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## BLUE OAK WOODLAND FACT SHEETS

### Blue Oaks; *Quercus douglasii*<sup>1</sup>

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#### WOOD PRODUCTS VALUE:

- Blue oak wood is not used in manufacturing because of the tree's frequently short stature and poor form.
- Products are limited to fenceposts and fuelwood [16].
- Historically, the wood was used for shaft supports in gold and silver mines [33].

#### IMPORTANCE TO LIVESTOCK AND WILDLIFE:

Blue oak is an important species for livestock and wildlife. Sixty-five percent of California livestock forage is provided within blue oak-gray pine woodland [14]. A 3-year study in the central Sierra Nevada foothills showed that blue oak woodland is utilized by 92 species of birds, 60 of which nest there [12]. Bird species of federal protected status inhabiting the woodland are the bald and golden eagles. It is also inhabited by seven species of rodents, three species of lizards, four species of snakes, and the state-endangered foothill yellow-legged frog.

Blue oak is browsed by livestock, black-tailed deer, lagomorphs, and rodents. The acorns are eaten by at least a dozen species of songbirds, several upland game birds, rodents, black-tailed deer, feral and domestic pig, and all other classes of livestock [2,20,60]. The acorns are a critical food source for black-tailed deer, who migrate from high-elevation dry summer ranges to blue oak woodland for fall and winter forage [16]. On the Tehema County winter range, blue oak acorns account for about 15 percent of the total volume of food consumed by black-tailed deer [60].

#### PALATABILITY:

Blue oak acorns are highly palatable to livestock, black-tailed deer, and other wildlife. The sprouts are palatable to all classes of browsing wildlife and livestock. Sampson and Jespersen [60] gave mature blue oak foliage the following browse rating:

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

#### NUTRITIONAL VALUE:

The crude protein content of young, partially expanded leaves of blue oak on the San Joaquin Experimental Range averages 30 percent, while that of fully developed leaves averages 11 percent. The ratio of calcium to phosphorus is nutritionally satisfactory in young leaves (2.2:1.0), but disproportionate in mature leaves (15:1). Acorns are low in crude protein (4%) but high in crude fiber, fat, and oils [60].

<sup>1</sup> FEIS provides up-to-date information about fire effects on plants and animals. It was developed at the United States Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory in Missoula, Montana.

#### COVER VALUE:



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Blue oak is the preferred nesting, foraging, and escape cover of the Nuttall's woodpecker, plain titmouse, and white-breasted nuthatch [11].

### VALUE FOR REHABILITATION OF DISTURBED SITES:

Blue oak is planted for wildlife and riparian habitat and watershed restoration. Trees are established from acorn plantings or from transplanting nursery stock. Top-quality acorns are obtained by harvested directly from branches in early to mid-fall. They require refrigeration at just above freezing for a few weeks to prevent premature germination. Acorns are planted in late fall or early winter after soil is saturated from the first rains [48]. Dusting acorns with captan fungicide prior to planting may improve emergence [2]. When transplanting, 2-month-old nursery stock is recommended because it shows better establishment and is cheaper to grow, transport, and plant than older stock [1]. Protection against herbivory greatly enhances seedling survival, and may include fencing or wire cages extending 36 inches (92 cm) aboveground and 18 inches (46 cm) belowground [56]. Fertilizer has a negative effect on survival because it enhances growth of annual grasses over that of blue oak; weed control improves blue oak seedling survival. Netting may be necessary at some sites to reduce losses from grasshopper herbivory [1]. Auguring holes where seedlings or acorns are to be planted will increase survival and growth rates. Roots of individuals planted in 3-foot-deep (0.9 m) auger holes are able to more quickly access the deeper soil horizons where more moisture is available [48].

Blue oak roots bind soil of steep watersheds, reducing the incidence of mass soil movement down slope into permanent and ephemeral streams [16]. Blue oak was successfully used to revegetate upper stream banks in Almaden Valley [25].

Blue oak scions can be grafted onto blue oak stumps following fuel wood harvesting. Grafting genetically superior scions onto rootstock allows for more rapid reestablishment of depleted blue oak woodland [63].

