Research Article

A Summary of Fire Frequency Estimates for California Vegetation before Euro-American Settlement

Kip M. Van de Water[1] and Hugh D. Safford[2,3*]

[1]Forest Service, Plumas National Forest,
875 Mitchell Avenue, Oroville, California 95965, USA

[2]Forest Service, Pacific Southwest Region,
1323 Club Drive, Vallejo, California 94592, USA

[3]Department of Environmental Science and Policy, University of California,
One Shields Avenue, Davis, California 95616, USA

[*]Corresponding author: Tel.: 001-707-562-8934; e-mail: hughsafford@fs.fed.us

ABSTRACT

California fire regimes have been altered from those that occurred prior to Euro-American settlement, and are predicted to continue to change as global climates warm. Inclusion of fire as a landscape-level process is considered essential to successful ecological restoration in many ecosystems, and presettlement fire regimes provide foundational information for restoration or "realignment" of ecosystems as climate change and land use changes progress. The objective of our study was to provide an up-to-date, comprehensive summary of presettlement fire frequency estimates for California ecosystems dominated by woody plants, and to supply the basis for fire return interval departure (FRID) mapping and analysis in California. Using the LANDFIRE Biophysical Settings (BpS) vegetation-fire regime types as a framework, we used literature review and the outcomes of regional expert workshops to develop twenty-eight presettlement fire regime (PFR) groups based on similarity of their relationships with fire. We then conducted an exhaustive review of the published and unpublished literature pertaining to fire return intervals (FRIs) observed prior to significant Euro-American settlement in the twenty-eight PFRs, and summarized the values to provide a single estimate of the mean, median, mean minimum, and mean maximum FRI for each PFR.

Much variability was evident among PFRs, with mean FRIs ranging from 11 yr to 610 yr, and median FRIs ranging from 7 yr to 610 yr; mean minimum FRIs ranged from 5 yr to 190 yr, and mean maximum FRIs ranged from 40 yr to 1440 yr. There was also high variability within many PFRs, and differences between minimum and maximum FRIs ranged from 32 yr to 1324 yr. Generally, median FRIs were lowest for productive drier forests such as yellow pine, dry and moist mixed conifer, and oak woodland (7 yr, 9 yr, 12 yr, and 12 yr, respectively). Median FRIs were highest for less productive woodlands such as pinyon-juniper (94 yr), high elevation types such as subalpine forest (132 yr), very dry types such as desert mixed shrub (610 yr), and productive moist forests such as spruce-hemlock (275 yr mean FRI). Our summary of California's presettlement fire regimes should be a useful reference for scientists and resource managers, whether they are seeking a general estimate of the central tendency and variability of FRIs in a broadly defined vegetation type, background information for a planned restoration project or a mechanistic model of vegetation-fire interactions, or a list of literature pertaining to a specific vegetation type or geographic location.

Keywords: California, fire frequency, fire history, fire return interval, FRID, presettlement fire regime

Citation: Van de Water, K.M., and H.D. Safford. 2011. A summary of fire frequency estimates for California vegetation before Euro-American settlement. Fire Ecology 7(3): 26-58. doi: 10.4996/fireecology.0703026

INTRODUCTION

Fire is an important process in many of California's ecosystems, and it is becoming increasingly evident that fire regimes (including fire frequency, severity, extent, spatial patterning, etc.) have been greatly altered in some vegetation types by land use patterns and altered ecosystem processes associated with Euro-American settlement (i.e., after 1850) (Sugihara *et al.* 2006, Stephens *et al.* 2007, Skinner *et al.* 2009). Climatic variability at a variety of temporal scales has been shown to be associated with fire regime fluctuations in the past (Swetnam 1993). Anthropogenic climate change is a driver of current observed trends of increasing fire activity, and is predicted to continue to alter fire regimes and vegetation types in the future (Lenihan *et al.* 2003, Westerling *et al.* 2006, Miller *et al.* 2009, Gedalof 2011, National Research Council 2011). Consideration of fire as a landscape-level process is considered essential to facilitating ecological restoration or "realignment" (*sensu* Millar *et al.* 2007) efforts intended to increase ecosystem resilience in the face of climate change (North *et al.* 2009*a*). Restoration of narrowly defined historical conditions may no longer be a preferred management prescription in light of the uncertainty surrounding the effects of climate change on fire and other ecological processes. However, information on fire regimes before Euro-American settlement is of fundamental importance to modern and future management of many ecosystems in western North America (Millar *et al.* 2007; Wiens *et al.*, in press). Such historical information can help, among other things, to document the current status of fire in ecosystems and trends in fire activity and ecological effects over time; to encourage understanding of the underlying mechanisms that drive ecosystem response to changes in climate, fire, landscapes, and their interactions; and to provide data upon which models of "properly functioning" or "resilient" ecosystems might be built (Wiens *et al.*, in press).

Drawing comparisons between presettlement and current fire regimes can also assist land managers in prioritizing areas for ecological restoration. Fire return interval departure (FRID) analysis facilitates quantification of the difference between current and presettlement fire return intervals (FRIs), allowing managers to target areas at high risk of type conversion due to altered fire regimes (Caprio *et al.* 1997, Caprio and Graber 2000, van Wagtendonk *et al.* 2002). Robust estimates of the variability of presettlement FRIs in different vegetation types are a crucial part of FRID analysis, yet most fire history studies are highly localized, making it difficult to apply the results of individual studies to a regional-scale mapping and assessment effort.

Much work has been accomplished in documenting historical fire regimes in various vegetation types throughout California, and while several manuscripts summarize different subsets of this information, they are often either restricted to data derived from tree-ring studies, limited to forest vegetation types in a particular geographic region, or not intended to be comprehensive (e.g., Heyerdahl *et al.* 1995, Skinner and Chang 1996, Stephens *et al.* 2007). Thus, scientists and land managers currently lack a single source that summarizes all of the literature pertaining to presettlement fire regimes. The objectives of this paper are to provide an up-to-date comprehensive summary of presettlement fire frequency estimates for California ecosystems dominated by woody plants, and to provide the quantitative basis for fire return interval departure (FRID) mapping across California.

METHODS

Although the state of California is home to a high diversity of species, vegetation types, and fire regimes (Barbour *et al.* 2007), similarities among fire regimes and their effects on vegetation generally allow the organization of ecosystems into broad fire regime groups. Published efforts to categorize relationships between fire and vegetation in California include Agee (1993; northern California), Skinner and Chang (1996; Sierra Nevada), Stephenson and Calcarone (1999; southern California), Arno (2000; western US), Sugihara *et al.* (2006; statewide), Sawyer *et al.* (2010; statewide), and the LANDFIRE project (2010; Rollins 2009; entire US). Both the Sugihara *et al.* (2006) and Sawyer *et al.* (2010) efforts drew from a series of Joint Fire Science Program supported regional workshops held between 2000 and 2002 that reunited fire and vegetation experts from across the state and developed descriptions of fire regime characteristics for California vegetation communities. All of this information also fed the development of the LANDFIRE Biophysical Settings (BpS), which are potential natural vegetation (PNV) types linked to quantitative models of disturbance and succession (Rollins 2009). The disturbance-succession models for the California BpS types (which apply to the pre-Euro-American settlement period) were developed at a series of regional expert workshops sponsored by The Nature Conservancy in 2004 and 2005. After refinement and peer review, the BpS classification was finalized and mapped as part of the national LANDFIRE project (see Rollins 2009 and www.landfire.gov for details).

As an evolutionary outgrowth of the previous fire regime work cited above, the LANDFIRE Biophysical Settings represents the current state of the art for linking vegetation and pre-Euro-American settlement fire regimes across California. There are more than eighty individual BpS types mapped in California by LANDFIRE, but some are extremely uncommon, and many share similar fire regimes. Using the fire regime information provided for each BpS in the type description (LANDFIRE 2010), and referring to integrative vegetation and fire resources in the literature (see citations above, plus, e.g., Burns and Honkala 1990, Potter 1998, Barbour and Billings 2000, Barbour *et al.* 2007) and on the internet (e.g., the Fire Effects Information System [http://www.fs.fed.us/database/feis/]), we reduced the BpS list down to a smaller number of pre-Euro-American settlement fire regime groups (PFRs) that we subjectively considered sufficiently different to warrant retention. From our research, we also identified a number of PFRs that were not represented in the BpS classification. PFRs were designed to balance a reasonably small number of fire regime groups with sufficiently high discrimination in fire regime characteristics. We solicited peer review of the PFR list from 27 California fire and vegetation ecology experts and received responses from eleven. After adjustment, our final list included 28 PFRs.

For each PFR, we conducted an exhaustive review of the published and unpublished literature pertaining to mean, median, minimum, and maximum fire return intervals observed prior to significant Euro-American settlement (i.e., the middle of the nineteenth century). Sources included fire histories derived from dendrochronological and charcoal deposition records, modeling studies, and expert quantitative estimates. Priority was given to studies conducted in California, but sources from other states in western North America were included as appropriate for PFRs for which information was limited. When all sources were compiled, the average was taken of all mean, median, minimum, and maximum FRI values to yield a single mean, median, mean minimum, and mean maximum FRI estimate for each PFR. Thus, the minimum and maximum FRI estimates we provide for each PFR are not absolute minima and maxima, but typical mean values that would be expected across the geographical range of each PFR.

For conifer-dominated PFRs, most FRI values considered in this assessment were derived from small-scale (<4 ha) composite dendrochronological fire histories including records from multiple trees in a defined area, although some values were obtained from modeling or stand age-based studies (in the latter case, for PFRs characterized by stand-replacing fires). Composite FRIs often represent the fire history of a given area better than point FRIs (derived from a single tree) because some fire events fail to scar every recording tree within the fire perimeter, especially in regimes characterized by frequent low intensity fire (Collins and Stephens 2007, Falk *et al.* 2011). Furthermore, composite FRIs are more sensitive and better suited to analyzing changes in fire occurrence than point FRIs (Dieterich 1980, Swetnam and Baisan 2003). While there is some variability introduced by using composite FRIs from different-sized areas, they are less likely to underestimate presettlement FRI values than point FRIs.

RESULTS

Relationships between the PFRs and LANDFIRE BpS types are shown in Table 1; characteristic dominant woody species for each PFR are listed in Table 2. Four PFRs were not represented by any BpS types, due to their geographic rarity or their focus on single species. These were the "fire sensitive spruce or fir," the "big cone Douglas-fir," the "shore pine," and the "silver sagebrush" PFRs.

We derived fire frequency estimates for the 28 PFRs from 298 sources (Table 2). Most of our sources (213 of 298; 71.5%) were based on data collected in California. For the average PFR, 26.5% of sources were non-Californian, but seven PFRs had more than 50% of their sources from outside California (Table 2). These seven, which accounted for about two thirds of all of the non-California sources, are PFRs for which the dominant woody species are at the southern or western edge of their range in California, or are California endemics and very rare in the state (e.g., *Abies bracteata* [D. Don] D. Don ex Poit and *Picea breweriana* S. Watson in the fire sensitive spruce or fir PFR). Sixteen PFRs had ≤20% of their sources from outside California, and seven had exclusively California sources.

Derived mean, median, mean minimum, and mean maximum fire frequencies for each PFR are given in Table 2. Information on median FRIs was lacking for some PFRs, so median values were either taken from expert quantitative estimates of mean FRI (desert mixed shrub, semi-desert chaparral) or were not estimated (coastal fir, shore pine, spruce-hemlock). Because FRI distributions are often skewed (with more short or long intervals, depending on the PFR), median FRI values may be a better approximation of how often a given PFR burned than mean FRIs (Falk 2004).

Much variability is evident among PFRs, with mean FRIs ranging from 11 yr (dry mixed conifer and yellow pine) to 610 yr (desert mixed shrub), median FRIs ranging from 7 yr

Table 1. Relationship between Presettlement Fire Regime types (PFRs) and LANDFIRE Biophysical Settings (BpS) mapped in California. BpS types with "none" as PFR assignment are types for which we do not have sufficient data on presettlement fire regimes (e.g., non-woody vegetation, riparian types).

LANDFIRE Biophysical Setting	PFR
Inter-mountain basins aspen-mixed conifer forest and woodland	Aspen
Rocky Mountain aspen forest and woodland	Aspen
Columbia Plateau steppe and grassland	Big sagebrush
Inter-mountain basins big sagebrush shrubland	Big sagebrush
Inter-mountain basins big sagebrush steppe	Big sagebrush
Inter-mountain basins montane sagebrush steppe	Big sagebrush
Columbia Plateau low sagebrush steppe	Black and low sagebrush
Great Basin xeric mixed sagebrush shrubland	Black and low sagebrush
California coastal closed-cone conifer forest and woodland	Chaparral-serotinous conifers
California maritime chaparral	Chaparral-serotinous conifers
California mesic chaparral	Chaparral-serotinous conifers
California xeric serpentine chaparral	Chaparral-serotinous conifers
Klamath-Siskiyou xeromorphic serpentine savanna and chaparral	Chaparral-serotinous conifers
Mediterranean California mesic serpentine woodland and chaparral	Chaparral-serotinous conifers
Northern and central California dry-mesic chaparral	Chaparral-serotinous conifers
Southern California dry-mesic chaparral	Chaparral-serotinous conifers
North Pacific maritime dry-mesic Douglas-fir-western hemlock forest	Coastal fir
Baja semi-desert coastal succulent scrub	Coastal sage scrub
Northern California coastal scrub	Coastal sage scrub
Southern California coastal scrub	Coastal sage scrub
Inter-mountain basins curl-leaf mountain mahogany woodland and shrubland	Curl-leaf mountain mahogany
Colorado plateau blackbrush-mormon-tea shrubland	Desert mixed shrub
Inter-mountain basins greasewood flat	Desert mixed shrub
Inter-mountain basins mixed salt desert scrub	Desert mixed shrub
Inter-mountain basins semi-desert shrub-steppe	Desert mixed shrub
Mojave mid-elevation mixed desert scrub	Desert mixed shrub
Sonora-Mojave creosotebush-white bursage desert scrub	Desert mixed shrub
Sonora-mojave mixed salt desert scrub	Desert mixed shrub
Sonoran mid-elevation desert scrub	Desert mixed shrub
Sonoran paloverde-mixed cacti desert scrub	Desert mixed shrub
Mediterranean California dry-mesic mixed conifer forest and woodland	Dry mixed conifer
Northern rocky mountain foothill conifer wooded steppe	Dry mixed conifer
Sierra Nevada subalpine lodgepole pine forest and woodland	Lodgepole pine
Sierra Nevada subalpine lodgepole pine forest and woodland—dry	Lodgepole pine
Sierra Nevada subalpine lodgepole pine forest and woodland—wet	Lodgepole pine
Central and southern California mixed evergreen woodland	Mixed evergreen
Mediterranean California mixed evergreen forest	Mixed evergreen
Klamath-Siskiyou upper montane serpentine mixed conifer woodland	Moist mixed conifer
Mediterranean California mesic mixed conifer forest and woodland	Moist mixed conifer
California montane woodland and chaparral	Montane chaparral
Southern California oak woodland and savanna	Oak woodland

Table 1, continued.

