was not associated or only slightly associated with blue oak sapling recruitment.

Tall saplings with thick stems are most likely to survive moderate-severity fire. Following a low- to moderate-severity wildfire in Vacaville, 9% of blue oak saplings died within 5 postfire years. Of blue oaks saplings that were completely top-killed, 76% were significantly smaller than those only partially top-killed (P<0.001). Generally, saplings taller than 79.1 inches (201 cm) or with stem diameter >2.2 inches at 12 inches stem height (5.6 cm at 30 cm stem height) were partially top-killed. Twenty percent of top-killed blue oaks regained their prefire height by postfire year 5. Sprout height gain was greatest in postfire year 1, with stem growth slowing afterwards. Meadow voles browsed new sprouts, further slowing blue oak postfire growth [228]. Swiecki and Bernhardt [228] concluded that moderate-severity fire negatively affected blue oak regeneration.

Tietje and others [235] concluded that low-severity prescribed fire neither set back nor benefited blue oak sapling recruitment. A September prescribed surface fire was set at Camp Roberts, San Luis Obispo and Monterey counties, in a blue oak-coast live oak woodland. Based on flame lengths, fire intensity was estimated as low to moderate. The fire was patchy, burning only about 250 (100 ha) acres of a 500-acre (200 ha) treatment area. Most blue oak saplings were top-killed. In postfire year 1, overall survivorship of blue oak saplings tagged before fire was 75%. Saplings that failed to sprout tended to have heavier prefire fuel loads within 3.3 feet (1 m) of their stems than saplings that survived, and the researchers concluded that the fire killed the saplings' roots. Across the study area, however, percentage of blue oak saplings that sprouted was similar for sites with light, medium, and heavy fuel loads (P=0.745). Prefire sapling height was not related to postfire survivorship: blue oak saplings that died averaged 45.6 inches (101 cm) in height before fire, and saplings that survived averaged 43.3 inches (110 cm) before fire. In postfire year 1, mean length of the longest sprouts on individual root crowns was 24.8 inches (63 cm), with a mean of 15.8 sprouts/root crown. Although the fire had little short-term effect on blue oak growth, the researchers concluded that frequent, low-severity prescribed fire would benefit the Camp Roberts blue oak population by reducing annual grasses, recycling nutrients, and reducing the risk of severe fire [235].

Crown scorch: Mature trees crown-scorched by surface fires often replace their leaves the next year with no apparent ill effects [173]. Mature blue oaks with most of their leaves scorched may be top-killed or die back to the bole, however. After moderate-severity prescribed burning on Mt Hamilton in Santa Clara County, most blue oaks with 100% crown scorch sprouted from the root crown, although a few died [78].

On sites in the Sierra Nevada, most mature blue oaks survived surface wildfires even with 100% crown scorch. For mature trees incurring bole damage, bole sprouting was more common than basal sprouting. Basal sprouting from large, top-killed trees occurred on 10 of 11 burn sites but was infrequent (approximately 10% of trees with bole damage). Basal sprouting occurred mostly in blue oaks <5.9 inches (15 cm) in DBH and did not occur in trees >24 inches (60 cm) in DBH [103].

In a related study, recovery of blue oak after a severe surface arson fire in Sequoia National Park was monitored for 2 years. Precipitation for the 2 study years was below average [100]. Medium-sized blue oaks (4-15 inches (11-39 cm) DBH) were mostly top-killed, with root crown sprouts appearing in postfire year 1 [102]. Some large, mature trees escaped basal scarring but sustained crown scorch. A mean of 65% large, crown-scorched blue oaks died back to the bole and grew bole sprouts. Bole sprouting was most common in trees with >50% crown scorch [100]. For detailed information on this study, see the Research Paper by Haggerty.

Across 11 sites on the Kaweah River watershed in Tulare County, blue oak mortality rate was highest in the largest (≥15 inches (40 cm) DBH) and smallest (≤4 inches (10 cm) DBH) size classes. Top-kill was highest in seedlings and saplings, while crowns of most large trees survived. Top-kill rate was slightly higher than mortality rate in blue oaks ≤2 inches (5 cm) in DBH [102].

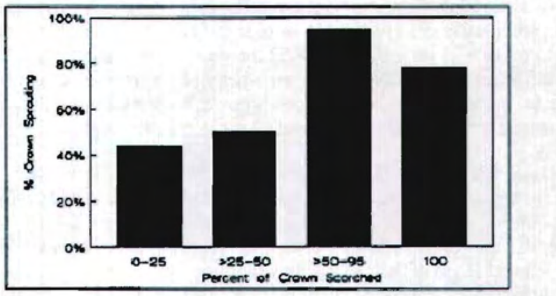
Survival (number of live trees) of crown-scorched blue oak after a 1987 wildfire in Sequoia National Park [102]

Year	Crown scorch (%)			
	≤25	25-50	50-75	100
1987	39	20	22	36
1988	39	19	22	36
1989	39	19	21	30
Mortality	0%	5%	4.5%	16.7%

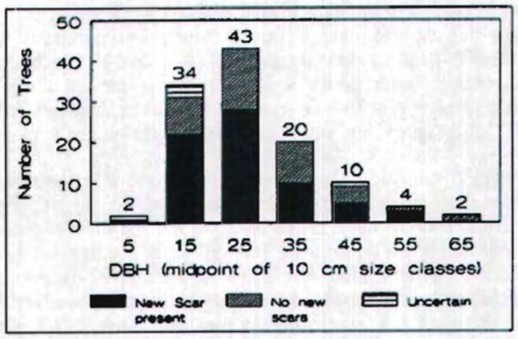
Basal scarring occurred most often in saplings [102]. Across 4 Kaweah River watershed sites, fire severity and damage to blue oak was greatest on the ridgetop, and the ridgetop site supported the greatest number of sprouting blue oaks after fire [100]. Fire damage and postfire response of blue oak are shown in the table and figures below.

Fire damage to and response of blue oaks 2 years following wildfire in Sequoia National Park [100]							
Transect	Mean crown scorch (%)	100% crown scorch (*n*)	Mean scorch height (cm)	Mean bole char height (cm)	Fire scars (%)	Aboveground mortality (%)	Basal sprouting (%)
Northwest slope	27a	3	36a	20a	65	0	7
Ridge	90b	28	58b	60ab	59	19	32
Lower southeastern slope	45ac	9	50ab	50a	64	5	8
Upper southeastern slope	54c	6	50ab	100b	40	9	24
*Within columns, numbers with different letters are significantly different ($P<0.05$).							

Crown sprouting in scorched blue oak wildfire in Sequoia National Park [102]



New scar formation on blue oaks after a wildfire in Sequoia National Park [102]



Postfire seedling establishment is apparently rare for blue oak. Fire probably plays an important role in seedling establishment, but its role is not well understood. Postfire blue oak establishment from acorns may occur only when a suite of favorable factors coincide (see Barriers to regeneration).

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE:
Blue oak may recover slowly following moderate-severity fire, and some ecotypes may fail to sprout following even low-severity fire [66,102]. Based on tree size and fire effects, Horney and others [124] present regression models to predict blue oak survivorship after wildfire.

Mortality of juvenile blue oaks (seedlings and saplings) can be high when a wet growing season results in dense annual grass growth, which fuels severe surface fire when dry. Fuel buildup from a combination of dense annual grasses and decades of fire exclusion led to a moderately severe surface fire on an undeveloped valley oak-blue oak-coast live oak/wild oat-Italian ryegrass (*Lolium multiflorum*) woodland at Stanford University. The oak woodland had been closed to grazing since 1989 or before, on some sites. Oak sapling recruitment was low, so study plots were established in 1990 to monitor oak regeneration. Heavy spring rainfalls in 1991 and 1992 caused an "unusually lush growth of grasses, forbs, and other understory plants". Annual grasses were dense and tall, reaching 8 to 10 feet (2-3 m) in height on some plots. In the absence of fire, small- and large-diameter fallen and standing deadwood had accumulated, and shrubs were encroaching into the oak woodland. The woodland burned in a July 1992 wildfire that spread onto some of the study plots. Mortality rate of juvenile blue oaks in postfire year 1 (1993) was 14% on burned plots and 8% on unburned plots. Rodents girdling juvenile blue oaks in 1992 and 1993 reduced blue oak growth on both burned and unburned plots. Prefire height of blue oaks that survived the fire tended to be more than prefire height of blue oaks that the fire killed. For all oak species combined, 32% of oaks >10 inches (25 cm) tall survived, while only 9% of oaks less than 10 inches tall survived (data for blue oak alone are unavailable). However, for oaks that sprouted after fire, there was no significant correlation between prefire height and postfire growth rate [214].

Pre- and postfire mean annual growth rates (inches) of blue oaks before and after a 1992 wildfire at Stanford University [214]		
Plot type	Prefire growth rate (inches/year)	Postfire growth rate (inches/year)
Blue oaks killed by fire	1.4a*	not applicable
Surviving blue oaks on burned plots	2.4a	3.2a
Blue oaks on unburned plots	7.3b	2.0a
*Within columns, numbers with different letters are significantly different ($P=0.002$).		

Oaks on fire plots were generally younger and smaller than oaks on unburned plots. Therefore, the above results are not directly comparable but show a general trend of similar growth rates for unburned blue oak juveniles and juveniles top-killed by fire. The researchers suggested that the significant difference in blue oak growth in 1990 to 1991 was due to higher rodent browsing on plots that later burned compared to plots that did not burn [214].

A Kern County study illustrates possible interactive effects of fire and browsing on blue oak recruitment. Blue oak recruitment on the study site was low, but relatively continuous, under the frequent, low-severity surface fire regime in place before European settlement around 1842. Fires were frequent during the 1843 to 1865 settlement period, and blue oak had a regeneration peak in 1856. Nearly half the 1856 cohort had double stems, suggesting they originated as postfire sprouts. Hunting pressure from soldiers in nearby Fort Tejon probably minimized postfire mule deer browsing of blue oak sprouts. The study area became a cattle ranch in 1866, and a fire-free interval of 70 years followed. The 1856 cohort has matured to a

14-1617 Public Comment
PC Rcvd 01-14-16

dense, even-aged stand, with almost no blue oak recruitment since then. The author concluded that a change in fire regime and subsequent canopy closure contributed to lack of blue oak recruitment, but many other factors may also be contributing. Since 1856, nonnative annuals have invaded the understory and are likely outcompeting blue oak seedlings for water, and browsing pressure from mule deer and cattle has greatly increased [178].

Grazing does not always reduce blue oak recruitment. On the Hopland Field Station, moderate domestic sheep grazing and low-severity prescribed fire had no significant effects on blue oak seedling recruitment ($P>0.10$). Blue oak seedlings established in similar numbers on grazed, burned, and grazed-and-burned plots [11]. See Fire Case Studies for further details on this study.

FIRE MANAGEMENT CONSIDERATIONS:

Prescribed fire: Urban development in blue oak ecosystems makes prescribed burning programs difficult to implement [221], and it is unclear if prescribed fire is needed for conservation management of blue oak [100]. Important questions include how often prescribed surface fires are needed —if they are needed at all—to maintain blue oak types [95,100]; whether fire can increase blue oak recruitment [100,165]; and how fire affects succession in blue oak woodlands [12,100]. Some suggest that frequent surface fires help maintain the open character of blue oak savannas [18,100]. There is general consensus that wildfires burning dry fuels under high air temperatures and low relative humidities reduce blue oak density [11,187,192,214,235,242].

Prescribed fire may help control nonnative annual grasses in blue oak ecosystems, although it may also increase cover of nonnative forbs. Fire eliminates the thatch layer that inhibits blue oak emergence, and may reduce annual grass establishment. In a blue oak savanna in Sequoia National Park, either a single prescribed spring fire, repeat spring fires (2 or 3 successive fires), or repeat fall prescribed fires (3 successive fall fires) increased the diversity and relative dominance of native and nonnative forbs to nonnative annual grasses compared to an unburned control. Wild oat and ripgut brome showed greatest reduction in response to successive spring fires (12.4% reduction), while nonnative Maltese starthistle (*Centaurea melitensis*) showed the greatest increase (46.3%) after successive fall fires. Nonnative annual grasses regained prefire biomass in 2 to 3 years when prescribed burning was stopped, so the researchers stated that prescribed fires need to be repeated regularly for annual grass control [195]. For detailed information on this study, see the Research Paper by Parsons and Stohlgren [195].

Prescribed burning is conducted after annual grasses have dried in spring—usually in May—or after the first rains of fall. Such burning does not mimic the natural fire regime of frequent summer and fall surface fires under which blue oak evolved; however, since foothill woodlands have undergone a type shift from blue oak/perennial grass to blue oak/annual grass, it is impossible to recreate historic fuel conditions [8]. Because sprouting ability of blue oak may vary with ecotype or site [66,102], managers may want to use small prescribed fires to test the sprouting capability of juvenile blue oaks on their site before conducting prescribed burning over large areas.

Fire research methods: McClaran [164] found that using both cat-faced and unscarred blue oaks gave the best estimate of fire-return intervals on the Sierra Field Station. Using only cat-faced blue oaks and excluding trees with heal-ever scars, mean fire-return interval was recorded as 6.4 years across 2 study sites. Using only healed-over blue oaks with internal scars, mean fire-return interval was 4.2 years. On 1 of the sites, mean fire-return interval was longer on small plots (0.05 ha, 17.7-year mean fire-return interval) than on large plots (0.1 ha, 13.0-year mean fire-return interval). The difference in fire-return intervals across small and large plots was significant at $P<0.025$ [164].

Fire effects on small animals: Low- to moderate-severity October prescribed burning in blue oak and valley oak-coast live oak-blue oak woodlands on Camp Roberts, San Luis Obispo and Monterey counties, had little overall effect on small animals. Relative abundance of small mammals, breeding birds, reptiles, and amphibians did not change from prefire levels after burning, and oak canopy cover did not change after burning [247,248]. See Sapling response for further details of this study.

FIRE CASE STUDY:

Blue oak seedling response to fire and grazing on the Hopland Field Station, California

---

FIRE CASE STUDY CITATION:

Fryer, Janet L., compiler. 2007. Blue oak seedling response to fire and grazing on the Hopland Field Station, California. In: Quercus douglasii. 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 9].

