Silvicultural Systems for Managing Ponderosa Pine[1]

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Abstract

Silviculturists have primarily relied on classical even-aged silvicultural systems (the planned series of treatments for tending, harvesting, and re-establishing a stand) for ponderosa pine, with uneven-aged systems used to a lesser degree. Current management practices involve greater innovation because of conflicting management objectives. Silvicultural systems used in the foreseeable future will likely meld traditional systems with greater reliance on variation across the landscape because of differing values and desired outputs. Significant changes in the management of ponderosa pine are reviewed; issues that likely will affect the future management of ponderosa pine systems are listed; and critical gaps in our understanding of ponderosa pine silviculture that may affect our management in the near term are identified.

Introduction

Ponderosa pine (*Pinus ponderosa* P. & C. Lawson) is one of the most widely distributed pines in western North America (Oliver and Ryker 1990). It occurs from southern British Columbia in Canada into Mexico, and from the Pacific Coast along the California-Oregon border as far east as western Nebraska and Oklahoma. Two subspecies are recognized; Pacific ponderosa pine (var. *ponderosa*) ranges along the flanks of the Cascade and Sierra Nevada Ranges as far south as Riverside County in southern California, while Rocky Mountain ponderosa pine (var. *scopulorum* Engelm.) occurs in Idaho, Montana, Utah, and east of the continental divide (USDA 2004).

Ponderosa pine is a major component of three forest cover types (Eyre 1980). The Interior Ponderosa Pine cover type (Society of American Foresters Type 237), the most widespread pine type in the western United States, is composed of pure or mixed stands east of the Cascade-Sierra Nevada crest in northern California, east of the Cascade Range crest in Oregon and Washington, and eastward into the Plains States: Pacific Ponderosa Pine-Douglas-fir cover type (Society of American Foresters Type 244) is composed of mixed stands on eastern slopes of the Coast Range and western slopes of the Cascades in Oregon, extending southward through the Klamath Mountains into northern California. The Pacific Ponderosa Pine Type (Society of American Foresters Type 245) is essentially pure stands of ponderosa pine in the Klamath Mountains of Oregon and Washington, extending southward along the Sierra Nevada into central California. Ponderosa pine also occurs as a minor component in at least 23 other cover types.

Of all the North American forest types, ponderosa pine forests offer the greatest opportunity for meeting multiple objectives such as water, minerals, timber, forage,

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wildlife habitat, recreation, subsistence or spiritual purposes, firewood, homesites, and scenic beauty (Morgan 1988). Given that ponderosa occurs across diverse landscapes with broad ecological amplitude, and the relative ease in accessibility at lower elevations has led to greater intensity of management activities for multiple objectives compared to cover types occurring at higher elevations, it is not surprising that numerous silvicultural systems for stand management on public lands have been applied. In this paper, the traditional or conventional silvicultural systems recommended for managing ponderosa pine on public lands are summarized, recent changes in ponderosa pine silviculture and the underlying causes for the change are examined, future management actions and their effect on ponderosa pine sites are hypothesized, and the critical gaps in our understanding of ponderosa pine silviculture are identified.

Traditional Silvicultural Systems

Graham and Jain (2004) traced the role of silviculturists from the late 1800s with the transfer of public lands into homesteads, through the rapid expansion westward of railroads, the creation of national forests, and the advent of timber management and fire suppression for the growth and protection of cities and town during in the late 1800s and early 1900s, into the era of multiple use beginning in the 1960s. Ponderosa pine stands figured prominently in these events because they were relatively easy to access and they yielded high quality timber. With passage of the National Forest Management Act of 1976, silvicultural systems that emphasized multiple values of ponderosa pine stand became increasingly important.

Traditional or conventional silvicultural systems (the planned series of treatments for tending, harvesting, and re-establishing a stand) used for managing ponderosa pine stands include clearcutting, seed tree, shelterwood, single tree selection, and group selection. These systems, named after the regeneration method, are fully defined in Helms (1998). Clearcutting is the method of cutting essentially all existing trees, producing a fully exposed microsite for the development of a new age class, with regeneration from either natural seeding, direct seeding, or planted seedlings. A variant is overstory removal, when the presence of advance regeneration is sufficient to warrant no additional action other than the complete harvesting of the overstory. The seed tree method is the cutting of all trees except for a limited number of widely dispersed trees retained for seed production. The shelterwood method is the cutting of most trees, leaving only those needed to produce sufficient shade or insulation from temperature extremes to produce a new age class in a moderated microenvironment. Variants are based on the distribution of the residual trees left for shading. Selection methods involve the removal of some trees in all size classes either singly (single tree selection) or in groups (group selection), with regeneration occurring in the resulting gaps and continued growth of all remaining trees. Clearcutting, seed tree, and shelterwood methods result in the establishment of even-aged stands while selection methods maintain uneven-aged stands. The coppice method may be used for species that sprout from the stump or produce root suckers, thus is not applicable for managing ponderosa pine.

