Fire Effects Information System (FEIS)

FEIS Home Page

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SPECIES: Frangula californica

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California buckthorn. Image ©2012 Jean Pawek, used with permission.

Introductory

AUTHORSHIP AND CITATION:
McMurray, Nancy E. 1990. Frangula californica. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: https://www.fs.fed.us/database/feis/plants/shrub/fracal [2021, August 31].

Updates: On 10 July 2018, the common name of this species was changed
from: California coffeeberry
to: California buckthorn.
Images were also added.

ABBREVIATION:
FRACAL

NRCS PLANT CODE [79]:
FRCA12

COMMON NAMES:
California buckthorn
California coffeeberry
California false buckthorn
hoary coffeeberry

TAXONOMY:
The scientific name of California buckthorn is Frangula californica (Eschsch.) Gray (Rhamnaceae). There are 6 subspecies [37,79,81]:

Frangula californica subsp. californica
Frangula californica subsp. crassifolia (Jep.) Kartesz & Gandhi
Frangula californica subsp. cuspidata (Greene) Kartesz & Gandhi
Frangula californica subsp. occidentalis (J. Howell) Kartesz & Gandhi
Frangula californica subsp. tomentella (Benth.) Kartesz & Gandhi, hoary coffeeberry
Frangula californica subsp. ursina (Greene) Kartesz & Gandhi

SYNONYMS:
Rhamnus californica Esch.
Rhamnus californica subsp. californica
Rhamnus californica subsp. occidentalis (J. Howell) C. Wolf
Rhamnus tomentella Benth.
Rhamnus tomentella Benth. subsp. crassifolia (Jeps.) J.S. Sawyer
Rhamnus tomentella Benth. subsp. cuspidata (Greene) J.S. Sawyer
Rhamnus tomentella Benth. subsp. ursina (Greene) J.S. Sawyer [76]

LIFE FORM:
Shrub

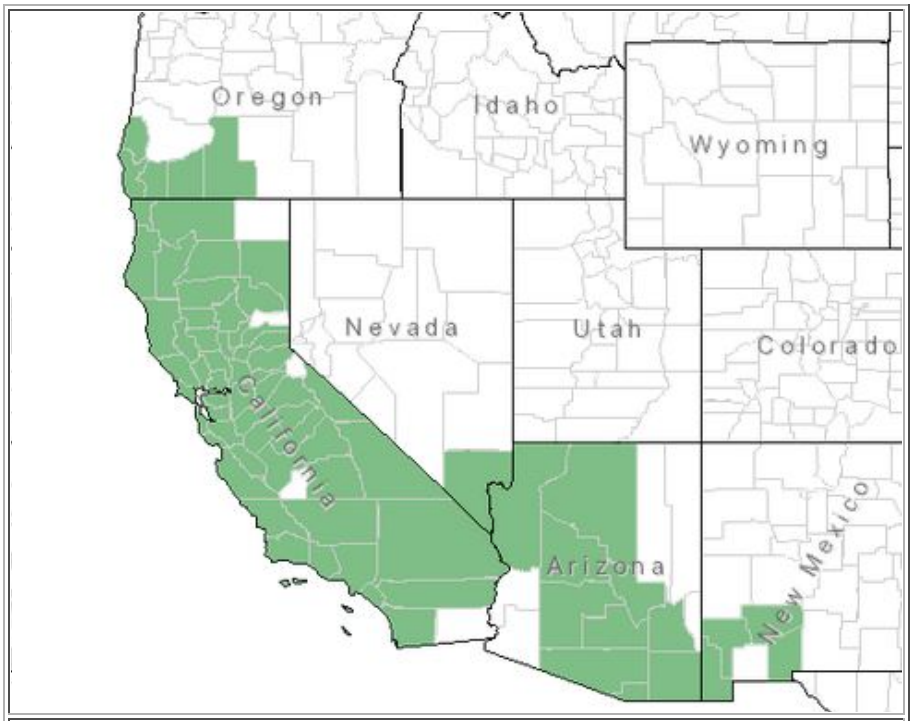
FEDERAL LEGAL STATUS:
No special status

OTHER STATUS:
NO-ENTRY

DISTRIBUTION AND OCCURRENCE

SPECIES: Frangula californica

GENERAL DISTRIBUTION:
California buckthorn ranges from extreme southwestern Oregon southward along the coast and Coast Ranges to southwestern California 976]. It is cultivated in Hawaii [80].



Distribution of California buckthorn. Map courtesy of USDA, NRCS. 2018. The PLANTS Database. National Plant Data Team, Greensboro, NC [2018, July 10] [79].

