11140
California Lower Montane Blue Oak-Foothill Pine Woodland and Savanna

BpS Model/Description Version: Aug. 2020

Modelers		Reviewers	
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Vegetation Type
Steppe/Savanna

Map Zones
3, 6, 7

Geographic Range
This system is primarily in the valley margins and foothills of the Sierra Nevada and coast ranges from approximately 120-1,200m (360-3,600ft) in elevation on rolling plains or dry slopes.

Biophysical Site Description
Sea level to 4,000ft in elevation, on rolling plains or dry slopes with relatively poor, shallow infertile soils.

Vegetation Description
More than a century of anthropogenic changes have altered the density and distribution of woody vegetation. A high-quality occurrence often consists of open and park-like stands. These savannahs are dominated by *Pinus sabiniana*, with oaks and various broadleaf tree and shrub species, including *Quercus douglasii*, *Quercus wislizeni*, *Quercus agrifolia*, *Quercus lobata*, *Aesculus californica*, *Arctostaphylos* spp*., Cercis canadensis* var*. texensis* (= *Cercis occidentalis*), *Ceanothus cuneatus*, *Frangula californica* (=*Rhamnus californica*), *Ribes quercetorum*, *Juniperus californica*, and *Pinus coulteri*. *Pinus sabiniana* tends to drop out altogether in the driest sites, which are often dominated by *Quercus douglasii*. Northern extensions of this system include *Quercus garryana* as the dominant oak, where it becomes successional to oak-evergreen woodlands. Historically, understory vegetation included mixed chaparral, poison oak, and perennial bunchgrass. Variable canopy densities in existing occurrences are likely due to variations in soil-moisture regime, natural patch dynamics of fire, and land use (fire suppression, livestock grazing, herbivory, etc.).

Typical phases are dominated by open-cover oak savannah, with a relatively uniform size distribution of mature trees at low densities (<40% cover), with understory vegetation structure a function of frequent surface fires mediating woody plant development. In some instances and in some sites, tree density will increase to 70% or more, forming a relatively stable hardwood forest type subject to surface fires in the hardwood litter and rare stand-replacement fire.

BpS Dominant and Indicator Species

Symbol	Scientific Name	Common Name
QUDO	*Quercus douglasii*	Blue oak
QUWI	*Quercus willdenowiana*	Quercus willdenowiana
QUAG	*Quercus agrifolia*	California live oak
QULO	*Quercus lobate*	California white oak
AECA	*Aesculus californica*	California buckeye
ARCTO3	*Arctostaphylos*	Manzanita
CECA4	*Cercis canadensis*	Eastern redbud
CECU	*Ceanothus cuneatus*	Buckbrush

Species names are from the NRCS PLANTS database. Check species codes at http://plants.usda.gov.

Disturbance Description

McClaran and Bartolome (1989) reported pre-settlement fire return intervals ranging from 8-49yrs, with a median of 28.5yrs for blue oaks in the Sierra Nevada. Overstory dominated by deciduous hardwood species results in an herbaceous surface-fuel complex dominating fuel/fire influences. Typical regime is frequent, low-severity fire that likely exert positive influence on crown development and canopy resilience to fire damage. Infrequent, isolated areas of stand-replacement fires create gaps of grasslands that require patch-gap recruitment and edge re-colonization over time. Grass fuels allow very frequent fire, up to annually. Fire regime likely influenced strongly by Native American ignitions, but this is currently undocumented. Areas dominated by greater species richness -- typically on higher elevations with understory shrub species and *P. sabiniana* -- appear to experience higher intensity fires and likely a greater proportion of stand-replacement fires.

Recruitment in the absence of fire appears to be slow, but a wide range of disturbances -- biotic and abiotic -- influence the life history of oaks. Due to undergrazing, seedling/sapling growth forms may become more prostrate and hence more susceptible to foliar combustion and direct fire-related mortality. Complexity of grazing interactions not captured by this model version.

Fire Frequency

Severity	Avg FI	Percent of All Fires	Min FI	Max FI
Replacement	127	7		
Moderate (Mixed)	569	2		
Low (Surface)	10	91		
All Fires	9	100		

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is the central tendency modeled. Percent of all fires is the percent of all fires modeled in that severity class. Minimum and Maximum FIs show the relative range of fire intervals as estimated by model contributors, if known.

