Natural Forest Succession and Fire History

Modified from Gruell and others (1982)

"Succession" is the term applied to a change or sequence of vegetation on a given site through time following disturbance. For example, a succession of plant communities that follows clearcutting with broadcast burning of slash might be (1) grass-forb, (2) shrubfield, (3) saplings and shrubs, (4) pole-size trees, (5) mature forest, and (6) old-growth forest. Succession also applies to the sequence of species that dominate a general community type. Thus, a forest stand may initially be dominated by ponderosa pine (a shade-intolerant tree), which gives way to inland Douglas-fir (intermediate in shade-tolerance), and finally to grand fir (shade-tolerant) with increasing time since disturbance. Forest managers need to be able to understand and predict succession because vegetation change greatly affects management for livestock grazing, wildlife, timber, fire and fuels, watershed, and recreational values.

The Lick Creek photopoints present a rare opportunity to witness forest succession in managed stands through 88 years. But to assess this management-influenced succession, we should be aware of the kind of forest succession that preceded it and may have occurred if the stand was left unmanaged. The photopoints occur on two general types of sites or "habitat types," which support somewhat different vegetation and have different patterns of succession (Pfister and others 1977). A habitat type is a measure of site (physical environment), based upon the potential or "climax" vegetation—the type of plant community that represents the conceptual self-perpetuating endpoint of succession.

Fire and other disturbances usually intervene and prevent development of climax communities in these forests, but a knowledge of shade tolerances and successional trends allows us to identify the theoretical or potential climax on most sites. This ultimate vegetative type is a reflection of the overall physical environment. The potential climax vegetation can be used as clues to the site conditions (Pfister and others 1977).

All of the Lick Creek photopoints occur on sites where Douglas-fir is the potential climax dominant tree. The majority of points are located on two relatively dry Douglas-fir habitat types:

1. *Pseudotsuga menziesii*/*Calamagrostis rubescens* h.t., *Pinus ponderosa* phase (PSME/CARU-PIPO; Douglas-fir/pinegrass h.t., ponderosa pine phase).
2. *Pseudotsuga menziesii*/*Symphoricarpos albus* h.t., *Calamagrostis rubescens* phase (PSME/SYAL-CARU; Douglas-fir/snowberry h.t., pinegrass phase).

However, four photopoints are on moist Douglas-fir habitat types:

1. *Pseudotsuga menziesii*/*Vaccinium caespitosum* h.t. (PSME/VACA; Douglas-fir/dwarf huckleberry h.t.); and
2. *Pseudotsuga menziesii*/*Vaccinium globulare* h.t., *Arctostaphylos uva-ursi* phase (PSME/VAGL-ARUV; Douglas-fir/blue huckleberry h.t., kinnikinnick phase).

It is evident from the early photographs, accounts of early forest conditions (Leiberg 1899), and fire history studies (Arno 1976), that prior to logging and the advent of fire suppression in the early 1900's, the lower elevation forests of the Bitterroot Valley were made up of moderately dense stands of large ponderosa pine (fig. 2). Surface fires swept through these stands at intervals of between 3 and 30 years (Arno 1976), killing most of the smallest trees but causing little damage except for fire scars at the base of some, but not all, of the larger trees (Leiberg 1899). These fires killed the aerial portions of grasses and shrubs, but afterwards most of these species regenerated from underground organs. Tree seedlings also became established after the fires.

Lightning was a principal cause of these fires, but recent studies (Arno and others 1997; Barrett and Arno 1982) point out that Native American Indians (Salish and others) were also an important ignition source. Settlement by European-Americans became significant in the Bitterroot Valley below Lick Creek starting about 1860, but apparently this had little

Figure 2—Photo of unlogged forest at Lick Creek in 1909.

effect upon the role of fire until about 1900 (Arno 1976). Fire scar studies from similar sites in the Bitterroot Valley indicate that the pattern of frequent surface fires was in effect at least as early as 1500 (Barrett and Arno 1982).