ECOSYSTEMS:

FRES20 Douglas-fir
FRES21 Ponderosa pine
FRES23 Fir-spruce
FRES27 Redwood
FRES28 Western hardwoods
FRES34 Chaparral - mountain shrub

STATES:

CA HI OR

BLM PHYSIOGRAPHIC REGIONS:

1 Northern Pacific Border
3 Southern Pacific Border

KUCHLER PLANT ASSOCIATIONS:

K005 Mixed conifer forest
K006 Redwood forest
K007 Red fir forest
K009 Pine - cypress forest
K012 Douglas-fir forest
K029 California mixed evergreen forest
K030 California oakwoods
K033 Chaparral
K035 Coastal sagebrush
K036 Mosaic of K030 and K035

SAF COVER TYPES:

207 Red fir
229 Pacific Douglas-fir
231 Port-Orford-cedar
232 Redwood

234 Douglas-fir - tanoak - Pacific madrone
248 Knobcone pine
249 Canyon live oak
250 Blue oak - gray pine
255 California coast live oak

SRM (RANGELAND) COVER TYPES:
201 Blue oak woodland
202 Coast live oak woodland
203 Riparian woodland
204 North coastal shrub
205 Coastal sage shrub
207 Scrub oak mixed chaparral

HABITAT TYPES AND PLANT COMMUNITIES:
California buckthorn is a shrub component of chaparral, woodland, and forest communities throughout its distribution [4,8,52,55,56]. It has not been used as an indicator species in published classification schemes for California. In the Siskiyou Mountains of southwestern Oregon and extreme northern California, Atzet and Wheeler [1] describe a tanoak/California buckthorn (Lithocarpus densiflorus/Rhamnus californica) plant association on ultrabasic parent materials. Although the tanoak series typically occurs on deep, fertile soils in the Siskiyou Mountain province, this association is the ultrabasic version of a tanoak climax. Dominance of coffeeberry apparently indicates a soil imbalance [1].

In southern and central California, California buckthorn is a frequent member of coastal chaparral and sage scrub [13,18] and is most commonly associated with relatively mesic scrub oak (Quercus spp.) chaparral [30]. It also becomes locally abundant on cool, fog-dominated sites along the central Coast Range where it occurs beneath mixed-hardwood forests dominated by coast live oak (Quercus agrifolia) [15,54,65,70]. Although never very abundant, California buckthorn is often associated with woodland and forest mosaics throughout southern and central California. Within oak woodlands, knobcone pine (Pinus attenuata), and coastal forests, it occurs both as a scattered understory shrub and as a component of intermixed stands of "woodland chaparral" [35,30,67,68]. Some common associates are chaparral whitethorn (Ceanothus leucodermis), toyon (Heteromeles arbutifolia), skunkbush sumac (Rhus trilobata), redberry (Rhamnus crocea), hollyleaf redberry (R. crocea var. ilicifolia), and poison-oak (Toxicodendron diversilobum).

In northern California and southwestern Oregon, California buckthorn occurs in mixed evergreen, red fir (Abies magnifica var. shastensis), and redwood (Sequoia sempervirens) forests [49,52,65]. On mixed-evergreen sites with ultrabasic parent materials, the sclerophyllous subcanopy is largely replaced by a shrub layer dominated by California buckthorn (ssp. occidentalis) and evergreen huckleberry (Vaccinium ovatum) [1,64,65]. The open, conifer overstory is usually composed of Port-Orford cedar (Chamaecyparis lawsoniana), knobcone pine, sugar pine (Pinus lambertiana), and Douglas-fir (Pseudotsuga menziesii) with a sparse subcanopy of tanoak, huckleberry oak (Quercus vaccinifolia), and California laurel (Umbellularia californica) [1,2,3,65].

California buckthorn is also a characteristic shrub within extensive, evergreen brushfields in the Siskiyou Mountain province [21,24,25]. Common brushfield associates include whiteleaf manzanita (Arctostaphylos viscida), greenleaf manzanita (A. patula), hoary manzanita (A. canescens), wedgeleaf ceanothus (Ceanothus cuneatus), and deer brush (C. integerrimus) [21,25].

MANAGEMENT CONSIDERATIONS

SPECIES: Frangula californica

IMPORTANCE TO LIVESTOCK AND WILDLIFE:
California buckthorn is distributed throughout much of California and is generally considered a staple browse of both big game and livestock [12]. Browse is more greater important to sheep, goats, and deer than to cattle [17,63,74]. Use typically occurs in the fall when more palatable herbaceous plants are cured [50]. California buckthorn is an important mule deer browse on winter ranges in portions of California [17].

The fruits of California buckthorn are extensively utilized by numerous wildlife species, particularly birds [12,17]. In many areas, the berries are often the only abundant "juicy" fruit available in the fall [75]. Berries are readily eaten by band-tailed pigeons, black-tailed deer, and black bears [12,74]. Woodrats eat limited quantities of the seeds [33].

PALATABILITY:
The palatability of California buckthorn browse depends upon stem age and community associates [17,63]. Cattle utilization is usually limited, particularly in communities where California buckthorn has a scattered distribution. However, where plants are locally abundant, the current annual growth is often heavily utilized [63]. postfire sprouts are highly preferred by livestock and big game [17,27,63].

Browse ratings for California buckthorn are presented below [63]:

sheep	good - poor
goats	good - poor
deer	good - poor
cattle	fair - poor
horses	useless

NUTRITIONAL VALUE:
Nutritionally, California buckthorn is a satisfactory food source for livestock and big game [63]. Although foliar protein content is never particularly high, California buckthorn is important because it remains succulent throughout the year [23]. Nutritional studies of the foliage indicate that protein content of mature leaves is low (7.5 percent) from November through March. Maximum values are reached between April and August when the protein content of newly developed foliage reaches an average of 19 percent [63].
Nutrient content of
the leaves compares favorably with common shrub associates such as wedgeleaf ceanothus and chaparral whitethorn [23]. Crude fiber values show little seasonal variation, ranging from 13.5 percent in newly initiated leaves to 15 percent in mature foliage [63].