LANDFIRE Biophysical Setting	PFR
California central valley and southern coastal grassland	none
California central valley riparian woodland and shrubland	none
California mesic serpentine grassland	none
California montane riparian systems	none
California northern coastal grassland	none
Inter-mountain basins montane riparian systems	none
Inter-mountain basins semi-desert grassland	none
Mediterranean California alpine dry tundra	none
Mediterranean California alpine fell-field	none
Mediterranean California subalpine meadow	none
North American warm desert riparian systems	none
North Pacific montane grassland	none
Pacific coastal marsh systems	none
California central valley mixed oak savanna	Oak woodland
California coastal live oak woodland and savanna	Oak woodland
California lower montane blue oak-foothill pine woodland and savanna	Oak woodland
Mediterranean California mixed oak woodland	Oak woodland
North Pacific oak woodland	Oak woodland
Columbia Plateau western juniper woodland and savanna	Pinyon juniper
Colorado Plateau pinyon-juniper woodland	Pinyon-juniper
Great Basin pinyon-juniper woodland	Pinyon-juniper
Inter-mountain basins juniper savanna	Pinyon-juniper
Mediterranean California red fir forest	Red fir
Mediterranean California red fir forest—Cascades	Red fir
Mediterranean California red fir forest—southern Sierra	Red fir
California coastal redwood forest	Redwood
Great Basin semi-desert chaparral	Semi-desert chaparral
Sonora-Mojave semi-desert chaparral	Semi-desert chaparral
North pacific hypermaritime sitka spruce forest	Spruce-hemlock
North Pacific lowland riparian forest and shrubland	Spruce-hemlock
North Pacific maritime mesic-wet Douglas-fir-western hemlock forest	Spruce-hemlock
Inter-mountain basins subalpine limber-bristlecone pine woodland	Subalpine forest
Mediterranean California subalpine woodland	Subalpine forest
Mediterranean California subalpine woodland	Subalpine forest
North Pacific maritime mesic subalpine parkland	Subalpine forest
Northern California mesic subalpine woodland	Subalpine forest
Sierra Nevada alpine dwarf-shrubland	Subalpine forest
Sierran-intermontane desert western white pine-white fir woodland	Western white pine
California montane Jeffrey pine(-ponderosa pine) woodland	Yellow pine
Mediterranean California lower montane black oak-conifer forest and woodland	Yellow pine
Northern Rocky Mountain ponderosa pine woodland and savanna—mesic	Yellow pine
Northern Rocky Mountain ponderosa pine woodland and savanna—xeric	Yellow pine

Table 2. Reference fire return intervals (FRIs) of pre-Euro-American settlement fire regimes (PFRs) considered in this analysis, and sources (citations on following pages, asterisks denote studies conducted wholly or mostly outside of California). Mean minimum and mean maximum are rounded to the nearest multiple of 5.

PFR	Characteristic dominant woody species	Mean	Median	Mean Min	Mean Max	Sources
Aspen	*Populus tremuloides* Michx, various conifers	19	20	10	90	1-7
Big sagebrush	*Artemisia tridentata* Nutt., *Purshia tridentata* (Pursh.) DC., *Chrysothamnus* spp.	35	41	15	85	2, 4, 7-22, 281-283
Bigcone Douglas-fir	*Pseudotsuga macrocarpa* (Vasey) Mayr, *Quercus chrysolepis* Liebm.	31	30	5	95	2, 23-26
Black and low sagebrush[1]	*Artemisia nova* A. Nelson, *A. arbuscula* Nutt.	66	53	35	115	2, 4, 12, 13, 21, 22, 27-31, 284
California juniper	*Juniperus occidentalis* Hook.	83	77	5	335	2, 13, 15, 18, 32
Chaparral and serotinous conifers	*Adenostoma* spp., *Arctostaphylos* spp., *Ceanothus* spp., *Quercus berberidifolia* Liebm., other shrubs; *Pinus attenuata* Lemmon, *P. muricata* D. Don, *Cupressus* spp., other serotinous conifers	55	59	30	90	2, 33-72
Coastal fir[1]	*Abies grandis* (Douglas ex D. Don) Lindl., *Pseudotsuga menziesii* (Mirb.) Franco	99	NA[2]	90	435	73-84
Coastal sage scrub	*Artemisia californica* Less.,*Baccharis pilularis* DC., *Eriogonum fasciculatum* Benth., *Salvia* spp., etc.	76	100	20	120	2, 25, 44, 47, 48, 71, 85-94
Curl-leaf mountain mahogany[1]	*Cercocarpus ledifolius* Nutt.	52	62	30	130	2, 4, 7, 14, 16, 18, 22, 95-98
Desert mixed shrub	*Atriplex* spp., *Sarcobatus vermiculatus* (Hook.) Torr., *Larrea tridentata* (DC.) Coville, *Coleogyne ramosissima* Torr., *Prosopis* spp., *Yucca* spp., *Ephedra* spp., *Opuntia* spp., etc.	610	610	120	1440	2, 99-108
Dry mixed conifer	*Pinus ponderosa, P. lambertiana* Douglas, *Calocedrus decurrens* (Torr.) Florin, *Abies concolor* (Gord. & Glend.) Lindl ex Hildebr., *Quercus kelloggii* Newberry	11	9	5	50	3, 6, 24, 68, 70, 71, 109-140
Fire sensitive spruce or fir[1]	*Abies amabilis* (Douglas ex Louden) Douglas ex Forbes, *A. bracteata, Picea engelmannii* Perry ex Engelm., *P. breweriana*	117	93	90	250	2, 22, 44, 141-157, 278-280, 285-297
Lodgepole pine	*Pinus contorta* Douglas ex Louden ssp. *murrayana* (Balf.) Engelm.	37	36	15	290	2, 3, 5, 6, 21, 68, 70, 112, 125, 127, 132, 158-172
Mixed evergreen	*Pseudotsuga menziesii, Lithocarpus densiflorus* (Hook. & Arn.) Rehder, *Quercus agrifolia* Née, *Q. chrysolepis, Umbellularia californica* (Hook.& Arn.) Nutt., *Arbutus menziesii* Pursh, *Acer macrophyllum* Pursh, *Taxus brevfolia* Nutt.	29	13	15	80	2, 23, 44, 74, 82, 127, 173-187
Moist mixed conifer	*A. concolor, Pseudotsuga menziesii, Calocedrus decurrens, Pinus ponderosa, P. lambertiana, P. contorta* ssp. *murrayana, Sequoiadendron giganteum* (Lindl.) J. Buchholz	16	12	5	80	2, 3, 6, 68, 70, 71, 98, 110-113, 116, 117, 119, 121-123, 125, 127-130, 132, 133, 136, 145, 147, 164, 168, 170, 183, 187-209

[1] PFRs for which >50% of sources are from outside California.
[2] Not applicable.

Table 2, continued.

PFR	Characteristic dominant woody species	Mean	Median	Mean Min	Mean Max	Sources
Montane chaparral	*Arctostaphylos* spp., *Ceanothus* spp., *Quercus vaccinifolia* Kellogg, *Prunus ilicifolia* (Nutt. Ex Hook. & Arn) D. Dietr., *Chrysolepis sempervirens* (Kellogg) Hjelmquist, other shrubs	27	24	15	50	2, 33, 58, 68, 209-211
Oak woodland	*Quercus douglasii* Hook & Arn, *Q. lobata* Née, *Q. wislizenii* A. DC., *Pinus sabiniana* Douglas ex Douglas	12	12	5	45	2, 44, 68, 127, 186, 212-225
Pinyon-juniper[1]	*Pinus monophylla* Torr. & Frém., *Juniperus* spp.,	151	94	50	250	2, 14, 16, 22, 71, 89, 226-233
Port Orford cedar	*Chamaecyparis lawsoniana* (A. Murray) Parl.	30	16	10	160	2, 98, 144, 147, 168, 173, 177, 187, 188, 205, 234-237
Red fir	*Abies magnifica* A. Murray, *A. concolor, Pinus montícola* Douglas ex D. Don, *P. murrayana*	40	33	15	130	2, 3, 6, 68, 110, 112, 119, 127, 132, 134, 162, 164, 168-170, 172, 181, 187, 238-248
Redwood	*Sequoia sempervirens* (Lamb. Ex D. Don) Endl.	23	15	10	170	2, 44, 74, 82, 174, 178, 179, 182, 186, 249-257
Semi-desert chaparral	*Adenostoma fasciculatum* Hook. & Arn., *Arctostaphylos* spp., *Cercocarpus betuloides* Nutt., *Eriogonum fasciculatum* Benth., *Purshia glandulosa* Curran, *Fremontodendon californicum* (Torr.) Coville, *Quercus john-tuckeri* Nixon & C.H. Mull, etc.	65	65	50	115	2, 258-261
Shore pine[1]	*Pinus contorta* Douglas ex Louden ssp. *contorta*	250	NA[2]	190	1025	78, 262, 277
Silver sagebrush	*Artemisia cana* Pursh	35	31	15	65	2, 10, 58, 263, 264, 298
Spruce-hemlock[1]	*Picea sitchensis* (Bong.) Carrière, *Tsuga heterophylla* (Raf.) Sarg., *Pseudotsuga menziesii*	275	NA[2]	180	550	75, 77, 80, 265-269
Subalpine forest	*Tsuga mertensiana* (Bong.) Carrière, *Pinus albicaulis* Engelm., *P. monticola, P. contorta* ssp. *murrayana, P. flexilis* James, *P. balfouriana* Balf., *P. longaeva* D.K. Bailey, *Abies magnifica*	133	132	100	420	2, 68, 98, 112, 143, 164, 165, 168, 172, 187, 199, 270-272
Western white pine	*Pinus monticola*	50	42	15	370	2, 6, 98, 112, 119, 127, 134, 147, 164, 166, 168-170, 172, 199, 245, 257, 273
Yellow pine	*Pinus ponderosa, P. jeffreyi, P. washoensis* H. Mason & Stockw., *P. lambertiana, Quercus kelloggii*	11	7	5	40	2, 3, 14, 21, 68, 70, 71, 113, 116, 117, 119, 127, 131, 132, 134, 165, 169, 189, 200, 224, 263, 274-276

[1] PFRs for which >50% of sources are from outside California.
[2] Not applicable.

1 Richardson and Provencher 2005
2 Sawyer *et al.* 2009
3 Van de Water and North 2010
4 Wall *et al.* 2001*
5 Riegel *et al.* 2006
6 Beaty and Taylor 2008
7 Miller *et al.* 2001*
8 Major *et al.* 2005
9 Zielinski and Provencher 2005
10 Medlyn and Kolden 2005
11 Winward 1991*
12 Miller and Rose 1999*
13 Young and Evans 1981
14 Gruell 1999*
15 Martin and Johnson 1979
16 Gruell *et al.* 1994*
17 Mensing *et al.* 2006*
18 Miller and Heyerdahl 2008
19 Sapsis 1990*
20 Bork 1984*
21 Norman and Taylor 2005
22 Kitchen 2010*
23 Sugihara and Borgias 2005
24 Safford and Keeler-Wolf 2005
25 Byrne 1978
26 Lombardo *et al.* 2009
27 Kolden and Medlyn 2005
28 Burkhardt and Tisdale 1976*
29 Kitchen and McArthur 2007*
30 Knick *et al.* 2005*
31 Loope and Gruell 1973*
32 Reeberg and Weisberg 2006
33 Sugihara *et al.* 2004
34 Foster 2006*a*
35 Syphard and Foster 2006
36 Beyers and Parker 2006
37 Keeler-Wolf *et al.* 2005
38 Syphard and Beyers 2006
39 Minnich 2006
40 Ne'eman *et al.* 1999
41 Vogl 1973
42 Conard and Weise 1998
43 Minnich 1989
44 Greenlee and Langenheim 1990
45 Keeley and Fotheringham 2001
46 Borchert 2008
47 Byrne *et al.* 1977
48 Mensing *et al.* 1999
49 Minnich and Chou 1997
50 Minnich 2001
51 Moritz *et al.* 2004
52 Moritz 2003
53 Zedler 1995
54 De Gouvenain and Ansary 2006
55 Wells *et al.* 2003
56 Mallek 2009
57 Stephens *et al.* 2004
58 Wright and Bailey 1982
59 Keeley 1982
60 Walter and Taha 1999
61 Wells and Getis 1999
62 Borchert and Foster 2006
63 Vogl *et al.* 1977
64 Keeley 1981
65 Florence 1987
66 Davis and Borchert 2006
67 Jackson 1977
68 Caprio and Lineback 2002
69 Zedler 1981
70 Minnich *et al.* 2000*
71 Stephenson and Calcarone 1999
72 Moir 1982*
73 Kertis *et al.* 2005*
74 Finney and Martin 1989
75 Long and Whitlock 2002*
76 Veirs 1980
77 Long *et al.* 2007*
78 Brown and Hebda 2002*
79 Long *et al.* 2010*
80 Long *et al.* 1998*
81 McCoy 2006*
82 Stuart 1987
83 Agee and Dunwiddie 1984*
84 Walsh *et al.* 2008*
85 Taylor 2006
86 Keeler-Wolf and Foster 2006
87 Hanes 1971
88 Westman 1982
89 Paysen *et al.* 2000
90 O'Leary 1990
91 Vogl 1976
92 Russell 1983
93 Talluto and Suding 2008
94 Keeley *et al.* 2005
95 Ross *et al.* 2005
96 Arno and Wilson 1983*
97 Erhard 2008*
98 Minckley *et al.* 2007*
99 Dingman and Esque 2005
100 Novak-Echenique 2005*a*
101 Novak-Echenique 2005*b*
102 Alford and Ambos 2005
103 Esque and McPherson 2005
104 Nachlinger 2005*
105 Thomas 1991
106 Wright 1986*
107 Brooks and Matchett 2006
108 Brown and Minnich 1986
109 Arabas *et al.* 2006*
110 Beaty and Taylor 2001
111 Beaty and Taylor 2009
112 Bekker and Taylor 2001
113 Caprio and Swetnam 1995
114 Everett 2008
115 Evett *et al.* 2007*
116 Fry and Stephens 2006
117 Gill and Taylor 2009
118 Keeler-Wolf 1991
119 Beaty and Taylor 2007
120 Hemstrom *et al.* 2008*a**
121 Wagener 1961
122 Kotok 1930
123 Show and Kotok 1924
124 Warner 1980
125 Caprio 2004*c*
126 Skinner *et al.* 2008*
127 Skinner and Chang 1996
128 Skinner *et al.* 2006
129 Skinner *et al.* 2009
130 Stephens and Collins 2004
131 Stephens *et al.* 2003*
132 Swetnam *et al.* 2001
133 Swetnam *et al.* 2009
134 Taylor 2000
135 Taylor 2004*
136 Taylor and Skinner 2003
137 Trouet *et al.* 2010*
138 Vaillant and Stephens 2009
139 Sherlock and Sugihara 2008
140 Gassaway 2005
141 Powell and Swanson 2005*
142 Simpson *et al.* 2005*
143 Swanson 2005
144 Borgias *et al.* 2005
145 Talley and Griffin 1980
146 Briles *et al.* 2005
147 Briles *et al.* 2008
148 Grissino-Mayer *et al.* 1995*
149 Touchan *et al.* 1996*
150 Wadleigh and Jenkins 1996*
151 White and Vankat 1993*
152 Hemstrom *et al.* 2008*b**
153 Toney and Anderson 2006*
154 Fulé *et al.* 2003*
155 Schellhaas *et al.* 2001*
156 Anderson *et al.* 2008*
157 Allen *et al.* 2008*
158 Caprio 2004*a*
159 Caprio 2004*b*
160 Keifer 1991
161 Caprio 2002
162 van Wagtendonk 1995
163 Brunelle and Anderson 2003
164 Daniels *et al.* 2005
165 North *et al.* 2009*b*
166 Pitcher 1987
167 Sheppard and Lassoie 1998
168 Skinner 2003
169 Stephens 2001
170 Taylor and Solem 2001
171 Caprio 2008
172 Hallett and Anderson 2010
173 Sugihara *et al.* 2005*a*
174 Veirs 1982
175 Hunter 1997
176 Atzet and Wheeler 1982*
177 Agee 1991*
178 Brown *et al.* 1999
179 Greenlee 1983
180 Olson and Agee 2005*
181 Sensenig 2002*
182 Stephens and Fry 2005
183 Taylor and Skinner 1995
184 Wills and Stuart 1994
185 Atzet 1979*
186 Finney and Martin 1992
187 Atzet and Martin 1992
188 Reilly *et al.* 2005*a*
189 Bradley *et al.* 2005
190 Sherlock *et al.* 2005*a*
191 Sherlock *et al.* 2005*b*
192 Kilgore and Taylor 1979
193 Thornburgh 1995
194 Collins and Stephens 2007
195 Fiegener 2002

