HISTORICAL EFFECTS OF LOGGING ON THE FORESTS OF THE CASCADE AND SIERRA NEVADA RANGES OF CALIFORNIA

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Abstract: Ponderosa pine, Jeffrey pine, mixed conifer, and white fir forests of the Cascade and Sierra Nevada Ranges of California have been important resources and were extensively altered by timber harvest between 1850 and 1950. Many historical logging operations were small in size and of short duration. Other operations encompassed thousands of acres and existed for relatively long periods of time. Before settlement of California by Europeans, there were extensive forests in the Cascade and Sierra Nevada Ranges of California, much of it suitable for timber production. The forests were dominated by a variety of tree species depending on factors such as elevation, precipitation, aspect, and soils of the particular location. Tree species found as monocultures or in mixed assemblages include ponderosa pine (*Pinus ponderosa*), Jeffrey pine (*P. jeffreyi*), sugar pine (*P. lambertiana*), lodgepole pine (*P. contorta*), California white fir (*Abies concolor lowiana*), incense-cedar (*Calocedrus decurrens*), and California black oak (*Quercus kelloggii*). The forests, especially those dominated by ponderosa and Jeffrey pine, generally were composed of small stands of even-aged trees interspersed with other even-aged patches of different ages. Vegetation found under the forest canopy was generally composed of perennial grasses with few shrubs. The logging industry evolved from the labor-intensive and inefficient days of the 1850's to the relatively efficient railroad logging methods of the 1930's and later. Annual production of timber ranged from as little as 500,000 board feet in the early 1850's to nearly 5 billion board feet by 1950. By 1950, at least 20 percent of the forests in the Cascade and Sierra Nevada Ranges had been harvested as least once. Because of their value as lumber and the susceptibility of sugar pine to white pine blister rust (*Cronartium ribicola*), ponderosa and sugar pine declined, and incense-cedar and California white fir increased over those parts of the forest where they coexisted. At present, trees are, in general, younger and smaller in diameter and height; however, occasional larger, older trees that were left after logging can still be found. Also, grasses have declined and higher amounts of shrubs and small trees are now found under the tree canopy.

The existing landscape of California and its constituent flora and fauna are the result of the climatic regime, characteristics of the landscape before settlement by Europeans, and effects of their activities (e.g., grazing, agricultural development, timber harvest, wildfire suppression and prevention) subsequent to settlement. Timber harvest, in particular, has caused dramatic changes in vegetation composition and structure. Timber harvest, especially in the forests of the Cascade and Sierra Nevada Ranges of California, affected extensive acres of forest especially between 1860 and 1950. Many sources document the growth of and methods used by the timber industry in California; however, they generally do not characterize the composition and structure of the vegetation before and after harvest.

This paper describes the effects of timber harvesting between about 1860 and 1950 on ponderosa pine, Jeffrey pine, mixed conifer, and white fir forests in the Cascade and Sierra Nevada Ranges of California. It also describes the composition and structure of the forest before 1850 and the evolution of the lumber industry in California. To characterize typical long-standing harvest practices, it details the effects of the logging operations of the Weed/Long-Bell, Michigan-California, and Madera Sugar Pine companies.

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METHODS

The basic information source for this report was historic literature. In addition, we examined early photographs and available timber valuation reports (descriptions of the vegetation communities on lands that were transferred to the U.S.D.A. Forest Service by timber companies for cutting rights on National Forests).

STUDY AREA

Our study area is the region occupied by ponderosa pine, Jeffrey pine, mixed conifer, and white fir forests in California from the Oregon border, east and west of the Cascades and Sierra Nevada, south to the Tehachapi Mountains (Fig. 1). Our study area is also defined in time from the date of the first commercial logging operations in these forests, in the 1860's, until the demise of railroad logging in those areas, about 1950.