COVER VALUE:
The cover value of California buckthorn has not been documented. Tanoak/coffeeberry associations in southern Oregon and northern California are characterized by a diverse vertical structure, supplying nesting cover and perching sites for numerous bird species [1].

VALUE FOR REHABILITATION OF DISTURBED SITES:
California buckthorn is useful for erosion control on dry, steep hillsides [19]. One- to two-year-old transplants produce substantial seed crops and large numbers of volunteers occur on sites receiving additional irrigation. On suitable sites, transplants may grow 8 to 12 feet (2.4-3.7 m) tall with comparable spreads within approximately 20 years [19]. Since the berries are highly preferred by a variety of bird species, California buckthorn is a good selection for wildlife plantings [34].

Plants are easily propagated from seed sown in nursery beds using either fresh, unstratified seed in the fall or stratified seed in the spring [34,74]. Seed should be collected in the fall approximately 2 weeks before it is fully ripe, and the pulp removed prior to sowing [34]. When stored in sealed containers at 41 degrees F (5 degrees C), buckthorn (Rhamnus spp.) seed remains viable for several years [34]. Propagation from stem cuttings is difficult but can be achieved using soft or hardwood cuttings made at the nodes [34,43,74].

OTHER USES AND VALUES:
California buckthorn is frequently cultivated for ornamental purposes since the shiny, colorful berries contrast nicely with the light green foliage [19,60,63]. The berries are sweet and edible and were gathered historically by West Coast Indian tribes for culinary as well as medicinal purposes [12]. Although the berries superficially resemble the commercial coffee bean, attempts at using California buckthorn as a coffee substitute have not been successful. The bark was once exported for use as a laxative [14].

OTHER MANAGEMENT CONSIDERATIONS:
Planting programs: Some species belonging to the buckthorn (Rhamnus) genus serve as alternate hosts for the oat rust, Puccinia coronata [34]. California buckthorn, however, is a secondary host for the rust of velvet grass (Holcus spp.) and is not a concern when planted near fields of cultivated oats [74].

Herbicides: California buckthorn is sensitive to almost all forestry-registered herbicides [11]. If sprouts are treated following burning, plants are usually killed by retreatment [7,9,26,69].

BOTANICAL AND ECOLOGICAL CHARACTERISTICS

SPECIES: Frangula californica

GENERAL BOTANICAL CHARACTERISTICS:
California buckthorn is a native, broad-leaved, sclerophyllous shrub [13,63,74]. Growth habit varies according to subspecies with plants ranging from low, spreading shrubs to upright, arborescent individuals [52]. On favorable sites along the coast, California buckthorn occasionally grows as a small tree, reaching heights of approximately 20 feet (6.1 m) [45]. More often, however, it grows as a 4 to 6 foot (1.2-1.8 m) tall shrub [63]. Bark of young twigs is usually reddish; older branches have gray, brown, or reddish bark [12,52]. The small, pinnately veined, evergreen leaves are commonly dark green above and paler beneath, and are arranged alternately on the stem [53]. Leaf margins are typically inrolled [12,14]. When growing on xeric sites, leaves tend to be small and thick; in moist situations they are relatively large and thin [63]. The inconspicuous, bisexual flowers are green and occur in small, axillary clusters [53]. The fruit is a juicy,

berrylike drupe approximately 0.25 inch (7-9 mm) in diameter and may be either green, black, or red in color [34,52]. Berries contain two smooth, nutlike seeds which closely resemble the commercial coffee bean [12,14,34]. Although the root crown may become enlarged in response to repeated postfire sprouting, this structure is not a lignotuber [38,40]. Longevity of California buckthorn is estimated at 100 to 200 years [39].

RAUNKIAER LIFE FORM:

Phanerophyte

REGENERATION PROCESSES:
California buckthorn regenerates by both sexual and vegetative means. On chaparral sites in southern California, California buckthorn maintains itself primarily through sprouting [41]. Seedling establishment is never very abundant and is restricted to stands of mature chaparral [39,40,41]. Little or no seedling establishment occurs immediately following fire [38,40,41]. However, seemingly different establishment patterns have been observed in other communities [63,66]

Vegetative regeneration: In the absence of fire, many long-lived sprouters within stands of mature chaparral rejuvenate their canopies by continually producing new sprouts from established root crowns [40,42]. Generalized information indicates that California buckthorn may also maintain itself in this manner [40]. Following disturbances such as fire or cutting, California buckthorn sprouts from surviving adventitious buds on the root crown [36,62].