196 Sherlock *et al.* 2008
197 Kilgore 1973
198 Swetnam *et al.* 1990
199 Mohr *et al.* 2000
200 Moody *et al.* 2006
201 Drumm 1996
202 North *et al.* 2005
203 Phillips 2002
204 Scholl and Taylor 2010
205 Skinner 2002
206 Swetnam 1993
207 Taylor and Skinner 1998
208 Stuart and Salazar 2000
209 Nagel and Taylor 2005
210 Wilken 1967
211 Botti 1979
212 Wills *et al.* 2005
213 Reilly *et al.* 2004
214 Evans *et al.* 2005
215 Klein and Evens 2006
216 Davis 2006
217 Evens and Klein 2006*a*
218 Evens and Klein 2006*b*
219 Mensing 1992
220 Sugihara and Reed 1987
221 Anderson and Moratto 1996
222 McClaran 1988
223 Purcell and Stephens 1997
224 Stephens 1997
225 Agee and Biswell 1978
226 Weisberg 2005
227 Arno 1985*
228 Gruell 1997*
229 Bauer 2006*
230 Bauer and Weisberg 2009*
231 Jamieson 2008*
232 Romme *et al.* 2009
233 Wangler and Minnich 1996
234 Reilly *et al.* 2005*b*
235 Zobel *et al.* 1982*
236 Agee *et al.* 1990*b**
237 Scher and Jimerson 1989
238 Atzet and White 2005
239 Safford and Sherlock 2005*a*
240 Safford and Sherlock 2005*b*
241 Barbour and Minnich 2000
242 Chappell and Agee 1996*
243 Bancroft 1979
244 Atzet and McCrimmon 1990*
245 Scholl and Taylor 2006*
246 Foster 1998*
247 Taylor 1993
248 Taylor and Halpern 1991
249 Sugihara *et al.* 2005*b*
250 Huff *et al.* 2005
251 Brown and Baxter 2003
252 Swetnam 1994
253 Fritz 1931
254 Hunter and Parker 1993
255 Jacobs *et al.* 1985
256 Norman 2007
257 Brown and Smith 2000
258 Provencher *et al.* 2005
259 Brooks 2005
260 Cable 1975
261 Brooks *et al.* 2007*
262 Parminter 1991*
263 Norman and Taylor 2003
264 Quinnild and Cosby 1958*
265 Acker *et al.* 2004
266 Whitlock *et al.* 2008*
267 Teensma *et al.* 1991*
268 Impara 1997*
269 Agee 1993*
270 van Wagtendonk *et al.* 2005
271 Richardson and Howell 2005
272 Short *et al.* 2005
273 Foster 2006*b*
274 Safford *et al.* 2005
275 McBride and Laven 1976
276 Taylor and Beaty 2005
277 Cope 1993
278 Uchytil 1991
279 Cope 1992*a*
280 Cope 1992*b*
281 Howard 1999
282 Johnson 2000
283 Tirmenstein 1999
284 Steinberg 2002
285 Sibold *et al.* 2006*
286 Veblen *et al.* 1994*
287 Buechling and Baker 2001*
288 Donnegan *et al.* 2001*
289 Kipfmueller and Baker 2000*
290 Suffling 1993*
291 Romme and Knight 1981*
292 Millspaugh and Whitlock 2003*
293 Brunelle and Whitlock 2003*
294 Brunelle *et al.* 2005*
295 Gavin *et al.* 2006*
296 Hallet and Hills 2006*
297 Brown *et al.* 1994*
298 Howard 2002

(yellow pine) to 610 yr (desert mixed shrub), minimum FRIs ranging from 5 yr (bigcone Douglas-fir, California juniper, dry mixed conifer, moist mixed conifer, oak woodland, and yellow pine) to 190 yr (shore pine), and maximum FRIs ranging from 40 yr (yellow pine) to 1440 yr (desert mixed shrub) (Table 2). There was also a great deal of variability within PFRs, as evidenced by differences between minimum and maximum FRIs ranging from 32 yr and 34 yr (montane chaparral and yellow pine, respectively) to 1324 yr (desert mixed shrub). FRI distributions ranged from unskewed distributions with little difference between mean and median FRIs (aspen, bigcone Douglas-fir, dry mixed conifer, lodgepole pine, montane chaparral, oak woodland, subalpine forest), to highly skewed distributions dominated by relatively short FRIs (coastal sage scrub), to highly skewed distributions dominated by relatively long FRIs (pinyon-juniper). Figure 1 graphically depicts the mean, median, mean minimum, and mean maximum FRIs for the 11 most widely distributed PFRs on Forest Service lands in California.

DISCUSSION

Our summary of California's presettlement fire regimes should be a useful reference for scientists and resource managers, whether they are seeking a general estimate of the central tendency and variability of FRIs in a broadly defined vegetation type, background information for a planned restoration project or a mechanistic model of vegetation-fire interactions, or a list of literature pertaining to a specific vegetation type or geographic location. A high degree of confidence can be placed in the validity of the FRI values for most conifer

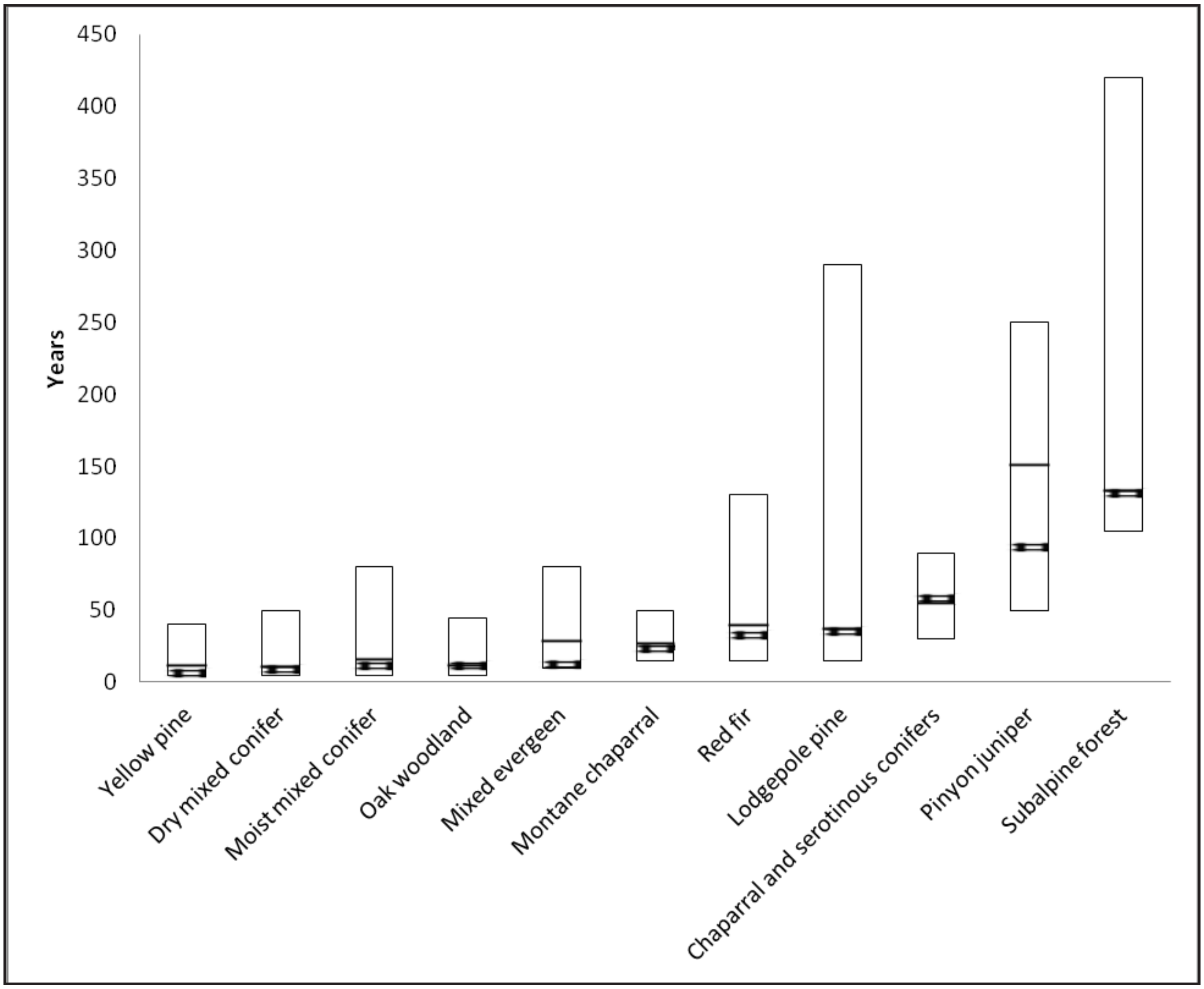

Figure 1. Fire return intervals (FRIs) for the 11 most widely distributed presettlement fire regime groups in California. Solid line is mean FRI, dotted line is mean median FRI, bottom of each bar is mean minimum FRI, top of each bar is mean maximum FRI.

PFRs, especially in the Sierra Nevada, due to the abundance of published dendrochronological studies. Less confidence is afforded to the FRI values of PFRs for which presettlement fire history is less well-studied, such as California juniper, desert mixed shrub, semi-desert chaparral, and silver sagebrush. For shrub-dominated PFRs in which presettlement fires are difficult to detect due to a lack of dendrochronological evidence, FRI values were derived from other types of data that may be less precise, such as charcoal in sediment cores, modeling, and expert quantitative evidence.

More research is needed in PFRs that currently have little quantitative fire history data available for California (see Table 2), or have high geographic variability in FRIs. The difficulties associated with obtaining high-resolution presettlement FRI data in shrub-dominated vegetation types categorically necessitates further study in most of these PFRs (e.g., big sagebrush, black and low sagebrush, chaparral, coastal sage scrub, curl-leaf mountain mahogany, desert mixed shrub, montane chaparral, semi-desert chaparral, silver sagebrush), and perhaps innovation of new or adaptation of existing fire history techniques. Similarly, PFRs dominated by tree species that are easily killed by fire (California juniper, coastal fir, fire sensitive spruce or fir, pinyon-juniper, shore pine, spruce-hemlock) require further study and application of techniques other than fire scar studies. The PFRs of limited geographical distribution in California (bigcone Douglas-fir, coastal fir, fire sensitive spruce or fir, Port Orford cedar, shore pine, spruce-hemlock, western white pine) are chronically understudied. Other PFRs (shore pine, desert mixed shrub, spruce-hemlock, California juniper, coastal fir, pinyon-juniper, western white pine, subalpine forest) are characterized by high geographic variability in fire frequency (high standard error of FRI statistics), requiring scientists and managers to carefully search for literature from local or similar areas.

Several interesting patterns in FRIs within and among different PFRs emerged from the body of fire history literature assessed for this article. For example, analyses of the correlation between fire scar sampling area and fire return interval revealed no trend of decreasing FRI with increasing sampling area for all PFRs pooled and most PFRs individually. Sampling area was significantly correlated with mean minimum FRI for the big sagebrush ($r = 0.867$, $P = 0.012$), Port Orford cedar ($r = -0.974$, $P = 0.026$), and red fir ($r = 0.742$, $P = 0.014$) PFRs. The trend of decreasing FRI with increasing sampling area for the Port Orford cedar PFR was consistent with established expectations (Baker and Ehle 2001, Swetnam and Baisan 2003), while the opposite trend for the big sagebrush and red fir PFRs may be indicative of the long minimum return interval, mixed severity, and stand replacement fire regimes that typify these vegetation types (Sugihara *et al.* 2006).

Ignitions by indigenous peoples were likely a large component of the presettlement fire record in some PFRs, such as redwood (Greenlee and Langenheim 1990) and oak woodland, and are difficult or impossible to definitively differentiate from lightning ignitions, although fire cause may be inferred from seasonality in some cases (Anderson and Moratto 1996). Some vegetation types in certain areas were probably maintained mostly by presettlement anthropogenic fire regimes, which may have resulted in vegetation type conversions in some parts of the landscape prior to Euro-American arrival. Widespread indigenous ignitions were probably uncommon in other PFRs, however, such as subalpine forest and desert mixed shrub (Anderson 2005). Regardless, no attempt is made in this assessment to differentiate between lightning and indigenous ignitions.

This paper provides background information for the FRID mapping products developed by the Forest Service's Pacific Southwest Region Ecology Program and Remote Sensing Lab (Safford *et al.* 2011; available at: http://www.fs.fed.us/r5/rsl/clearinghouse/r5gis/frid/). These annually updated maps provide information on geographic distribution of PFRs, and a number of different FRID statistics calculated using the California fire perimeters database (available at: http://www.frap.cdf.ca.gov/data/frapgisdata/select.asp). These map layers are useful for land and resource planning and assessment, as well as other natural resource applications such as fuels treatment planning, postfire restoration project design, management response to fire, and general ecological understanding of the historical and current occurrence of fire on the California national forests and neighboring jurisdictions.

Our process necessarily generalized across scales of both space and time. In general, and assuming all else is equal, areas with higher precipitation or less ignition within a given PFR would be expected to burn less often than drier areas with an ignition source (Agee 1993, Sugihara *et al.* 2006). A PFR in northwestern California therefore might be expected to support somewhat longer fire return intervals than the same PFR in southern California. A solution for this may be to use the median fire frequency as the preferred measure of central tendency for PFRs in parts of their range where vegetation is relatively more flammable, and the mean fire frequency where vegetation is relatively less flammable (at least where the median is shorter than the mean, which is the typical case). Patch sizes can also influence fire frequency, with small patches of mesic vegetation embedded in a matrix of drier vegetation having shorter fire return intervals than large patches of mesic vegetation, and vice-versa (Agee *et al*. 1990*a*). Obviously, where higher local accuracy is required, the reader should consult the primary literature (e.g., see the citations supporting Table 2).

Temporally, changes in vegetation on California landscapes since the middle of the nineteenth century can make comparisons between historical and contemporary conditions difficult. A good example is provided by the geographic distribution of the yellow pine PFR, which is dominated by ponderosa pine (*Pinus ponderosa* C. Lawson) and Jeffrey pine (*P. jeffreyi* Balf.). The Forest Service mapped vegetation on about 60 % of its California lands in the 1930s (Wieslander 1935). Modern vegetation mapping can be generalized to the same polygon resolution and compared with the 1930s maps to get a broad idea of landscape-level vegetation changes. After >75 years of fire exclusion, logging, and other anthropogenic change, the area occupied by the yellow pine PFR appears to have decreased by about two thirds in the central Sierra Nevada, with about two thirds of the loss due to infilling by shade-tolerant (mostly fire-intolerant) conifer species, for example from the genus *Abies* (Thorne *et al.* 2008; J. Thorne, University of California, Davis, USA, and H. Safford, USDA Forest Service, Vallejo, California, USA, unpublished data). The FRID mapping is often based on contemporary vegetation data, and these sorts of temporal changes cannot be properly accounted for. After completion of digitization of the 1930s vegetation maps, we hope to use them (where they are available) to update the geographic distribution of PFRs to allow a more accurate assessment of changes in fire frequency.