SPECIES INCLUDED IN THE STUDY:

Common name	Scientific name
blue oak	*Quercus douglasii*

FIRE CASE STUDY REFERENCES:
Unless otherwise indicated, the information in this Fire Case Study comes from the following study:

Allen-Diaz, Barbara H.; Bartolome, James W. 1992. Survival of Quercus douglasii (Fagaceae) seedlings under the influence of fire and grazing. Madrono. 39(1): 47-53. [11].

STUDY LOCATION:
This study was conducted on the University of California's Hopland Field Station in Mendocino County.

SITE DESCRIPTION:
The study sites were located on 2 wildland pastures, each around 30 ha in size. Domestic sheep have grazed the pastures since before 1951. Annual precipitation was below normal during the 4 years of study, ranging from 600 to 720 mm. Mean annual precipitation at Hopland Field Station is 950 mm.

PREFIRE PLANT COMMUNITY:
The study site is a blue oak woodland-annual grassland mosaic. Seventy-six percent of the study site is blue oak woodland with mature blue oaks and an understory dominated by nonnative annual grasses. A pretreatment vegetation survey found blue oak seedlings in the woodland understory, but there were no blue oak saplings. Understory cover and production of the annual grasses average 65% and 1,500 kg/ha, respectively. The open annual grassland occupies 18% of the study site; the other 6% is a dense stand of interior live oak (*Q. wislizenii*). Three 0.5 ha study plots were set up within the pastures. Within the study blocks, the overstory was composed of blue oaks >10 cm DBH, providing 50% canopy coverage.

Study sites are classified in the following plant community and likely experienced the historic fire regime described below:

Fire regime information on the plant community in which blue occurred in this study. Fire regime characteristics are taken from the LANDFIRE Rapid Assessment Vegetation Model [150]. This vegetation model was developed by local experts using available literature and expert opinion as documented in the PDF file linked below.

Vegetation Community (Potential Natural Vegetation Group)	Fire severity*	Fire regime characteristics	
		Percent of fires	Mean interval (years)
California oak woodlands	Replacement	8%	120
	Mixed	2%	500
	Surface or low	91%	10

*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 [108,149].

SPECIES PHENOLOGY:
Not stated. Blue oak was likely shedding leaves during the October fire treatments.

FIRE SEASON/SEVERITY CLASSIFICATION:
Fall/low severity

FIRE DESCRIPTION:
Fire management objective: The objective of this study was to document the effects of prescribed fire and domestic sheep grazing on naturally regenerating blue oak seedlings.

Fire prescription and behavior: Four treatments were randomly applied to each 0.5 ha study block:

1) prescribed fire with domestic sheep grazing
2) prescribed fire without domestic sheep grazing
3) domestic sheep grazing without fire
4) no domestic sheep grazing and no fire (control)

Domestic sheep—mostly dry ewes—used the grazing-treatment pastures from 15 May 1985 to 15 October 1985: the dormant season for annual grasses at Hopland Field Station. Stocking rates were adjusted to produce residual understory fuels of around 600 kg/ha. The domestic sheep were returned from 15 December 1985 to 15 February 1986 and from 15 May 1986 to 15 October 1986.

Prescribed burning was conducted at 12:01 PM in October 1986 after the first fall rains. Fuels were a mixture of dry grass, blue oak litter, and a small amount (about 50 kg/ha) of green grass.

Burning conditions for the blue oak woodland prescribed fire at Hopland Field Station [11]

Air temperature	Relative humidity	Wind speed	Total understory fuel load
18 °C	40%	5-10 km/hour	750 kg/ha

The fires did not completely consume the dry grass and oak litter.

FIRE EFFECTS ON TARGET SPECIES:
All the blue oak seedlings on the study plots were top-killed. Growth of sprouting blue oak seedlings was monitored from the spring of 1987 through May 1990 (posttreatment growing seasons 1-3).

Neither prescribed fire nor domestic sheep grazing had significant effects on blue oak seedling recruitment compared to control plots. The only factor that approached statistical significance was year of seedling establishment (F=4.60, P<0.10), with highest rate of blue oak seedling establishment in 1988 (postfire year 2). Neither fire, grazing, nor a combination of fire and grazing had significant effects on the number of blue oak seedlings observed on study plots compared to control plots. Some seedlings were sprouts of seedlings that had established before treatments; others germinated after treatments.

Overall blue oak seedling density was low in postfire year 1, increased greatly in postfire year 2, then declined to near postfire year 1 levels in postfire years 3 and 4. Overall blue oak seedling mortality rate was about 50% per year. For seedling sprouts, mortality was not significantly associated with plant age before treatment, number of postfire sprouts, or plant size. Blue oak germinants continued to establish in each of the 4 posttreatment study years, including 1989 and 1990, which were droughty. Results from fire and grazing treatments were pooled because they were not statistically different. Blue oak seedling mortality was 49% in postfire year , 43% in postfire year 2, and 48% in postfire year 3.

Number of sprouts, leaves, and height of blue oak seedlings, measured each May [11]					
Year	Age (yr)	Sprouts (*n*)	Leaves (*n*)	Height (cm)	*n*
Fall 1987 cohort					
1988 (postfire year 1)	1+*	1.74 (0.96)**	5.99 (2.78)	4.33 (1.74)	110
1989 (postfire year 2)	2+	2.84 (1.10)	5.66 (2.24)	5.08 (1.70)	56
1990 (postfire year 3)	3+	2.94 (1.03)	5.09 (1.91)	3.73 (1.16)	32
Fall 1988 cohort					
1989 (postfire year 2)	1	2.63 (0.91)	5.33 (2.71)	4.75 (1.93)	63
1990 (postfire year 3)	2	2.76 (0.82)	4.51 (1.86)	3.65 (1.67)	33
Fall 1989 cohort					
1990 (postfire year 3)	1	2.54 (0.65)	4.73 (1.76)	2.95 (1.18)	11
For seedlings that died, number of sprouts, leaves, and height of blue oak seedlings by cohort, measured the May prior to seedling death [11]					
Year	Age (yr)	Sprouts (*n*)	Leaves (*n*)	Height (cm)	*n*
Fall 1987 cohort					
1988 (postfire year 1)	1+*	1.76 (1.00)	6.12 (3.43)	4.56 (2.03)	54
1989 (postfire year 2)	2+	2.58 (0.74)	5.04 (2.67)	4.69 (2.03)	26
Fall 1988 cohort					
1989 (postfire year 2)	1	2.59 (0.96)	5.00 (1.80)	5.09 (2.24)	29
*True seedling ages are known for 1988 and 1989 cohorts but not for the 1987 cohort. **Standard deviations are in parentheses.					

FIRE MANAGEMENT IMPLICATIONS:
Fire outcome: This study shows that blue oak seedling establishment is potentially compatible with prescribed fire and/or domestic sheep grazing.

Limitations of this study: The study does not show the effects of fire and/or domestic sheep grazing on blue oak saplings, a critical and vulnerable life stage for blue oak (see Sapling recruitment) that was absent from this study site. Results of this study may not apply to all blue oak woodland sites, as site characteristics, particularly soil water, vary greatly across blue oak's distribution. Allen-Diaz and Bartolome [11] concluded that blue oak seedling recruitment is adequate at the Hopland Field Station. Although blue oak seedling numbers fluctuate and their spatial distribution is irregular, seedlings are always present in the understory. Blue oak seedlings are maintaining a constant mortality and replacement rate over time. With canopy closure of 50% on the study sites, blue oak seedlings may require some canopy removal for successful release. Further prescribed fire and fire surrogate studies (for example, selection cutting of overstory blue oaks) are needed to determine how managers can successfully transition blue oaks from the seedling to sapling stage.

MANAGEMENT CONSIDERATIONS

SPECIES: Quercus douglasii

- IMPORTANCE TO LIVESTOCK AND WILDLIFE
- VALUE FOR REHABILITATION OF DISTURBED SITES
- OTHER USES

- OTHER MANAGEMENT CONSIDERATIONS

IMPORTANCE TO LIVESTOCK AND WILDLIFE:
Blue oak is an important species for livestock and wildlife [196]. Blue oak woodlands are the most heavily utilized cattle rangelands in California: 65% of California's total livestock forage is provided within blue oak-gray pine woodlands [38].

Blue oak woodlands are important habitat for small mammals and birds [62,152]. A 3-year study in the central Sierra Nevada foothills showed that 92 species of birds utilized blue oak woodland, with 60 species nesting in the woodland [30]. For inventories of small mammals, birds, and herptiles using blue oak habitats, see Block and others [31] and Verner and Boss [245].

Blue oak woodlands are important mule deer habitat. Use is particularly heavy during fall acorn drop and into winter, when annual grass green-up occurs [140]. On the North Coast Ranges, mule deer used blue oak woodlands significantly more than chaparral ($P<0.001$) except for one growing season after a prescribed fire in the chaparral [141].

Predators frequenting blue oak habitats include mountain lions, coyotes, bobcats, gray foxes, northern raccoons, American badgers, and skunks [62]. A night-camera survey in a mixed-oak riparian woodland in Napa County's wine country showed that striped skunks, bobcats, coyotes, gray foxes, and mountain lions used the oak woodland corridors extensively. Predator usage was significantly greater in wide, undisturbed corridors compared to narrow or denuded corridors ($P=0.03$). Blue oak was one of the dominant oaks in the woodland [115].

Several rare or threatened species use blue oak woodland habitat. Bald eagles, golden eagles, peregrine falcons, and California condors inhabit blue oak woodlands [245]. A study on the Sierra National Forest found California spotted owls used live blue oaks for nesting [220]. Purple martins in the Tehachapi Mountains, where what are probably the last remaining purple martin populations in the state occur, also use blue oaks for nesting [254]. The state-endangered foothill yellow-legged frog inhabits blue oak woodlands [31], and the western spadefoot is restricted to blue oak woodlands [245]. Blue oak woodland was prime habitat for the now-extinct California grizzly bear, the largest of the brown bear subspecies [164].

Livestock, mule deer, lagomorphs, and rodents browse blue oak. The acorns are eaten by at least a dozen species of songbirds, several upland game birds, rodents, mule deer, feral and domestic pig, cattle, and all other classes of livestock [5,68,213]. The acorns are a critical food source for mule deer, which migrate from dry, high-elevation summer ranges to blue oak woodland for fall and winter forage [28,173]. Blue oak acorns accounted for about 15% of the total volume of food consumed by mule deer on the Tehama County winter range [28,213].

Band-tailed pigeons and acorn woodpeckers preferentially select small blue oak acorns over large acorns [9,79], which may positively affect blue oak seedling establishment by leaving large acorns available for establishment.

Palatability/nutritional value: Blue oak browse and acorns are highly palatable to livestock and wildlife. Ungulates generally prefer browsing blue oak's spineless leaves over spiny leaves of associated live oaks [164]. Blue oak sprouts are palatable to all classes of browsing wildlife and livestock. Sampson and Jesperson [213] gave mature blue oak foliage the following browse ratings:

Columbian black-tailed deer: excellent to good
domestic sheep: fair to poor
domestic goats: fair to poor
cattle: poor
horses: poor to useless

Blue oak browse is relatively high in protein and low in tannins compared to levels in associated oaks [164]. The crude protein content of young, partially expanded leaves of blue oak on the San Joaquin Experimental Range averaged 30%, while that of fully developed leaves averaged 11%. The ratio of calcium to phosphorus is nutritionally satisfactory for cattle in young leaves (2.2:1.0) but disproportionate in mature leaves (15:1). Blue oak acorns are low in crude protein but high in crude fiber, fat, and oils [84,213]. For detailed nutritional analyses of blue oak browse and acorns, see Sampson and others [84,213].

Cover value: Blue oak canopies provide important shade cover for a variety of animals during California's hot summer months. Beef cattle gain more weight on rangelands where blue oak provides relief from summer heat compared to rangelands without blue oak cover [120].

Blue oak provides cover for cavity-nesting birds. A breeding bird survey on the Hopland Field Station showed that cavity-nesting species dominated the avian community within blue oak woodlands. Violet-green swallows and plain titmice were the 2 most common of 72 bird species that used blue oak woodland habitats [257].

Since blue oak is the dominant—and sometimes the only— oak in the foothills surrounding the Central Valley, many species of birds use blue oak for cover. Blue oak provides preferred nesting, foraging, and escape cover for the Nuttall's woodpecker, plain titmouse, and white-breasted nuthatch [30]. On the Sierra Foothill Range and Field Station, Nuttall's woodpeckers foraged on blue oaks more often than associated oaks or gray pine, with this preference extending across all seasons [29]. A San Luis Obispo survey of red-tailed hawk nest sites revealed that red-tailed hawks used blue oaks as their nest tree 74% of the time [233].

Downed blue oak woody debris provides cover for small mammals such as dusky-footed woodrats [247] and herptiles. Lizards used downed blue oak logs and branches as cover on the Sierra Foothill Range and Field Station [32].

Except in riparian zones, xeric conditions may make blue oak woodlands poor habitat for many amphibians in summer; however, salamanders including 3 Species of Concern (yellow-blotched, Tehachapi slender, and Kern County slender salamanders) utilize blue oak cavities and downed logs for thermal, foraging, and mating cover [30,222]. Reptiles are frequently encountered in blue oak woodlands [30], using downed blue oak logs and branches for foraging, thermal, and mating cover [36]. Several species (for example, the western fence lizard and western skink) prefer the drier environment of blue oak and other deciduous oak woodlands, and seldom use the more mesic evergreen oak woodlands [30]. Borchert and others [36] provide an inventory of herptiles found in blue oak communities of the Southern Coast Ranges.

Blue oaks overhanging water courses provide shade in fish habitats. Water temperatures increase when riparian-zone blue oaks are removed, lowering habitat quality for salmonids. Blue oak woody debris affects the physical structure of rivers and streams by creating pools and reducing the sediment load. To protect fisheries, Giusti and Merenlender [82] call for increased protection of and management guidelines for low-elevation hardwoods in riparian zones.