Seed reproduction: Onset of seed production occurs early in California coffeeberry, usually by 2 to 3 years of age [19]. Seeds are dispersed in the fall [41]. Significant, widespread dispersal of the pea-sized berries occurs through animals, particularly birds [10,41]. Bird harvest of the fruit crop is often so complete that relatively few seeds fall beneath the parent plant. The seeds of California buckthorn are apparently quite short lived. When dried at room temperature, viability is retained for no longer than 9 months. At the time of dispersal, each seed exhibits a chlorophyllous cotyledon, indicating that germination is imminent [41]. If kept too moist prior to germination, seeds are prone to rot [19]. Germination occurs readily under favorable moisture and temperature conditions [34,41]. Keeley [41] recently studied the germination requirements of California buckthorn using seed samples collected in southern California. After a 1-month stratification at 41 degrees F (5 degrees C), 65 percent of California buckthorn seeds germinated when light incubated at 73 degrees F (23 degrees C) for 3 weeks. Rate of germination was rapid with more than 75 percent of germination occurring during the first week. Addition of charate (powdered charred wood) greatly reduced germination under similar conditions (15% germination); in the dark, however, addition of charate stimulated germination relative to the control (90% germination). In this study, heat treatments generally decreased germination. Longer heating at low temperatures was more detrimental than short bursts of high temperature [41]. Sampson [62] found that heat treatments produced a slight increase in germination.

Keeley [38,39,40,41] reported that buckthorns (Rhamnus spp.) are obligate sprouters after fires in southern California chaparral and included both California buckthorn and redberry (Rhamnus crocea) within this grouping. Obligate sprouting species are restricted to sprouting following fire and do not establish seedlings in the initial postfire environment. In fact, seedling establishment of obligate sprouters is always quite limited and follows the generalized scenario

presented below [40,41,71,72]:

-- Seedlings are established primarily in mature chaparral in gaps resulting from the death of senescing, shorter-lived species.
-- Seedling establishment is often episodic and coincides with periods of above normal rainfall .
-- Although initial establishment may occur in burned or unburned stands during very wet years, continued survival is favored beneath mature stands on sites that are relatively mesic (north slopes) and which possess a well-developed litter layer.
-- Long-term survival beneath mature chaparral is rare; seedlings are stunted and are subjected to heavy browsing by small mammals.
-- Seedlings are most common in very old stands (60 to 100+ years) where long fire free intervals allow for the build up of seedling populations.

Redberry tends to follow the above pattern [28,29,31,32,42,57], but data is scant concerning the seedling ecology of California buckthorn. A review of the literature found no data on California buckthorn seedling establishment within southern California chaparral. On Coast Range sites in northern California, Sampson [62] did not observe any California buckthorn seedlings beneath stands of manzanita-ceanothus (Arctostaphylos spp.-Ceanothus spp.) chaparral. Seedlings were present on adjacent burns. Densities equaled 4,400 seedlings/acre (10,872 seedlings/ha) 1 year after fire; 4 years later, there were approximately 2,300 seedlings/acre (5,683 seedlings/ha). Precipitation was apparently below normal during the first three postfire growing seasons [62]. Pelton [58] found occasional California buckthorn seedlings beneath mixed-hardwood forests in the Santa Cruz Mountains. Seedlings of var. occidentalis apparently require some shade during the establishment period [19].

SITE CHARACTERISTICS:
California buckthorn exhibits a wide ecological amplitude. Sites include dry flats, moist slopes, ravines, and rocky ridges, usually at elevations below 5,500 feet (1,677 m) [52,63]. Soils are typically dry and well drained [74]. Established plants tolerate full sun to moderate shade [13,74].

In the Siskiyou Mountains, sites supporting tanoak/coffeeberry plant associations occur on flat, lower slope positions at elevations ranging from 1,040 to 3,460 feet (317 to 1,055 m) on southerly aspects; ultrabasic soils reach depths of approximately 30 inches (76 cm).

SUCCESSIONAL STATUS:
California buckthorn is a long-lived and moderately shade-tolerant shrub that is highly persistent within chaparral, hardwood woodland, and open conifer forests [13,39]. During extended fire free-intervals, California buckthorn is able to outlive, overtop, and shade out many shorter-lived species [71]. As a component of relatively open canopied stands, plants persist until the next fire occurs [36,66], at which time sprouted individuals become part of the initial postfire vegetation [66]. Griffin [75], however, observed many senescing plants of California buckthorn on mixed hardwood sites in the southern Coast Range; according to Griffin, California buckthorn had been the dominant shrub on these sites for quite some time. Shrubs with bird-dispersed seed, such as California buckthorn, have apparently increased in abundance on relic oak savanna sites in central California [35].

SEASONAL DEVELOPMENT:
California buckthorn typically flowers from April to June [34,52]. Fruit ripening commonly occurs from July through November with dispersal taking place during the fall [34,41,74]. Immature fruits are green, turning red or reddish-black when fully ripened [53,63]. Although an evergreen species, California buckthorn produces at least some new leaves each year [23]. Observations on the phenological development of California buckthorn during 1936 for sites in Shasta County, California, are presented below [62]:

Phenological stage	Date
Leaves half developed	April 11
Leaves fully developed	May 16
Leaves fully developed & fruit forming	June 24

FIRE ECOLOGY

SPECIES: Frangula californica

FIRE ECOLOGY OR ADAPTATIONS:
Following fires which kill aerial stems, California buckthorn sprouts vigorously from dormant buds located on the root crown [62]. The root crown serves as a source of numerous perennating buds and stored carbohydrates, enabling California buckthorn to rapidly reoccupy the initial postfire environment [41,48].