Although this study presents summarized estimates of presettlement fire frequency, it does not imply that contemporary fire should necessarily be applied at historical intervals, which may be neither feasible nor desirable in the context of altered anthropogenic influences and climatic conditions (Anderson and Moratto 1996; Millar *et al.* 2007; Wiens *et al.*, in press). Instead, the estimated presettlement FRIs are intended to serve as an assessment tool for comparison with current fire regimes and trends in those regimes, and to provide general guidelines for ecological restoration (or realignment) in vegetation types that are currently in jeopardy of type conversion due to fire frequencies that are outside the historical range of variation. In order to promote ecosystem resilience in the face of climate change and other uncertainties, efforts to restore fire to ecosystems should focus on the variability of fire frequencies (and other characteristics of the fire regime) that historically facilitated resilience, rather than applying fire to an ecosystem precisely at the mean or median interval.

ACKNOWLEDGMENTS

We thank C. Skinner, C. Chang, S. Stephens, R. Martin, N. Clinton, E. Heyerdahl, D. Berry, J. Agee, T. Keeler-Wolf, J. Sawyer, and all of the authors of species reports in the Fire Effects Information System for their previous work compiling fire history literature, which greatly aided our efforts. We also thank D. Schmidt for developing the first generation FRID maps for southern California and supporting metadata, which formed a basis for this paper. Funding for this project was provided by the Forest Service, Pacific Southwest Region Ecology Program.

LITERATURE CITED

Acker, S., J. Kertis, and K. Kopper. 2004. LANDFIRE biophysical setting model 0310360 North Pacific hypermaritime sitka spruce forest. <http://www.landfire.gov>. Accessed 4 June 2011.

Agee, J.K. 1991. Fire history along an elevational gradient in the Siskiyou Mountains, Oregon. Northwest Science 65: 188-199.

Agee, J.K. 1993. Fire ecology of the Pacific Northwest. Island Press, Washington, D.C, USA.

Agee, J.K., and H.H. Biswell. 1978. The fire management plan for Pinnacles National Monument. Pages 1231-1238 in: R.M. Linn, editor. Proceedings of the first conference on scientific research in the national parks. USDI National Park Service Transactions and Proceedings Series 5, Washington, D.C., USA.

Agee, J.K., and P.W. Dunwiddie. 1984. Recent forest development on Yellow Island, San Juan County, Washington. Canadian Journal of Botany 62: 2074-2080. doi: /10.1139/b84-282

Agee, J.K., M. Finney, and R. deGouvenain. 1990*a*. Forest fire history of Desolation Peak, Washington. Canadian Journal of Forest Research 20: 350-356. doi: 10.1139/x90-051

Agee, J.K., L. Potash, and M. Gracz. 1990*b*. Oregon Caves forest and fire history. USDI National Park Service Cooperative Park Studies Unit Report CPSU/UW 90-1, University of Washington, Seattle, USA.

Alford, E., and N. Ambos. 2005. LANDFIRE biophysical setting model 1310910 Sonoran mid-elevation desert scrub. <http://www.landfire.gov>. Accessed 4 June 2011.

Allen, C.D., R.S. Anderson, R.B. Jass, J.L. Toney, and C.H. Baisan. 2008. Paired charcoal and tree-ring records of high-frequency Holocene fire from two New Mexico bog sites. International Journal of Wildland Fire 17: 115-130. doi: 10.1071/WF07165

Anderson, M.K. 2005. Tending the wild. University of California Press, Berkeley, USA.

Anderson, M.K., and M.J. Moratto. 1996. Native American land-use practices and ecological impacts. Pages 187-206 in: Sierra Nevada ecosystem project final report to Congress, volume 2. Wildland Resources Center Report No. 37, University of California, Davis, USA.

Anderson, R.S., C.D. Allen, J.L. Toney, R.B. Jass, and A.N. Bair. 2008. Holocene vegetation and fire regimes in subalpine and mixed conifer forests, southern Rocky Mountains, USA. International Journal of Wildland Fire 17: 96-114. doi: 10.1071/WF07028

Arabas, K.B., K.S. Hadley, and E.R. Larson. 2006. Fire history of a naturally fragmented landscape in central Oregon. Canadian Journal of Forest Research 36: 1108-1120. doi: 10.1139/x06-004

Arno, S.F. 1985. Ecological effects and management implications of Indian fires. Pages 81-86 in: J.E. Lotan, B.M. Kilgore, W.C. Fisher, and R.W. Mutch, editors. Proceedings of the symposium and workshop on wilderness fire. USDA Forest Service General Technical Report INT-GTR-182. Intermountain Forest and Range Experiment Station, Ogden, Utah, USA.

Arno, S.F. 2000. Fire in western forest ecosystems. Pages 97-120 in: J.K. Brown and J.K. Smith, editors. Wildland fire in ecosystems: effects of fire on flora. USDA Forest Service General Technical Report RMRS-GTR-42-vol. 2, Rocky Mountain Research Station, Ogden, Utah, USA.

Arno, S.F., and A.E. Wilson. 1983. Dating past fires in curlleaf mountain-mahogany communities. Journal of Range Management 39: 241-243. doi: 10.2307/3899058

Atzet, T. 1979. Description and classification of the forests of the Upper Illinois River drainage of southwestern Oregon. Dissertation, Oregon State University, Corvallis, USA.

Atzet, T., and R.E. Martin. 1992. Natural disturbance regimes in the Klamath Province. Pages 40-48 in: R.R. Harris, D.E. Erman, and H.M. Kerner, editors. Proceedings of symposium on biodiversity of northwestern California. University of California, Berkeley, Wildland Resources Center Report 29.

Atzet, T., and L.A. McCrimmon. 1990. Preliminary plant associations of the southern Oregon Cascade Mountain Province. USDA Forest Service, Siskiyou National Forest, Medford, Oregon, USA.

Atzet, T., and D.L. Wheeler. 1982. Historical and ecological perspectives on fire activity in the Klamath Geological Province of the Rogue River and Siskiyou National Forests. USDA Forest Service, Pacific Northwest Region, Portland, Oregon, USA.

Atzet, T., and D. White. 2005. LANDFIRE biophysical setting model 01310320 Mediterranean California red fir forest. <http://www.landfire.gov>. Accessed 4 June 2011.

Baker, W.L., and D. Ehle. 2001. Uncertainty in surface-fire history: the case of ponderosa pine forests in the western United States. Canadian Journal of Forest Research 31: 1205-1226. doi: 10.1139/cjfr-31-7-1205

Bancroft, L. 1979. Fire management plan: Sequoia and Kings Canyon national parks. USDI National Park Service, Sequoia and Kings Canyon national parks, Three Rivers, California, USA.

Barbour, M.G., and W.D. Billings. 2000. North American terrestrial vegetation. Second edition. Cambridge University Press, United Kingdom.

Barbour, M.G., T. Keeler-Wolf, and A.A. Schoenherr. 2007. Terrestrial vegetation of California. University of California Press, Berkeley, USA.

Barbour, M.G., and R.A. Minnich. 2000. California upland forests and woodlands. Pages 161-202 in: M.G. Barbour and W.D. Billings, editors. North American terrestrial vegetation, second edition. Cambridge University Press, England, United Kingdom.

Bauer, J.M. 2006. Fire history and stand structure of a central Nevada pinyon-juniper woodland. Thesis, University of Nevada, Reno, USA.

Bauer, J.M., and P.J. Weisberg. 2009. Fire history of a central Nevada pinyon-juniper woodland. Canadian Journal of Forest Research 39: 1589-1599. doi: 10.1139/X09-078

Beaty, R.M., and A.H. Taylor. 2001. Spatial and temporal variation of fire regimes in a mixed conifer forest landscape, southern Cascades, California, USA. Journal of Biogeography 28: 955-966. doi: 10.1046/j.1365-2699.2001.00591.x

Beaty, R.M., and A.H. Taylor. 2007. Fire disturbance and forest structure in old-growth mixed conifer forests in the northern Sierra Nevada, California. Journal of Vegetation Science 18: 879-890. doi: 10.1111/j.1654-1103.2007.tb02604.x

Beaty, R.M., and A.H. Taylor. 2008. Fire history and the structure and dynamics of a mixed conifer forest landscape in the northern Sierra Nevada, Lake Tahoe Basin, California, USA. Forest Ecology and Management 255: 707-719. doi: 10.1016/j.foreco.2007.09.044

Beaty, R.M., and A.H. Taylor. 2009. A 14 000 year sedimentary charcoal record of fire from the northern Sierra Nevada, Lake Tahoe Basin, California, USA. The Holocene 19: 347-359. doi: 10.1177/0959683608101386

Bekker, M.F., and A.H. Taylor. 2001. Gradient analysis of fire regimes in montane forests of the southern Cascade Range. Plant Ecology 155: 15-28. doi: 10.1023/A:1013263212092

Beyers, J., and T. Parker. 2006. LANDFIRE biophysical setting model 0410960 California maritime chaparral. <http://www.landfire.gov>. Accessed 4 June 2011.

Borchert, M. 2008. LANDFIRE rapid assessment reference condition model R1CHAP chaparral. <http://www.landfire.gov>. Accessed 4 June 2011.

Borchert, M., and J. Foster. 2006. LANDFIRE biophysical setting model 0311770 California coastal closed-cone conifer forest and woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Borgias, D., T. Bradley, and S. Norman. 2005. LANDFIRE biophysical setting model 310270 Mediterranean California dry-mesic mixed conifer forest and woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Bork, J.L. 1984. Fire history in three vegetation types on the east side of the Oregon Cascades. Dissertation, Oregon State University, Corvallis, USA.

Botti, S. 1979. Natural, conditional, and prescribed fire management plan. USDI National Park Service, Yosemite National Park, California, USA.

Bradley, T., D. Sandifer, and R. Wills. 2005. LANDFIRE biophysical setting model 0610300 Mediterranean lower montane black-oak conifer forest and woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Briles, C.E., C. Whitlock, P.J. Bartlein, and P. Higuera. 2008. Regional and local controls on postglacial vegetation and fire in the Siskiyou Mountains, northern California, USA. Palaeogeography, Palaeoclimatology, Palaeoecology 265: 159-169. doi: 10.1016/j.palaeo.2008.05.007

Briles, C.E., C. Whitlock, and P.J. Bartlein. 2005. Postglacial vegetation, fire, and climate history of the Siskiyou Mountains, Oregon, USA. Quaternary Research 64: 44-56. doi: 10.1016/j.yqres.2005.03.001

Brooks, M. 2005. LANDFIRE biophysical setting model 1311080 Sonora-Mojave semi-desert chaparral. <http://www.landfire.gov>. Accessed 4 June 2011.

Brooks, M.L., T.C. Esque, and T. Duck. 2007. Chapter 6. Creosotebush, blackbrush, and interior chaparral shrublands. Pages 97-110 in: S.M. Hood and M. Miller, editors. Fire ecology and management of the major ecosystems of southern Utah. USDA Forest Service General Technical Report RMRS-GTR-202, Fort Collins, Colorado, USA.

Brooks, M.L., and J.R. Matchett. 2006. Spatial and temporal patterns of wildfires in the Mojave Desert, 1980-2004. Journal of Arid Environments 67: 148-164. doi: 10.1016/j.jaridenv.2006.09.027

Brown, D.E., and R.A. Minnich. 1986. Fire and changes in creosote bush scrub of the western Sonoran Desert, California. American Midland Naturalist 116: 411-422. doi: 10.2307/2425750

Brown, J.K., S.F. Arno, S.W. Barrett, and J.P. Menakis. 1994. Comparing the prescribed natural fire program with presettlement fires in the Selway-Bitterroot Wilderness. International Journal of Wildland Fire 4: 157-168. doi: 10.1071/WF9940157

Brown, J.K., and J.K. Smith. 2000. Wildland fire in ecosystems, effects of fire on flora. USDA Forest Service General Technical Report RMRS-GTR-42 Volume 2, Fort Collins, Colorado, USA.

Brown, K.J., and R.J. Hebda. 2002. Origin, development, and dynamics of coastal temperate conifer rainforests of southern Vancouver Island, Canada. Canadian Journal of Forest Research 32: 353-372. doi: 10.1139/x01-197

Brown, P.M., and W.T. Baxter. 2003. Fire history in coast redwood forests of the Mendocino Coast, California. Northwest Science 77: 147-158.

Brown, P.M., M.W. Kaye, and D. Buckley. 1999. Fire history in Douglas-fir and coast redwood forests at Point Reyes National Seashore, California. Northwest Science 73: 205-216.

Brunelle, A., and R.S. Anderson. 2003. Sedimentary charcoal as an indicator of late-Holocene drought in the Sierra Nevada, California, and its relevance to the future. The Holocene 13: 21-28. doi: 10.1191/0959683603hl591rp

Brunelle, A., and C. Whitlock. 2003. Postglacial fire, vegetation, and climate history in the Clearwater Range, northern Idaho, USA. Quaternary Research 60: 307-318. doi: 10.1016/j.yqres.2003.07.009

Brunelle, A., C. Whitlock, P. Bartlein, and K. Kipfmueller. 2005. Holocene fire and vegetation along environmental gradients in the northern Rocky Mountains. Quaternary Science Reviews 24: 2281-2300. doi: 10.1016/j.quascirev.2004.11.010

Buechling, A., and W.L. Baker. 2001. A fire history from tree rings in a high-elevation forest of Rocky Mountain National Park. Canadian Journal of Forest Research 34: 1259-1273.

Burkhardt, J.W., and E.W. Tisdale. 1976. Causes of juniper invasion in southwestern Idaho. Ecology 57: 472-484. doi: 10.2307/1936432

Burns, R.M., and B.H. Honkala. 1990. Silvics of North America. USDA Forest Service Agriculture Handbook 654. Washington, D.C., USA.

Byrne, R. 1978. Fossil record discloses fire history. California Agriculture 10: 13-14.

Byrne, R.I., J. Michaelsen, and A. Soutar. 1977. Fossil charcoal as a measure of wildfire frequency in southern California: a preliminary analysis. Pages 361-367 in: H.A. Mooney and C.E. Conrad, editors. Proceedings of the symposium on environmental consequences of fire and fuel management in Mediterranean ecosystems. USDA Forest Service General Technical Report WO-GTR-3, Washington, D.C., USA.

Cable, D.R. 1975. Range management in the chaparral type and its ecological basis: the status of our knowledge. USDA Forest Service Research Paper RM-RP-155, Fort Collins, Colorado, USA.

Caprio, A.C. 2002. Fire history of lodgepole pine on Chagoopa Plateau, Sequoia and Kings Canyon national parks. Page 38 in: N.G. Sugihara, M. Morales, and T. Morales, editors. Abstracts: managing fire and fuels in the remaining wildlands and open spaces of the southwestern United States. Association for Fire Ecology Miscellaneous Publication 1.