### OTHER USES AND VALUES:

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 [61]. It showed that the aesthetic and amenity values of trees at a density of 40 stems per acre (16 stems/ha) resulted in a 21 to 27 percent increase in land value when compared to acreage with no trees present.

California Indians made meal from blue oak acorns. They used the acorn leachate for dyeing baskets. The wood was fashioned into bowls [64].

### OTHER MANAGEMENT CONSIDERATIONS:

Blue oak woodland covers 8 percent of California's total land area [2,5]. Seventy-five percent of this resource is in private ownership, 14 percent is in the National Forest System, and 11 percent is in various other public ownerships [13]. Management of this species is controversial. From the late 1950's through the early 1970's, several studies showed that palatability and production of graze in the understory of blue oak was low when compared to graze in open grassland areas [8,34,36,37,54,55]. As a result of these studies, statewide "rangeland improvement" was recommended, involving removal of blue oak from grazing areas [8,67]. This recommendation resulted in the loss of 1 million acres (0.4 million ha) of blue oak woodland to cutting, prescribed burning, and aerosol spraying [13,67]. In contrast, more recent studies [20,31,32] found forage production to be from 15 to over 100 percent higher under blue oaks than in open grassland, and that herbaceous plants beneath blue oak were nutritionally superior to plants growing in open grassland. Forage under blue oak started growing



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earlier and remained green after surrounding graze had dried. Additionally, Duncan and Clawson [20] reported that cattle prefer forage beneath blue oak to that of open grassland, even in summer after graze in both areas has dried. Holland [31] found that death or removal of blue oak resulted in a gradual decline in forage production. Supporting this, a separate study [37] showed an increase in tarweed (*Madia gracilis*) following blue oak removal. The discrepancy between early and later studies on the effects of blue oak on forage production remains unresolved. One study [7] suggests that understory production increases on dry sites but is lowered on wetter ones. Another recent study [71] indicates that blue oak with shallow, fine roots inhibits understory production. This may be partially attributable to allelopathic blue oak root exudates as well as competition for water and nutrients. Variations in root morphology may therefore explain differences in understory production of blue oak.

Most current public rangeland managers regard blue oak as a desirable species. Continued clearing of blue oak for rangeland improvement projects and poor natural regeneration were two major management concerns identified by the Hardwood Task Force of the California Board of Forestry [2]. Other factors contributing to species decline are road construction, residential, and commercial development. Limited data suggests that development accounted for 46 percent of blue oak loss between 1973 and 1985, surpassing the loss from rangeland clearing that dominated before that time. Water tables that have lowered from historic levels may also be contributing to the decline of this species [69]. In addition, use of blue oak for fuelwood has greatly increased in recent years [16].

**Damaging agents:** Blue oak is vulnerable to several species of fungi. The most serious of these are *Inonotus dryophilus*, *Laetiporus sulphureus*, and *Armillaria mellea*, which cause heart rot [16].

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 various species of cynipid wasps, the filbert weevil (*Curculio uniformis*), and the filbert worm (*Melissopus latiferreanus*). These insects can destroy large portions of a year's mast [16].



## **DISTRIBUTION AND OCCURRENCE**

### **Quercus douglasii**

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#### **GENERAL DISTRIBUTION:**

Blue oak is endemic to California. It occurs in valleys and lower slopes of the Coast Ranges and in lower foothills of the Sierra Nevada. Its distribution almost completely encircles the Central Valley [30,53].

#### **ECOSYSTEMS:**

- Ponderosa pine
- Western hardwoods
- Chaparral - mountain shrub
- Pinyon - juniper
- Annual grasslands

#### **BLM PHYSIOGRAPHIC REGIONS :**

- 3 Southern Pacific Border
- 4 Sierra Mountains

#### **KUCHLER PLANT ASSOCIATIONS (inherent vegetation communities):**

- K010 Ponderosa shrub forest
- K011 Western ponderosa forest
- K023 Juniper - pinyon woodland
- K030 California oakwoods
- K033 Chaparral
- K035 Coastal sagebrush
- K038 Great Basin sagebrush
- K048 California steppe