In the spring of 1980, Arno and Gruell spent several hours searching the central portion of the photopoint study area for evidence of fire history. They found that large, old fire-scarred stumps (mostly ponderosa pine, but also some Douglas-fir on north-facing slopes) were common throughout the area. Evidently, most of these were the remains of trees cut in the 1907 to 1911 logging, and many of them were scarred by at least six to 12 fires in the 200 to 250 years prior to logging. Six of the best preserved and most complete fire-scar sequences, four from pitch-laden ponderosa pine stumps and two from live ponderosa pine, were cross-sectioned. The cross-sections were sanded and annual rings were counted under magnification to date the probable year of each fire scar. These fire-scar dates from the individual stumps and trees were then correlated and adjusted slightly to account for minor ring-counting errors as described by Arno and Sneck (1977). This produced a fire chronology for the stand as a whole. Table 1 presents the individual fire scar records and the fire chronology.

These records indicate that light surface fires swept through the forest at intervals averaging 7 years between A.D. 1600 and 1895. One of the cross-sectioned stumps (labeled “below photopoint 6” in table 1) shows 16 fire scars between 1752 and 1890 (fig. 3). For a more detailed discussion of the fire history for ponderosa pine forests on the Bitterroot National Forest see Arno and Petersen (1983).

Although the sites at Lick Creek are capable of supporting both ponderosa pine and Douglas-fir, the pre-1900 fire regime brought about development of uneven-aged stands of ponderosa pine. Douglas-fir saplings are readily killed by surface fires, whereas some ponderosa pine saplings often survive. (Small Douglas-fir are sensitive to fire because of the thin, photosynthetically active bark along with their small buds and fine branchlets. Ponderosa pine of comparable size have already developed a layer of corky outer bark and they have large, protected buds and thicker twigs.) Thus, there was a continual selection pressure against Douglas-fir. This phenomenon was acknowledged by W. W. White (1924). Figure 4 depicts relative abundance of these two conifers in both the overstory and the understory during the pre-1900 fire regime. If it had not been for frequent fires, the more shade-tolerant Douglas-fir would have been able to regenerate under the pine and eventually dominate the site, as shown in figure 5.

Field observations by Leiberg (1899) and historical accounts compiled by Weaver (1974) and Barrett (1981) state that many pre-1900 ponderosa pine/Douglas-fir forests had open, grassy undergrowth, and this is borne out by the 1909 photographs at Lick Creek. (See also Leiberg 1899.)

The native, dry grassland species—bluebunch wheatgrass, Idaho fescue, and arrowleaf balsamroot (identifiable in the early photographs)—formed the undergrowth on the drier sites (PSME/CARU-PIPO and PSME/SYAL-CARU). The undergrowth on moist habitat types (PSME/VACA and PSME/VAGL-ARUV) was primarily sod-forming (rhizomatous) woodland grasses—pinegrass and elk sedge—along with the low shrubs—kinnikinnick, snowberry, white spiraea, dwarf huckleberry, and blue huckleberry. On both dry and moist habitat types, understory conifers and large shrubs such as bitterbrush, willow, and serviceberry were scarce because of the frequent surface fires.

The 1909 photos, as well as the Leiberg (1899) photos, show that although the understories were open, the stands were “heavily stocked” with large ponderosa pine trees (modest growth rates and relatively high basal areas of tree stems per acre attest that these early stands were fully stocked or overstocked in terms of timber production). The trees had clear boles because the lower limbs had been shaded out and scorched by fire. In addition to fire, dominance of large pines contributed to a scarcity of tree regeneration and shrubs in the understory. Shrubs and small trees were probably also inhibited by tree root systems utilizing much of the soil moisture and nutrients.

The overstory pines often lived 300 to 600 years (Arno and others 1995). They evidently died and were replaced individually or in small groups. When openings occurred, new pines would generally grow and fill them. Some saplings would succumb to damage by the next surface fire, but others would survive.