VALUE FOR REHABILITATION OF DISTURBED SITES:
Blue oak is planted for restoration of wildlife habitat, riparian zones, and watersheds. The roots bind soil of steep watersheds, reducing the incidence of mass soil movement downslope into permanent and ephemeral streams [173]. Trees are established from acorn plantings or from transplanting nursery stock. Blue oak was successfully used to revegetate upper streambanks in Almaden Valley [83] and elsewhere; however, restoration on some rangelands where blue oak was removed for "rangeland improvement" (see Management Considerations) is sometimes difficult. Sites where oaks were removed are subject to increased rates of soil erosion compared to sites where oaks were not removed [40].

A case study from northwestern California illustrates how oak removal was accomplished and why blue oak has difficulty regenerating on some sites where oaks were removed. An inventory of a tree-removal site on the Hopland Research Station showed that evergreen oaks (coast and interior live oaks and scrub oak (*Quercus berberidifolia*)) were regenerating successfully on tree-removal sites. Deciduous oaks (blue oak and California black oak), however, were not regenerating. Tree removal was conducted from 1959 to 1965, using herbicide spraying followed by prescribed fire. The burn was seeded to nonnative clovers (*Trifolium* spp.), nonnative perennial pasture grasses, and nonnative soft chess (*Bromus hordeaceus*). A few mature oaks were left for aesthetics and to provide thermal cover for domestic sheep, and a few oaks sprouted after being sprayed and burned. These few remaining oaks are the parents of current oak regeneration. Aerial and GIS surveys show that 52% of the area was blue oak woodland prior to tree removal. In 1996, blue oak woodland covered 2.5% of the area, showing the greatest cover loss of 5 oak species. Blue oak is now regenerating only in riparian zones and in clusters beneath parent blue oaks. Dry soils, browsing pressure from domestic sheep, mule deer, small mammals, and insects, and/or competition from nonnative herbaceous species are implicated in blue oak's failure to regenerate on the site. The authors concluded that deciduous oaks, particularly blue oak, required artificial plantings given shade and protection from browsing for successful restoration [40].

Field and greenhouse experiments show that blue oak establishment is highest beneath shrub canopies or under shade cloth [43,184]. Protection from herbivory and full sunlight are generally recommended to optimize establishment of artificial blue oak regeneration [6,40,171,229]. Propagation techniques are discussed in the following sources: [2,5,168,168,183,192,234]. See these sources for acorn harvest methods [148], evaluation of herbivory protection devices [60,148,171], shade devices [171], control methods for annual grasses growing with blue oak seedlings [171], and planting methods for acorns and containerized blue oak seedlings [148,216]. Rehabilitation of a site on the Sierra Foothill Range and Field Station where blue oaks had been completely removed in the 1960s was finally successful—after 2 attempts were thwarted by grasshopper and rodent browsing—by using a combination of cattle grazing to reduce rodents, which compete poorly for herbaceous forage against cattle, and tree shelters to protect artificial blue oak regeneration from the cattle [229].

OTHER USES:
Blue oak is a valuable landscaping ornamental. A study was conducted in Mendocino and Sonoma Counties to assess the value of blue oak on lands undergoing subdivision. It showed that the aesthetic and amenity values of blue oaks at a density of 40 stems/acre resulted in a 21% to 27% increase in land value when compared to sites with no blue oaks [217].

Native peoples processed blue oak acorns into meal [16]. They used blue oak sprouts for making baskets [14], acorn leachate for dying baskets, and blue oak wood for making bowls and other implements [53,237].

OTHER MANAGEMENT CONSIDERATIONS:
Blue oak occurs mostly on private lands. Blue oak woodland covers 8% of California's total land area [5,19]. Seventy-five percent of this resource is in private ownership, 14% is in the National Forest System, and 11% is in various other public ownerships [33].

Management of this species has been controversial. From the late 1950s through the early 1970s, many studies showed that palatability and production of forage in the understories of blue oak ecosystems were low compared to forage on open sites without blue oaks [111,132,135,136,189,190]. Murphy and Crampton [190] and Kay and Leonard [136] found blue oak removal increased productivity of annual grasses. As a result of these studies, statewide "rangeland improvement" was recommended, involving removal of blue oak from livestock rangelands [238,243]. This recommendation resulted in the loss of more than 1 million acres (0.4 million ha) of blue oak woodland from combinations of cutting, prescribed burning, and herbicide spraying [33,243].

In contrast, other studies found forage production was 15% to over 100% higher under blue oaks than in open grassland [64,68,76,77,118,119,202], and that herbaceous plants beneath blue oak were higher in protein, nitrogen, phosphorus, and potassium and lower in lignin and fiber than herbs growing in open grassland. Forage under blue oak started growing earlier and remained green after surrounding forage had dried [42,119].

Blue oak removal may result in decline of soil quality and fertility. In a study on the Sierra Foothill Range and Field Station, soils where blue oaks were removed 21 years prior had less soil microbe biomass and bulk density, less total carbon, nitrogen, and phosphorus, and higher pH compared to soils with blue oaks [49]. Callaway [48] found nutrient deposition under blue oak canopies was 5 to 10 times greater than in open annual grassland. Nutrients came mainly from tree litterfall and precipitation/dew throughfall. Nutrient deposition varied seasonally. Nitrogen was mostly deposited in litterfall from September through December. Phosphorus, potassium, and magnesium deposition occurred mainly from rain throughfall in winter and spring. Blue oak canopies play an important role in nutrient cycling [48]. A study on the Hasting Natural History Reservation found that by throughfall, epiphytic lichens on blue oak deposited a mean of 2.85 kg/ha/year of atmospheric nitrogen and 0.15 kg/has/year of atmospheric phosphorus [143].

Duncan and Clawson [68] reported that cattle prefer forage beneath blue oak to that of open grassland, even in summer after forage in both areas has dried. Holland [118] found that death or removal of blue oak resulted in a gradual decline in forage production and quality. Supporting this, another study showed an increase in unpalatable tarweed (*Madia gracilis*) following blue oak removal [136].

Plant-water-site interactions may explain the discrepancies between studies showing that blue oak decreases forage production and those showing that blue oak enhances forage production. One study [23] suggests that forage production beneath blue oaks is relatively high on dry sites but is low on more mesic sites. Another study found that blue oaks with shallow, fine roots inhibited production of understory herbs compared to production of herbs beneath deeply-rooted blue oaks [47] (see General Botanical Characteristics for information on how blue oaks develop roots). This inhibition may be partially attributable to allelopathic blue oak root exudates as well as competition for water and nutrients. Variations in root morphology may also partially explain differences in understory production in blue oak ecosystems. Climate fluctuations and degree of canopy closure also influence understory forage production. Annual grass production varied significantly among years ($P<0.05$) on the Sierra Foothill Range and Field Station, with high rainfall years favoring growth of groundlayer vegetation under blue oak canopies, and low rainfall years depressing forage production beneath blue oak canopies [57]. In the North Coast Ranges and Sacramento Valley, blue oaks on sites receiving less than 20 inches (500 mm) mean annual precipitation had no effect on or enhanced understory production, while blue oaks on sites receiving more precipitation generally suppressed understory production [75].

Blue oak probably has both positive (facilitation) and negative effects (allelopathy) on understory herbs, with both influencing groundlayer plant species composition. A study on the Hopland Field Station found ripgut brome tended to dominate under blue oak canopies, while soft chess dominated open grassland. The researchers credited better performance of ripgut brome beneath blue oak canopies to increased nutrient availability there [207]. However, blue oak can retard growth of annual grasses. Reciprocal transplant experiments in the field and greenhouse indicate that some blue oak root exudates are allelopathic to ripgut brome. This effect probably also extends to other annual grass species.

Blue oak's negative effects on annual grass productivity may be at least partially ameliorated by blue oak's "root pump", which facilitates annual grass growth. Blue oak's fine roots leak water and nutrients into surrounding soil [42,127]. Callaway [42] suggests that blue oak roots deep in the soil extract nutrients from low soil layers, then transport and exude the nutrients into upper soil layers where they are available for groundlayer herbs [48]. Holland [118] and others [119] also found these facilitative effects of blue oak on annual grasses, with soil nutrient levels remaining higher under blue oak canopies than in open grassland for 10 or more years after tree death.

Although blue oak is now generally regarded as a desirable species, blue oak populations continue to decline. Continued clearing of blue oak on rangelands and poor natural regeneration were 2 major management concerns identified by the Hardwood Task Force of the California Board of Forestry [5]. Road construction and residential and commercial development [196], lowering water tables [246], and use of blue oak for fuelwood [173] all contribute to blue oak decline. Since most blue oak woodlands are on private lands, development is probably the largest threat to blue oak habitats [196]. Development accounted for 46% of blue oak loss between 1973 and 1985, surpassing the loss from rangeland clearing before that.

Damaging agents: Blue oak is vulnerable to several species of fungi. The most serious of these are *Inonotus dryophilus*, *Laetiporus sulphureus*, and *Armillaria mellea*, all of which cause heart and root rot [173]. Compacted soil may increase blue oak susceptibility to root-rot fungi [59]. Like other oaks in the white oak subgenus, blue oak is resistant to the fungus-like water mold causing sudden oak death disease [210].

Pacific mistletoe (*Phordendron villosum*) infects blue oak [230].

A large number of insects infest blue oak. One study showed that 38 species of insects inhabit blue oak, attacking every part of the tree. The most damaging of these pests in terms of regeneration are the acorn feeders, which include cynipid wasps, the filbert weevil (*Curculio uniformis*), and the filbert worm (*Melissopus latiferreanus*). These insects can destroy large portions of a year's acorn crop [173].

Raabe [201] provides a general review of diseases and insect pests on blue oak and other California oaks. See Swiecki and others [224,225] for more detailed descriptions of insect and diseases affecting blue oak.

Quercus douglasii: REFERENCES

1. Abrams, Marc D. 1990. Adaptations and responses to drought in Quercus species of North America. Tree Physiology. 7(1-4): 227-238. [14065]

2. Adams, Theodore E., Jr.; Sands, Peter B.; Weitkamp, William H.; McDougald, Neil K. 1987. Enemies of white oak regeneration in California. In: Plumb, Timothy R.; Pillsbury, Norman H., technical coordinators. Proceedings of the symposium on multiple-use management of California's hardwood resources; 1986 November 12-14; San Luis Obispo, CA. Gen. Tech. Rep. PSW-100. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 459-462. [5396]

3. Adams, Theodore E., Jr.; Sands, Peter B.; Weitkamp, William H.; McDougald, Neil K. 1991. Blue and valley oak seedling establishment on California's hardwood rangelands. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; 1990 October 31 - November 2; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: Pacific Southwest Research Station: 41-47. [18887]

4. Adams, Theodore E., Jr.; Sands, Peter B.; Weitkamp, William H.; McDougald, Neil K. 1992. Oak seedling establishment in California oak woodlands. In: Ffolliott, Peter F.; Gottfried, Gerald J.; Bennett, Duane A.; Hernandez C., Victor Manuel; Ortega-Rubio, Alfred; Hamre, R. H., tech. coords. Ecology and management of oak and associated woodlands: perspectives in the southwestern United States and northern Mexico: Proceedings; 1992 April 27-30; Sierra Vista, AZ. Gen. Tech. Rep. RM-218. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 137-140. [19753]

5. Adams, Theodore E., Jr.; Sands, Peter B.; Weitkamp, William H.; McDougald, Neil K. 1992. Oak seedling establishment on California rangelands. Journal of Range Management. 45(1): 93-98. [17435]

6. Adams, Theodore E., Jr.; Sands, Peter B.; Weitkamp, William H.; Stanley, Marion E. 1997. Oak seedling establishment by artificial regeneration on California rangelands. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 213-223. [29014]

7. Adams, Theodore E.; McDougald, Neil K. 1995. Planted blue oaks may need help to survive in southern Sierras. California Agriculture. 49(5): 13-17. [26011]

8. Agee, James K.; Biswell, Harold H. 1978. The fire management plan for Pinnacles National Monument. In: Linn, Robert M., ed. Proceedings, 1st conference on scientific research in the National Parks: Vol. 2; 1976 November 9-12; New Orleans, LA. NPS Transactions and Proceedings No. 5. Washington, DC: U.S. Department of the Interior, National Park Service: 1231-1238. [14368]

9. Aizen, Marcelo A.; Patterson, William A., III. 1990. Acorn size and geographical range in the North American oaks (Quercus L.). Journal of Biogeography. 17: 327-332. [13450]

10. Allen, Barbara H.; Holzman, Barbara A.; Evett, Rand R. 1991. A classification system for California's hardwood rangelands. Hilgardia. 59(2): 1-45. [17371]

11. Allen-Diaz, Barbara H.; Bartolome, James W. 1992. Survival of Quercus douglasii (Fagaceae) seedlings under the influence of fire and grazing. Madrono. 39(1): 47-53. [17539]

12. Allen-Diaz, Barbara H.; Holzman, Barbara A. 1991. Blue oak communities in California. Madrono. 38(2): 80-95. [15424]

13. Allen-Diaz, Barbara; Jackson, Randall D.; Phillips, Catherine. 2001. Spring-fed plant communities of California's East Bay Hills oak woodlands. Madrono. 48(2): 98-111. [40591]

14. Anderson, M. Kat. 1999. The fire, pruning, and coppice management of temperate ecosystems for basketry material by California Indian tribes. Human Ecology. 27(1): 79-113. [35820]

15. Anderson, M. Kat. 2006. The use of fire by Native Americans in California. In: Sugihara, Neil G.; van Wagtendonk, Jan W.; Shaffer, Kevin E.; Fites-Kaufman, Joann; Thode, Andrea E., eds. Fire in California's ecosystems. Berkeley, CA: University of California Press: 417-430. [65564]

16. Anderson, M. Kat; Moratto, Michael J. 1996. Native American land-use practices and ecological impacts. In: Status of the Sierra Nevada. Sierra Nevada Ecosystem Project: Final report to Congress. Volume II: Assessments and scientific basis for management options. Wildland Resources Center Report No. 37. Davis, CA: University of California, Centers for Water and Wildland Resources: 187-206. [28967]

17. Anderson, Melanie Vael; Pasquinelli, Renee L. 1984. Ecology and management of the northern oak woodland community, Sonoma County, California. Rohnert Park, CA: Sonoma State University. 125 p. Thesis. [68830]