Caprio, A. 2004*a*. LANDFIRE biophysical setting model 0610581 Sierra Nevada subalpine lodgepole pine forest and woodland-wet. <http://www.landfire.gov>. Accessed 4 June 2011.

Caprio, A. 2004*b*. LANDFIRE biophysical setting model 0610582 Sierra Nevada subalpine lodgepole pine forest and woodland-dry. <http://www.landfire.gov>. Accessed 4 June 2011.

Caprio, A.C. 2004*c*. Temporal and spatial dynamics of the pre-Euro-American fire at a watershed scale, Sequoia and Kings Canyon national parks. USDI Park Service, Sequoia and Kings Canyon national parks, Three Rivers, California, USA.

Caprio, A.C. 2008. Reconstructing fire history of lodgepole pine on Chagoopa Plateau, Sequoia National Park, California. Pages 255-262 in: M.G. Narog, editor. Proceedings of the 2002 fire conference: managing fire and fuels in the remaining wildlands and open spaces of the southwestern United States. USDA Forest Service General Technical Report PSW-GTR-189, Albany, California, USA.

Caprio, A.C., C. Conover, M.B. Keifer, and P. Lineback. 1997. Fire management and GIS: a framework for identifying and prioritizing fire planning needs. Pages 102-113 in: Proceedings of the conference on fire in California ecosystems: integrating ecology, prevention, and management. 17-20 November 1997, San Diego, California, USA.

Caprio, A.C., and D.M. Graber. 2000. Returning fire to the mountains: can we successfully restore the ecological role of pre-Euro-American fire regimes to the Sierra Nevada? Pages 233-241 in: D.N. Cole, S.F. McCool, W.T. Borrie, and J. O'Loughlin, editors. Wilderness science in a time of change conference-Volume 5: Wilderness ecosystems, threats, and management. Proceedings RMRS-P-15-VOL-5, USDA Forest Service, Rocky Mountain Research Station, Ogden, Utah, USA.

Caprio, A.C., and P. Lineback. 2002. Pre-twentieth century fire history of Sequoia and Kings Canyon national parks: a review and evaluation of our knowledge. Pages 180-199 in: N.G. Sugihara, M. Morales, and T. Morales, editors. Proceedings of the symposium—fire in California ecosystems: integrating ecology, prevention, and management. Association for Fire Ecology Miscellaneous Publication 1.

Caprio, A.C., and T.W. Swetnam. 1995. Historic fire regimes along an elevational gradient on the west slope of the Sierra Nevada, California. Pages 173-199 in: J.K. Brown, R.W. Mutch, C.W. Spoon, and R.H. Wakimoto, editors. Proceedings of the symposium on fire in wilderness and park management: past lessons and future opportunities. USDA Forest Service General Technical Report INT-GTR-320, Ogden, Utah, USA.

Chappell, C.B., and J.K. Agee. 1996. Fire severity and tree seedling establishment in *Abies magnifica* forests, southern Cascades, Oregon. Ecological Applications 6: 628-640. doi: 10.2307/2269397

Collins, B.M., and S.L. Stephens. 2007. Fire scarring patterns in Sierra Nevada wilderness areas burned by multiple wildland fire use fires. Fire Ecology 3: 53-67. doi: 10.4996/fireecology.0302053

Conard, S.G., and D.R. Weise. 1998. Management of fire regime, fuels, and fire effects in southern California chaparral: lessons from the past and thoughts for the future. Pages 342-350 in: T.L. Pruden and L.A. Brennan, editors. Fire in ecosystem management: shifting the paradigm from suppression to prescription. Tall Timbers Fire Ecology Conference Proceedings 20.

Cope, A.B. 1992*a*. *Abies amabilis.* In: Fire Effects Information System. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. <http://www.fs.fed.us/database/feis/>. Accessed 11 November 2011.

Cope, A.B. 1992*b*. *Picea breweriana.* In: Fire Effects Information System. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. <http://www.fs.fed.us/database/feis/>. Accessed 11 November 2011.

Cope, A.B. 1993. *Pinus contorta* var. *contorta.* In: Fire Effects Information System. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. <http://www.fs.fed.us/database/feis/>. Accessed 4 June 2011.

Daniels, M.L., R.S. Anderson, and C. Whitlock. 2005. Vegetation and fire history since the late Pleistocene from the Trinity Mountains, northwestern California, USA. The Holocene 15: 1062-1071. doi: 10.1191/0959683605hl878ra

Davis, F. 2006. LANDFIRE biophysical setting model 0511130 California coastal live oak woodland and savanna. <http://www.landfire.gov>. Accessed 4 June 2011.

Davis, F.W., and M.I. Borchert. 2006. Central coast bioregion. Pages 321-349 in: N.G. Sugihara, J.W. van Wagtendonk, K.E. Shaffer, J. Fites-Kaufman, and A.E. Thode, editors. Fire in California's ecosystems. University of California Press, Berkeley, USA.

De Gouvenain, R.C., and A.M. Ansary. 2006. Association between fire return interval and population dynamics in four California populations of Tecate cypress (*Cupressus forbesii*). The Southwest Naturalist 51: 447-454. doi: 10.1894/0038-4909(2006)51[447:ABFRIA]2.0.CO;2

Dieterich, J. 1980. The composite fire interval—a tool for more accurate interpretation of fire history. Pages 8-14 in: M. Stokes and J. Dieterich, editors. Proceedings of the fire history workshop. USDA Forest Service General Technical Report RM-GTR-81, Fort Collins, Colorado, USA.

Dingman, S., and T. Esque. 2005. LANDFIRE biophysical setting model inter-mountain basins mixed salt desert scrub. <http://www.landfire.gov>. Accessed 4 June 2011.

Donnegan, J.A., T.T. Veblen, and J.S. Sibold. 2001. Climatic and human influences on fire history in Pike National Forest, central Colorado. Canadian Journal of Forest Research 31: 1526-1539. doi: 10.1139/cjfr-31-9-1526

Drumm, M.K. 1996. Fire history in a mixed conifer series of the Kings River Adaptive Management Area, Sierra National Forest. Thesis, Humboldt State University, Arcata, California, USA.

Erhard, D. 2008. LANDFIRE rapid assessment reference condition model R3MSHB mountain mahogany shrubland. <http://www.landfire.gov>. Accessed 4 June 2011.

Esque, T. ,and G. McPherson. 2005. LANDFIRE biophysical setting model 1311090 Sonoran paloverde-mixed cacti desert scrub. <http://www.landfire.gov>. Accessed 4 June 2011.

Evans, J., R. Crawford, and J. Kagan. 2005. LANDFIRE biophysical setting model 0710600 east Cascades oak-ponderosa pine forest and woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Evens, J., and A. Klein. 2006*a*. LANDFIRE biophysical setting model 0511140 California lower montane blue oak-foothill pine woodland and savanna. <http://www.landfire.gov>. Accessed 4 June 2011.

Evens, J., and A. Klein. 2006*b*. LANDFIRE biophysical setting model 0511180 southern California oak woodland and savanna. <http://www.landfire.gov>. Accessed 4 June 2011.

Everett, R.G. 2008. Dendrochronology-based fire history of mixed-conifer forests in the San Jacinto Mountains, California. Forest Ecology and Management 256: 1805-1814. doi: 10.1016/j.foreco.2008.04.036

Evett, R.R., E.F. Franco-Vizcaino, and S.L. Stephens. 2007. Comparing modern and past fire regimes to assess changes in prehistoric lightning and anthropogenic ignitions in a Jeffrey pine-mixed conifer forest in the Sierra San Pedro Martir, Mexico. Canadian Journal of Forest Research 37: 318-330. doi: 10.1139/X06-280

Falk, D.A. 2004. Scaling rules for fire regimes. Dissertation, University of Arizona, Tucson, USA.

Falk, D.A., E.K. Heyerdahl, P.M. Brown, C.A. Farris, P.Z. Fulé, D. McKenzie, T.W. Swetnam, A.H. Taylor, and M.L. Van Horne. 2011. Multi-scale controls of historical forest-fire regimes: new insights from fire-scar networks. Frontiers in Ecology and the Environment 9: 446-454. doi: 10.1890/100052

Fiegener, R.P. 2002. The influence of sampling intensity on the fire history of the Teakettle Experimental Forest, Sierra Nevada, California. Thesis, University of California, Davis, USA.

Finney, M.A., and R.E. Martin. 1989. Fire history in a *Sequoia sempervirens* forest at Salt Point State Park, California. Canadian Journal of Forest Research 19: 1451-1457. doi: 10.1139/x89-221

Finney, M.A., and R.E. Martin. 1992. Short fire intervals recorded by redwoods at Annadel State Park, California. Madroño 39: 251-262.

Florence, M. 1987. Plant succession on prescribed burn sites in chamise chaparral. Rangelands 9: 119-122.

Foster, J. 2006*a*. LANDFIRE biophysical setting model 0310990 California xeric serpentine chaparral. <http://www.landfire.gov>. Accessed 4 June 2011.

Foster, J. 2006*b*. LANDFIRE biophysical setting model 0711720 Sierran-intermontane desert western white pine-white fir woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Foster, J.S. 1998. Fire regime parameters and their relationships with topography in the east side of the southern Oregon Cascade Range. Thesis, Oregon State University, Corvallis, USA.

Fritz, E. 1931. The role of fire in the redwood region. Journal of Forestry 29: 939-950.

Fry, D.L., and S.L. Stephens. 2006. Influence of humans and climate on the fire history of a ponderosa pine-mixed conifer forest in the southeastern Klamath Mountains, California. Forest Ecology and Management 223: 428-438. doi: 10.1016/j.foreco.2005.12.021

Fulé, P.Z., J.E. Crouse, T.A. Heinlein, M.M. Moore, W.W. Covington, and G. Verkamp. 2003. Mixed-severity fire regime in a high elevation forest of Grand Canyon, Arizona, USA. Landscape Ecology 18: 465-486. doi: 10.1023/A:1026012118011

Gassaway, L. 2005. Spatial and temporal patterns of anthropogenic fire in Yosemite Valley. Thesis, San Francisco State University, California, USA.

Gavin, D.G., F.S. Hu, K. Lertzman, and P. Corbett. 2006. Weak climatic controls of stand-scale fire history during the late Holocene. Ecology 87: 1722-1732. doi: 10.1890/0012-9658(2006)87[1722:WCCOSF]2.0.CO;2

Gedalof, Z. 2011. Climate and spatial patterns of wildfire in North America. Pages 89-115 in: D. McKenzie, C. Miller, and D. A. Falk, editors. The landscape ecology of fire. Ecological studies volume 213. Springer-Verlag, New York, New York, USA. doi: 10.1007/978-94-007-0301-8_4

Gill, L., and A.H. Taylor. 2009. Top-down and bottom-up controls on fire regimes along an elevational gradient on the east slope of the Sierra Nevada, California, USA. Fire Ecology 5: 57-75. doi: 10.4996/fireecology.0503057

Greenlee, J.M. 1983. Vegetation, fire history, and fire potential of Big Basin Redwoods State Park, California. Dissertation, University of California, Santa Cruz, USA.

Greenlee, J.M., and J.H. Langenheim. 1990. Historic fire regimes and their relation to vegetation patterns in the Monterey Bay area of California. American Midland Naturalist 124: 239-253. doi: 10.2307/2426173

Grissino-Mayer, H.D., C.H. Baisan, and T.W. Swetnam. 1995. Fire history in the Piñaleno Mountains of southeastern Arizona: effects of human-related disturbances. Pages 399-407 in: L.H. DeBano, P.H. Ffolliott, A. Ortega-Rubio, G.J. Gottfried, R.H. Hamre, and C.B. Edminster, technical coordinators. USDA Forest Service General Technical Report RM-GTR-264, Flagstaff, Arizona, USA.

Gruell, G.E. 1997. Historical role of fire in pinyon-juniper woodlands, Walker River watershed project, Bridgeport Ranger District. USDA Forest Service, Humboldt-Toiyabe National Forest, Sparks, Nevada, USA.

Gruell, G.E. 1999. Historical and modern roles of fire in pinyon-juniper. Pages 24-28 in: S.B. Monsen and R. Stevens, editors. Proceedings of the conference—ecology and management of pinyon-juniper communities within the interior west. USDA Forest Service Conference Proceedings RMRS-P-9: 24-28, Fort Collins, Colorado, USA.

Gruell, G.E., L.E. Eddleman, and R. Jandl. 1994. Fire history of the pinyon-juniper woodlands of Great Basin National Park. USDI National Park Service Technical Report NPS/PNROSU/NRTR-94/01, Seattle, Washington, USA.

Hallett, D.J., and R.S. Anderson. 2010. Paleofire reconstruction for high-elevation forests in the Sierra Nevada, California, with implications for wildfire synchrony and climate variability in the late Holocene. Quaternary Research 73: 180-190. doi: 10.1016/j.yqres.2009.11.008

Hallett, D.J., and L.V. Hills. 2006. Holocene vegetation dynamics, fire history, lake level and climate change in the Kootenay Valley, southeastern British Columbia, Canada. Journal of Paleolimnology 35: 351-371. doi: 10.1007/s10933-005-1335-6

Hanes, T.L. 1971. Succession after fire in the chaparral of southern California. Ecological Monographs 41: 27-52. doi: 10.2307/1942434

Hemstrom, M., E. Uebler, and B. McArthur. 2008*a*. LANDFIRE rapid assessment reference condition model R#MCONdy mixed conifer—eastside dry. <http://www.landfire.gov>. Accessed 4 June 2011.

Hemstrom, M., E. Uebler, and B. McArthur. 2008*b*. LANDFIRE rapid assessment reference condition model R#SPFI spruce-fir. <http://www.landfire.gov>. Accessed 4 June 2011.

Heyerdahl, E.K., D. Berry, and J.K. Agee. 1995. Fire history database of the western United States: final report. USDA Forest Service, Pacific Northwest Research Station, Seattle, Washington, USA.

Howard, J.L. 1999. *Artemisia tridentata* subsp. *wyomingensis.* In: Fire Effects Information System. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. <http://www.fs.fed.us/database/feis/>. Accessed 12 November 2011.

Howard, J.L. 2002. *Artemisia cana.* In: Fire Effects Information System. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. <http://www.fs.fed.us/database/feis/>. Accessed 12 November 2011.

Huff, M.H., N.E. Seavy, J.D. Alexander, and C.J. Ralph. 2005. Fire and birds in maritime Pacific Northwest. Pages 46-62 in: V.A. Saab and H.D.W. Powell, editors. Fire and avian ecology in North America. Studies in Avian Biology 30.

Hunter, J.C. 1997. Fourteen years of change in two old-growth *Pseudotsuga-Lithocarpus* forests in northern California. Journal of the Torrey Botanical Society 124: 273-279. doi: 10.2307/2997261

Hunter, J.C., and V.T. Parker. 1993. The disturbance regime of an old-growth forest in coastal California. Journal of Vegetation Science 4: 19-24. doi: 10.2307/3235729

Impara, P.C. 1997. Spatial and temporal patterns of fire in the forests of the central Oregon Coast Range. Dissertation, Oregon State University, Corvallis, USA.

Jackson, D.L. 1977. Dating and recurrence frequency of prehistoric mudflows near Big Sur, Monterey County, California. Journal of Research US Geological Survey 5: 17-32.

Jacobs, D.F., D.W. Cole, and J.R. McBride. 1985. Fire history and perpetuation of natural coast redwood ecosystems. Journal of Forestry 83: 494-497.