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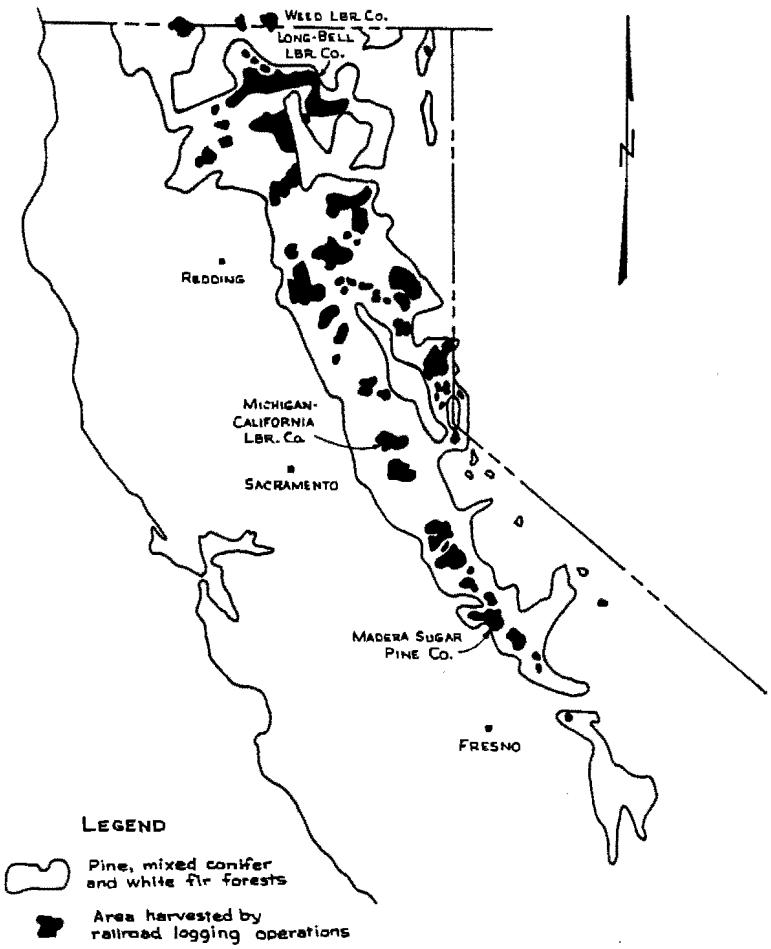

Fig. 1. Distribution of ponderosa pine, Jeffrey pine, mixed conifer, and white fir forests in the Cascade and Sierra Nevada Ranges of California, general locations where logging, principally railroad logging, took place, and locations of the Weed/Long-Bell Lumber Co., Michigan-California Lumber Co., and Madera Sugar Pine Co.

RESULTS AND DISCUSSION

Presettlement Forest Composition and Structure

Before settlement by Europeans, the ponderosa pine, Jeffrey pine, mixed conifer, and white fir forests of California were quite variable in composition. On large expanses of land, especially east of the Sierra Nevada crest, these forests consisted of monotypic stands or mixtures of ponderosa pine (*Pinus ponderosa*) and Jeffrey pine (*P. jeffreyi*), or mixtures with Washoe pine (*P. washoensis*) (Berry 1917, Applegate 1938, Laudenslayer et al. 1989). On other sites, especially west of the Sierra Nevada crest, ponderosa and Jeffrey pines were found in association with sugar pine (*P. lambertiana*), lodgepole pine (*P. contorta*), western white pine (*P. monticola*), California white fir (*Abies concolor lowiana*), incense-cedar (*Calocedrus decurrens*), and California black oak (*Quercus kelloggii*) (Fitch 1900*a,b*; Marshall 1900, Sudworth 1900).

Forest structure was also quite variable. Younger forests (40 to 60 years old) were often dense. These dense stands were later opened by frequent fire and natural thinning (Sudworth 1900). In older forests, trees were larger, both in diameter and height, and there were fewer trees in contrast with forested stands of today. Fitch (1900*b*) reported that many standing ponderosa, sugar, and western white pines in the Yosemite region exceeded 200 feet in height and 7 feet in diameter. On a single half-acre, Fitch (1900*b*) found 19 sugar pines averaging 70 feet in height from the ground to the first limb and 50 inches in diameter. Ground cover, especially in forested areas that were relatively open, was composed largely of perennial grasses. Shrub cover was generally less than it is today.

Wildfire in the ponderosa pine, Jeffrey pine, mixed conifer, and white fir forests of California contributed substantially to the historical structure of the forest (Biswell 1989). For the 10-year period preceding 1920, forests dominated by ponderosa or Jeffrey pine, averaged 350 lightning-caused fires each year, and 415,000 acres were burned (Show and Kotok 1924). Fire frequencies, on the areas studied by Show and Kotok, ranged from three to eleven years; most of these fires were of light intensity. Biswell (1989) concluded that widespread fires in Sierra Nevada mixed-conifer forests occurred at approximately eight-year intervals; in Oregon, intervals between widespread fires were approximately eight years and in Arizona intervals were between six and seven years.