18. Baker, Gail A.; Rundel, Philip W.; Parsons, David J. 1981. Ecological relationships of Quercus douglasii (Fagaceae) in the foothill zone of Sequoia National Park, California. Madrono. 28(1): 1-12. [6477]

19. Barbour, Michael G. 1987. Community ecology and distribution of California hardwood forests and woodlands. In: Plumb, Timothy R.; Pillsbury, Norman H., technical coordinators. Proceedings of the symposium on multiple-use management of California's hardwood resources; 1986 November 12-14; San Luis Obispo, CA. Gen. Tech. Rep. PSW-100. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 18-25. [5356]

20. Barnhart, Stephen J.; McBride, Joe R.; Warner, Peter. 1996. Invasion of northern oak woodlands by Pseudotsuga menziesii (Mirb.) Franco in the Sonoma Mountains of California. Madrono. 43(1): 28-45. [51847]

21. Barry, Sheila J.; Knight, Ronald S.; McCreary, Douglas D. 1997. Pruning oak resprouts to enhance growth. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 667-670. [54808]

22. Barry, W. James. 1972. The Central Valley prairie. Vol. 1: California prairie ecosystem. Sacramento, CA: California Department of Parks and Recreation. 82 p. [28344]

23. Bartolome, James W. 1987. California annual grassland and oak savannah. Rangelands. 9(3): 122-125. [2861]

24. Bartolome, James W.; McClaran, Mitchel P.; Allen-Diaz, Barbara H.; Ford, Lawrence D.; Standiford, Richard B.; McDougald, Neil K.; Forero, Larry C. 2002. Effects of fire and browsing on regeneration of blue oak. In: Standiford, Richard B.; McCreary, Douglas; Purcell, Kathryn L., technical coordinators. Proceedings of the 5th symposium on oak woodlands: oaks in California's changing landscape; 2001 October 22-25; San Diego, CA. Gen. Tech. Rep. PSW-GTR-184. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 281-286. [42326]

25. Bartolome, James W.; Muick, Pamela C.; McClaran, Mitchel P. 1987. Natural regeneration of Californian hardwoods. In: Plumb, Timothy R.; Pillsbury, Norman H., technical coordinators. Proceedings of the symposium on multiple-use management of California's hardwood resources; 1986 November 12-14; San Luis Obispo, CA. Gen. Tech. Rep. PSW-100. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 26-31. [5357]

26. Bauer, H. L. 1930. Vegetation of the Tehachapi Mountains, California. Ecology. 11(2): 263-280. [15102]

27. Biswell, H. H. 1956. Ecology of California grasslands. Journal of Forestry. 9: 19-24. [11182]

28. Biswell, H. H.; Gilman, J. H. 1961. Brush management in relation to fire and other environmental factors on the Tehama deer

winter range. California Fish and Game. 47(4): 357-389. [6275]

29. Block, William M. 1991. Foraging ecology of Nuttall's woodpecker. The Auk. 108(2): 303-317. [19074]

30. Block, William M.; Morrison, Michael L. 1990. Wildlife diversity of the Central Sierra foothills. California Agriculture. 44(2): 19-22. [12103]

31. Block, William M.; Morrison, Michael L. 1991. Influence of scale on the management of wildlife in California oak woodlands. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; 1990 October 31 - November 2; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: Pacific Southwest Research Station: 96-104. [18896]

32. Block, William M.; Morrison, Michael L. 1998. Habitat relationships of amphibians and reptiles in California oak woodlands. Journal of Herpetology. 32(1): 51-60. [52670]

33. Bolsinger, Charles L. 1988. The hardwoods of California's timberlands, woodlands, and savannas. Resour. Bull. PNW-RB-148. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 148 p. [5291]

34. Bonner, Franklin T. [In press]. Quercus L.--oak, [Online]. In: Bonner, Franklin T.; Nisley, Rebecca G.; Karrfait, R. P., coords. Woody plant seed manual. Agric. Handbook 727. Washington, DC: U.S. Department of Agriculture, Forest Service (Producer). Available: http://www.nsl.fs.fed.us/wpsm/Quercus.pdf [2006, July 19]. [62581]

35. Bonnicksen, Thomas M. 2000. The Spanish explorer's forests. In: Bonnicksen, Thomas M. America's ancient forests: From the Ice Age to the Age of Discovery. New York: John Wiley & Sons, Inc: 226-257. [46250]

36. Borchert, Mark I.; Cunha, Nancy D.; Krosse, Patricia C.; Lawrence, Marcee L. 1993. Blue oak plant communities of southern San Luis Obispo and northern Santa Barbara Counties, California. Gen. Tech. Rep. PSW-GTR-139. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 49 p. [23487]

37. Borchert, Mark I.; Davis, Frank W.; Michaelson, Joel; Oyler, Lynn Dee. 1989. Interactions of factors affecting seedling recruitment of blue oak (Quercus douglasii) in California. Ecology. 70(2): 389-404. [6626]

38. Borchert, Mark; Davis, Frank W.; Allen-Diaz, Barbara. 1991. Environmental relationships of herbs in blue oak (Quercus douglasii) woodlands of central coastal California. Madrono. 38(4): 249-266. [17067]

39. Boyd, Steve. 1999. Vascular flora of the Liebre Mountains, western Transverse Ranges, California. Aliso. 18(2): 93-139. [40639]

40. Brooks, Colin N.; Merenlender, Adina M. 2001. Determining the pattern of oak woodland regeneration for a cleared watershed in northwest California: a necessary first step for restoration. Restoration Ecology. 9(1): 1-12. [40127]

41. Brooks, William H. 1967. Some quantitative aspects of the grass-oak woodland in Sequoia National Park, California. Report to the superintendent. 19 p. Three Rivers, CA: U.S. Department of the Interior, National Park Service, Sequoia-Kings Canyon National Park. 24 p. [68835]

42. Callaway, Ragan M. 1990. Effects of soil water distribution on the lateral root development of three species of California oaks. American Journal of Botany. 77(11): 1469-1475. [13784]

43. Callaway, Ragan M. 1992. Effect of shrubs on recruitment of Quercus douglasii and Quercus lobata in California. Ecology. 73(6): 2118-2128. [18431]

44. Callaway, Ragan M. 1992. Morphological and physiological responses of three California oak species to shade. International Journal of Plant Science. 153(3): 434-441. [20097]

45. Callaway, Ragan M.; Davis, Frank W. 1993. Vegetation dynamics, fire, and the physical environment in coastal central California. Ecology. 74(5): 1567-1578. [21675]

46. Callaway, Ragan M.; Mahall, Bruce E. 1996. Variation in leaf structure and function in Quercus douglasii trees differing in root architecture and drought history. International Journal of Plant Science. 157(1): 129-135. [27153]

47. Callaway, Ragan M.; Nadkarni, Nalini M.; Mahall, Bruce E. 1991. Facilitation and interference of Quercus douglasii on understory productivity in central California. Ecology. 72(4): 1484-1499. [16501]

48. Callaway, Ragan Morrison. 1990. Effects of Quercus douglasii on grassland productivity and nutrient cycling in central California. Santa Barbara, CA: University of California. 150 p. Dissertation. [67427]

49. Camping, Trina J.; Dahlegren, Randy A.; Tate, Kenneth W.; Horwath, William R. 2002. Changes in soil quality due to grazing and oak tree removal in California blue oak woodlands. In: Standiford, Richard B.; McCreary, Douglas; Purcell, Kathryn L., technical coordinators. Proceedings of the 5th symposium on oak woodlands: oaks in California's changing landscape; 2001 October 22-25; San Diego, CA. Gen. Tech. Rep. PSW-GTR-184. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 75-85. [42308]

50. Canon, W. A. 1914. Specialization in vegetation and in environment in California. Plant World. 17: 223-237. [68590]

51. Carmen, William J.; Koenig, Walter D.; Mumme, Ronald L. 1987. Acorn production by five species of oaks over a seven year period at the Hastings Reservation, Carmel Valley, California. In: Plumb, Timothy R.; Pillsbury, Norman H., technical coordinators. Proceedings of the symposium on multiple-use management of California's hardwood resources; 1986 November 12-14; San Luis Obispo, CA. Gen. Tech. Rep. PSW-100. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 429-434. [5390]

52. Cheng, Xiaomei. 2002. Fine root production and nitrogen competition in California blue oak (Quercus douglasii) woodland. Davis, CA: University of California. 82 p. [Abstract]. Dissertation. [67432]

53. Chesnut, V. K. 1902. Plants used by the Indians of Mendocino County, California. Contributions from the U.S. National Herbarium. [Washington, DC]: U.S. Department of Agriculture, Division of Botany. 7(3): 295-408. [54917]

54. Clar, C. Raymond. 1969. California government and forestry -- II. Sacramento, CA: California Division of Forestry, Conservation Department. 319 p. [68837]

55. Clark, Andrew H. 1956. The impact of exotic invasion on the remaining New World mid-latitude grasslands. In: Thomas, William L., Jr., ed. Man's role in changing the face of the Earth. Chicago, IL: University of Chicago Press: 737-762. [68832]

56. Clark, Harold W. 1937. Association types in the North Coast Ranges of California. Ecology. 18: 214-230. [11187]

57. Connor, J. Michael; Willoughby, Bob L. 1997. Effects of blue oak canopy on annual forage production. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 321-326. [29025]

58. Cooper, William S. 1926. Vegetational development upon alluvial fans in the vicinity of Palo Alto, California. Ecology. 7(1): 1-30. [62837]

59. Costello, L. R.; MacDonald, J. D.; Jacobs, K. A. 1991. Soil aeration and tree health: correlating soil oxygen measurements with the decline of established oaks. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; 1990 October 31 - November 2; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 295-299. [19064]

60. Costello, L. R.; Schmidt, R. H.; Giusti, Gregory A. 1991. Evaluating tree protection devices: effects on growth and survival-- first-year results. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; 1990 October 31 - November 2; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 31-35. [17355]

61. Craft, Kathleen J.; Ashley, Mary V.; Koenig, Walter D. 2002. Limited hybridization between Quercus lobata and Quercus douglasii (Fagaceae) in a mixed stand in central coastal California. American Journal of Botany. 89(11): 1792-1798. [43130]

62. Craig, Diana L. 1986. The seasonal food habits in sympatric populations. of puma (Puma concolor), coyote (Canis latrans), and bobcat (Lynx rufus) in the Diablo Range of California. San Jose, CA: San Jose State University. 61 p. Thesis. [21364]

63. Dahlgren, R. A.; Singer, M. J.; Huang, X. 1997. Oak tree and grazing impacts on soil properties and nutrients in a California oak woodland. Biogeochemistry. 39(1): 45-64. [68624]

64. Dahlgren, Randy A.; Horwath, William R.; Tate, Kenneth W.; Camping, Trina J. 2003. Blue oak enhance soil quality in California oak woodlands. California Agriculture. 57(2): 42-47. [47021]

65. Davis, Frank W.; Borchert, Mark; Harvey, L. E.; Michaelsen, Joel C. 1991. Factors affecting seedling survivorship of blue oak (Quercus douglasii H. & A.) in central California. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; 1990 October 31 - November 2; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: Pacific Southwest Research Station: 81-86. [18894]

66. DeLasaux, Michael J.; Pillsbury, Norman H. 1987. Site index and yield equations for blue oak and coast live oak. In: Plumb, Timothy R.; Pillsbury, Norman H., technical coordinators. Proceedings of the symposium on multiple-use management of California's hardwood resources; 1986 November 12-14; San Luis Obispo, CA. Gen. Tech. Rep. PSW-100. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 325-334. [5383]

67. Downie, Denise D.; Taskey, Ronald D. 1997. Soil characteristics of blue oak and coast live oak ecosystems. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 65-73. [28998]

68. Duncan, D. A.; Clawson, W. J. 1980. Livestock utilization of California's oak woodlands. In: Plumb, Timothy R., technical coordinator. Proceedings of the symposium on the ecology, management, and utilization of California oaks; 1979 June 26-28; Claremont, CA. Gen. Tech. Rep. PSW-44. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 306-313. [7051]

69. Duncan, Don A.; McDougald, Neil K.; Westfall, Stanley E. 1987. Long-term changes from different uses of foothill hardwood rangelands. In: Plumb, Timothy R.; Pillsbury, Norman H., technical coordinators. Proceedings of the symposium on multiple-use management of California's hardwood resources; 1986 November 12-14; San Luis Obispo, CA. Gen. Tech. Rep. PSW-100. Berkeley,

CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 367-372. [5389]

70. Ewing, Robert A. 1990. How are oaks protected? What are the issues? Fremontia. 18(3): 83-83-88. [51867]

71. Finney, Mark A.; Martin, Robert E. 1992. Short fire intervals recorded by redwoods at Annadel State Park, California. Madrono. 39(4): 251-262. [19885]

72. Flora of North America Association. 2008. Flora of North America: The flora, [Online]. Flora of North America Association (Producer). Available: http://www.fna.org/FNA. [36990]

73. Franco, Geria Maria Montanari. 1976. Grazing effects on oak distribution in Jasper Ridge and adjacent areas. Palo Alto, CA: Stanford University. 33 p. Thesis. [68839]

74. Frost, William E. 1989. The Ellis Ranch Project: a case study in controlled burning. No. 891002. Fresno, CA: California Agricultural Technology Institute; San Joaquin Experimental Range. 11 p. [13817]

75. Frost, William E.; Bartolome, James W.; Connor, J. Michael. 1997. Understory-canopy relationships in oak woodlands and savannas. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 183-190. [29011]

76. Frost, William E.; McDougald, Neil K. 1989. Tree canopy effects on herbaceous production of annual rangeland during drought. Journal of Range Management. 42(4): 281-283. [48306]

77. Frost, William E.; McDougald, Neil K.; Demment, Montague W. 1991. Blue oak canopy effect on seasonal forage production and quality. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; 1990 October 31 - November 2; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 307-311. [19065]

78. Fry, Danny L. 2002. Effects of a prescribed fire on oak woodland stand structure. In: Standiford, Richard B.; McCreary, Douglas; Purcell, Kathryn L., technical coordinators. Proceedings of the 5th symposium on oak woodlands: oaks in California's changing landscape; 2001 October 22-25; San Diego, CA. Gen. Tech. Rep. PSW-GTR-184. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 235-242. [42320]