Jamieson, L.P. 2008. Fire history of a pinyon-juniper/ponderosa pine ecosystem in the intermountain west. Thesis, University of Nevada, Reno, USA.

Johnson, K.A. 2000. *Artemisia tridentata* subsp. *vaseyana.* In: Fire Effects Information System. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. <http://www.fs.fed.us/database/feis/>. Accessed 12 November 2011.

Keeler-Wolf, T. 1991. Ecological survey of the proposed Big Pine Mountain Research Natural Area, Los Padres National Forest, Santa Barbara County, California. USDA Forest Service, Pacific Southwest Research Station, Albany, California, USA.

Keeler-Wolf, T., J. Beyers, and R. Taylor. 2005. LANDFIRE biophysical setting model 0410970 California mesic chaparral. <http://www.landfire.gov>. Accessed 4 June 2011.

Keeler-Wolf, T., and J. Foster. 2006. LANDFIRE biophysical setting model 0411280 northern California coastal scrub. <http://www.landfire.gov>. Accessed 4 June 2011.

Keeley, J.E. 1981. Reproductive cycles and fire regimes. Pages 231-277 in: H.A. Mooney, T.M. Bonnicksen, and N.L. Christensen, editors. Fire regimes and ecosystem properties. USDA Forest Service General Technical Report WO-GTR-26, Washington, D.C., USA.

Keeley, J.E. 1982. Distribution of lightning- and man-caused wildfires in California. Pages 431-437 in: C.C. Conrad and W.C. Oechel, editors. Proceedings of the symposium on dynamics and management of Mediterranean-type ecosystems. USDA Forest Service General Technical Report PSW-GTR-58, Albany, California, USA.

Keeley, J.E, and C.J. Fotheringham. 2001. Historic fire regime in southern California shrublands. Conservation Biology 15: 1536-1548. doi: 10.1046/j.1523-1739.2001.00097.x

Keeley, J.E., M. Baer-Keeley, and C.J. Fotheringham. 2005. Alien plant dynamics following fire in Mediterranean-climate California shrublands. Ecological Applications 15: 2109-2125. doi: 10.1890/04-1222

Keifer, M. 1991. Forest age structure, species composition, and fire disturbance in the Sierra Nevada subalpine zone. Thesis, University of Arizona, Tucson, USA.

Kertis, J., S. Acker, and K. Kopper. 2005. LANDFIRE biophysical setting model 0210370 north Pacific maritime dry-mesic Douglas-fir-western hemlock forest. http://www.landfire.gov>. Accessed 4 June 2011.

Kilgore, B.M. 1973. The ecological role of fire in Sierran conifer forests. Quaternary Research 3: 496-513. doi: 10.1016/0033-5894(73)90010-0

Kilgore, B.M., and D. Taylor. 1979. Fire history of a sequoia-mixed conifer forest. Ecology 60: 129-142. doi: 10.2307/1936475

Kipfmueller, K.F., and W.L. Baker. 2000. A fire history of a subalpine forest in south-eastern Wyoming, USA. Journal of Biogeography 27: 71-85. doi: 10.1046/j.1365-2699.2000.00364.x

Kitchen, S.G. 2010. Historic fire regimes of eastern Great Basin (USA) mountains reconstructed from tree rings. Dissertation, Brigham Young University, Provo, Utah, USA.

Kitchen, S.G., and E.D. McArthur. 2007. Chapter 5. Big and black sagebrush landscapes. Pages 73-95 in: S.M. Hood, M. Miller, editors. Fire ecology and management of the major ecosystems of southern Utah. USDA Forest Service General Technical Report RMRS-GTR-202, Fort Collins, Colorado, USA.

Klein, A., and J. Evens. 2006. LANDFIRE biophysical setting model 0511120 California Central Valley mixed oak savanna. <http://www.landfire.gov>. Accessed 4 June 2011.

Knick, S.T., A.L. Holmes, and R.F. Miller. 2005. The role of fire in structuring sagebrush habitats and bird communities. Studies in Avian Biology 30: 1-13.

Kolden, C., and G. Medlyn. 2005. LANDFIRE biophysical setting model 0610790 Great Basin mixed sagebrush shrubland. <http://www.landfire.gov>. Accessed 4 June 2011.

Kotok, E.I. 1930. Fire, a problem in American forestry. The Scientific Monthly 31: 450-452.

LANDFIRE. 2010. LANDFIRE 1.1.0 Vegetation Dynamics Models. Homepage of the LANDFIRE Project, US Department of Agriculture, Forest Service; US Department of Interior. <http://www.landfire.gov/index.php>. Accessed 10 June 2011

Lenihan, J.M., R. Drapek, D. Bachelet, and R.P. Neilson. Climate change effects on vegetation distribution, carbon, and fire in California. Ecological Applications 13: 1667-1681. doi: 10.1890/025295

Lombardo, K.J., T.W. Swetnam, C.H. Baisan, and M.I. Borchert. 2009. Using bigcone Douglas-fir fire scars and tree rings to reconstruct interior chaparral fire history. Fire Ecology 5: 35-56. doi: 10.4996/fireecology.0503035

Long, C.J., M.J. Power, and P.J. Bartlein. 2010. The effects of fire and tephra deposition on forest vegetation in the central Cascades, Oregon. Quaternary Research 75: 151-158 doi: 10.1016/j.yqres.2010.08.010

Long, C.J., and C. Whitlock. 2002. Fire and vegetation history from the coastal rain forest of the western Oregon coast range. Quaternary Research 58: 215-225. doi: 10.1006/qres.2002.2378

Long, C.J., C. Whitlock, and P.J. Bartlein. 2007. Holocene vegetation and fire history of the coast range, western Oregon, USA. The Holocene 17: 917-926. doi: 10.1177/0959683607082408

Long, C.J., C. Whitlock, P.J. Bartlein, and S.H. Millspaugh. 1998. A 9000-year fire history from the Oregon Coast Range, based on a high-resolution charcoal study. Canadian Journal of Forest Research 28: 774-787. doi: 10.1139/x98-051

Loope, L.L., and G.E. Gruell. 1973. The ecological role of fire in the Jackson Hole area, northwestern Wyoming. Quaternary Research 3: 425-443. doi: 10.1016/0033-5894(73)90007-0

Major, D., G. Medlyn, and C. Kolden. 2005. LANDFIRE biophysical setting model 0610800 inter-mountain basins big sagebrush shrubland. <http://www.landfire.gov>. Accessed 4 June 2011.

Mallek, C.R. 2009. Fire history, stand origins, and the persistence of McNab cypress, northern California, USA. Fire Ecology 5: 100-119. doi: 10.4996/fireecology.0503100

Martin, R.E., and A.H. Johnson. 1979. Fire management of Lava Beds National Monument. Pages 1209-1217 in: R.E. Linn, editor. Proceedings of the first conference on scientific research in the national parks. USDI National Park Service Transactions Proceedings Series Number 5. Washington, D.C., USA.

McBride, J.R., and R.D. Laven. 1976. Scars as an indicator of fire frequency in the San Bernardino Mountains, California. Journal of Forestry 74: 439-442.

McClaran, M.P. 1988. Comparison of fire history estimates between open-scarred and intact *Quercus douglasii*. American Midland Naturalist 120: 432-435. doi: 10.2307/2426015

McCoy, M.M. 2006. High resolution fire and vegetation history of Garry oak ecosystems in British Columbia. Thesis, Simon Fraser University, Vancouver, Canada.

Medlyn, G., and C. Kolden. 2005. LANDFIRE biophysical setting model 0611260 inter-mountain basins montane sagebrush steppe. <http://www.landfire.gov>. Accessed 4 June 2011.

Mensing, S.A. 1992. The impact of European settlement on blue oak (*Quercus douglasii*) regeneration and recruitment in the Tehachapi Mountains, California. Madroño 39: 36-46.

Mensing, S., S. Livingston, and P. Barker. 2006. Long-term fire history in Great Basin sagebrush reconstructed from macroscopic charcoal in spring sediments, Newark Valley, Nevada. Western North American Naturalist 66: 64-77. doi: 10.3398/1527-0904(2006)66[64:LFHIGB]2.0.CO;2

Mensing, S.A., J. Michaelsen, and R. Byrne. 1999. A 560-year record of Santa Ana fires reconstructed from charcoal deposited in the Santa Barbara Basin, California. Quaternary Research 51: 295-305. doi: 10.1006/qres.1999.2035

Millar, C.I., N.L. Stephenson, and S.L. Stephens. 2007. Climate change and forests of the future: managing in the face of uncertainty. Ecological Applications 17: 2145-2151. doi: 10.1890/06-1715.1

Miller, J.D., H.D. Safford, M. Crimmins, and A.E. Thode. 2009. Quantitative evidence for increasing forest fire severity in the Sierra Nevada and southern Cascade mountains, California and Nevada, USA. Ecosystems 12: 16-32. doi: 10.1007/s10021-008-9201-9

Miller, R., C. Baisan, J. Rose, and D. Pacioretty. 2001. Pre- and post-settlement fire regimes in mountain big sagebrush steppe and aspen: the northwestern Great Basin. Final report to the National Interagency Fire Center, Boise, Idaho, USA.

Miller, R.F., and E.K. Heyerdahl. 2008. Fine-scale variation of historical fire regimes in sagebrush-steppe and juniper woodland: an example from California, USA. International Journal of Wildland Fire 17: 245-254. doi: 10.1071/WF07016

Miller, R.F., and J.A. Rose. 1999. Fire history and western juniper encroachment in sagebrush steppe. Journal of Range Management 52: 550-559. doi: 10.2307/4003623

Millspaugh, S.H., and C. Whitlock. 1995. A 750-year fire history based on lake sediment records in the central Yellowstone National Park, USA. The Holocene 5: 283-292. doi: 10.1177/095968369500500303

Minckley, T.A., C. Whitlock, and P.J. Bartlein. 2007. Vegetation, fire, and climate history of the northwestern Great Basin during the last 14,000 years. Quaternary Science Reviews 26: 2167-2184. doi: 10.1016/j.quascirev.2007.04.009

Minnich, R.A. 1989. Chaparral fire history in San Diego County and adjacent northern Baja California: an evaluation of natural fire regimes and the effects of suppression management. Pages 37-47 in: S.C. Keeley, editor. The California chaparral: paradigms reexamined. Natural History Museum of Los Angeles County, California Science Series 34.

Minnich, R.A. 2001. An integrated model of two fire regimes. Conservation Biology 15: 1549-1553. doi: 10.1046/j.1523-1739.2001.01067.x

Minnich, R. 2006. LANDFIRE biophysical setting model 0411770 California closed-cone conifer forest and woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Minnich, R.A., M.G. Barbour, J.H. Burk, and J. Sosa-Ramirez. 2000. California mixed-conifer forests under unmanaged fire regimes in the Sierra San Pedro Martir, Baja California, Mexico. Journal of Biogeography 27: 105-129. doi: 10.1046/j.1365-2699.2000.00368.x

Minnich, R.A., and Y.H. Chou. 1997. Wildland fire patch dynamics in the chaparral of southern California and northern Baja California. International Journal of Wildland Fire 7: 221-248. doi: 10.1071/WF9970221

Mohr, J.A., C. Whitlock, and C.N. Skinner. 2000. Postglacial vegetation and fire history, eastern Klamath Mountains, California, USA. The Holocene 10: 587-601. doi: 10.1191/095968300675837671

Moir, W.H. 1982. A fire history of the high chisos, Big Bend National Park, Texas. The Southwestern Naturalist 27: 87-98. doi: 10.2307/3671411

Moody, T.J., J. Fites-Kaufman, and S.L. Stephens. 2006. Fire history and climate influences from forests in the northern Sierra Nevada, USA. Fire Ecology 2: 115-142. doi: 10.4996/fireecology.0201115

Moritz, M.A. 2003. Spatiotemporal analysis of controls on shrubland fire regimes: age dependency and fire hazard. Ecology 84: 351-361. doi: 10.1890/0012-9658(2003)084[0351:SAOCOS]2.0.CO;2

Moritz, M.A., J.E. Keeley, E.A. Johnson, and A.A. Schaffner. 2004. Testing a basic assumption of shrubland fire management: how important is fuel age? Frontiers in Ecology and the Environment 2: 67-72. doi: 10.1890/1540-9295(2004)002[0067:TABAOS]2.0.CO;2

Nachlinger, J. 2005. LANDFIRE biophysical setting model 1311530 inter-mountain basins greasewood flat. <http://www.landfire.gov>. Accessed 4 June 2011.

Nagel, T.A., and A.H. Taylor. 2005. Fire and persistence of montane chaparral in mixed conifer forest landscapes in the northern Sierra Nevada, Lake Tahoe Basin, California, USA. Journal of the Torrey Botanical Society 132: 442-457. doi: 10.3159/1095-5674(2005)132[442:FAPOMC]2.0.CO;2

National Research Council. 2011. Climate stabilization targets: emissions, concentrations, and impacts over decades to millennia. The National Academies Press, Washington, D.C., USA.

Ne’eman, G., C.J. Fotheringham, and J.E. Keeley. 1999. Patch to landscape patterns in post fire recruitment of a serotinous conifer. Plant Ecology 145: 235-242. doi: 10.1023/A:1009869803192

Norman, S.P. 2007. A 500-year record of fire from a humid coast redwood forest: a report to Save the Redwoods League. USDA Forest Service Redwood Sciences Laboratory, Arcata, California, USA.

Norman, S.P., and A.H. Taylor. 2003. Tropical and north Pacific teleconnections influence fire regimes in pine-dominated forests of north-eastern California USA. Journal of Biogeography 30: 1081-1092. doi: 10.1046/j.1365-2699.2003.00889.x

Norman, S.P., and A.H. Taylor. 2005. Pine forest expansion along a forest-meadow ecotone in northeastern California, USA. Forest Ecology and Management 215: 51-68. doi: 10.1016/j.foreco.2005.05.003

North, M., M. Hurteau, R. Fiegener, and M. Barbour. 2005. Influence of fire and El Niño on tree recruitment varies by species in Sierra mixed conifer. Forest Science 51: 187-197.

North, M., P. Stine, K. O'Hara, W. Zielinski, and S. Stephens. 2009*a*. An ecosystem management strategy for Sierran mixed-conifer forests. USDA Forest Service General Technical Report PSW-GTR-220, Albany, California, USA.

North, M.P., K.M. Van de Water, S.L. Stephens, and B.M. Collins. 2009*b*. Climate, rain shadow, and human-use influences on fire regimes in the eastern Sierra Nevada, California, USA. Fire Ecology 5: 20-34. doi: 10.4996/fireecology.0503020

Novak-Echenique, P. 2005*a*. LANDFIRE biophysical setting model 1310820 Mojave mid-elevation mixed desert scrub. <http://www.landfire.gov>. Accessed 4 June 2011.

Novak-Echenique, P. 2005*b*. LANDFIRE biophysical setting model 1310870 Sonora-Mojave creosotebush-white bursage desert scrub. <http://www.landfire.gov>. Accessed 4 June 2011.

O'Leary, J.R. 1990. California coastal sage scrub: general characteristics and considerations for biological conservation. Pages 24-41 in: A.A. Schoenherr, editor. Endangered plant communities of southern California. Southern California Botanists Special Publication 3.

Olson, D.L., and J.K. Agee. 2005. Historical fires in Douglas-fir dominated riparian forests of the southern Cascades, Oregon. Fire Ecology 1: 50-74. doi: 10.4996/fireecology.0101050

Parminter, J. 1991. Fire history and effects on vegetation in three biogeoclimatic zones of British Columbia. Pages 263-277 in: S.C. Nodvin and T.A. Waldrop, editors. Fire and the environment: ecological and cultural perspectives. USDA Forest Service General Technical Report SE-GTR-69, Asheville, North Carolina, USA.