FIRE REGIMES:
Find 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".

POSTFIRE REGENERATION STRATEGY:
Tall shrub, adventitious-bud root crown

FIRE EFFECTS

SPECIES: Frangula californica

IMMEDIATE FIRE EFFECT ON PLANT:
California buckthorn is quite resistant to fire mortality [62,66]. Although aerial portions may be top-killed, most plants survive fire [66].

DISCUSSION AND QUALIFICATION OF FIRE EFFECT:
NO-ENTRY

PLANT RESPONSE TO FIRE:
Vigorous sprouting is the primary means by which California buckthorn reestablishes itself in the postfire environment [38,40,41,62]. The degree to which seedlings contribute to its postfire recovery seems to vary with fire intensity, community type, and perhaps geographical

location [41,66].

Vegetative regeneration: California buckthorn sprouts vigorously following fires which kill the aerial stems [6,36,39,63]. Although cover and basal area may be initially reduced following burning [26,47], most plants rapidly regain their prefire size and biomass [59].

Seedling reproduction: California buckthorn produces short-lived seeds, the majority of which germinate readily under favorable temperature and moisture conditions [34,41,62]. Consequently, postfire establishment may occur through bird dispersal of off-site seed [41,42]. Seed production by residual plants may also be a factor on some sites. Generalized information on obligate sprouters suggests that sprouted plants begin to produce seed crops within 1 to 2 years of burning and that postfire fruit crops are often substantial [40]. Although most seeds are not well adapted to resist fire or for long-term survival in the soil [41], germination in a portion of the seeds may be cued to the postfire environment. Sampson [62] reported a slight increase in germination when California buckthorn seeds were exposed for 5 minutes to heat treatments of 140 to 180 degrees F (60 to 82 degrees C). Heat treated samples from both southern California (San Bernardino Co.) and northern California (Mendocino Co.) showed an increase in germination over controls; the greatest increase occurred in the northern California sample [62]. Keeley [41] found that heat treatments generally decreased germination; optimal germination occurred when charred wood was added to dark incubated controls.

Limited information presents an unclear pattern of postfire seedling establishment in California buckthorn. In southern California chaparral, it apparently behaves as an obligate spouter and rarely establishes seedlings in the initial postfire environment [40,41]. Generalized information indicates that seedlings of obligate sprouting species are rarely observed during the first postfire season except during periods of above-normal precipitation [40,73]. Although seedlings may initially establish in fire-created gaps in very wet years, successful establishment seems restricted to mesic sites beneath mature chaparral where litter layers are well developed [40,72].

On chaparral sites in northern California, however, Sampson [62] found seedling densities of 4,400 /acre (10,872 seedlings/ha) on 1-year-old burns. Although individual seedling survival was not followed, there were 2,300 seedlings/acre (5,683 seedlings/ha) at the end of the fifth postfire season. Prior to burning, seedlings were not observed beneath adjacent unburned stands consisting of a cover of sprouting manzanita and ceanothus (stand age not given) [62]. California buckthorn seedlings did not establish the first year after a wildfire burned a summit sugar pine forest in the Santa Lucia Range of central California despite its common occurrence in the prefire vegetation [66]. This wildfire was described as intense and burned an extensive area.

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE:
Response of vegetation to prescribed burning in a Jeffrey pine-California black oak woodland and a deergrass meadow at Cuyamaca State Park, California, provides information on prescribed fire use and postfire response of many mixed-conifer woodland species including California coffeeberry.

FIRE MANAGEMENT CONSIDERATIONS:
Wildlife management: Burning initially increases the palatability of California buckthorn browse [27,62,63]. Plants on recently burned sites are higher in crude protein and crude fiber values than plants in unburned stands [62]. Sprouts are generally utilized for up to two

postfire growing seasons [7]. On small burns, use of California coffeeberry may be so concentrated that plants are weakened to the point that mortality ensues [27].

REFERENCES

SPECIES: Frangula californica

REFERENCES:

1. Atzet, Thomas; Wheeler, David L. 1984. Preliminary plant associations of the Siskiyou Mountain Province. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. 278 p. [9351]

2. Atzet, Tom; Wheeler, David; Smith, Brad; [and others]. 1984. The tanoak series of the Siskiyou Region of southwest Oregon. Forestry Intensified Research [Oregon State University]. 6(3): 6-7. [8593]

3. Atzet, Tom; Wheeler, David; Smith, Brad; [and others]. 1985. The tanoak series of the Siskiyou region of southwest Oregon (Part 2). Forestry Intensified Research. 6(4): 7-10. [8594]

4. Barbour, Michael G.; Major, Jack, eds. 1977. Terrestrial vegetation of California. New York: John Wiley & Sons. 1002 p. [388]

5. Bernard, Stephen R.; Brown, Kenneth F. 1977. Distribution of mammals, reptiles, and amphibians by BLM physiographic regions and A.W. Kuchler's associations for the eleven western states. Tech. Note 301. Denver, CO: U.S. Department of the Interior, Bureau of Land Management. 169 p. [434]