79. Fry, Michael E.; Vaughn, Charles E. 1977. Acorn selection by band-tailed pigeons. California Fish and Game. 63(1): 59-60. [64143]

80. Gardner, Robert A. 1958. Soil-vegetation associations in the redwood - Douglas-fir zone of California. In: Proceedings, 1st North American forest soils conference; [Date of conference unknown]; East Lansing, MI. East Lansing, MI: Michigan State University, Agricultural Experiment Station: 86-101. [12581]

81. Gervais, Bruce R. 2006. A three-century record of precipitation and blue oak recruitment from the Tehachapi Mountains, southern California, USA. Dendrochronologia. 24(1): 29-37. [65027]

82. Giusti, Gregory A.; Merenlender, Adina M. 2002. Inconsistent application of environmental laws and policies to California oak woodlands. In: Standiford, Richard B.; McCreary, Douglas; Purcell, Kathryn L., technical coordinators. Proceedings of the 5th symposium on oak woodlands: oaks in California's changing landscape; 2001 October 22-25; San Diego, CA. Gen. Tech. Rep. PSW-GTR-184. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 473-482. [42341]

83. Goldner, Bernard H. 1988. The Alamitos Creek Revegetation Project-the lessons learned. In: Rieger, John P.; Williams, Bradford K., eds. Proceedings of the second native plant revegetation symposium; 1987 April 15-18; San Diego, CA. Madison, WI: University of Wisconsin Arboretum, Society for Ecological Restoration & Management: 185-192. [4113]

84. Gordon, Aaron; Sampson, Arthur W. 1939. Composition of common California foothill plants as a factor in range management. Bull. 627. Berkeley, CA: University of California, College of Agriculture, Agricultural Experiment Station. 95 p. [3864]

85. Gordon, D. R.; Welker, J. M.; Menke, J. W.; Rice, K. J. 1989. Competition for soil water between annual plants and blue oak (Quercus douglasii) seedlings. Oecologia. 79: 533-541. [8733]

86. Gordon, Doria R.; Rice, Kevin J. 2000. Competitive suppression of Quercus douglasii (Fagaceae) seedling emergence and growth. American Journal of Botany. 87(7): 986-994. [36165]

87. Gordon, Doria Ruth. 1989. Competition for water among blue oak (Quercus douglasii) seedlings and grassland annuals. Davis, CA: University of California. 120 p. Dissertation. [67426]

88. Graves, George W. 1932. Ecological relationships of Pinus sabiniana. Botanical Gazette. 94(1): 106-133. [63160]

89. Graves, Walter C. 1980. Annual oak mast yields from visual estimates. In: Plumb, Timothy R., tech. coord. Proceedings of the symposium on the ecology, management, and utilization of California oaks; 1979 June 26-28; Claremont, CA. Gen. Tech. Rep. PSW-44. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 270-274. [7047]

90. Greene, D. F.; Johnson, E. A. 2004. Modelling the temporal variation in the seed production of North American trees. Canadian

Journal of Forest Research. 34: 65-75. [56141]

91. Greenlee, J. M.; Moldenke, A. 1982. History of woodland fires in the Gabilan Mountains region of central coastal California. Unpublished report. Paicinies, CA: Department of the Interior, National Park Service, Pinnacles National Monument. [68667]

92. Griffin, James R. 1971. Oak regeneration in the upper Carmel Valley, California. Ecology. 52(5): 862-868. [9677]

93. Griffin, James R. 1973. Xylem sap tension in three woodland oaks of central California. Ecology. 54(1): 152-159. [3707]

94. Griffin, James R. 1974. Notes on environment, vegetation and flora: Hastings Natural History Reservation. [Place of publication unknown]: [Publisher unknown]. 90 p. On file at: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Fire Sciences Laboratory, Missoula, MT. [10531]

95. Griffin, James R. 1977. Oak woodland. In: Barbour, Michael G.; Malor, Jack, eds. Terrestrial vegetation of California. New York: John Wiley and Sons: 383-415. [7217]

96. Griffin, James R. 1980. Animal damage to valley oak acorns and seedlings, Carmel Valley, California. In: Plumb, Timothy R., technical coordinator. Proceedings of the symposium on the ecology, management, and utilization of California oaks; 1979 June 26-28; Claremont, CA. Gen. Tech. Rep. PSW-44. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 242-245. [7044]

97. Griffin, James R. 1980. Sprouting in fire-damaged valley oaks, Chews Ridge, California. In: Plumb, Timothy R., technical coordinator. Proceedings of the symposium on the ecology, management, and utilization of California oaks; 1979 June 26-28; Claremont, CA. Gen. Tech. Rep. PSW-44. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 216-219. [7040]

98. Griffin, James R.; Critchfield, William B. 1972. The distribution of forest trees in California. Res. Pap. PSW-82. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 118 p. [1041]

99. Gruell, George E. 2001. Fire in Sierra Nevada forests: A photographic interpretation of ecological change since 1849. Missoula, MT: Mountain Press Publishing Company. 238 p. [43843]

100. Haggerty, P. K. 1994. Damage and recovery in southern Sierra Nevada foothill oak woodland after a severe ground fire. Madrono. 41(3): 185-198. [41156]

101. Haggerty, Patricia K. 1991. Fire effects in blue oak (Quercus douglasii) woodland in the southern Sierra Nevada, California. Davis, CA: University of California. 105 p. Thesis. [67433]

102. Haggerty, Patricia K. 1991. Fire effects in blue oak woodland. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; 1990 October 31 - November 2; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 342-344. [19068]

103. Haggerty, Patricia K. 1993. Mortality and resprouting of Quercus douglasii following fire in southern Sierra Nevada oak woodlands. In: Bulletin of the Ecological Society of America. 74(2): 262. (Supplement). [Abstract]. [23759]

104. Hall, Lillian M.; George, Melvin R.; Adams, Theodore E.; Sands, Peter B.; McCreary, Douglas D. 1991. The effect of season and stock density on blue oak establishment. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; 1990 October 31 - November 2; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 312-314. [19066]

105. Hall, Lillian M.; George, Melvin R.; McCreary, Douglas D.; Adams, Theodore E. 1992. Effects of cattle grazing on blue oak seedling damage and survival. Journal of Range Management. 45(5): 503-506. [19615]

106. Hall, Lillian Marie. 1990. The effects of season of grazing and stock density on blue oak (Quercus douglasii) regeneration in the Sierra foothills of California. Davis, CA: University of California. 43 p. Thesis. [67436]

107. Halvorson, William L.; Clark, Ronilee A. 1989. Vegetation and floristics of Pinnacles National Monument. Tech. Rep. No. 34. Davis, CA: University of California at Davis, Institute of Ecology, Cooperative National Park Resources Study Unit. 113 p. [11883]

108. Hann, Wendel; Havlina, Doug; Shlisky, Ayn; [and others]. 2005. Interagency fire regime condition class guidebook. Version 1.2, [Online]. In: Interagency fire regime condition class website. U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior; The Nature Conservancy; Systems for Environmental Management (Producer). Variously paginated [+ appendices]. Available: http://www.frcc.gov/docs/1.2.2.2/Complete_Guidebook_V1.2.pdf [2007, May 23]. [66734]

109. Harris, Richard W.; Leiser, Andrew T.; Fissell, Robert E. 1980. Tolerance of oaks to flooding. In: Plumb, Timothy R., technical coordinator. Proceedings of the symposium on the ecology, management, and utilization of California oaks; 1979 June 26-28; Claremont, CA. Gen. Tech. Rep. PSW-44. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 238-241. [7043]

110. Harvey, Larry Edward. 1989. Spatial and temporal dynamics of a blue oak woodland. Santa Barbara, CA: University of California, Santa Barbara. 170 p. [68826]

111. Harvey, W. A.; Johnson, W. H.; Bell, F. L. 1959. Control of oak trees on California foothill range. Down to Earth. 15: 3-6.

[68827]

112. Heady, H. F.; Bartolome, J. W.; Pitt, M. D.; Savelle, G. D.; Stroud, M. C. 1992. California prairie. In: Coupland, R. T., ed. Natural grasslands: Introduction and western hemisphere. Ecosystems of the World 8A. Amsterdam, The Netherlands: Elsevier Science Publishers B. V.: 313-335. [23831]

113. Heady, Harold F. 1977. Valley grassland. In: Barbour, Michael G.; Major, Jack, eds. Terrestrial vegetation of California. New York: John Wiley and Sons: 491-514. [7215]

114. Hickman, James C., ed. 1993. The Jepson manual: Higher plants of California. Berkeley, CA: University of California Press. 1400 p. [21992]

115. Hilty, Jodi A.; Merenlender, Adian M. 2004. Use of riparian corridors and vineyards by mammalian predators in northern California. Conservation Biology. 18(1): 126-135. [47449]

116. Holland, Robert F. 1986. Preliminary descriptions of the terrestrial natural communities of California. Sacramento, CA: California Department of Fish and Game. 156 p. [12756]

117. Holland, V. L. 1969. Canopy effect of Quercus douglasii H. & A. Fresno, CA: California State University. 71 p. Thesis. [67431]

118. Holland, V. L. 1980. Effect of blue oak on rangeland forage production in central California. In: Plumb, Timothy R., technical coordinator. Proceedings of the symposium on the ecology, management, and utilization of California oaks; 1979 June 26-28; Claremont, CA. Gen. Tech. Rep. PSW-44. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 314-318. [7052]

119. Holland, V. L.; Morton, Jimmy. 1980. Effect of blue oak on nutritional quality of rangeland forage in central California. In: Plumb, Timothy R., technical coordinator. Proceedings of the symposium on the ecology, management, and utilization of California oaks; 1979 June 26-28; Claremont, CA. Gen. Tech. Rep. PSW-44. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 319-322. [7053]

120. Holland, Vorcie Loies. 1972. A study of soil and vegetation under Quercus douglasii H. & A. compared to open grassland. Berkeley, CA: University of California. 369 p. Dissertation. [67428]

121. Holmes, Tyson H. 1990. Botanical trends in northern California oak woodland. Rangelands. 12(1): 3-7. [10939]

122. Holzman, Barbara A.; Allen-Diaz, Barbara H. 1991. Vegetation change in blue oak woodlands in California. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; 1990 October 31 - November 2; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 189-197. [19059]

123. Holzman, Barbara Ann. 1993. Vegetation change in California's blue oak (Quercus douglasii) woodlands 1932-1992. Berkeley, CA: University of California. 123 p. Dissertation. [67424]

124. Horney, Marc; Standiford, Richard B.; McCreary, Douglas; Tecklin, Jerry; Richards, Roy. 2002. Effects of wildfire on blue oak in the Northern Sacramento Valley. In: Standiford, Richard B.; McCreary, Douglas; Purcell, Kathryn L., technical coordinators. Proceedings of the 5th symposium on oak woodlands: oaks in California's changing landscape; 2001 October 22-25; San Diego, CA. Gen. Tech. Rep. PSW-GTR-184. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 261-267. [42323]

125. Horton, J. S. 1951. Vegetation. In: Some aspects of watershed management in southern California vegetation. Misc. Pap. 1. Berkeley, CA: U.S. Department of Agriculture, Forest Service, California Forest and Range Experiment Station: 10-17. [10685]

126. Hunter, John C. 1993. Quercus douglasii (Fagaceae) in California's Central Valley. Madrono. 40(1): 62-65. [20723]

127. Ishikawa, C. Millikin; Bledsoe, C. S. 2000. Seasonal and diurnal patterns of soil water potential in the rhizosphere of blue oaks: evidence for hydraulic lift. Oecologia. 125(4): 459-465. [38797]

128. Jackson, Louise E.; Roy, Jacques. 1986. Growth patterns of Mediterranean annual and perennial grasses under simulated rainfall regimes of southern France and California. Acta Ecologica. 7(21): 191-212. [36976]

129. Jacobs, Karel A.; MacDonald, James D.; Berry, Alison M.; Costello, Laurence R. 1997. Rooting responses of three oak species to low oxygen stress. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 91-99. [29001]

130. Jepson, W. L. 1910. The silva of California. University of California Memoirs. Vol. 2. Berkeley, CA: University of California. 480 p. [18743]

131. Jepson, Willis L. 1909. The trees of California. San Francisco: Cunningham, Curtis, & Welch. 228 p. [68844]

132. Johnson, Walter; McKell, Cyrus M.; Evans, Raymond A.; Berry, L. J. 1959. Yield and quality of annual forage following 2,4-D application on blue oak trees. Journal of Range Management. 12: 18-20. [19901]

133. Karlik, John F.; McKay, Alistair H. 2002. Leaf area index, leaf mass density, and allometric relationships derived from harvest of blue oaks in a California oak savanna. In: Standiford, Richard B.; McCreary, Douglas; Purcell, Kathryn L., technical coordinators. Proceedings of the 5th symposium on oak woodlands: oaks in California's changing landscape; 2001 October 22-25; San Diego, CA. Gen. Tech. Rep. PSW-GTR-184. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 719-729. [42367]

134. Kartesz, John T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. 1st ed. In: Kartesz, John T.; Meacham, Christopher A. Synthesis of the North American flora (Windows Version 1.0), [CD-ROM]. Chapel Hill, NC: North Carolina Botanical Garden (Producer). In cooperation with: The Nature Conservancy; U.S. Department of Agriculture, Natural Resources Conservation Service; U.S. Department of the Interior, Fish and Wildlife Service. [36715]

135. Kay, Burgess L. 1987. Long-term effects of blue oak removal on forage production, forage quality, soil, and oak regeneration. In: Plumb, Timothy R.; Pillsbury, Norman H., technical coordinators. Proceedings of the symposium on multiple-use management of California's hardwood resources; 1986 November 12-14; San Luis Obispo, CA. Gen. Tech. Rep. PSW-100. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 351-357. [5386]

136. Kay, Burgess L.; Leonard, O. A. 1980. Effect of blue oak removal on herbaceous forage production in the North Sierra Foothills. In: Plumb, Timothy R., technical coordinator. Proceedings of the symposium on the ecology, management, and utilization of California oaks; 1979 June 26-28; Claremont, CA. Gen. Tech. Rep. PSW-44. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 323-328. [7054]