The volume of standing timber in ponderosa pine, Jeffrey pine, mixed conifer, and white fir forests, before substantial timber was harvested, also varied. Estimates of board feet may be made using several methods. The following reports did not specify the rule used to estimate volume; therefore, one must be cautious when making comparisons. Sudworth (1900) reported that standing volume of pine forests on the Stanislaus and Lake Tahoe Forest Reserves averaged about 20,000 board feet per acre but, on some sites, reached 50,000 board feet per acre. In the ponderosa and sugar pine forest northeast of Sonora, Fitch (1900*a*) reported that approximately 30,000 board feet per acre was standing. At selected sites in the Yosemite area, Fitch (1900*b*) reported from 80,000 to 140,000 board feet per acre. Marshall (1900) reported, for the forests in the vicinity of Mount Lyell, that an average stand of timber had 20,000 board feet per acre, but better sites exceeded 40,000 board feet per acre. Berry (1917) indicated that standing volume east of the Sierra Nevada crest averaged 11,000 board feet per acre, but standing volumes west of the Sierra Nevada crest, in areas where sugar pines were prevalent, averaged 50,000 board feet per acre; the maximum stand volume recorded by Berry was 200,000 board feet per acre, of which about 75 percent was sugar pine.

Evolution of Lumber Industry

Wood and wood products have long been important in the development of California. Wood was harvested for logs, timbers, boards, and shingles to construct dwellings, barns, commercial buildings, and other structures. Wood fuel was used for heating, cooking, and fueling steam-powered equipment. Other uses of wood were for timbers and planks for mines, water ditches, and railroads, and for box shook (wooden slats for fabricating fruit boxes), coffins, and sash and door stock.

Small quantities of wood products were produced in California from the time of the earliest Spanish settlements (Zivnuska et al. 1965). During the Spanish and Mexican periods (before 1848), wood was used sparingly as a building material because much of the development was in areas relatively far removed from timber growing lands (Ayres 1958). Much of the lumber that was used before about 1840 was imported from South America or the eastern United States (Supernowicz 1981). However, hardwoods used in the floors of houses owned by the wealthy Spanish and Mexican elite may have been imported from Spain or Australia (Ayres 1958).

Sawmills began to appear in California about 1818 with a mill at Fort Ross. Mills were established before 1850 near San Gabriel (1822) (Cox 1974), Sonoma, and Yerba Buena (San Francisco) (1838), at a location in Santa Cruz County (1842), near Oakland, at several locations in Marin County, and at Coloma (Ayres 1958). The demands of mines of the Gold Rush period, beginning in 1848, caused expansion of the timber industry, especially the redwood industry. By 1852 there were 70 mills along the Mendocino coast sending lumber to market (Ayres 1958).

Technology used to harvest and mill lumber also developed as the industry grew. Early procedures that were very labor intensive were quickly replaced by efficient, labor-saving machines. Initially, trees were felled, limbed, and cut into logs with axes and hand-powered saws. Logs were then taken to the mill using animal power by skidding them on the ground, along a lubricated, log-lined chute, or with high wheels, or hauling on wagons (Niles and Supernowicz 1990). If the terrain was relatively steep, logs were moved by gravity on lubricated chutes.

The earliest mills were located close to the timber to be harvested because adequate methods for transporting logs were lacking. Whipsaws were used to saw logs in these inefficient mills. Two sawyers, positioned above and beneath the log, slowly made lengthwise cuts through logs, producing boards.

Beginning in the 1870's, if adequate water supplies were available, logs or lumber could be shipped from the woods using flumes. Several of

after harvest, residual trees, varied considerably. On private timberlands, generally trees under 12 in. dbh (diameter at breast height) were left standing (Ayres 1958). However, National Forest sales, in the 1920's and '30's, generally called for leaving trees under 24 to 28 in. dbh depending on species. Trees that were defective were frequently left standing. Seed trees were left on private lands by operators concerned with sustained yields, however this was not a common practice especially in the early years of the industry (Ayres 1958). On National Forests, regeneration cutting on a large scale was not common. Rather, sanitation, salvage, and selective cutting were normal (J. Fiske, pers. comm). On sites where intensive harvests were allowed, operators were required to leave the smaller trees, that were not merchantable, and some residual overstory trees to reforest the site.