Ponderosa pine stands have been managed to provide a wide range of outputs and values by using these silvicultural systems, including timber, habitat for large game and avian species, protection of wildland resources from damaging insects, disease, or wildfire, quality forage for domestic ungulates, and water. Traditional or conventional silvicultural systems commonly recommended for managing ponderosa pine are summarized (*table 1*) for four regions: 1) northern Rocky Mountains, including western Montana, northern Idaho, and extreme northeastern Washington; 2) Pacific Northwest, including eastside forests of Washington and Oregon; 3) westside California, including southwest Oregon; and 4) eastside California.

In general, the even-aged silvicultural system based on clearcutting was frequently recommended for use across all four regions through the early 1980s. This recommendation likely was in response to a general preference for managing ponderosa pine stands with a primary emphasis on timber production that featured conversion of old stands to more vigorously growing young stands. Other even-aged systems, including seed tree and shelterwood methods, were clearly secondary in preference. A special variant of even-aged management practices in the Blue Mountains of northeastern Oregon and southeastern Washington was either a complete or partial overstory removal of old-growth ponderosa pine followed by management of the advance regeneration that developed after decades of fire exclusion or suppression. This practice had at least three underpinnings: 1) the overstory ponderosa pine was growing slowly and had high susceptibility to bark beetles; 2) the overstory ponderosa pine had very high value and revenue that was generated could be used for other land management projects within the timber sale area; and 3) management of the advanced regeneration avoided the high cost of tree planting, it maintained a green, forested setting thus avoided the visual impacts associated with clearcutting, and it capitalized on the initial growth of the understory trees (Powell 1994). Selection systems were restricted in application to special areas such as high visibility stands surrounding recreation areas.

Clearcutting and other even-aged methods continued to be the preferred means of managing ponderosa pine stands into the early 1990s, except in the Blue Mountains where overstory removals prevailed. Clearcutting and planting was recommended when timber management was the primary objective because it required less sale administration, resulted in lower costs of wood production, and probably had higher wood productivity because of fewer difficulties in controlling tree density compared to uneven-aged management (Helms and Lotan 1988). At the same time, uneven-aged systems became increasingly popular in the northern Rocky Mountains and the Pacific Northwest for protecting visuals, for managing recreation sites, and for providing wildlife habitat. The advisability of uneven-aged systems for ponderosa pine remained in question throughout California.

More recently, uneven-aged silvicultural systems for managing ponderosa pine were frequently suggested, with emphasis on group selection. A further refinement is termed “free selection”, described as the combination of group and single tree selection systems with reserve trees left in all structural stages, and recommended for creating clumpy and irregular stand structure that is preferred for species such as the northern goshawk (*Accipiter gentiles*) (Graham and Jain 2004). Even-aged systems, especially seed tree or shelterwood systems with retention of some overstory into the next rotation, also were recommended because they ensured some high structure, had greater visual appeal, and accommodated the needs of more cavity-dependent avian species.

Table 1—*Recommended silvicultural systems for ponderosa pine forests in the northern Rocky Mountains, Pacific Northwest, eastside California, and westside California.*

Region	Recommended silvicultural system	Source
Northern Rocky Mountains	Clearcutting with planting on dry sites, with limited use of seed tree or shelterwood methods; clearcutting with planting on moist sites, with limited use of group selection or seed tree methods	Foiles and Curtis 1973
Pacific Northwest	Clearcutting, limited use of shelterwood method; selection systems used for special areas	Barrett 1977
Northern Rocky Mountains	Clearcutting or shelterwood methods; selection systems used for special areas	Adams 1980
Pacific Northwest	Overstory removal followed by shelterwood or clearcutting method	Scott 1980
Eastside California	Clearcutting method with planting	Helms 1980
Westside California	Clearcutting or seed tree method, and group selection	Helms 1980
Northern Rocky Mountains	Clearcutting and planting on sites with infections of dwarf mistletoe; single tree or group selection on dry sites where natural regeneration is difficult to obtain; group selection or shelterwood on more moist sites	Ryker and Losensky 1983
Pacific Northwest	Both even-aged and uneven-aged systems; uneven-aged systems sometimes preferred for visuals, in recreations, and for wildlife habitat	Barrett and others 1983
Westside California	Clearcutting, seed tree, or shelterwood methods; uneven-aged systems are impractical	Oliver and others 1983
Westside California	Seed tree, shelterwood, and group selection methods	Minore and Kingsley 1983
Northern Rocky Mountains	Group selection, seed tree, or shelterwood systems with increasing emphasis on green-tree retention	Adams 1994
Pacific Northwest	Multiple-entry management using either long-rotation even-aged systems or uneven-aged system; some type of group selection likely to be most successful	Tesch 1994
Eastside California	Group selection with regeneration best achieved by planting	Helms 1994
Westside California	Clearcutting or seed-tree well-suited where wood production is the primary objective; group selection preferable to single-tree selection because of overstory competition constraints	Helms 1994