137. Keeley, Jon E. 1982. Distribution of lightning- and man-caused wildfires in California. In: Conrad, C. Eugene; Oechel, Walter C., technical coordinators. Proceedings of the symposium on dynamics and management of Mediterranean-type ecosystems; 1981 June 22-26; San Diego, CA. Gen. Tech. Rep. PSW-58. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 431-437. [6049]

138. Keeley, Jon E. 2002. Plant diversity and invasives in blue oak savannas of the southern Sierra Nevada. In: Standiford, Richard B.; McCreary, Douglas; Purcell, Kathryn L., technical coordinators. Proceedings of the 5th symposium on oak woodlands: oaks in California's changing landscape; 2001 October 22-25; San Diego, CA. Gen. Tech. Rep. PSW-GTR-184. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 693-704. [42358]

139. Keeley, Jon E.; Lubin, Daniel; Fotheringham, C. J. 2003. Fire and grazing impacts on plant diversity and alien plant invasions in the southern Sierra Nevada. Ecological Applications. 13(5): 1355-1374. [52941]

140. Kie, John G.; Loft, Eric R. 1990. Using livestock to manage wildlife habitat: some examples from California annual grassland and wet meadow communities. In: Severson, Kieth E., tech. coord. Can livestock be used as a tool to enhance wildlife habitat: Proceedings, 43rd annual meeting of the Society for Range Management; 1990 February 13; Reno, NV. Gen. Tech. Rep. RM-194. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 7-24. [15996]

141. Klinger, Robert C.; Kutilek, Michael J.; Shellhammer, Howard S. 1989. Population responses of black-tailed deer to prescribed burning. Journal of Wildlife Management. 53(4): 863-871. [10686]

142. Knops, Johannes M. H.; Koenig, Walter D. 1994. Water use strategies of five sympatric species of Quercus in central coastal California. Madrono. 41(4): 290-301. [40867]

143. Knops, Johannes M. H.; Nash, Thomas H., III; Schlesinger, William H. 1997. The influence of epiphytic lichens on the nutrient cycling of a blue oak woodland. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 75-82. [28999]

144. Koenig, Walter D.; Carmen, William J.; Stanback, Mark T.; Mumme, Ronald L. 1991. Determinants of acorn productivity among five species of oaks in central coastal California. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; 1990 October 31 - November 2; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: Pacific Southwest Research Station: 136-142. [18900]

145. Koenig, Walter D.; Haydock, Joseph. 1999. Oaks, acorns, and the geographical ecology of acorn woodpeckers. Journal of Biogeography. 26(1): 159-165. [68661]

146. Koenig, Walter D.; Knops, Johannes M. H. 1997. Patterns of geographic synchrony in growth and reproduction of oaks within California and beyond. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 101-108. [29002]

147. Koenig, Walter D.; Knops, Johannes M. H. 2002. The behavioral ecology of masting in oaks. In: McShea, William J.; Healy, William M., eds. Oak forest ecosystems: Ecology and management for wildlife. Baltimore, MD: The Johns Hopkins University Press: 129-148. [43526]

148. Kraetsch, Ralph. 2002. Ten years of oak restoration in city of Walnut Creek Open Spaces. In: Standiford, Richard B.; McCreary, Douglas; Purcell, Kathryn L., technical coordinators. Proceedings of the 5th symposium on oak woodlands: oaks in California's changing landscape; 2001 October 22-25; San Diego, CA. Gen. Tech. Rep. PSW-GTR-184. Albany, CA: U.S. Department of

Agriculture, Forest Service, Pacific Southwest Research Station: 581-590. [42349]

149. LANDFIRE Rapid Assessment. 2005. Reference condition modeling manual (Version 2.1), [Online]. In: LANDFIRE. Cooperative Agreement 04-CA-11132543-189. Boulder, CO: The Nature Conservancy; U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior (Producers). 72 p. Available: http://www.landfire.gov/downloadfile.php?file=RA_Modeling_Manual_v2_1.pdf [2007, May 24]. [66741]

150. LANDFIRE Rapid Assessment. 2007. Rapid assessment reference condition models. In: LANDFIRE. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Lab; U.S. Geological Survey; The Nature Conservancy (Producers). Available: http://www.landfire.gov/models_EW.php [66533]

151. Lanner, Ronald M. 1996. Made for each other: a symbiosis of birds and pines. New York: Oxford University Press. 160 p. [29914]

152. Laudenslayer, William F., Jr.; Fargo, Roberta J. 1997. Small nocturnal mammals in oak woodlands: some considerations for assessing presence and abundance. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 373-380. [29030]

153. Lawrence, George E. 1966. Ecology of vertebrate animals in relation to chaparral fire in the Sierra Nevada foothills. Ecology. 47(2): 278-291. [147]

154. Leiberg, John B. 1902. Forest conditions in the northern Sierra Nevada, California. Document 216. Washington, DC: U.S. Department of the Interior, U.S. Geological Survey. 195 p. [37915]

155. Lewis, D. C.; Burgy, R. H. 1964. The relationship between oak tree roots and groundwater in fractured rock as determined by tritium tracing. Journal of Geophysical Research. 69(12): 2579-2587. [249]

156. Lewis, Henry T. 1973. Patterns of Indian burning in California: ecology and ethnohistory. Ballena Press Anthropological Papers No. 1. Ramona, CA: Ballena Press. 101 p. [28351]

157. Little, Elbert L., Jr. 1979. Checklist of United States trees (native and naturalized). Agric. Handb. 541. Washington, DC: U.S. Department of Agriculture, Forest Service. 375 p. [2952]

158. Longhurst, W. H.; Garton, E. O.; Heady, H. F.; Connolly, G. E. 1976. The California deer decline and possibilities for restoration. In: Yoakum, Jim, ed. Cal-Neva wildlife transactions 1976: Annual meeting for the western section of the Wildlife Society and the California-Nevada chapter ofthe American Fisheries Society; 1976 January 29-31; Fresno, CA. Bethesda, MD: The Wildlife Society; The American Fisheries Society: 74-103. [68843]

159. Longhurst, William M. 1956. Stump sprouting of oaks in response to seasonal cutting. Journal of Range Management. 9(4): 194-196. [68842]

160. Matsuda, Kozue; McBride, Joe R. 1987. Germination and shoot development of seven California oaks planted at different elevations. In: Plumb, Timothy R.; Pillsbury, Norman H., technical coordinators. Proceedings of the symposium on multiple-use management of California's hardwood resources; 1986 November 12-14; San Luis Obispo, CA. Gen. Tech. Rep. PSW-100. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 79-85. [5400]

161. Matsuda, Kozue; McBride, Joe R.; Kimura, Makoto. 1989. Seedling growth form of oaks. Annals of Botany. 64(4): 439-446. [13578]

162. Matzner, Steven Lee. 1999. Population and size class differences in water relations traits in Quercus douglasii (Hook. and Arn.) and Quercus wislizenii (A. DC.). Davis, CA: University of California. 73 p. Dissertation. [67430]

163. McBride, J. R.; Norberg, E.; Bertenshaw, J.; Kloss, S.; Mossadegh, A. 1997. Genetic variation in shoot growth, phenology, and mineral accumulation of northern and central Sierra Nevada foothill populations of blue oak. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 117-125. [29004]

164. McClaran, Mitchel P. 1987. Yearly variation of blue oak seedling emergence in northern California. In: Plumb, Timothy R.; Pilsbury, Norman H., technical coordinators. Proceedings of the symposium on multiple-use management of California's hardwood resources; 1986 November 12-14; San Luis Obispo, CA. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 76-78. [5531]

165. McClaran, Mitchel P.; Bartolome, James W. 1989. Fire-related recruitment in stagnant Quercus douglasii populations. Canadian Journal of Forest Research. 19: 580-585. [7416]

166. McClaran, Mitchel P.; Bartolome, James W. 1990. Comparison of actual and predicted blue oak age structures. Journal of Range Management. 43(1): 61-63. [10048]

167. McClaran, Mitchel Paul. 1986. Age structure of Quercus douglasii in relation to livestock grazing and fire. Berkeley, CA: University of California. 119 p. Dissertation. [67425]

14-1617 Public Comment
PC Rcvd 01-14-16

168. McCreary, Douglas D. 1990. Blue oaks withstand drought. California Agriculture. 44(2): 15-17. [12102]

169. McCreary, Douglas D. 1990. Native oaks--the next generation. Fremontia. 18(3): 44-47. [14261]

170. McCreary, Douglas D. 1991. Seasonal growth patterns of blue and valley oak seedlings established on Foothill Rangelands. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; 1990 October 31 - November 2; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: Pacific Southwest Research Station: 36-40. [18886]

171. McCreary, Douglas D.; Tecklin, Jerry. 1997. Effects of seedling protectors and weed control on blue oak growth and survival. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 243-250. [29017]

172. McCreary, Douglas D.; Tietje, William D.; Schmidt, Robert H.; Gross, Rob; Weitkamp, William H.; Willoughby, Bob L.; Bell, Fremont L. 1991. Stump sprouting of blue oaks in California. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; 1990 October 31 - November 2; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: Pacific Southwest Research Station: 64-69. [18891]

173. McDonald, Philip M. 1990. Quercus douglasii Hook & Arn. Blue oak. In: Burns, Russell M.; Honkala, Barbara H., tech. coords. Silvics of North America. Vol.2. Hardwoods. Agric. Handb. 654. Washington, DC: U.S. Department of Agriculture, Forest Service: 631-639. [68310]

174. McDougald, Neil K.; Frost, William E. 1997. Assessment of a prescribed burning project: 1987-1995. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 671-678. [29051]

175. McKibben, Laurence A.; Graves, Walter C. 1987. Managing blue oak for wildlife based on acorn production. In: Plumb, Timothy R.; Pillsbury, Norman H., technical coordinators. Proceedings of the symposium on multiple-use management of California's hardwood resources; 1986 November 12-14; San Luis Obispo, CA. Gen. Tech. Rep. PSW-100. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 227-229. [5377]

176. Mensing, Scott A. 1992. The impact of European settlement on blue oak (Quercus douglasii) regeneration and recruitment in the Tehachapi Mountains, California. Madrono. 39(1): 36-46. [17540]

177. Mensing, Scott Andrew. 1988. Blue oak (Quercus douglasii) regeneration in the Tehachapi Mountains, Kern County, California. Berkeley, CA: University of California. 71 p. Thesis. [67435]

178. Mensing, Scott. 1991. The effect of land use changes on blue oak regeneration and recruitment. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; 1990 October 31 - November 2; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 230-232. [19063]

179. Millikin, Catherine S.; Bledsoe, Caroline S.; Tecklin, Jerry. 1997. Woody root biomass of 40- to 90-year-old blue oaks (Quercus douglasii) in western Sierra Nevada foothills. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 83-89. [29000]

180. Mirov, N. T.; Kraebel, C. J. 1937. Collecting and propagating the seeds of California wild plants. Res. Note No. 18. Berkeley, CA: U.S. Department of Agriculture, Forest Service, California Forest and Range Experiment Station. 27 p. [9787]

181. Momen, B.; Menke, J. W.; Welker, J. M.; Rice, K. J.; Chapin, F. S., III. 1994. Blue-oak regeneration and seedling water relations in four sites within a California oak savanna. International Journal of Plant Sciences. 155(6): 744-749. [68625]

182. Momen, Bahram. 1988. Water relations and drought resistance mechanisms of Quercus douglasii (blue oak) and Q. wislizenii (interior live oak) seedlings. University of California, Davis. 68 p. Thesis. [67437]

183. Motz, Ronald W. 1997. Acorn collection, storage, sorting, and planting for the establishment of native oaks without supplemental irrigation. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 679-682. [29052]

184. Muick, Pamela C. 1991. Effects of shade on blue oak and coast live oak regeneration in California annual grasslands. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; 1990 October 31 - November 2; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 21-24. [17382]

185. Muick, Pamela C. 1997. Effects of shade and clipping on coast live and blue oak seedling mortality and growth in California annual grasslands. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 135-145. [29006]

186. Muick, Pamela C.; Bartolome, James W. 1987. Factors associated with oak regeneration in California. In: Plumb, Timothy R.; Pillsbury, Norman H., technical coordinators. Proceedings of the symposium on multiple-use management of California's hardwood resources; 1986 November 12-14; San Luis Obispo, CA. Gen. Tech. Rep. PSW-100. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 86-91. [5370]

187. Muick, Pamela Celeste. 1995. Effects of shade and simulated herbivory on seedling emergence, survival and growth of two California oaks: coast live oak (Quercus agrifolia Nee) and blue oak (Quercus douglasii Hook and Arn.). Berkeley, CA: University of California. 104 p. Dissertation. [67429]

188. Munz, Philip A.; Keck, David D. 1973. A California flora and supplement. Berkeley, CA: University of California Press. 1905 p. [6155]

189. Murphy, A. H.; Berry, L. J. 1973. Range pasture benefits. California Agriculture. January: 8-10. [19132]

190. Murphy, Alfred H.; Crampton, Beecher. 1964. Quality and yield of forage as affected by chemical removal of blue oak (Quercus douglasii). Journal of Range Management. 17: 142-144. [19902]

191. Neal, Donald L. 1980. Blue oak-digger pine. In: Eyre, F. H., ed. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters: 126-127. [50060]

192. Odion, Dennis C.; Bornstein, Carol J.; Carroll, Mary C. 1988. Revegetation in the Santa Barbara region: enduring dilemmas and potential solutions. In: Rieger, John P.; Williams, Bradford K., eds. Proceedings of the second native plant revegetation symposium; 1987 April 15-18; San Diego, CA. Madison, WI: University of Wisconsin Arboretum, Society of Ecological Restoration and Management: 76-91. [4099]

193. Olson, David F., Jr. 1974. Quercus L. oak. In: Schopmeyer, C. S., ed. Seeds of woody plants in the United States. Agric. Handb. 450. Washington, DC: U.S. Department of Agriculture, Forest Service: 692-703. [7737]

194. Oyler, Lynne Dee. 1987. Factors affecting establishment and survival of Quercus douglasii seedlings. San Luis Obispo, CA: California Polytechnic State University. 118 p. Thesis. [67434]