California tax policy also influenced timber harvest practices on private lands. In the 1920's, taxes assessed on the industry were based on timber inventories rather than yield. If more than 70 percent of the standing timber was harvested, the remaining timber growing on the site would be exempt from property taxes for 40 years. This practice discouraged professional selection management and commercial thinnings. This tax policy encouraged clearcutting and shelterwood harvest methods, as well as harvesting within 39 years of the last cut, before the young forests reached physical or economic maturity (J. Fiske, pers. comm.).

Historically, logging generally left large amounts of material on the ground after harvest. Only desirable logs were taken to the mill, while undesirable logs and the logging slash were usually left on the site. The shake industry was particularly known to leave large amounts of material after harvest.

Leaving residual trees did not necessarily ensure their survival after harvest. Yarding logs, especially when high-lead cable logging was used, frequently damaged residual trees. Wildfires also could reduce the residual stand of trees. The risk of fire after harvest was high because of the large amounts of logging debris left and the common use of open fires for cooking and heating. Steam-powered engines, especially those that were wood fired, also increased the risk of wildfire. Often cutover lands were severely burned, sometimes intentionally but often inadvertently.

Stump height and the number of snags remaining after harvest were also variable. In many pine stands, the tree butts were swollen or scarred as a result of the frequent, naturally occurring low-intensity fires that burned before fire prevention and suppression programs existed (Munger 1917, Show and Kotok 1924). Trees with these characteristics were cut high, up to 36 inches above the ground (Berry 1917), to avoid having to deal with these flaws at the mill. National Forests however, required much shorter stumps, usually 18 inches or less in height (Supernowicz 1981). Snags were generally removed from the forest on private and public lands because of concerns about wildfire and potential injury to forest users. Forest Service policy regarding timber sales dating from the 1920's vigorously stipulated removing snags (Ayres 1958). Snag removal was of such importance that machines were developed to more easily drop snags. Burning snags in the wet season was also an effective method of removal.

The pattern of timber harvest, regardless of operation, was generally similar. In contrast to today's practice of distributing small cut units throughout the landscape, historic logging practice was to gradually work across relatively large blocks of land. Railroads and roads were costly to construct, and revenues derived from timber harvest had to be great enough to cover construction and other costs and return a profit to the investors. Harvesting relatively large blocks of land at one time reduced the cost of railroad and road construction relative to income. The size and patterning of the blocks varied depending on costs of development of the access system and harvest, the quality of timber available, and the market conditions.

Weed/Long-Bell Lumber Company

The Weed Lumber Co. (Fig. 1) began operations in 1900 and by 1918 became part of the Long-Bell Lumber Co. Timber harvested was predominately ponderosa pine with lesser amounts of California white fir, sugar pine, Douglas-fir, incense-cedar, and California black oak. Initial timber harvests occurred near Weed in eastern Siskiyou County, and over time operations moved east to near Crank Mountain overlooking the Pit River in Modoc County (Signor 1982, Shoup and Baker 1987) (Fig. 2). The operation was based on a logging railroad that hauled raw logs to the mill at Weed for processing. The main line of the railroad extended 80 (Signor 1982) to 100 miles (Shoup and Baker 1987) into the forest. In addition to the main