6. Biswell, H. H. 1959. Prescribed burning and other methods of deer range improvement in ponderosa pine in California. In: Proceedings, Society of American Foresters; 1959; San Francisco, CA. Bethesda, MD: Society of American Foresters: 102-105. [5269]

7. Biswell, H. H. 1961. Manipulation of chamise brush for deer range improvement. California Fish and Game. 47(2): 125-144. [6366]

8. Bolsinger, Charles L. 1989. Shrubs of California's chaparral, timberland, and woodland: area, ownership, and stand characteristics. Res. Bull. PNW-RB-160. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Experiment Station. 50 p. [7426]

9. Bovey, Rodney W. 1977. Response of selected woody plants in the United States to herbicides. Agric. Handb. 493. Washington, DC: U.S. Department of Agriculture, Agricultural Research Service. 101 p. [8899]

10. Bullock, Stephen H. 1978. Fruit abundance and distribution in relation to types of seed dispersal in chaparral. Madrono. 25: 104-105. [9792]

11. Burrill, Larry C.; Braunworth, William S., Jr.; William, Ray D.; [and others], compilers. 1989. Pacific Northwest weed control handbook. Corvallis, OR: Oregon State University, Extension Service, Agricultural Communications. 276 p. [6235]

12. Conrad, C. Eugene. 1987. Common shrubs of chaparral and associated ecosystems of southern California. Gen. Tech. Rep. PSW-99. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 86 p. [4209]

13. Cooper, W. S. 1922. The broad-sclerophyll vegetation of California. Publ. No. 319. Washington, DC: The Carnegie Institution of Washington. 145 p. [6716]

14. Dale, Nancy. 1986. Flowering plants: The Santa Monica Mountains, coastal and chaparral regions of southern California. Santa Barbara, CA: Capra Press. In coooperation with: The California Native Plant Society. 239 p. [7605]

15. Davis, Frank W.; Hickson, Diana E.; Odion, Dennis C. 1988. Composition of maritime chaparral related to fire history and soil, Burton Mesa, Santa Barbara County, California. Madrono. 35(3): 169-195. [6162]

16. Detling, LeRoy E. 1961. The chaparral formation of southwestern Oregon, with considerations of its postglacial history. Ecology. 42(2): 348-357. [6360]

17. Dayton, William A. 1931. Important western browse plants. Misc. Publ. 101. Washington, DC: U.S. Department of Agriculture. 214 p. [768]

18. Dunn, Paul H.; Barro, Susan C.; Wells, Wade G., II; [and others]. 1988. The San Dimas Experimental Forest: 50 years of research. Gen. Tech. Rep. PSW-104. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 49 p. [8400]

19. Everett, Percy C. 1957. A summary of the culture of California plants at the Rancho Santa Ana Botanic Garden 1927-1950. Claremont, CA: The Rancho Santa Ana Botanic Garden. 223 p. [7191]

20. Eyre, F. H., ed. 1980. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters. 148 p. [905]

21. Franklin, Jerry F.; Dyrness, C. T. 1973. Natural vegetation of Oregon and Washington. Gen. Tech. Rep. PNW-8. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 417 p. [961]

22. Garrison, George A.; Bjugstad, Ardell J.; Duncan, Don A.; [and others]. 1977. Vegetation and environmental features of forest and range ecosystems. Agric. Handb. 475. Washington, DC: U.S. Department of Agriculture, Forest Service. 68 p. [998]

23. 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]

24. Gratkowski, H. 1961. Brush seedlings after controlled burning of brushlands in southwestern Oregon. Journal of Forestry. 59(12): 885-888. [3392]

25. Gratkowski, H. 1961. Brush problems in southwestern Oregon. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 53 p. [8596]

26. Gratkowski, H. J.; Philbrick, J. R. 1965. Repeated aerial spraying and burning to control sclerophyllous brush. Journal of Forestry. 63(12): 919-923. [8797]

27. Greenlee, Jason. 1977. Prescribed burning program for the coastal redwoods and chaparral. In: Mooney, Harold A.; Conrad, C. Eugene, technical coordinators. Proc. 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: 397-403. [4869]

28. Hanes, Ted L. 1971. Succession after fire in the chaparral of southern California. Ecological Monographs. 41(1): 27-52. [11405]

29. Hanes, Ted L. 1974. The vegetation called chaparral. In: Rosenthal, Murray, ed. Symposium on living with the chaparral: Proceedings; 1973 March 30-31; Riverside, CA. San Francisco, CA: The Sierra Club: 1-5. [3261]

30. Hanes, Ted L. 1977. California chaparral. In: Barbour, Michael G.; Major, Jack, eds. Terrestrial vegetation of California. New York: John Wiley and Sons: 417-469. [7216]

31. Hanes, Ted L.; Jones, Harold W. 1967. Postfire chaparral succession in southern California. Ecology. 48(2): 259-264. [9824]

32. Horton, J. S.; Kraebel, C. J. 1955. Development of vegetation after fire in the chamise chaparral of southern California. Ecology. 36(2): 244-262. [3737]

33. Horton, Jerome S.; Wright, John T. 1944. The wood rat as an ecological factor in southern California watersheds. Ecology. 25(3): 341-351. [10682]