#### **Society of American Forester (SAF) COVER TYPES:**

- 239 Pinyon - juniper
- 245 Pacific ponderosa pine
- 246 California black oak
- 248 Knobcone pine
- 249 Canyon live oak
- 250 Blue oak - gray pine
- 255 California coast live oak

#### **SRM (Society of Rangeland Management) COVER TYPES:**

- 201 Blue oak woodland
- 202 Coast live oak woodland
- 203 Riparian woodland
- 204 North coastal shrub



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- 205 Coastal sage shrub
- 206 Chamise chaparral
- 207 Scrub oak mixed chaparral
- 208 Ceanothus mixed chaparral
- 422 Riparian

### HABITAT TYPES AND PLANT COMMUNITIES:

Blue oak-dominated communities are highly variable in composition. Blue oak frequently associates with gray pine (*Pinus sabiniana*). It also occurs in mono-specific stands or co-dominates with several other oak species. Oak co-dominants not listed in previous frames include interior live (*Q. wislizenii*) and valley (*Q. lobata*) oaks. The blue oak community ranges in physiognomy from open savanna to fairly dense woodland with a shrubby understory. It merges or forms a mosaic with annual grassland at low elevation and with chaparral, other oak woodland phases, or singleleaf pinyon-California juniper (*Pinus monophylla*-*Juniperus californica*) woodland at higher elevation [26].

The following publications name blue oak as a dominant species:

1. Allen-Diaz, Barbara H.; Holzman, Barbara A. 1991. Blue Oak Communities in California. *Madrono*. 38(2): 80-95. [15424]
2. 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]
3. Holland, Natural communities of California. Sacramento, CA: California Department of Fish and Game. 156 p.
4. 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]

**Plant associations:** Overstory associates not previously listed include Coulter pine (*Pinus coulteri*) and California buckeye (*Aesculus californica*). Shrub associates include leather oak (*Q. durata*), California scrub oak (*Q. dumosa*), buckbrush (*Ceanothus cuneatus*), California coffeeberry (*Rhamnus californica*), chamise (*Adenostoma fasciculatum*), manzanita (*Arctostaphylos* spp.), poison-oak (*Toxicodendron diversilobum*), and toyon (*Heteromeles arbutifolia*). Some common ground cover associates are annual bluegrass (*Poa annua*), annual fescues (*Vulpia* spp.), annual ryegrass (*Lolium multiflorum*), medusahead (*Taeniatherum caput-medusae*), ripgut brome (*Bromus rubens*), wild oat (*Avena fatua*), bur clover (*Medicago polymorpha*), filaree (*Erodium* spp.), star thistle (*Centaurea* spp.), and tarweed (*Hemizonia*, *Holocarpha*, and *Madia* spp.) [5,6,16].



## **BOTANICAL AND ECOLOGICAL CHARACTERISTICS**

### **Quercus douglasii**

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#### **GENERAL BOTANICAL CHARACTERISTICS:**

Blue oak is a native, deciduous, flood-tolerant, drought-resistant tree [28,53]. It is generally short and straight, from 20 to 66 feet (6-20 m) in height and from 14 to 24 inches (36-60 cm) in d.b.h. [16]. The acorns are from 0.8 to 1.2 inches (2-3 cm) long [53]. The bark is thin and flaky [19]. Roots are extensive, and may grow through fractured and jointed rock to a depth of 80 feet (24 m) or more to tap groundwater reserves [39]. Stands are typically from 90 to 100 years old [19]. The oldest known blue oak is in Sequoia National Park and is about 400 years old [16].

#### **RAUNKIAER LIFE FORM:**

Phanerophyte

#### **REGENERATION PROCESSES:**

Sexual: The age of sexual maturity is unreported for this species. Catkins develop from flora primordia formed during the previous growing season. During drought, these flower buds may not develop [4]. Acorns mature in 1 year [17]. Abundant crops are produced every 2 to 3 years, with bumper crops every 5 to 8 years [57]. One 38-foot (11.6 m) blue oak in Shasta County produced 3,750 acorns during a favorable season [16]. Fresh acorns collected by Mirov and Kraebel [51] from various locations around the state were 72 percent viable. Acorns are disseminated by various animals. Magpies, scrub jays, and various rodents bury them in caches, resulting in high rates of emergence [27]. The acorns are capable of immediate germination. Germination may be epigeal or hypogeal, with buried acorns showing greater recruitment [14]. At plots in various Sierra Nevada locations, germination was initiated at the first rainfall and slowly continued through winter [42]. Germinants are susceptible to fungal infection during this time, and many acorns in the various plots rotted over winter. A study conducted in Berkeley and Mendocino Counties found that emergence was greatest at 75 percent of normal rainfall [45]. Greater than normal rainfall results in high rates of germinant death due to damping-off fungi.