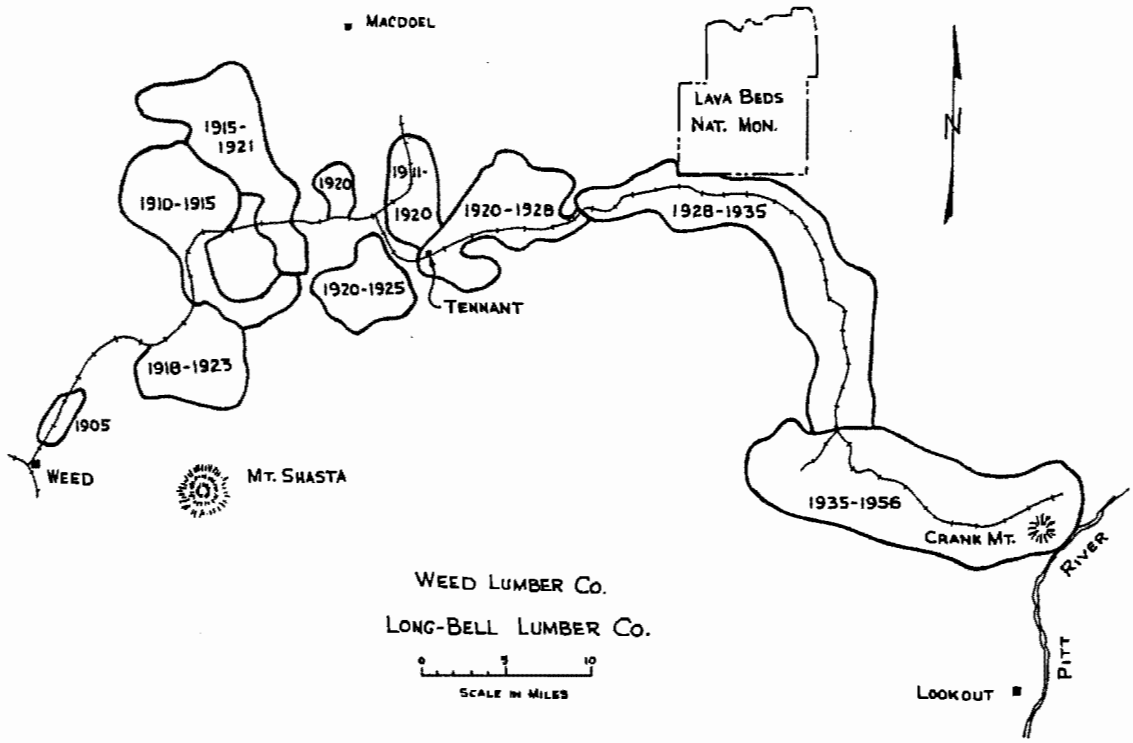

Fig. 2. The Weed/Long-Bell Lumber Co. operations (1900 to 1955) showing the general location of the main logging railroad line and the general locations of harvest units through time.

line, approximately 500 miles of logging spurs were constructed. Log trucks gradually increased in importance so that by 1956 the railroad was scrapped (Shoup and Baker 1987).

The practice of the Weed/Long-Bell operation was to take all merchantable trees, leaving only those too small, defective, or not marketable. The company generally left few seed trees for reproduction of the stand and dense shrub vegetation quickly occupied the areas after harvest (Shoup and Baker 1987). Records indicate that the Weed/Long-Bell operations often left California white fir, incense-cedar and in some locations a residual understory of pine (B.C. Goldsmith 1933, unpubl. land valuation reports on file at the Klamath National Forest Supervisor's Office, Yreka, Calif.).

Timber production increased during the early years of the Weed/Long-Bell operation and then held relatively stable. In 1901, approximately 10.5 million board feet, primarily sugar pine, was produced (Shoup and Baker 1987). Land holdings of the company exceeded 70,000 acres by 1905 and contained over 1.2 billion board feet of ponderosa pine and other conifers. By 1908, approximately 12,000 acres of nearly pure ponderosa pine stands had been harvested (Shoup and Baker 1981). Production in 1905 reached 25 million board feet and by 1915 reached 75 million board feet. From 1921 through 1955 approximately 3.5 billion board feet were produced, an average of 100 million board feet per year (Shoup and Baker 1987). The total production of the Weed/Long-Bell operation, from inception to scrapping of its railroad logging operation, approached 4.3 billion board feet (Shoup and Baker 1981).

Michigan-California Lumber Company

The Michigan-California Lumber Company (Fig. 1) and its predecessors, American River Land and Lumber Co. (1891-1900), El Dorado Lumber Co. (1900-1911), and C.D. Danaher Pine Co. (1911-1918), operated on the Georgetown Divide, El Dorado County (Fig. 3). Ponderosa and sugar pine were the principal tree species harvested, however a large volume of fir was said to have been cut during the Danaher period. In the early years of operation, logs were shipped by a 2900-foot log chute into the South Fork of the American River and then floated to the mill at Folsom. This system was effective only during years with substantial water flows.