Paysen, T.E., R.J. Ansley, J.K. Brown, G.J. Gottfried, S.M. Haase, M.G. Harrington, M.G. Narog, S.S. Sacket, and R.C. Wilson. 2000. Fire in western shrubland, woodland, and grassland ecosystems. Pages 121-160 in: J.K. Brown and J.K. Smith, editors. Wildland fire in ecosystems: effects of fire on flora. USDA Forest Service General Technical Report RMRS-GTR-42 Volume 2, Fort Collins, Colorado, USA.

Phillips, C. 2002. Fire-return intervals in mixed-conifer forests of the Kings River Sustainable Forest Ecosystems Project Area. USDA Forest Service General Technical Report PSW-GTR-183, Albany, California, USA.

Pitcher, D.C. 1987. Fire history and age structure in the red fir forests of Sequoia National Park, California. Canadian Journal of Forest Research 17: 582-587. doi: 10.1139/x87-098

Potter, D.A. 1998. Forested communities of the upper montane in the central and southern Sierra Nevada. USDA Forest Service General Technical Report PSW-GTR-169. Pacific Southwest Region Research Station, Albany, California, USA.

Powell, D., and D. Swanson. 2005. LANDFIRE biophysical setting model 710550 Rocky Mountain subapline dry-mesic spruce-fir forest and woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Provencher, L., B. Bracken, and J. Sheffey. 2005. LANDFIRE biophysical setting model 1311030 Great Basin Semi-Desert Chaparral. <http://www.landfire.gov>. Accessed 4 June 2011.

Purcell, K.L., and S.L. Stephens. 1997. Changing fire regimes and the avifauna of California oak woodlands. Studies in Avian Biology 30: 33-45.

Quinnild, C.L., and H.E. Cosby. 1958. Relicts of climax vegetation on two mesas in western North Dakota. Ecology 39: 29-32. doi: 10.2307/1929963

Reeberg, P., and P. Weisberg. 2006. LANDFIRE biophysical setting model 0410190 Great Basin pinyon-juniper woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Reilly, E., P. Martinez, and D. Borgias. 2005*a*. LANDFIRE biophysical setting model 0310210 Klamath-Siskiyou lower montane serpentine mixed conifer woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Reilly, E., P. Martinez, and D. Borgias. 2005*b*. LANDFIRE biophysical setting model 0310220 Klamath-Siskiyou upper montane serpentine mixed conifer woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Reilly, E., D. White, and D. Borgias. 2004. LANDFIRE biophysical setting model 0710290 Mediterranean California mixed oak woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Richardson, J.H., and C. Howell. 2005. LANDFIRE biophysical setting model 1210200 inter-mountain basins subalpine limber-bristlecone woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Richardson, J.H., and L. Provencher. 2005. LANDFIRE biophysical setting model 0610110 Rocky Mountain aspen forest and woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Riegel, G.M., R.F. Miller, C.N. Skinner, and S.E. Smith. 2006. Northeastern plateaus bioregion. Pages 225-263 in: N.G. Sugihara, J.W. van Wagtendonk, K.E. Shaffer, J. Fites-Kaufman, and A.E. Thode, editors. Fire in California's ecosystems. University of California Press, Berkeley, USA.

Rollins, M.G. 2009. LANDFIRE: a nationally consistent vegetation, wildland fire, and fuel assessment. International Journal of Wildland Fire 18: 235-249. doi: 10.1071/WF08088

Romme, W.H., and D.H. Knight. 1981. Fire frequency and subalpine forest succession along a topographic gradient in Wyoming. Ecology 62: 319-326. doi: 10.2307/1936706

Romme, W.H., C.D. Allen, J.D. Bailey, W.L. Baker, B.T. Bestelmeyer, P.M. Brown, K.S. Eisenhart, J.L. Floyd, D.W. Huffman, B.F. Jacobs, R.F. Miller, E.H. Muldavin, T.W. Swetnam, R.J. Tausch, and P.J. Weisberg. 2009. Historical and modern disturbance regimes, stand structures, and landscape dynamics in pinon-juniper vegetation of the western United States. Rangeland Ecology and Management 62: 203-222. doi: 10.2111/08-188R1.1

Ross, C., D. Major, and L. Provencher. 2005. LANDFIRE biophysical setting model 1210620 inter-mountain basins curl-leaf mountain mahogany woodland and shrubland. <http://www.landfire.gov>. Accessed 4 June 2011.

Russell, E.W.B. 1983. Pollen analysis of past vegetation at Point Reyes National Seashore, California. Madroño 30: 1-12.

Safford, H., and T. Keeler-Wolf. 2005. LANDFIRE biophysical setting model 0410270 Mediterranean California dry-mesic mixed conifer forest and woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Safford, H., and J. Sherlock. 2005*a*. LANDFIRE biophysical setting model 0610321 Mediterranean California red fir forest—Cascades. <http://www.landfire.gov>. Accessed 4 June 2011.

Safford, H., and J. Sherlock. 2005*b*. LANDFIRE biophysical setting model 0610322 Mediterranean California red fir forest—southern Sierra. <http://www.landfire.gov>. Accessed 4 June 2011.

Safford, H., J. Sherlock, and N. Sugihara. 2005. LANDFIRE biophysical setting model 0610310 California montane Jeffrey pine(-ponderosa pine) woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Safford, H.D., K. Van de Water, and D. Schmidt. 2011. California Fire Return Interval Departure (FRID) map, 2010 version. USDA Forest Service, Pacific Southwest Region and The Nature Conservancy-California. <http://www.fs.fed.us/r5/rsl/clearinghouse/r5gis/frid/>. Accessed 10 June 2011.

Sapsis, D.B. 1990. Ecological effects of spring and fall prescribed burning on basin big sagebrush/Idaho fescue-bluebunch wheatgrass communities. Thesis, Oregon State University, Corvallis, USA.

Sawyer, J.O., T. Keeler-Wolf, and J.M. Evens. 2009. A manual of California vegetation, second edition. California Native Plant Society, Sacramento, California, USA.

Schellhaas, R.D., D. Spurbeck, P. Ohlson, D. Keenum, and H. Riesterer. 2001. Fire disturbance effects in subalpine forests of north central Washington. USDA Forest Service, Pacific Northwest Region, Portland, Oregon, USA.

Scher, S., and T.M. Jimerson. 1989. Does fire regime determine the distribution of Pacific yew in forested watersheds? Pages 160-161 in: N.H. Berg, editor. Proceedings of the symposium on fire and watershed management. USDA Forest Service General Technical Report PSW-GTR-109, Albany, California, USA.

Scholl, A.E., and A.H. Taylor. 2006. Regeneration patterns in old-growth red fir-western white pine forests in the northern Sierra Nevada, Lake Tahoe, USA. Forest Ecology and Management 235: 143-154. doi: 10.1016/j.foreco.2006.08.006

Scholl, A.E., and A.H. Taylor. 2010. Fire regimes, forest change, and self-organization in an old-growth mixed-conifer forest, Yosemite National Park, USA. Ecological Applications 20: 362-380. doi: 10.1890/08-2324.1

Schwilk, D.W., and J.E. Keeley. 2006. The role of fire refugia in the distribution of *Pinus sabiniana* (Pinaceae) in the southern Sierra Nevada. Madroño 53: 364-372. doi: 10.3120/0024-9637(2006)53[364:TROFRI]2.0.CO;2

Sensenig, T.S. 2002. Development, fire history and current and past growth, of old-growth and young-growth forest stands in the Cascade, Siskiyou and mid-coast mountains of southwestern Oregon. Dissertation, Oregon State University, Corvallis, USA.

Sheppard, P.R., and J.P. Lassoie. 1998. Fire regime of the lodgepole pine forest of Mt. San Jacinto, California. Madroño 45: 47-56.

Sherlock, J., and N. Sugihara. 2008. LANDFIRE rapid assessment reference condition model R1MCONss mixed conifer—south slopes. <http://www.landfire.gov>. Accessed 4 June 2011.

Sherlock, J., N. Sugihara, and H. Safford. 2005*a*. LANDFIRE biophysical setting model 0610270 Mediterranean California dry-mesic mixed conifer forest and woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Sherlock, J., N. Sugihara, and H. Safford. 2005*b*. LANDFIRE biophysical setting model 0610290 Mediterranean California mesic mixed conifer forest and woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Sherlock, J., N. Sugihara, and A. Shlisky. 2008. LANDFIRE rapid assessment reference condition model R1MCONns mixed conifer—north slopes. <http://www.landfire.gov>. Accessed 4 June 2011.

Short, B., S. Kitchen, and L. Chappell. 2005. LANDFIRE biophysical setting model 1210570 Rocky Mountain subalpine-montane limber-bristlecone pine woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Show, S.B., and E.I. Kotok. 1924. The role of fire in the California pine forests. USDA Bulletin 1294, Washington, D.C., USA.

Sibold, J.S., T.T. Veblen, and M.E. Gonzalez. 2006. Spatial and temporal variation in historic fire regimes in subalpine forests across the Colorado Front Range in Rocky Mountain National Park, Colorado, USA. Journal of Biogeography 32: 631-647.

Simpson, M., D. Swanson, and D. Powell. 2005. LANDFIRE biophysical setting model 710560 Rocky Mountain subalpine mesic-wet spruce-fir forest and woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Skinner, C.N. 2002. Fire history in the riparian reserves of the Klamath Mountains. Association for Fire Ecology Miscellaneous Publication 1: 164-169.

Skinner, C.N. 2003. Fire history of upper montane and subalpine glacial basins in the Klamath Mountains of northern California. Pages 145-151 in: K.E.M. Galley, R.C. Klinger, and N.G. Sugihara, editors. Proceedings of Fire Conference 2000—the first national congress on fire ecology, prevention, and management. Tall Timbers Research Station Miscellaneous Publication 13.

Skinner, C.N., C.S. Abbott, D.L. Fry, S.L. Stephens, A.H. Taylor, and V. Trouet. 2009. Human and climatic influences on fire occurrence in California's North Coast Range, USA. Fire Ecology 5: 76-99. doi: 10.4996/fireecology.0503076

Skinner, C.N., J.H. Burk, M.G. Barbour, E. Franco-Vizcaino, and S.L. Stephens. 2008. Influences of climate on fire regimes in montane forests of north-western Mexico. Journal of Biogeography 35: 1436-1451. doi: 10.1111/j.1365-2699.2008.01893.x

Skinner, C.N., and C. Chang. 1996. Fire regimes, past and present. Pages 1041-1069 in: Sierra Nevada ecosystem project final report to Congress. Wildland Resources Center Report 37, University of California, Davis, USA.

Skinner, C., S. Stephens, and R. Everett. 2006. Final report: fire regimes of forests in the Peninsular and Transverse Ranges of southern California. Joint Fire Science Project 01B-3-3-18, Boise, Idaho, USA.

Steinberg, P.D. 2002. *Artemisia arbuscula.* In: Fire Effects Information System. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. <http://www.fs.fed.us/database/feis/>. Accessed 12 November 2011.

Stephens, S.L. 1997. Fire history of a mixed oak-pine forest in the foothills of the Sierra Nevada, El Dorado County, California. Pages 191-197 in: N.H. Pillsbury, J. Verner, and W.D. Tietje, editors. Proceedings of a symposium on oak woodlands: ecology, management, and urban interface issues. USDA Forest Service General Technical Report PSW-GTR-160, Albany, California, USA.

Stephens, S.L. 2001. Fire history differences in adjacent Jeffrey pine and upper montane forests in the eastern Sierra Nevada. International Journal of Wildland Fire 10: 161-167. doi: 10.1071/WF01008

Stephens, S.L., and B.M. Collins. 2004. Fire regimes of mixed conifer forests in the north-central Sierra Nevada at multiple spatial scales. Northwest Science 78: 12-23.

Stephens, S.L., and D.L. Fry. 2005. Fire history in coast redwood stands in the northeastern Santa Cruz Mountains, California. Fire Ecology 1: 2-19. doi: 10.4996/fireecology.0101002

Stephens, S.L., R.E. Martin, and N.E. Clinton. 2007. Prehistoric fire area and emissions from California's forests, woodlands, shrublands, and grasslands. Forest Ecology and Management 251: 205-216. doi: 10.1016/j.foreco.2007.06.005

Stephens, S.L., D.D. Piirto, and D.F. Caramagno. 2004. Fire regimes and resultant forest structure in the native año nuevo Monterey pine (*Pinus radiata*) forest, California. American Midland Naturalist 152: 25-36. doi: 10.1674/0003-0031(2004)152[0025:FRARFS]2.0.CO;2

Stephens, S.L., C.N. Skinner, and S.J. Gill. 2003. Dendrochronology-based fire history of Jeffrey pine-mixed conifer forests in the Sierra San Pedro Martir, Mexico. Canadian Journal of Forest Research 33: 1090-1101. doi: 10.1139/x03-031

Stephenson, J.R., and G.M. Calcarone. 1999. Southern California mountains and foothills assessment: habitat and species conservation issues. USDA Forest Service General Technical Report PSW-GTR-172, Albany, California, USA.

Stuart, J.D. 1987. Fire history of an old-growth forest of *Sequoia sempervirens* (Taxodiaceae) forest in Humboldt Redwoods State Park, California. Madroño 34: 128-141.

Stuart, J.D., and L.A. Salazar. 2000. Fire history of white fir forests in the coastal mountains of northwestern California. Northwest Science 74: 280-285.

Suffling, R. 1993. Induction of vertical zones in sub-alpine valley forests by avalanche-formed fuel breaks. Landscape Ecology 8: 127-138. doi: 10.1007/BF00141592

Sugihara, N., and D. Borgias. 2005. LANDFIRE biophysical setting model 0410140 central and southern California mixed evergreen woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Sugihara, N., D. Borgias, and T. Bradley. 2005*a*. LANDFIRE biophysical setting model 0310430. Mediterranean California mixed evergreen forest. <http://www.landfire.gov>. Accessed 4 June 2011.

Sugihara, N., S. Norman, and J. Sherlock. 2005*b*. LANDFIRE biophysical setting model 0410150 California coastal redwood forest. <http://www.landfire.gov>. Accessed 4 June 2011.

Sugihara, N.G., and L.J. Reed. 1987. Prescribed fire for restoration and maintenance of Bald Hills oak woodlands. Pages 446-451 in: T.R. Plumb and N.H. Pillsbury, editors. Proceedings of the symposium on multiple-use management of California's hardwood resources. USDA Forest Service General Technical Report PSW-GTR-100, Albany, California, USA.

Sugihara, N., J. Sherlock, and A. Shlisky. 2004. LANDFIRE biophysical setting model 0310340 Mediterranean California mesic serpentine woodland and chaparral. <http://www.landfire.gov>. Accessed 4 June 2011.

Sugihara, N., J.W. van Wagtendonk, K. Shaffer, J. Fites-Kaufman, and A.E. Thode. 2006. Fire in California's ecosystems. University of California Press, Berkeley, USA.