Scale Description

Fire regimes in grass surface-fuel complexes likely were large, but limited in significant influence on overstory. Patches of stand-replacement fire likely limited to individual or groups of trees to 100ac, with smaller gaps more prevalent.

Adjacency or Identification Concerns

This biophysical setting (BpS) is often intermixed with chaparral and mixed-evergreen forest types as well as ponderosa pine in the Sierra Nevada Range. Non-native invasives have become a serious threat in these types.

This PNVG may be similar to the PNVG R#OWOA for the Pacific Northwest Model Zone.

Grazing and urbanization are big disturbances (Creasy, pers. comm.).

Issues or Problems

Relatively wide variance in species associations and site productivity likely influence the frequency and extent of stand-replacement fire events. However, the resiliency of the system to lack of fire (both in terms of vegetation and fuel changes) indicate that the model is likely relatively robust in determining significant disturbance effects on the distribution of phases and fire impacts on key ecosystem components.

Main fire- and fuel-related issues in oak savannah/woodland systems concern lack of fire where fire is an agent stimulating new regeneration, and grazing by domestic livestock impacting adversely successful recruitment of immature individuals into the mature phase. Wholesale replacement of native perennial grasses by annual grasses has likely led to increases in fuel continuity and a longer fire season, both contributing to increases in fire frequency in many areas. Increased frequency appears to favor a positive feedback for alien annual presence and abundance, thus causing a trend toward ecological instability when compared to pre-invasion ecosystem structure and function.

Native Uncharacteristic Conditions

Comments

During the 2017 review, Kori Blankenship added information about fire frequency, added references, and adjusted the minimum cover of the late classes from 50% to 40% to prevent a gap in the cover rules and for consistency with the Mediterranean California Lower Montane Black Oak-Conifer Forest and Woodland (10300) and Mediterranean California Mixed-Oak Woodland (10290) BpSs, which use a 40% break for open versus closed classes based on Bigelow et al. (2011).

Succession Classes

Mapping Rules

Upper Layer Lifeform	Height (m)	Canopy Cover (%)									
		0-10	11-20	21-30	31-40	41 - 50	51-60	61-70	71-80	81-90	91-100
Herb	0-0.5	A	A	A	A	A	A	A	A	A	A
Herb	0.5-1.0	A	A	A	A	A	A	A	A	A	A
Herb	>1.0	A	A	A	A	A	A	A	A	A	A
Shrub	0-0.5	A	A	A	A	A	A	A	A	A	A
Shrub	0.5-1.0	A	A	A	A	A	A	A	A	A	A
Shrub	1.0-3.0	A	A	A	A	A	A	A	A	A	A
Shrub	>3.0	A	A	A	A	A	A	A	A	A	A
Tree	0-5	A	A	A	A	A	A	A	A	A	A
Tree	5-10	B	B	B	B	D	D	D	D	D	D

Tree	10-25	C	C	C	C	D	D	D	D	D	D
Tree	25-50	C	C	C	C	D	D	D	D	D	D
Tree	>50	C	C	C	C	D	D	D	D	D	D

Succession class letters A-E are described in the Succession Class Description section. Some classes use a leafform distinction where a qualifier is added to the class letter: Brdl (broadleaf), Con (conifer), or Mix (mixed conifer and broadleaf). UN refers to uncharacteristic native or a combination of height and cover that would not be expected under the reference condition. NP refers to not possible or a combination of height and cover which is not physiologically possible for the species in the BpS.

Description

Class A 18 Early Development 1 - Open

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
QUDO	Quercus douglasii	Blue oak	Upper
QUCH2	Quercus chrysolepis	Canyon live oak	Upper
QUGA4	Quercus garryana	Oregon white oak	Upper
PISA2	Pinus sabiniana	California foothill pine	Upper

Description

Post-replacement sapling/regeneration phase. Largely a function of either early seral remaining in early seral due to replacement fire, or to less common later seral replacement fire. Trees are the upper lifeform at 0-10% cover, 0- to 5-m-tall saplings. Re-establishment can occur from basal resprouting or sexual reproduction, depending on composition, growth form, and seed dynamics. Patch size likely ranges from very small gap recruitment to areas approximately 100ac. Diameter up to 4in typical. May include interior and/or coast live oak, and a variety of shrubs.