Blue oaks show rapid, early root elongation prior to shoot development [43]. Seedlings growing on the canopy edge or in open positions establish more frequently than those beneath the parent tree. Seedlings do not compete well with annual grasses. Radicles of unburied acorns often fail to reach the soil surface before desiccation when growing through the thatch of these grasses. Additionally, annual grasses often out compete blue oak seedlings for water and light [15]. Nonnative annuals now represent 50 to 90 percent of ground cover in blue oak woodlands, and may have irreversibly altered the seasonal availability of soil moisture to blue oak seedlings [10].

Because of a flush of blue oak establishment that occurred statewide from 1850 to 1900, it has been suggested in the literature that recruitment of this species occurs in episodic bursts [4,68,70]. Tree-ring age analysis of trees in Kern County, however, showed blue oak recruitment to be fairly continuous from 1570 to 1850, when the seedling flush occurred [50]. Successful establishment of this species depends upon a favorable combination of many factors. Major factors include abundant acorn production, escape from acorn predation, sufficient rainfall, protection from desiccation during germination, limited competition for light and water, and escape from browsers and burrowing gophers [44]. Seedling recruitment is successful in some areas, but few blue oak survive to the sapling stage. Lack of sapling recruitment was once attributed mainly to livestock herbivory. At the San Joaquin Experimental Range, however, few blue oak have reached sapling size despite lack of livestock grazing



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since 1934; lack of sapling recruitment there is attributed to wildlife herbivory [21]. McClaran and Bartolome [47] suggest that seedlings must grow quickly enough to surpass the browse line in 10 to 13 years for new stand establishment, and that this may not be possible during periods of prolonged drought.

In a statewide study, sapling stand establishment varied according to geographical location [52]. In the northern Sierra Nevada, the steeper slopes supported the greatest number of saplings. Along the Delta 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.

**Vegetative:** Blue oak produces root crown and coppice sprouts after cutting or burning but is generally regarded as a weak sprouter [16]. Sprouting ability varies with geographic location and may be poor or in some areas nonexistent [19,72]. Frequent resprouting may result in bushlike or stunted trees [19]. Sprouting is vigorous in some locations, however. At the University of California's Sierra Foothill Range Field Station on the east side of the Sacramento Valley, coppice and root crown sprouts grew rapidly from experimentally-cut trees measuring 4 to 36 inches (10-91 cm) in diameter [36]. Sprouting ability declines with age. Mature trees produce a greater number of coppice sprouts, which are less vigorous and show higher mortality rates than do root crown sprouts [27]. Very old trees either do not sprout or produce only coppice sprouts [16]. Winter cutting or burning results in more vigorous sprouting than tree removal in other seasons [49].

### **SITE CHARACTERISTICS:**

**Soil:** 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 gravelly clay-loam [16].

**Climate:** Blue oak occurs in a Mediterranean climate, with hot, dry summers and cool, wet winters. The mean maximum July temperature is 90 degrees Fahrenheit (32 deg C); the mean minimum January temperature is 30 degrees Fahrenheit (-1 deg 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 [16].

**Elevation:** Blue oak ranges in elevation from 165 feet (50 m) at the Central Valley floor to 5,900 feet (1,800 m) in its southernmost distributional limits [16].

### **SUCCESSIONAL STATUS:**

Blue oak is shade intolerant [22,30,52].

### **SEASONAL DEVELOPMENT:**

Acorns planted at the Hastings Reservation in Carmel Valley emerged from late February to late March [26]. The following seasonal development was reported for blue oak in Sequoia National Park [4]:

- 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



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