

What Was the Role of Fire in Coast Redwood Forests?¹

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Fire has long been recognized as an important disturbance in coast redwood (*Sequoia sempervirens*) forests (Fritz 1931), but the exact nature of historical fire regimes in many areas is uncertain. Coast redwood grows in relatively mesic, often fog-shrouded coastal locations not usually associated with widespread or frequent fires. Past reviews of coast redwood fire ecology have concluded that over much of its range fires were typically infrequent and that effects on forest composition and structure varied depending primarily on fire severity (for example, Sawyer and others 2000). However, a growing body of evidence from fire scars documents that frequent, episodic surface fires were a dominant fire regime in many coast redwood forests, and that loss of surface fires has occurred over the recent century in response to loss of Native American ignition sources, active fire suppression, and other changes brought about by Euro-American settlement and land use (Brown and Baxter 2003; Brown and others 1999; Brown and Swetnam 1994; Finney 1990; Finney and Martin 1989, 1992). This fire-scar evidence is usually poorly preserved as a result of both the nature of the preservation of fire-scar records on coast redwood trees and past harvest practices—especially broadcast burning of slash—that has tended to remove the record from many locations.

In this talk, I described results from fire history reconstructions in coast redwood and coast redwood/Douglas-fir forests at Point Reyes National Seashore, Jackson State Forest in the Mendocino area, and Redwood National Park. Fire chronologies based mainly on fire scar evidence from these locations span the past two to four centuries, and average pre-20th century intervals between fires varied from seven to 20 years (*table 1, fig. 1*). Although the tree-ring evidence is fragmentary and—as with all historical reconstructions—an imperfect model of past conditions, these data document that coast redwood forests in these areas experienced fire regimes of frequent, recurrent surface fires. Many of the past fires were likely set by humans because of a general lack of lightning in forests along the coast.

Loss of surface fires from coast redwood forests has led to changes in associated ecosystem patterns and processes that are analogous to those in ponderosa pine and other low-elevation forests of the western North America. Frequent surface fires promote open, low-density stand structure by killing a majority of tree regeneration before it has a chance to reach canopy status. Fire-intolerant species, such as grand fir, western hemlock, and hardwoods, would have had less opportunity to establish between fires and likely were not as abundant in pre-fire exclusion forests as they are today. Biomass of shrubs also would have been reduced because of recurrent mortality during episodic burns. Duff and woody litter would have been reduced, and

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diversity and biomass of grass and herbaceous vegetation likely were correspondingly greater. Increases in fuel loads, tree density, canopy coverage, and formation of ladder fuels result in feedbacks to the fire regime, with the result that crown fires replace surface fires as the dominant fire behavior when fires occur. Although fire exclusion on the California Coast occurred later in the 20th century than many other low elevation forests in North America, coast redwood forests are often nearly twice as productive as pine or mixed-conifer forests of the central mountains or Sierra Nevada in California. Because of higher productivity in these relatively warm, wet coastal forests, changes in community composition and fuels structure may be as pronounced as in other forests that experienced earlier loss of surface fire regimes.

Table 1—Fire frequencies in coast redwood stands at Jackson Demonstration State Forest.

Site	Period analyzed	Intervals per stand			Intervals per tree	
		MFI ± 1 SD (yr)	WMPI (yr)	Range (yr)	No. of trees	MFI ± 1 SD (yr)
PYG	1700s	-	-	-	-	-
	1750 - 1850	17.4 ± 12.3	15.8	6 - 34	5	24.5 ± 5.9
NSF	1800s	13.2 ± 6.3	12.9	6 - 23	6	18.8 ± 7.7
	1700s	21.8 ± 4.6	22.1	16 - 27	3	21.6 ± 0.1
TCR	1750 - 1850	12.9 ± 6.7	12.4	5 - 23	3	14.4 ± 5.1
	1800s	9.8 ± 4.4	9.6	5 - 19	4	13.0 ± 5.1
HLT	1700s	9.4 ± 7.4	8.3	3 - 28	2	9.9 ± 2.3
	1750 - 1850	9.3 ± 5.3	8.8	3 - 19	3	12.4 ± 0.9
WTF	1800s	10.0 ± 5.2	9.6	4 - 19	3	11.1 ± 0.7
	1700s	7.1 ± 4.9	6.5	3 - 18	8	11.6 ± 6.2
CHG	1750 - 1850	6.0 ± 3.3	5.7	2 - 15	10	13.0 ± 4.9
	1800s	8.6 ± 4.6	8.1	2 - 17	14	14.5 ± 2.6
DRG	1700s	-	-	-	2	14.7 ± 3.3
	1750 - 1850	10.0 ± 3.4	10.1	5 - 15	5	12.7 ± 1.5
DRG	1800s	13.4 ± 2.4	13.6	10 - 17	8	14.9 ± 2.3
	1700s	10.8 ± 3.3	10.9	6 - 16	8	12.2 ± 2.0
DRG	1750 - 1850	11.6 ± 4.7	11.5	6 - 21	8	13.7 ± 2.0
	1800s	9.8 ± 3.1	9.8	7 - 14	7	14.1 ± 3.7
DRG	1700s	14.0 ± 5.1	14.0	10 - 22	3	15.0 ± 4.3
	1750 - 1850	15.2 ± 6.2	15.1	9 - 23	4	17.9 ± 3.2
	1800s	15.5 ± 5.0	15.6	9 - 22	5	24.1 ± 7.0