195. Parsons, David J.; Stohlgren, Thomas J. 1989. Effects of varying fire regimes on annual grasslands in the southern Sierra Nevada of California. Madrono. 36(3): 154-168. [9244]

196. Pavlik, Bruce M.; Muick, Pamela C.; Johnson, Sharon G.; Popper, Marjorie. 1991. Oaks of California. Los Olivos, CA: Cachuma Press, Inc. 184 p. [21059]

197. Paysen, Timothy E.; Derby, Jeanine A.; Black, Hugh, Jr.; Bleich, Vernon C.; Mincks, John W. 1980. A vegetation classification system applied to southern California. Gen. Tech. Rep. PSW-45. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 33 p. [1849]

198. Phillips, Ralph L.; McDougald, Neil K.; McCreary, Doug; Atwill, Edward R. 2007. Blue oak seedling age influences growth and mortality. California Agriculture. 61(1): 11-15. [67895]

199. Phillips, Ralph L.; McDougald, Neil K.; Standiford, Richard B.; McCreary, Douglas D.; Frost William E. 1997. Blue oak regeneration in southern Sierra Nevada foothills. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 177-181. [29010]

200. Plumb, Tim R. 1980. Response of oaks to fire. In: Plumb, Timothy R., technical coordinator. Proceedings of the symposium on the ecology, management, and utilization of California oaks; 1979 June 26-28; Claremont, CA. Gen. Tech. Rep. PSW-44. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 202-215. [7039]

201. Raabe, Robert D. 1980. Diseases of oaks in California. In: Plumb, Timothy R., tech. coord. Proceedings of the symposium on the ecology, management, and utilization of California oaks; 1979 June 26-28; Claremont, CA. Gen. Tech. Rep. PSW-44. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 195-201. [7038]

202. Ratliff, Raymond D.; Duncan, Don A.; Westfall, Stanley E. 1991. California oak-woodland overstory species affect herbage understory: management implications. Journal of Range Management. 44(4): 306-310. [16118]

203. Raunkiaer, C. 1934. The life forms of plants and statistical plant geography. Oxford: Clarendon Press. 632 p. [2843]

204. Reynolds, Richard Dwan. 1959. Effect of natural fires and aboriginal burning upon the forests of the central Sierra Nevada. Berkeley, CA: University of California. 268 p. Thesis. [37435]

205. Rice, K. J.; Gordon, D. R.; Hardison, J. L.; Welker, J. M. 1993. Phenotypic variation in seedlings of a "keystone" tree species (Quercus douglasii): the interactive effects of acorn source and competitive environment. Oecologia. 96(4): 537-547. [23627]

206. Rice, Kevin J.; Gordon, Doria R.; Hardison, Jeanine L.; Welker, Jeffrey M. 1991. Intraspecific phenotypic variation and ecological genetics of blue oak (Quercus douglasii Hook. & Arn.). In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; 1990 October 31 - November 2; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: Pacific Southwest Research Station: 59-63. [18890]

207. Rice, Kevin J.; Nagy, Eric S. 2000. Oak canopy effects on the distribution patterns of two annual grasses: the role of competition and soil nutrients. American Journal of Botany. 87(11): 1699-1706. [43756]

208. Rice, Kevin J.; Richards, James H.; Matzner, Steven L. 1997. Patterns and processes of adaptation in blue oak seedlings. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 109-115. [29003]

209. Riggs, Lawrence A.; Millar, Constance I.; Delany, Diane L. 1991. Genetic variation sampled in three California oaks. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; 1990 October 31 - November 2; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 233-234. [69071]

210. Rizzo, David M.; Garbelotto, Matteo; Davidson, Jennifer M.; Slaughter, Garey W.; Koike, Steven T. 2002. Phytophthora ramorum and sudden oak death in California: I. Host relationships. In: Standiford, Richard B.; McCreary, Douglas; Purcell, Kathryn L., tech. coords. Proceedings of the 5th symposium on oak woodlands: oaks in California's changing landscape; 2001 October 22-25; San Diego, CA. Gen. Tech. Rep. PSW-GTR-184. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 733-740. [42368]

211. Robbins, W. W. 1940. Alien plants growing without cultivation in California. Bulletin 637. Berkeley, CA: University of California, College of Agriculture, Agricultural Experiment Station. 128 p. [68834]

212. Sampson, Arthur W. 1944. Plant succession on burned chaparral lands in northern California. Bull. 65. Berkeley, CA: University of California, College of Agriculture, Agricultural Experiment Station. 144 p. [2050]

213. Sampson, Arthur W.; Jespersen, Beryl S. 1963. California range brushlands and browse plants. Berkeley, CA: University of California, Division of Agricultural Sciences, California Agricultural Experiment Station, Extension Service. 162 p. [3240]

214. Schwan, Joan; Fong, Herb; Hug, Hilary K. 1997. Wildfire and oak regeneration at the urban fringe. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 559-564. [29044]

215. Standiford, Richard B. 1997. Growth of blue oak on California's hardwood rangelands. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 169-176. [29009]

216. Standiford, Richard B.; Appleton, Donald L. 1993. Preliminary study on harsh site offers hope for blue oak regeneration. California Agriculture. 47(4): 17-20. [52012]

217. Standiford, Richard B.; Diamond, Nancy; Passof, Peter C.; LeBlanc, John. 1987. Value of oaks in rural subdivisions. In: Plumb, Timothy R.; Pillsbury, Norman H., technical coordinators. Proceedings of the symposium on multiple-use management of California's hardwood resources; 1986 November 12-14; San Luis Obispo, CA. Gen. Tech. Rep. PSW-100. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 156-160. [5371]

218. Standiford, Richard; McDougald, Neil; Frost, William; Phillips, Ralph. 1997. Factors influencing the probability of oak regeneration on southern Sierra Nevada woodlands in California. Madrono. 44(2): 170-183. [51873]

219. Standiford, Richard; McDougald, Neil; Phillips, Ralph; Nelson, Aaron. 1991. South Sierra oak regeneration weak in sapling stage. California Agriculture. 45(2): 12-14. [64660]

220. Steger, George N.; Eberlein, Gary E.; Munton, Thomas E.; Johnson, Kenneth D. 1997. Characteristics of California spotted owl nests in foothill riparian and oak woodlands of the southern Sierra Nevada, California. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 355-364. [29027]

221. Stephens, Scott L. 1997. Fire history of a mixed oak-pine forest in the foothills of the Sierra Nevada, El Dorado County, California. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 191-198. [29012]

222. Stewart, Glenn R.; Jennings, Mark R.; Goodman, Robert H., Jr. 2005. Sensitive species of snakes, frogs, and salamanders in southern California conifer forest areas: status and management. In: Kus, Barbara E.; Beyers, Jan L., tech. coords. Planning for biodiversity: Bringing research and management together: Proceedings of a symposium for the south coast ecoregion; 2000 February 29 - March 2; Pomona, CA. Gen. Tech. Rep. PSW-GTR-195. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 165-197. [64510]

223. Stickney, Peter F. 1989. Seral origin of species comprising secondary plant succession in Northern Rocky Mountain forests. FEIS workshop: Postfire regeneration. Unpublished draft on file at: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Fire Sciences Laboratory, Missoula, MT. 10 p. [20090]

224. Swiecki, Tedmund J.; Bernhardt, Elizabeth A.; Arnold, Richard A. 1991. Insect and disease impacts on blue oak acorns and seedlings. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; 1990 October 31 - November 2; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 149-155. [19056]

225. Swiecki, Tedmund J.; Bernhardt, Elizabeth A.; Arnold, Richard A. 1991. Monitoring insect and disease impacts on rangeland oaks in California. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; 1990 October 31 - November 2; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 208-213. [19061]

226. Swiecki, Tedmund J.; Bernhardt, Elizabeth A.; Drake, Christiana. 1997. Factors affecting blue oak sapling recruitment. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 157-167. [29008]

227. Swiecki, Tedmund J.; Bernhardt, Elizabeth A.; Drake, Christiana. 1997. Stand-level status of blue oak sapling recruitment and regeneration. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 147-156. [29007]

228. Swiecki, Tedmund J.; Bernhardt, Elizabeth. 2002. Effects of fire on naturally occurring blue oak (Quercus douglasii) saplings. In: Standiford, Richard B.; McCreary, Douglas; Purcell, Kathryn L., technical coordinators. Proceedings of the 5th symposium on oak woodlands: oaks in California's changing landscape; 2001 October 22-25; San Diego, CA. Gen. Tech. Rep. PSW-GTR-184. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 251-259. [42322]

229. Tecklin, Jerry; Connor, J. Michael; McCreary, Douglas D. 2002. Rehabilitation of an oak planting project on cleared rangeland using treeshelters and grazing: a ten-year saga. In: Standiford, Richard B.; McCreary, Douglas; Purcell, Kathryn L., technical coordinators. Proceedings of the 5th symposium on oak woodlands: oaks in California's changing landscape; 2001 October 22-25; San Diego, CA. Gen. Tech. Rep. PSW-GTR-184. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 839-843. [42383]

230. Thomson, Vivian E.; Mahall, Bruce E. 1983. Host specificity by a mistletoe, Phoradendron villosum (Nutt.) Nutt. subsp. villosum, on three oak species in California. Botanical Gazette. 144(1): 124-131. [40859]

231. Thorne, Robert F. 1976. The vascular plant communities of California. In: Latting, June, ed. Symposium proceedings: plant communities of southern California; 1974 May 4; Fullerton, CA. Special Publication No. 2. Berkeley, CA: California Native Plant Society: 1-31. [3289]

232. Tietje, William D.; Berlund, Tristan C.; Garcia, Sergio L.; Halpin, Christopher G.; Jensen, Wayne A. 1997. Contribution of downed woody material by blue, valley, and coast live oaks in central California. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 423-430. [29038]

233. Tietje, William D.; Bloom, Peter H.; Vreeland, Justin K. 1997. Characteristics of red-tailed hawk nest sites in oak woodlands of central California. In: Pillsbury, Norman H.; Verner, Jared; Tietje, William D., technical coordinators. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues; 1996 March 19-22; San Luis Obispo, CA. Gen. Tech. Rep. PSW-GTR-160. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 365-372. [29028]

234. Tietje, William D.; Foott, John H.; Labor, Elizabeth L. 1990. Grafting California native oaks. California Agriculture. 44(2): 30-31. [12105]

235. Tietje, William D.; Vreeland, Justin K.; Weitkamp, William H. 2001. Live oak saplings survive prescribed fire and sprout. California Agriculture. 55(2): 18-22. [40986]

236. Tietje, William D.; Waddell, Karen L.; Vreeland, Justin K.; Bolsinger, Charles L. 2002. Coarse woody debris in oak woodlands of California. Western Journal of Applied Forestry. 17(3): 139-146. [45209]

237. Timbrook, Jan. 1990. Ethnobotany of Chumash Indians, California, based on collections by John P. Harrington. Economic Botany. 44(2): 236-253. [13777]

238. Tschirley, F. H. 1956. Project 3: Undesirable woody plants. In: Western weed control conference: Research progress reports. Weed Abstracts. 6(11): 26-42. [47824]

239. Tucker, John M. 1980. Taxonomy of California oaks. In: Plumb, Timothy R., tech. coord. Proceedings of the symposium on the ecology, management and utilization of California oaks; 1979 June 26-28; Claremont, CA. Gen. Tech. Rep. PSW-44. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 19-29. [7011]

240. Tunison, John Timothy. 1973. A synecological study of the oak-dominated communities of Bennett Mountain, Sonoma County, California. Sonoma, CA: California State College. 143 p. Thesis. [53743]

241. Tyler, Claudia M.; Kuhn, Bill; Davis, Frank W. 2006. Demography and recruitment limitations of three oak species in California. The Quarterly Review of Biology. 81(2): 127-152. [67421]

242. U.S. Department of Agriculture, Natural Resources Conservation Service. 2008. PLANTS Database, [Online]. Available: http://plants.usda.gov/. [34262]

243. U.S. Department of Agriculture, U.S. Department of the Interior; Range Seeding Equipment Committee. 1959. Handbook: Chemical control of range weeds. Washington, DC: [Publisher unknown]. 93 p. [12129]

244. Vankat, John L.; Major, Jack. 1978. Vegetation changes in Sequoia National Park, California. Journal of Biogeography. 5: 377-402. [17353]

245. Verner, Jared; Boss, Allan S., tech. coords. 1980. California wildlife and their habitats: western Sierra Nevada. Gen. Tech. Rep. PSW-37. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 439 p. [10237]

246. Vogl, Richard J. 1977. Fire frequency and site degradation. In: Mooney, Harold A.; Conrad, C. Eugene, technical coordinators. Proceedings of the symposium on the environmental consequences of fire and fuel management in Mediterranean ecosystems; 1977 August 1-5; Palo Alto, CA. Gen. Tech. Rep. WO-3. Washington, DC: U.S. Department of Agriculture, Forest Service: 193-201. [4843]

247. Vreeland, Justin K.; Tietje, William D. 2002. Numerical response of small vertebrates to prescribed fire in a California oak woodland. In: Standiford, Richard B.; McCreary, Douglas; Purcell, Kathryn L., technical coordinators. Proceedings of the 5th symposium on oak woodlands: oaks in California's changing landscape; 2001 October 22-25; San Diego, CA. Gen. Tech. Rep. PSW-GTR-184. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 269-279. [42325]

248. Vreeland, Justin K.; Tietje, William D. 2002. Numerical response of small vertebrates to prescribed fire in California oak woodlands. In: Ford, W. Mark; Russell, Kevin R.; Moorman, Christopher E., eds. The role of fire in nongame wildlife management and community restoration: traditional uses and new directions: Proceedings of a special workshop; 2000 December 15; Nashville, TN. Gen. Tech. Rep. NE-288. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northeastern Research Station: 100-110. [41566]

249. Walters, M. Alice; Teskey, Robert O.; Hinckley, Thomas M. 1980. Impact of water level changes on woody riparian and wetland communities. Volume 7: Mediterranean Region; Western Arid and Semi-Arid Region. Biological Services Program: FWS/OBS-78/93. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service. 84 p. [52899]