34. Hubbard, Richard L. 1974. Rhamnus L. Buckthorn. In: Schopmeyer, C. S., ed. Seeds of woody plants in the United States. Agriculture Handbook No. 450. Washington: U. S. Department of Agriculture, Forest Service: 704-708. [7738]

35. 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]

36. Griffin, James R. 1982. Pine seedlings, native ground cover, and Lolium multiflorum on the Marble-Cone burn, Santa Lucia Range, California. Madrono. 29(3): 177-188. [4935]

37. Kartesz, J. T.; The Biota of North America Program (BONAP). 2015. Taxonomic Data Center, [Online]. Chapel Hill, NC: The Biota of North America Program (Producer). Available online: bonap.org. [maps generated from Kartesz, J. T. 2010. Floristic synthesis of North America, Version 1.0. Biota of North America Program (BONAP). (in press)]. [84789]

38. Keeley, Jon E. 1977. Fire-dependent reproductive strategies in Arctostaphylos and Ceanothus. In: Mooney, Harold A.; Conrad, C. Eugene, technical coordinators. Symposium on the environmental consequences of fire and fuel management in Mediterranean ecosystems: Proceedings; 1977 August 1-5; Palo Alto, CA. Gen. Tech. Rep. WO-3. Washington, DC: U.S. Department of Agriculture, Forest Service: 391-396. [4868]

39. Keeley, Jon E. 1981. Reproductive cycles and fire regimes. In: Mooney, H. A.; Bonnicksen, T. M.; Christensen, N. L.; [and others], technical coordinators. Fire regimes and ecosystem properties: Proceedings of the conference; 1978 December 11-15; Honolulu, HI. Gen. Tech. Rep. WO-26. Washington, DC: U.S. Department of Agriculture, Forest Service: 231-277. [4395]

40. Keeley, Jon E. 1986. Resilience of Mediterranean shrub communities to fires. In: Dell, B.; Hopkins, A. J. N.; Lamont B. B., editors. Resilience in Mediterranean-type ecosystems. Dordrecht, the Netherlands: Dr. W. Junk Publishers: 95-112. [9826]

41. Keeley, Jon E. 1987. Role of fire in seed germination of woody taxa in

California chaparral. Ecology. 68(2): 434-443. [5403]

42. Keeley, J. E.; Brooks, A.; Bird, T.; [and others]. 1986. Demographic structure of chaparral under extended fire-free conditions. In: DeVries, Johannes J., ed. Proceedings of the chaparral ecosystems research conference; 1985 May 16-17; Santa Barbara, CA. Report No. 2. Davis, CA: University of California, California Water Resources Center: 133-137. [4834]

43. Kruckeberg, A. R. 1982. Gardening with native plants of the Pacific Northwest. Seattle: University of Washington Press. 252 p. [9980]

44. Kuchler, A. W. 1964. Manual to accompany the map of potential vegetation of the conterminous United States. Special Publication No. 36. New York: American Geographical Society. 77 p. [1384]

45. 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]

46. Lyon, L. Jack; Stickney, Peter F. 1976. Early vegetal succession following large northern Rocky Mountain wildfires. In: Proceedings, Tall Timbers fire ecology conference and Intermountain Fire Research Council fire and land management symposium; 1974 October 8-10; Missoula, MT. No. 14. Tallahassee, FL: Tall Timbers Research Station: 355-373. [1496]

47. Martin, Bradford D. 1982. Vegetation responses to prescribed burning in Cuyamaca Rancho State Park, 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: 617. [6088]

48. McDonald, Philip M. 1981. Adaptations of woody shrubs. In: Hobbs, S. D.; Helgerson, O. T., eds. Reforestation of skeletal soils: Proceedings of a workshop; 1981 November 17-19; Medford, OR. Corvallis, OR: Oregon State University, Forest Research Laboratory: 21-29. [4979]

49. McBride, Joe R.; Jacobs, Diana F. 1980. Information gathering for vegetation preservation management: a case study Muir Woods National Monument. In: Proceedings, 2nd conference on scientific research in the National Parks; 1979 November 26-30; San Francisco, CA. Volume 7: Ecosystem Studies/Interdisciplinary Studies. Washington, DC: U.S. Department of Agriculture, National Park Service, and American Institute of Biological Science: 464-477. [8780]

50. Minnich, Richard A. 1982. Grazing, fire, and the management of vegetation on Santa Catalina Island, 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: 444-449. [6051]

51. Minnich, R.; Howard, L. 1984. Biogeography and prehistory of shrublands. In: DeVries, Johannes J., ed. Shrublands in California: literature review and research needed for management. Contribution No. 191. Davis, CA: University of California, Water Resources Center: 8-24. [4998]

52. Munz, Philip A. 1973. A California flora and supplement. Berkeley, CA: University of California Press. 1905 p. [6155]

53. Munz, Philip A. 1974. A flora of southern California. Berkeley, CA:

University of California Press. 1086 p. [4924]

54. Parker, Virgil Thomas. 1984. Correlation of physiological divergence with reproductive mode in chaparral shrubs. Madrono. 31(4): 231-242. [5360]