Table 1—Fire chronologies for six fire-scarred trees and stumps at the Lick Creek photopoints, Bitterroot National Forest; X = an individual fire scar (42 fires between 1600 and 1900 yields a mean fire interval of 7 years).

Estimated fire year*	Live tree at photopoint 3 (cambium 1979)	Stump at photopoint 2 (cut about 1905)	Stump at photopoint 1 (Cut after 1903)	Live tree below photopoint 6 (cambium 1979)	Stump below photopoint 6 (cut about 1902)	Stump at photopoint 8 (cut about 1906)
1895		X		X		
1890		X		X	X	
1883			X			X
1875		X				
1871	X	X	X	X	X	X
1861			X	X	X	
1856				X		X
1850		X		X		
1846						X
1842			X			X
1838	X	X		X	X	X
1832						X
1828	X				X	
1821	X		X		X	X
1818		X	X		X	
1811					X	X
1806		X	X		X	
1798		X	X		X	X
1795	X		X			X
1790					X	X
1786			X			
1783		X			X	X
1780		X				
1776	X	X			X	X
1771					X	X
1758	X					X
1752	X				X	X
1744	X		X			X
1734			X			
1729						X
1719			X			
1713						X
1707			X			
1702(?)						X(?)
1693						X
1681						X
1672	X					
1657						X
1651						X
1646						X
1642						X
1618						X
1598						X
1586						X
1552						X
1545						X
1444						X
pith date	1648	1724	1617	rotten	rotten	1428

*These samples were not dendrochronologically cross-dated.

Occasionally, combinations of unusually dry years coupled with epidemics of yellow pine butterfly and pine beetles would cause substantial mortality as they did in some dry sites in the Bitterroot Valley during the early 1970's. C.A. Wellner (personal communication) noted that the beetle caused heavy losses at Trapper Creek and in some other areas of the Bitterroot in the mid- to late-1930's, which were dry years. Still, old-growth ponderosa pine forests with open understories perpetuated by surface fires evidently dominated the Lick Creek area for centuries prior to 1900 (see also Arno and others 1995, 1997).

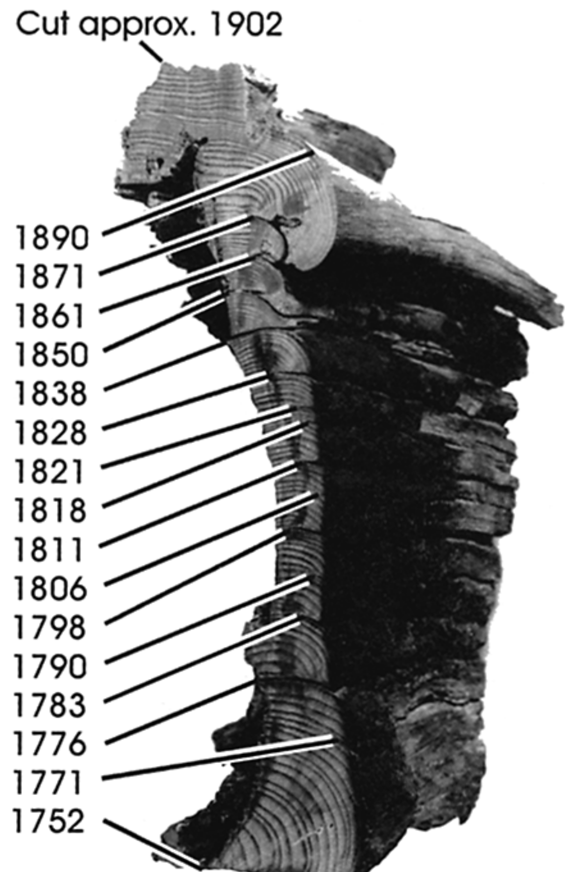

Figure 3—Cross-section from the ponderosa pine stump below photopoint 6 (see table 1) at Lick Creek, showing 16 fire scars between 1752 and 1890 (Gruell and others 1982).