Maximum Tree Size Class

Sapling >4.5ft; <5" DBH

Class B 28 Mid Development 1 - Open

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
QUDO	Quercus douglasii	Blue oak	Upper
QUCH2	Quercus chrysolepis	Canyon live oak	Upper
PISA2	Pinus sabiniana	California foothill pine	Upper
QUGA4	Quercus garryana	Oregon white oak	Upper

Description

Intermediate phase. Some new recruitment of cohorts occurs in the later stages of this phase, increasing tree density. Periodic surface fire is relatively common, but replacement fire rare due to low-intensity fire type and resilience of typical species to top kill. Patch size in the hundreds of acres. DBH up to 14in is typical. May include interior and/or coast live oak, and a variety of shrubs.

Maximum Tree Size Class
Pole 5-9" DBH

Class C 45 Late Development 1 - Open

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
QUDO	Quercus douglasii	Blue oak	Upper
QUCH2	Quercus chrysolepis	Canyon live oak	Upper
PISA2	Pinus sabiniana	California foothill pine	Upper
QUGA4	Quercus garryana	Oregon white oak	Upper

Description
Mature Oak Woodland phase. Highly stable, as most fire is frequent; low-severity fire acts as maintenance agent. Tree density and canopy cover increase over time to relatively stable conditions. In some cases, woody encroachment and increased tree density occur under rare events of missed fire cycles. Patch size in the hundreds to possibly thousands of acres. May include interior and/or coast live oak, and a variety of shrubs.

Maximum Tree Size Class
Large 21-33" DBH

Class D 9 Late Development 1 - Closed

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
QUCH2	Quercus chrysolepis	Canyon live oak	Upper
QUDO	Quercus douglasii	Blue oak	Upper
PISA2	Pinus sabiniana	California foothill pine	Upper
QUGA4	Quercus garryana	Oregon white oak	Upper

Description
Late seral stage arising from a rare period of no fire for about 25yrs, allowing woody understory encroachment and higher tree density. Patch size likely in the tens of acres. May include interior and/or coast live oak, and a variety of shrubs.

Maximum Tree Size Class
Large 21-33" DBH

Model Parameters

Deterministic Transitions

From Class	Begins at (yr)	Succeeds to	After (years)
Early1:OPN	0	Mid1:OPN	19
Mid1:OPN	20	Late1:OPN	59
Late1:OPN	60	Late1:OPN	999
Late1:CLS	100	Late1:CLS	999

Probabilistic Transitions

Disturbance Type	Disturbance occurs In	Moves vegetation to	Disturbance Probability	Return Interval (yrs)	Reset Age to New Class Start Age After Disturbance?	Years Since Last Disturbance
Replacement Fire	Early1:OPN	Early1:OPN	0.001	1000	Yes	0
Native Grazing	Early1:OPN	Early1:OPN	0.02	50	Yes	0
Surface Fire	Early1:OPN	Early1:OPN	0.1	10	No	0
Replacement Fire	Mid1:OPN	Early1:OPN	0.005	200	Yes	0
Surface Fire	Mid1:OPN	Mid1:OPN	0.1	10	No	0
Alternative Succession	Late1:OPN	Late1:CLS	1	1	Yes	24
Replacement Fire	Late1:OPN	Early1:OPN	0.01	100	Yes	0
Surface Fire	Late1:OPN	Late1:OPN	0.12	8	No	0
Mixed Fire	Late1:CLS	Late1:OPN	0.02	50	Yes	0
Replacement Fire	Late1:CLS	Early1:OPN	0.02	50	Yes	0

References

Arno, S.F. 2000. Fire in western forest ecosystems. In: Brown, James K. and Jane Kapler Smith, eds. Wildland fire in ecosystems: Effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-vol. 2. Ogden, UT: USDA Forest Service, Rocky Mountain Research Station. 97-120.

Barbour, M.G. 1988. Californian upland forests and woodlands. In: Barbour, Michael G. and William Dwight Billings, eds. North American terrestrial vegetation. Cambridge, New York: Cambridge University Press. 131-164.