By 1901, an alternative transport system was in place. Initial milling was done at a mill near Pino Grande. Rough-cut lumber was shipped over 20

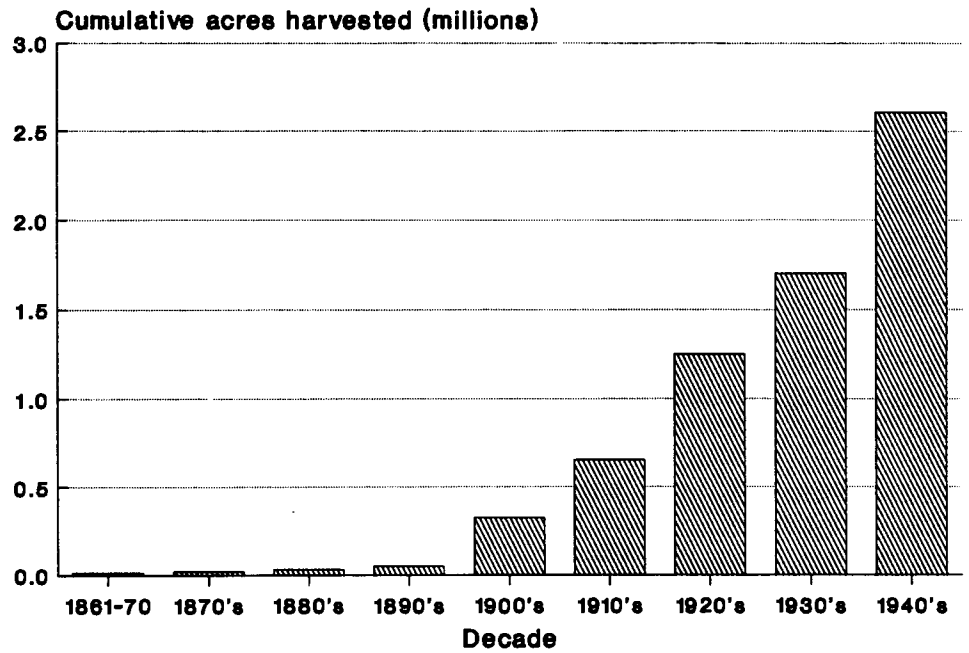

Fig. 6 Estimated cumulative acres harvested by decade for ponderosa pine, Jeffrey pine, and white fir forests of the Cascade and Sierra Nevada ranges of California (1861-1950).

the total production from the 51,000 acres. An estimate of the number of acres of forest may be calculated by dividing the total harvest (number of board feet) by the average production of an acre of forest (production is defined as the commercial output of finished lumber from the mill measured in board feet). Assuming an average production of 20,000 board feet per acre for all of these forest types, insignificant harvest of "young-growth" forest, and that historical acreages of these vegetation types did not differ much from current values, approximately 2.7 million acres were harvested before 1950 or about 20 percent of the current total (Fig. 6). Harvested areas were scattered throughout the pine region (Fig. 1). These figures did not necessarily take into account large amounts of wood used for ties and timbers by logging railroads nor did they necessarily account for pulpwood for paper or the take of fuelwood. The use of fuelwood for heating and cooking, and especially as fuel for all of the steam-powered equipment, must have been extensive.

Stand-Level Species Composition and Structure. The composition of the ponderosa pine, Jeffrey pine, mixed conifer, and California white fir forests has changed as a result of historic harvest practices combined with the change in fire regime and livestock grazing. Both ponderosa pine and sugar pine have declined at many locations relative to incense-cedar and especially, white fir. In some localities, sugar pine has almost disappeared. However, the decline of sugar pine cannot be ascribed entirely to the historic logging period. Almost all sugar pines are susceptible to white pine blister rust (*Cronartium ribicola*) considered to be the most destructive disease of trees of all ages (Fowells 1965). White pine blister rust was introduced from Europe and is most damaging to smaller-sized five-needle pines on moist sites especially in northern California (Arvola 1978).

The change in the fire regime also has permitted encroachment of California white fir and incense-cedar into the forest. In the understory, the dominant perennial grasses have declined in contrast to woody shrubs. Opening the stands by logging permitted the establishment of many species of shrubs. The reduction in fire frequency reduced shrub mortality and unmanaged livestock grazing, early in the century, depleted many grasses.

The structure of harvested areas has also been altered. In areas that were harvested during our period of study, the resulting forest is now generally composed of younger and smaller trees with a few older, larger trees that were left at the time of

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