250. Warner, Richard E. 1984. Structural, floristic, and condition inventory of Central Valley riparian systems. In: Warner, Richard E.; Hendrix, Kathleen M., eds. California riparian systems: Ecology, conservation, and productive management: Proceedings of a conference; 1981 September 17-19; Davis, CA. Berkeley, CA: University of California Press: 356-374. [5840]

251. Weaver, John E.; Clements, Frederic E. 1938. Plant ecology. New York: McGraw Hill. 601 p. [68845]

252. White, Keith L. 1966. Old-field succession on Hastings Reservation, California. Ecology. 47(5): 865-868. [18873]

253. White, Keith L. 1966. Structure and composition of foothill woodland in central coastal California. Ecology. 47(2): 229-237. [17347]

254. Williams, Brian D. C. 2002. Purple martins in oak woodlands. In: Standiford, Richard B.; McCreary, Douglas; Purcell, Kathryn L., technical coordinators. Proceedings of the 5th symposium on oak woodlands: oaks in California's changing landscape; 2001 October 22-25; San Diego, CA. Gen. Tech. Rep. PSW-GTR-184. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 323-334. [42329]

255. Williams, Kimberlyn; Westrick, Lawrence J.; Williams, B. J. 2006. Effects of blackberry (Rubus discolor) invasion on oak population dynamics in a California savanna. Forest Ecology and Management. 228(1-3): 187-196. [62624]

256. Wills, Robin. 2006. Central Valley bioregion. In: Sugihara, Neil G.; van Wagtendonk, Jan W.; Shaffer, Kevin E.; Fites-Kaufman, Joann; Thode, Andrea E., eds. Fire in California's ecosystems. Berkeley, CA: University of California Press: 295-320. [65547]

257. Wilson, Randolph A.; Manley, Patricia; Noon, Barry R. 1991. Covariance patterns among birds and vegetation in a California oak woodland. In: Standiford, Richard B., technical coordinator. Proceedings of the symposium on oak woodlands and hardwood rangeland management; 1990 October 31 - November 2; Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 126-135. [18899]

AttACHMENT 4 of 4

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

14-1617 Public Comment
PC Rcvd 01-14-16

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

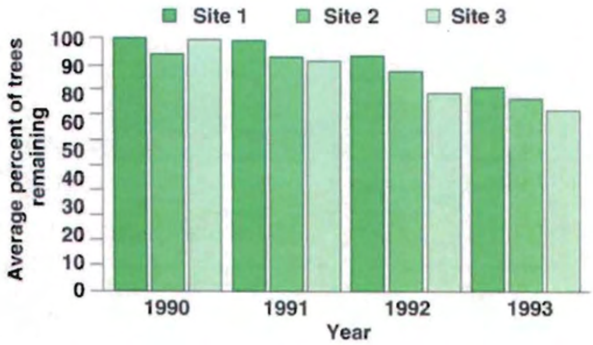


Fig. 1. Average percent of survival at three sites, 1990–1993.

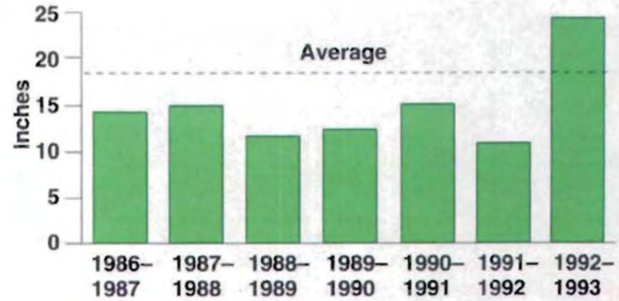


Fig. 2. Total annual rainfall recorded at a weather station in Glennville, 1986–1993. Average annual rainfall indicated by dotted line.

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.

R.L. Phillips is Range/Natural Resources and Livestock Advisor, UCCE Kern and Tulare Counties; N.K. McDougald is Natural Resources Specialist, UCCE Madera County; R.B. Standiford is IHRMP Program Manager, UC Berkeley; and W.E. Frost is Area Natural Resources Advisor, UCCE El Dorado County.

PC 1/14/16
#5
2 pages

(Delivered during hearing by Doug Wiele)

FOOTHILL PARTNERS
REAL ESTATE AND URBAN ECONOMICS

1121 WHITE ROCK ROAD, SUITE 205 ▲ EL DORADO HILLS, CALIFORNIA 95762
WWW.FOOTHILLPARTNERS.COM

January 14, 2016

Chair Rich Stewart and Members of The Planning Commission
The County of El Dorado
Community Development Agency/Development Services Division
2850 Fairlane Court
Placerville, California 95667

Via Hand Delivery

Re: **Planning Commission Agenda of January 14, 2016**
Item 5. 14-1617. Dixon Ranch

Dear Chair Stewart and Members of the Planning Commission:

I write in general support of the proposed Dixon Ranch project before you in today's hearing.

By way of introduction I've been a resident of Latrobe and a business owner in El Dorado Hills since 1997. My business is the business of economic development – we develop retail properties for select merchants around Northern California, and provide development consulting services to third-party clients. Notable Foothill Partners projects include The Gilman District, Berkeley (Whole Foods anchored); Uptown Monterey, Monterey (Trader Joe's anchored); Bridgeside Center, Alameda (Nob Hill Markets anchored) – and locally, the El Dorado Hills Town Center. From 1997 (when the property was largely a horse pasture) through 2012 (when the property reached the point you see it now) we consulted on the development and leasing of Town Center for The Mansour Company. I wrote and helped implement the project business plan, and was directly responsible for virtually all of the leasing and land sale deals which made the project what it has become; I was for many years a member of the Town Center East Owners Association Board of Directors, and I remain a member of the Town Center Design Review Committee. I'm here speaking only for myself, of course.

When ten years ago we announced that Target was coming to El Dorado Hills Town Center, there were many who were tired of driving to Folsom and delighted by the news – and others who sniffed and lamented that we were settling for Target when we should have been bringing Nordstrom, or Neiman Marcus (seriously!), or Macy's to Town Center. In fact, the western slope is populated with a high percentage of consumers who patronize those types of stores – but not nearly enough of them to attract those merchants here. And this is at the core of the dilemma of sales tax leakage in our County – the merchants at which many of us like to shop (Costco, Trader Joe's, Nordstrom, The Rack, etc.) are not located in our County, there aren't enough shoppers in the County to attract those merchants here, and so we clog up Highway 50 headed down the hill to shop elsewhere.

This is not to argue that the western slope of El Dorado County needs to get to a population of 300,000 so that we can have our very own (fill in the blank) department stores. But it is to say that for properties like Dixon Ranch – with access to utilities and road infrastructure and schools, with proximity to shopping and employment centers and hospitals and colleges and recreation – the urge to say "not in my back yard" needs to be vigorously resisted. If nothing else, the greenhouse gas consequences of having to leave the our County for most shopping needs argues vigorously in favor of infill development on properties such as Dixon Ranch.

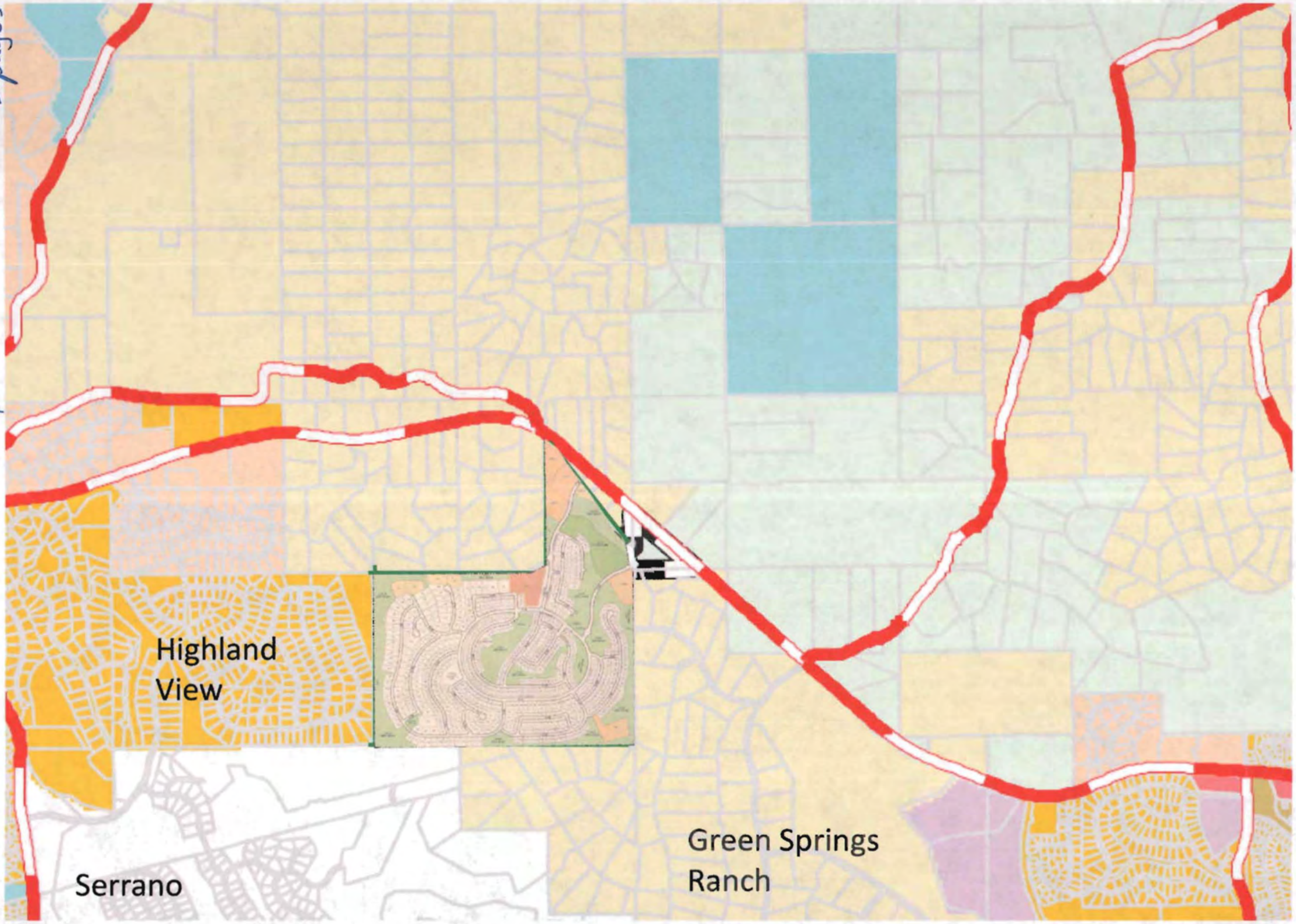
Beyond that, of course, the State of California continues to grow, now at a rate of about 300,000 people year. That population growth translates to demand for about 120,000 houses per year, somewhere in the State, and our County can accommodate a share of that growth. Better to do so on properties such as Dixon Ranch than to be plowing under farmlands in the San Joaquin or Sacramento Valleys.

Thank you for your consideration today. It is not my intent to advocate for any of the design particulars of the project plan before you. But it is my intent to argue for seeing the Dixon Ranch property developed with housing, and the sooner the better.

Respectfully,

Douglas Wiele
dwiele@foothillpartners.com

PC 1/14/16
#5
3 pages
(Distributed at hearing by Don Van Dyke)



14-1617 Public Comment
PC Rcvd 01-14-16

Planning Commission Meeting 1/14/16: Dixon Ranch

Don Van Dyke for Rural Communities United (RCU)

Measure E is a good indicator of what the voters think about more high-density housing. In the November 2014 vote, 91% of voters were against the rezone of the golf course for more high-density housing.

In 1998 and 2008, voters overwhelmingly approved Measure Y by about 70% to 30%. It's clear that voters in our county don't want more traffic.

This is a General Plan amendment project: it's ***entirely optional***. It must be held to very high standards. The burden of proof is on the developer to show how this project is a benefit to the community.

Map

- The light green area (and North) is all Low Density Residential. In the center dark green is the proposed project. Note that the proposed density is so high, it's difficult to make out the individual lots. The density of this project is far greater than anything in the area. Imagine the roar of 600 leaf blowers every Friday morning on the adjacent rural parcels. This might be a good project for the middle of San Jose or Sacramento, but not here.
- The project will dump 42% more traffic on this section of Green Valley Road, yet it does nothing to correct the deficiencies on the roadway. Imagine kids riding their bikes to school down Green Valley Road with traffic whizzing by at 60 Mph a couple of feet away. Most of the intersections on Green Valley Road in El Dorado Hills don't even have paved pedestrian access. Dozens of private driveways dump directly onto this section of roadway.
- General Plan policy 2.1.1.2 requires transitions of density at the community region boundaries. If anything, the density at the project should be ***lower*** than that of Highland View and Serrano, but it is much ***higher***. This is not transitional.

General Plan Requirements

- The Project doesn't meet the objectives of the GP: Jobs:housing (project makes this worse), sales tax leakage (worse), keep us rural (worse)

14-1617 Public Comment
PC Rcvd 01-14-16

- The Project triggers measure Y. Caltrans is very clear: Highway 50 is at LOS F at the County line during the AM commute. Approval of this project will be in violation of Measure Y and General Plan policy TC-Xe.
- Our approved Housing Element document says we don't need more housing. We have an excess of housing in every income category, and a particularly large excess in the "above moderate" income category.

Age Restricted Housing

- We have plenty of age restricted housing; Four seasons (460 homes), Carson Creek (800 homes), Versante (100 homes). Heritage just getting underway 1000 homes.
- Age restricted makes no sense in the middle of Green Valley Road Corridor: No transit available (anywhere in El Dorado Hills), no services nearby, windy road with lots of traffic.

Water

- The FEIR states there is not enough water available through EID to serve the buildout of the general plan plus the new GP amendment projects. Then it says that water meters are on a first-come first-serve basis. This would leave already approved projects high and dry until water infrastructure is again expanded. Who will foot the bill for this expansion?
- Given our current drought situation, why isn't the project required to hook up to recycled water?

Request

Please deny the project as it is currently defined. Send the applicant back to work with the public this time to come up with a project that is beneficial to the community. Greatly reduced number of homes, class I bike lanes to schools and shopping, intersection improvements, larger setbacks to adjacent properties, fewer oak trees removed, and a real plan for traffic and water.

Residents don't need or want this *optional* project