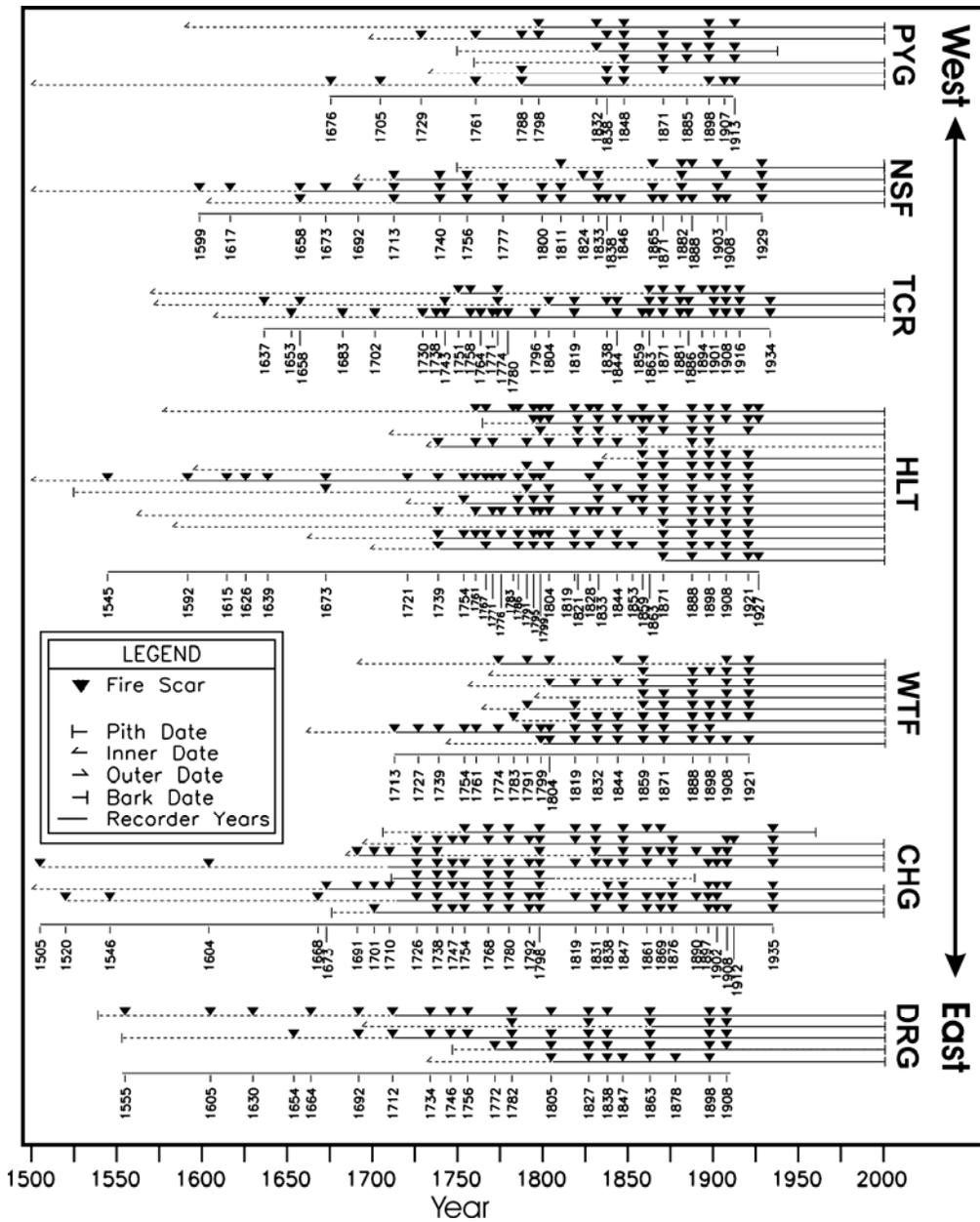


Figure 1—Fire chronologies along an ocean (top) to inland (bottom) gradient at Jackson Demonstration State Forest on the Mendocino Coast (Brown and Baxter 2003). All samples are from coast redwood. Time spans of individual trees are represented by horizontal lines with inverted triangles marking dates of fire scars. Pith or bark dates refer to pith or bark present on cross sections while inside or outside rings refer to cross sections with unknown numbers of rings to pith or bark. Inside dates on several trees extend earlier than 1500. Dashed segments on trees are decayed segments where fire scars are likely missing from the fire-scar record. These segments were not used to calculate point (tree) fire frequencies in *table 1*.

The probable role of Native-Americans in fire ignitions leads to questions concerning the appropriate approach to management of coast redwood ecosystems. In the absence of human ignitions, it is likely that fires would not have been as common,

and historical forest composition and structure may have been quite different under such altered fire regimes. Historical data are meant to provide restoration ecologists and land managers with descriptions of ecosystem conditions over long time scales, regardless of whether they were influenced by human or natural factors (for example, Landres and others 1999). How these data are used in management decisions is then as much a societal as it is an ecological question. Do we attempt to restore these forests to historical conditions, or let them return naturally to a fire regime that would have likely been present in the absence of Native American influence?

In my experience, I have found fire-scar records in coast redwood forests to be rare because of poor preservation. But in those locations where fire-scar records have been compiled, fire histories document these forests are not burning today nearly as often as they did in the past. Recognition of changes caused by loss of surface fires has resulted in efforts to restore historical processes in many low-elevation forests throughout western North America. Fire histories reconstructed by these studies provide both guidelines and justification for ecological restoration efforts in coast redwood forests throughout much of its range.

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