Silvicultural Systems Currently In Use

Currently, the full array of silvicultural systems, ranging from clearcutting to single and group selection, are found applied to ponderosa pine management on public lands from the northern Rocky Mountains to California. All the variations applied in specific situations probably are adequately defined and described as deviations within a more formally defined general system.

Perhaps the greatest change in management of ponderosa pine is the prominence of intermediate cuttings which have no expectation or objective of natural regeneration, especially improvement cuttings designed to remove less desirable trees in order to meet stand composition or vertical structure objectives. The emphasis of improvement cutting is on improving the stand structure rather than removal of any particular size stem. Many density-reduction treatments on dry sites in the Blue Mountains are improvement cuttings rather than strict thinning treatments because they have a strong species composition and tree quality component to them.

At least six recent social, political, and legal changes may appreciably influence the application of silvicultural prescriptions designed to implement silvicultural systems for managing ponderosa pine ecosystems:

- The USDA Forest Service adopted in 1992 a new policy limiting the use of clearcutting on national forests. The clearcutting regeneration method currently may be used only under specific circumstances such as to maintain habitat for threatened, endangered, or sensitive species; to enhance wildlife habitat; to rehabilitate lands adversely impacted by natural disturbances, or to rehabilitate lands due to past management practices.

- The Regional Forester amended the forest plans of National Forests in Oregon and Washington east of the crest of the Cascade Range in Oregon and Washington to include three “Eastside Screens”, one of which established a policy restricting the harvesting of trees greater than 53 centimeters (21 inches) in diameter at breast height for areas where stand structural characteristics of late and old successional stages were found to be deficient. This policy currently protects the larger and presumably older ponderosa pine, but it also limits management activities designed to reduce, for example, the spread of western dwarf mistletoe (*Arceuthobium campylopodum* Engelm.), western pine beetle (*Dendroctonus brevicomis* LeConte), or mountain pine beetle (*D. ponderosae* Hopk.).

- Interim Riparian Habitat Conservation Areas on federal lands, established under PACFISH (USDA Forest Service and USDI Bureau of Land Management 1994) and Inland Native Fish (USDA Forest Service 1995), established a buffer on either side of the active stream channel of fish-bearing streams, within which timber harvesting, including fuelwood cutting is prohibited except where silvicultural practices are needed to attain desired vegetation characteristics to meet riparian management objectives.

- Across the four regions, forest density management— silvicultural activities designed to improve stand conditions by concentrating tree growth on fewer stems, reduce fire risk and improve forest health, encourage undergrowth vegetation and wildlife forage, and promote patch- and landscape-scale diversity— has shifted to include a primary focus on reducing the number of small-diameter trees. In the Pacific Northwest Region of the Forest Service, the forest density management program of work has not kept pace with the programmed need, and the backlog continues to increase at about 200 square kilometers (50,000 acres) each year (Powell and others 2001). The policy restricting the size of trees that are harvested also may already limit the amount of thinning in some ponderosa pine stands, especially stands that have grown near or beyond the 53-centimeter diameter limit. Growth rates in these stands may decline without thinning and the stands will become more susceptible to bark beetle attack.

- A new emphasis on fuel reduction to lessen the risk and severity of wildfire, especially in low elevation forests that have developed under natural disturbance regimes dominated by high frequency, low-severity fires, is focusing much of the silvicultural activity within the wildland/urban interface. The wildland/urban interface in eastern Washington near Spokane, in central Oregon near Bend, and in eastern California in the Tahoe Basin are examples of rapidly expanding wildland/urban interface where fuel reductions treatments are being applied to protect people and homes. Fuel reduction activities commonly used in these areas, such as underburning or mowing, usually result in short term decreases in available browse that may be important for wild ungulates during winter months.