Bigelow, S.W., M.P. North and C.F. Salk. 2011. Using light to predict fuels-reduction and group-selection effects on succession in Sierran mixed-conifer forest. Canadian Journal of Forest Research 41: 2051-2063.

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

Brown, J.K. and J. Kapler Smith, eds. 2000. Wildland fire in ecosystems: effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-vol. 2. Ogden, UT: USDA Forest Service, Rocky Mountain Research Station. 257 pp.

Chang, Chi-Ru. 1996. Ecosystem responses to fire and variations in fire regimes. In: Sierra Nevada Ecosystem Project: Final report to Congress, vol. II, Assessments and scientific basis for management options, Chapter 39. Davis, CA: University of California, Centers for Water and Wildand Resources. 1071-1099.

Howard, J.L. Quercus douglasii. In: Fire Effects Information System, [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/ [2007, June 26].

Eyre, F.H., ed. 1980. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters. 148 pp.

Griffin, J.R. 1977. Oak woodland. In: Barbour, Michael G.; Malor, Jack, eds. Terrestrial Vegetation of California. New York: John Wiley and Sons: 383-415.

Haggerty, P.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. October 31 - November 2 1990. Davis, CA. Gen. Tech. Rep. PSW-126. Berkeley, CA: USDA Forest Service, Pacific Southwest Research Station: 342-344.

Hardy, C.C., Kirsten M. Schmidt, James P. Menakis and R. Neil Samson. 2001. Spatial data for national fire planning and fuel management. Int. J. Wildland Fire. 10(3&4): 353-372.

Hickman, J.C., ed. 1993. Jepson Manual: Higher plants of California. Berkeley, CA: University of California Press. 1400 pp.

Howard, J.L. 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/ [2007, June 26].

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. 26-28 June 26-28 1979. Claremont, CA. Gen. Tech. Rep. PSW-44. Berkeley, CA: USDA Forest Service, Pacific Southwest Forest and Range Experiment Station. 216-219.

Kilgore, B.M. 1981. Fire in ecosystem distribution and structure: western forests and scrublands. In: Mooney, H.A., T.A. Bonnicksen, N.L. Christensen et al, technical coordinators. Proceedings of the conference: Fire regimes and ecosystem properties. 11-15 December 1978. Honolulu, HI. Gen. Tech. Rep. WO-26. Washington, DC: USDA Forest Service. 58-89.

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 pp.

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

McClaran, M.P. and J.W. Bartolome. 1989. Fire-related recruitment in stagnant Quercus douglasii populations. Canadian Journal of Forest Research 19: 580-585.

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

Mensing, S. 1992. The impacts of European settlement on blue Oak (Quercus douglasii) regeneration and recruitment in the Tehachapi Mountains, California. Madrono 39: 36-46.

NatureServe. 2007. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. Data current as of 10 February 2007.

Parsons, D. J. and T.J. Stohlgren. 1989. Effects of varying fire regimes on annual grasslands in the southern Sierra Nevada of California. Madrono 36(3): 154-168.

Schmidt, K.M., J.P. Menakis, C.C. Hardy, W.J. Hann and D.L. Bunnel. 2002. Development of coarse-scale spatial data for wildland fire and fuel management. Gen. Tech. Rep. RMRS-GTR-87. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station. 41 pp. + CD.

Skinner, C.N. and C. Chang. 1996. Fire regimes, past and present. In: Sierra Nevada Ecosystem Project: Final report to Congress. Vol. II. Assessments and Scientific Basis for Management Options. Wildland Resources Center Report No. 37. Centers for Water and Wildland Resources, University of California, Davis. 1041-1069

Sweicki, T.J and E. Bernhardt. 1998. Understanding blue oak regeneration. Fremontia 26(1): 19-26.

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

Vogl, R.J. 1977. Fire frequency and site degradation. In: Mooney, Harold A. and C. Eugene Conrad, technical coordinators. Proc. Of the symp. On the environmental consequences of fire and fuel management in Mediterranean ecosystems 1-5 August 1977. Palo Alto, CA. Gen. Tech. Rep. WO-3. Washington, DC: USDA Forest Service: 193-201.

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