55. Pase, Charles P. 1982. Sierran montane conifer forest. In: Brown, David E., ed. Biotic communities of the American Southwest--United States and Mexico. Desert Plants. 4(1-4): 49-51. [8884]

56. Pase, Charles P. 1982. Californian (coastal) chaparral. In: Brown, David E., ed. Biotic communities of the American Southwest--United States and Mexico. Desert Plants. 4(1-4): 91-94. [8891]

57. Patric, James H.; Hanes, Ted L. 1964. Chaparral succession in a San Gabriel Mountain area of California. Ecology. 45(2): 353-360. [9825]

58. Pelton, John. 1962. Factors influencing survival and growth of a seedling population of Arbutus menziesii in California. Modrono. 16(8): 237-256. [9048]

59. Reid, C.; Oechel, W. 1984. Effect of shrubland management on vegetation. In: DeVries, Johannes J., ed. Shrublands in California: literature review and research needed for management. Contribution No. 191. Davis, CA: University of California, Water Resources Center: 25-41. [4999]

60. Roof, J. B. 1969. Some brief acquaintances with chinquapins. Four Seasons. 3(1): 16-19. [7535]

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

62. 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]

63. 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]

64. Sawyer, J. O., Jr.; Andre, James M. 1990. An integrated approach to enhancing rare plant populations through habitat restoration: I. Population estimates for the Menzies' wallflower. In: Hughes, H. Glenn; Bonnicksen, Thomas M., eds. Restoration `89: the new management challange: Proceedings, 1st annual meeting of the Society for Ecological Restoration; 1989 January 16-20; Oakland, CA. Madison, WI: The University of Wisconsin Arboretum, Society for Ecological Restoration: 469-477. [14716]

65. Sawyer, John O.; Thornburgh, Dale A.; Griffin, James R. 1977. Mixed evergreen forest. In: Barbour, Michael G.; Major, Jack, eds. Terrestrial vegetation of California. New York: John Wiley and Sons: 359-381. [7218]

66. Talley, Steven N.; Griffin, James R. 1980. Fire ecology of a montane pine forest, Junipero Serra Peak, California. Madrono. 27: 49-60. [4788]

67. Thorne, Robert F. 1977. Montane and subalpine forests of the Transverse and Peninsular ranges. In: Barbour, Michael G.; Major, Jack, eds. Terrestrial vegetation of California. New York: John Wiley and Sons: 537-557. [7214]

68. Vogl, Richard J.; Armstrong, Wayne P.; White, Keith L.; Cole, Kenneth L. 1977. The closed-cone pines and cypress. In: Barbour, Michael G.; Major, Jack, eds. Terrestrial vegetation of California. New York: John Wiley and Sons: 295-358. [7219]

69. Washington State Cooperative Extension Service. 1982. Herbicides in forestry. Pullman, WA: Washington State University, College of Agriculture, Cooperative Extension Service. 13 p. [7873]

70. Wells, Philip V. 1962. Vegetation in relation to geological substratum and fire in the San Luis Obispo Quadrangle, California. Ecological Monographs. 32(1): 79-103. [14183]

71. Zedler, Paul H. 1977. Life history attributes of plants and the fire cycle: a case study in chaparral dominated by Cupressus forbesii. In: Mooney, Harold A.; Conrad, C. Eugene, technical coordinators. Symposium on the environmental consequences of fire and fuel management on Menditerranean ecosystems: Proceedings; 1977 August 1-5; Palo Alto, CA. Gen. Tech. Rep. WO-3. Washington, DC: U.S. Department of Agriculture, Forest Service: 451-458. [4876]

72. Zedler, Paul H. 1981. Vegetation change in chaparral and desert communities in San Diego County, California. In: West, D. C.; Shugart, H. H.; Botkin, D. B., eds. Forest succession: Concepts and application. New York: Springer-Verlag: 406-430. [4241]

73. Zedler, Paul H. 1982. Plant demography and chaparral management in southern 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: 123-127. [6016]

74. Van Dersal, William R. 1938. Native woody plants of the United States, their erosion-control and wildlife values. Washington, DC: U.S. Department of Agriculture. 362 p. [4240]

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

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

77. Shiflet, Thomas N., ed. 1994. Rangeland cover types of the United States. Denver, CO: Society for Range Management. 152 p. [23362]

78. Stickney, Peter F. 1989. Seral origin of species originating in northern Rocky Mountain forests. Unpublished draft on file at: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Fire Sciences Laboratory, Missoula, MT; RWU 4403 files. 7 p. [20090]

79. U.S. Department of Agriculture, Natural Resources Conservation Service. 2018. PLANTS Database, [Online]. Available: https://plants.usda.gov/. [34262]

80. St. John, Harold. 1973. List and summary of the flowering plants in the Hawaiian islands. Hong Kong: Cathay Press Limited. 519 p. [25354]

81. Baldwin, Bruce G.; Goldman, Douglas H.; Keil, David J.; Patterson, Robert; Rosatti, Thomas J.; Wilken, Dieter H., eds. 2012. The Jepson manual. Vascular plants of California, second edition. Berkeley, CA: University of California

Press. 1568 p. [86254]

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