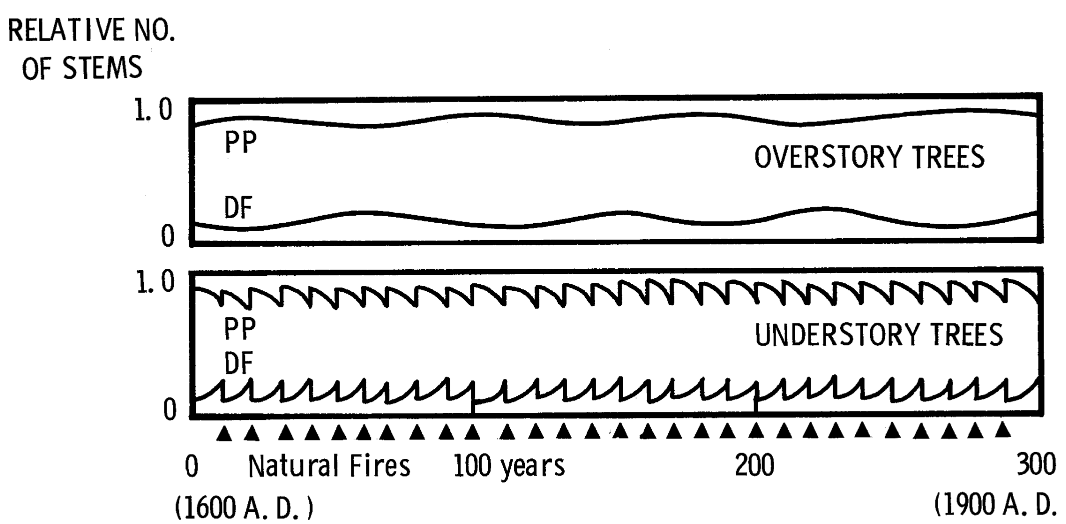

Figure 4—The effect of succession on relative abundance of ponderosa pine and Douglas-fir at Lick Creek: hypothesized succession with underburns at 5- to 15-year intervals (Gruell and others 1982).

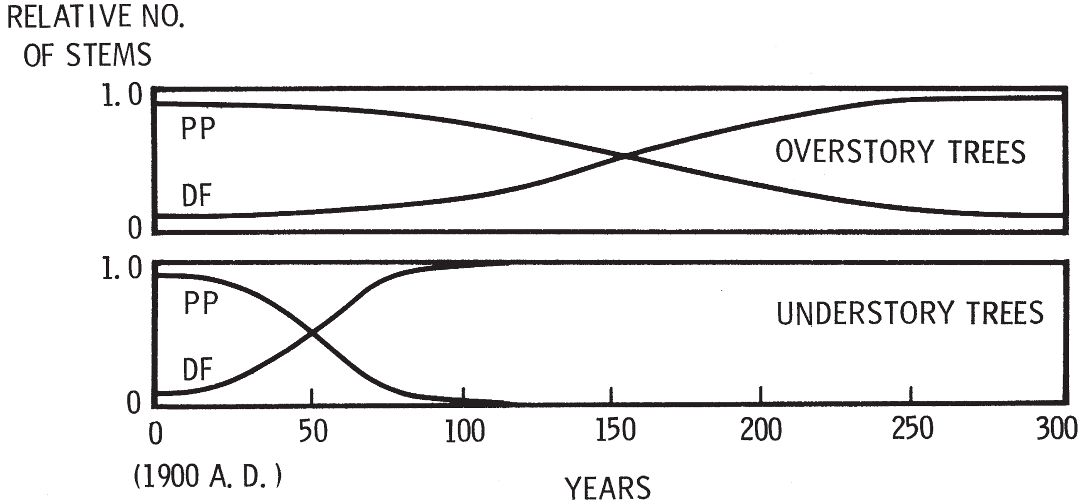

Figure 5—The effect of succession on relative abundance of ponderosa pine and Douglas-fir at Lick Creek: hypothesized succession with fire control and no cutting (Gruell and others 1982).