Swanson, D. 2005. LANDFIRE biophysical setting model 1210330 Mediterranean California subalpine woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Swetnam, T.W. 1993. Fire history and climate change in giant sequoia groves. Science 262: 885-889. doi: 10.1126/science.262.5135.885

Swetnam, T.W., and C.H. Baisan. 2003. Tree-ring reconstructions of fire and climate history in the Sierra Nevada of California and southwestern United States. Pages 154-191 in: T.T. Veblen, W. Baker, G. Montenegro, and T.W. Swetnam, editors. Fire and climatic change in temperate ecosystems of the western Americas. Springer-Verlag, New York, New York, USA. doi: 10.1007/0-387-21710-X_6

Swetnam, T.W. 1994. A cross-dated fire history from coast redwood near Redwood National Park, California. Canadian Journal of Forest Research 24: 21-31. doi: 10.1139/x94-004

Swetnam, T.W., C.H. Baisan, A.C. Caprio, P.M. Brown, R. Touchan, R.S. Anderson, and D.J. Hallett. 2009. Multi-millennial fire history of the Giant Forest, Sequoia National Park, California, USA. Fire Ecology 5: 120-150. doi: 10.4996/fireecology.0503120

Swetnam, T.W., C.H. Baisan, and K. Morino. 2001. Fire history along elevational transects in the Sierra Nevada, California. Final Report to USDI Geological Survey Biological Resources Division; Sequoia, Kings Canyon, and Yosemite National Parks; Three Rivers and El Portal, California, USA.

Swetnam, T.W., R. Touchan, C.H. Baisan, A.C. Caprio, and P.M. Brown. 1990. Giant sequoia fire history in Mariposa Grove, Yosemite National Park. Yosemite Centennial Symposium Proceedings—natural areas and Yosemite: prospects for the future. USDI National Park Service, Yosemite National Park, California, USA.

Syphard, A., and J. Beyers. 2006. LANDFIRE biophysical setting model 0411100 southern California dry-mesic chaparral. <http://www.landfire.gov>. Accessed 4 June 2011.

Syphard, A., and J. Foster. 2006. LANDFIRE biophysical setting model 0311050 northern and central California dry-mesic chaparral. <http://www.landfire.gov>. Accessed 4 June 2011.

Talley, S.N., and J.R. Griffin. 1980. Fire ecology of a montane pine forest, Junipero Serra Peak, California. Madroño 27: 49-60.

Talluto, M.V., and K.N. Suding. 2008. Historical change in coastal sage scrub in southern California, USA in relation to fire frequency and air pollution. Landscape Ecology 23: 803-815. doi: 10.1007/s10980-008-9238-3

Taylor, A.H. 1993. Fire history and structure of red fir (*Abies magnifica*) forests, Swain Mountain Experimental Forest, Cascade Range, northeastern California. Canadian Journal of Forest Research 23: 1672-1678. doi: 10.1139/x93-208

Taylor, A.H. 2000. Fire regimes and forest changes in mid and upper montane forests of the southern Cascades, Lassen Volcanic National Park, California, USA. Journal of Biogeograpy 27: 87-104. doi: 10.1046/j.1365-2699.2000.00353.x

Taylor, A.H. 2004. Identifying forest reference conditions on early cut-over lands, Lake Tahoe Basin, USA. Ecological Applications 14: 1903-1920. doi: 10.1890/02-5257

Taylor, A.H., and R.M. Beaty. 2005. Climatic influences on fire regimes in the northern Sierra Nevada mountains, Lake Tahoe Basin, Nevada, USA. Journal of Biogeography 32: 425-438. doi: 10.1111/j.1365-2699.2004.01208.x

Taylor, A.H., and C.B. Halpern. 1991. The structure and dynamics of *Abies magnifica* forests in the southern Cascade Range, USA. Journal of Vegetation Science 2: 189-200. doi: 10.2307/3235951

Taylor, A.H., and C.N. Skinner. 1995. Fire regimes and management of old-growth Douglas-fir forests in the Klamath Mountains of northwestern California. Pages 203-208 in: J. Greenlee, editor. Proceedings of the fire effects on rare and endangered species and habitats conference. International Association of Wildland Fire, Missoula, Montana, USA.

Taylor, A.H., and C.N. Skinner. 1998. Fire history and landscape dynamics in a late-successional reserve, Klamath Mountains, California, USA. Forest Ecology and Management 111: 285-301. doi: 10.1016/S0378-1127(98)00342-9

Taylor, A.H., and C.N. Skinner. 2003. Spatial patterns and controls on historical fire regimes and forest structure in the Klamath Mountains. Ecological Applications 13: 704-719. doi: 10.1890/1051-0761(2003)013[0704:SPACOH]2.0.CO;2

Taylor, A.H., and M.N. Solem. 2001. Fire regimes and stand dynamics in an upper montane forest landscape in the southern Cascades, Caribou Wilderness, California. Journal of the Torrey Botanical Society 128: 350-361. doi: 10.2307/3088667

Taylor, R. 2006. LANDFIRE biophysical setting model 0410920 southern California coastal scrub. <http://www.landfire.gov>. Accessed 4 June 2011.

Teensma, P.D.A., J.T. Rienstra, and M.A. Yelter. 1991. Preliminary reconstruction and analysis of change in forest stand age classes of the Oregon Coast Range from 1850 to 1940. Bureau of Land Management Technical Note OR-9, Portland, Oregon, USA.

Thomas, P.A. 1991. Response of succulents to fire: a review. International Journal of Wildland Fire 1: 11-22.

Thornburgh, D.A. 1995. The natural role of fire in the Marble Mountain Wilderness. Pages 273-274 in: J.K. Brown, R.W. Mutch, C.W. Spoon, and R.H. Wakimoto, editors. Proceedings of the symposium on fire in wilderness and park management. USDA Forest Service General Technical Report GTR-INT-320, Ogden, Utah, USA.

Thorne, J. H., B.J. Morgan, and J.A. Kennedy. 2008. Vegetation change over sixty years in the central Sierra Nevada, California, USA. Madroño 55: 223-237. doi: 10.3120/0024-9637-55.3.223

Tirmenstein, D. 1999. *Artemisia tridentata* spp. *tridentata.* In: Fire Effects Information System. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. <http://www.fs.fed.us/database/feis/>. Accessed 12 November 2011.

Toney, J.L., and R.S. Anderson. 2006. A postglacial palaeoecological record from the San Juan Mountains of Colorado USA: fire, climate and vegetation history. The Holocene 16: 505-518. doi: 10.1191/0959683606hl946rp

Touchan, R., C.D. Allen, and T.W. Swetnam. 1996. Fire history and climatic patterns in ponderosa pine and mixed-conifer forests of the Jemez Mountains, northern New Mexico. Pages 33-46 in: Craig D. Allen, technical editor. Fire effects in southwestern forests: proceedings of the second La Mesa Fire symposium. USDA Forest Service General Technical Report RM-GTR-286, Fort Collins, Colorado, USA.

Trouet, V., A.H. Taylor, E.R. Wahl, C.N. Skinner, and S.L. Stephens. 2010. Fire-climate interactions in the American West since 1400 CE. Geophysical Research Letters 37: 1-5. doi: 10.1029/2009GL041695

Uchytil, R.J. 1991. *Picea engelmannii.* In: Fire Effects Information System. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. <http://www.fs.fed.us/database/feis/>. Accessed 12 November 2011.

Valiant, N.M., and S.L. Stephens. 2009. Fire history of a lower elevation Jeffrey pine-mixed conifer forest in the eastern Sierra Nevada, California, USA. Fire Ecology 5: 4-19. doi: 10.4996/fireecology.0503004

Van de Water, K.M., and M.P. North. 2010. Fire history of coniferous riparian forests in the Sierra Nevada. Forest Ecology and Management 260: 384-395. doi: 10.1016/j.foreco.2010.04.032

van Wagtendonk, J.W. 1995. Large fires in wilderness areas. Pages 113-116 in: J.K. Brown, R. W. Mutch, C.W. Spoon, and R.H. Wakimoto, editors. Proceedings of the symposium on fire in wilderness and park management. USDA Forest Service General Technical Report INT-GTR-320, Ogden, Utah, USA.

van Wagtendonk, K., J. Hooke, and N. Sugihara. 2005. LANDFIRE biophysical setting model 0310440 northern California mesic subalpine woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

van Wagtendonk, J.W., K.A. van Wagtendonk, J.B. Meyer, and K.J. Painter. 2002. The use of geographic information for fire management planning in Yosemite National Park. George Wright Forum 19: 19-39.

Veblen, T.T., K.S. Hadley, E.M. Nel, T. Kitzberger, M. Reid, and R. Villalba. 1994. Disturbance regime and disturbance interactions in a Rocky Mountain subalpine forest. Journal of Ecology 82: 125-135. doi: 10.2307/2261392

Veirs, S.D., Jr. 1980. The role of fire in northern coast redwood forest dynamics. Pages 190-209 in: Proceedings of the second conference on scientific research in the national parks. USDI National Park Service, Washington, D.C., USA.

Veirs, S.D. 1982. Coast redwood forest: stand dynamics, successional status, and the role of fire. Pages 119-141 in: J.E. Means, editor. Forest succession and stand development research in the northwest. Oregon State University, Corvallis, USA.

Vogl, R.J. 1973. Ecology of knobcone pine in the Santa Ana Mountains, California. Ecological Monographs 43: 125-143. doi: 10.2307/1942191

Vogl, R.J. 1976. An introduction to the plant communities of the Santa Ana and San Jacinto Mountains. Pages 77-98 in: J. Latting, editor. Proceedings of the symposium—plant communities of southern California. California Native Plant Society Special Publication 2, Sacramento, California, USA.

Vogl, R.J., W.P. Armstrong, K.L. White, and K.L. Cole. 1977. The closed-cone pines and cypresses. Pages 295-358 in: M.G. Barbour and J. Major, editors. Terrestrial vegetation of California. John Wiley and Sons, New York, New York, USA.

Wadleigh, L., and M.J. Jenkins. 1996. Fire frequency and the vegetative mosaic of a spruce-fir forest in northern Utah. Great Basin Naturalist 56: 28-37.

Wagener, W.W. 1961. Past fire incidence in Sierra Nevada forests. Journal of Forestry 59: 739-748.

Wall, T.G., R.F. Miller, and T.G. Svejcar. 2001. Juniper encroachment into aspen in the northwest Great Basin. Journal of Range Management 54: 691-698. doi: 10.2307/4003673

Walsh, M.K., C. Whitlock, and P.J. Bartlein. 2008. A 14,300-year-long record of fire-vegetation-climate linkages at Battle Ground Lake, southwestern Washington. Quaternary Research 70: 251-264. doi: 10.1016/j.yqres.2008.05.002

Walter, H.S., and L.A. Taha. 1999. Regeneration of bishop pine (*Pinus muricata*) in the absence and presence of fire: a case study from Santa Cruz Island, California. Pages 172-181 in: Proceedings of the fifth California islands symposium. USDI National Park Service, Mediterranean Coast Network, Thousand Oaks, California, USA.

Wangler, M.J., and R.A. Minnich. 1996. Fire and succession in pinyon-juniper woodlands of the San Bernardino Mountains, California. Madroño 43: 493-514.

Warner, T.E. 1980. Fire history in the yellow pine forest of Kings Canyon National Park. Pages 89-92 in: M.A. Stokes and J.H. Dieterich, editors. Proceedings of a technical conference—fire history workshop. USDA Forest Service General Technical Report RM-GTR-81, Fort Collins, Colorado, USA.

Weisberg, P. 2005. LANDFIRE biophysical setting model 0610190 Great Basin pinyon-juniper woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Wells, M.L., and A. Getis. 1999. The spatial characteristics of stand structure in *Pinus torreyana.* Plant Ecology 143: 153-170. doi: 10.1023/A:1009866702320

Wells, M.L., J.F. O'Leary, J. Franklin, J. Michaelsen, and D.E. McKinsey. 2003. Variations in a regional fire regime related to vegetation type in San Diego County, California (USA). Landscape Ecology 19: 139-152. doi: 10.1023/B:LAND.0000021713.81489.a7

Westerling, A. L., H.G. Hidalgo, D.R. Cayan, and T.W. Swetnam. 2006. Warming and earlier spring increase western US forest wildfire activity. Science 313: 940-943. doi: 10.1126/science.1128834

Westman, W.E. 1982. Coastal sage scrub succession. Pages 91-99 in: C.E. Conrad and W.C. Oechel, editors. Proceedings of the symposium on dynamics and management of Mediterranean-type ecosystems. USDA Forest Service General Technical Report PSW-GTR-58, Berkeley, California, USA.

White, M.A., and J.L. Vankat. 1993. Middle and high elevation coniferous forest communities of the North Rim region of Grand Canyon National Park, Arizona, USA. Vegetatio 109: 161-174. doi: 10.1007/BF00044748

Whitlock, C., J. Marlon, C. Briles, A. Brunelle, C. Long, and P. Bartlein. 2008. Long-term relations among fire, fuel, and climate in the north-western US based on lake-sediment studies. International Journal of Wildland Fire 17: 72-83. doi: 10.1071/WF07025

Wiens, J.A., G. Hayward, H.D. Safford, and C. Giffen, editors. In press. Historical environmental variation in conservation and natural resource management. John Wiley and Sons, New York, New York, USA.

Wieslander, A. E. 1935. A vegetation type map for California. Madroño 3: 140-144.

Wilken, G.C. 1967. History and fire record of a timberland brush field in the Sierra Nevada of California. Ecology 48: 302-304. doi: 10.2307/1933114

Wills, R., K. Merriam, and D. Sandifer. 2005. LANDFIRE biophysical setting model 0710080 north Pacific oak woodland. <http://www.landfire.gov>. Accessed 4 June 2011.

Wills, R.D., and J.D. Stuart. 1994. Fire history and stand development of a Douglas-fir/hardwood forest in northern California. Northwest Science 68: 205-252.

Winward, A.H. 1991. A renewed commitment to management of sagebrush grasslands. Pages 2-7 in: Management of the sagebrush steppe. Oregon State University, Agriculture Experiment Station Special Report 880, Corvallis, USA.

Wright, H.A. 1986. Manipulating rangeland ecosystems with fire. Pages 3-6 in: E.V. Komarek, S.S. Coleman, C.E. Lewis, and G.W. Tanner, editors. Prescribed fire and smoke management. Society for Range Management, Washington, D.C., USA.

Wright, H.A., and A.W. Bailey. 1982. Fire ecology: United States and southern Canada. John Wiley and Sons, New York, New York, USA.

Young, J.A., and R.A. Evans. 1981. Demography and fire history of a western juniper stand. Journal of Range Management 34: 501-506. doi: 10.2307/3898108

Zedler, P.H. 1981. Vegetation change in chaparral and desert communities in San Diego County, California. Pages 415-420 in: D.C. West, H.H. Shugart, D.B. Botkin, and D.E., Reichle, editors. Forest succession. Springer-Verlag, New York, New York, USA.

Zedler, P.H. 1995. Fire frequency in southern California shrublands: biological effects and management options. Pages 101-112 in: J.E. Keeley and T. Scott, editors. Brushfires in California wildlands: ecology and resource management. International Association of Wildland Fire, Fairfield, Washington, USA.

Zielinski, M., and L. Provencher. 2005. LANDFIRE biophysical setting model 0611250 intermountain basins big sagebrush steppe. <http://www.landfire.gov>. Accessed 4 June 2011.

Zobel, D.B., L.F. Roth, and G.M. Hawk. 1982. Ecology, pathology, and management of Port-Orford-cedar (*Chamaecyparis lawsoniana*). USDA Forest Service General Technical Report PNW-GTR-184, Portland, Oregon, USA.