- Implementation of National Fire Plan objectives for reducing fuels is limited because of challenges for the efficient disposal and/or utilization of significant quantities of small trees, especially the large numbers of low-volume stems less than 10 centimeters (4 inches) in diameter. A recent analysis of potential yields from fuel reduction projects in western states indicated the potential size of the manufacturing infrastructure needed to process material from fuel reduction treatments is large (USDA Forest Service 2003). For example, to process the merchantable volume from only the western states where fire regimes have been significantly altered and there is a high risk of losing key ecosystem components in a wildfire (Class 3), fuel reduction treatments will require the capacity of about 75 average-sized conventional sawmills for 30 years. Loss of processing mills, however, has eliminated much of the infrastructure necessary to conduct these fuel reduction treatments across much of the four regions. As a result, many fuel reduction projects now require financial subsidies, resulting in smaller areas being treated. Adding to the problem is the concern that many even-aged stands of ponderosa pine that were precommercially thinned are approaching the target diameter (about 20 centimeters (8 inches)), previously projected for the first commercial thinning. The market and demand for these small trees do not currently exist.

While these changes tend to directly affect management of ponderosa pine ecosystems, they also have an effect on the management of other forest types, especially those forest types at mid elevations that may contain small amounts of ponderosa pine.

Issues Affecting Future Application of Silvicultural Prescriptions

Given the broad array of silvicultural systems that can be use to manage ponderosa pine, it is unlikely that silvicultural activities occurring in the near term (the next 10 years) will not readily fit into the existing framework of planned treatments. What is likely to occur, however, is that increasingly complex resource values associated with ponderosa pine ecosystems will require silviculturists to consider a wider array of treatments within the context of ponderosa pine silviculture. One common context for management is emulation of natural disturbance regimes. Silviculturists likely will be asked to design treatments that are closer analogues or surrogates for a specific disturbance event. Manipulations of stand structure with the objective of reducing fuels will become an increasingly common management action on landscapes supporting ponderosa pine. Fuel reduction treatments involving either mechanical manipulation of fuels, the use of fire, or a combination of the two can result in changes in the horizontal and vertical distribution of trees, their composition, and the number, size, and distribution of gaps or canopy openings. It is likely that federal, state, and private resources devoted to fire suppression will continue to battle wildfires, many of which will occur in ponderosa pine ecosystems. Density management activities will continue to the degree that funding allows projects to be implemented. If these activities continue to be generally restricted to small-diameter trees only, it is likely that little effort will be devoted to creating complex stand structures through spatial and structural diversity. At the same time, fuels will continue to accumulate across landscapes until treated or burned by wildfire. There is a possibility that our collective focus on reducing fire risk will overshadow the need to consider other disturbance factors in the context of long-term forest health. For example, failing to address the increase in dwarf mistletoe in overstory trees now will probably result in greater numbers of infected understory trees in the future. Similarly, failing to consider fully the risk of bark beetle outbreaks may limit our management options and lead to greater reliance on clearcutting in severely infested areas to restore healthy stands.

What are the critical gaps in our understanding of ponderosa pine silviculture that may affect our management in the near-term and beyond? We must first recognize that essentially all of our knowledge base for managing ponderosa pine ecosystems is derived from studies conducted in even-aged stands. While existing work compares the various methods of regeneration after harvests, there are few if any empirical comparisons of even- and uneven-aged systems for the management of ponderosa pine across any full suite of treatments (Helms and Lotan 1988).

Current amounts of old-growth ponderosa pine forest in the northern Rocky Mountains, the Pacific Northwest, and both eastside and westside California are estimated at 3 to 15 percent of pre-Euro-American settlement levels (Bolsinger and Waddell 1993; Beardsley and others 1999). Increasingly, managers are attempting to restore the frequency and intensity of disturbances within existing old-growth stands and thus the resulting periods of stability through various fuel reduction treatments designed to ultimately prevent stand-replacement fires (Conard and others 2001; Oliver 2001). Land managers may lack the knowledge of how disturbance agents, both natural and human-caused, interact with each other and how they interact across multiple scales to cause changes that may affect ecosystem integrity. Methods to protect remnant old-growth ponderosa pine stands and individual trees during implementation of prescribed fire as well as protocols to ensure variability in thinning density to mimic the spatial distribution of stems in old-growth stands (Youngblood and others 2004) are largely unknown or unavailable. At the same time, little is known of methods for developing future old-growth structure in young uneven-aged or even-aged stands, and forecasting the productivity of these multi-aged stands. Tools such as the Ponderosa Pine-Multi-aged Stocking Assessment Model (O'Hara and others 2003) are promising steps toward this goal.

Finally, it is clear that much of the recent changes in the management of ponderosa pine ecosystems on public lands are the result of changes in the way society— either the individual living in the wildland/urban interface, the local community, the special interest groups that represent user groups, or national and international organizations— values these forests. Perhaps our most challenging unknown is how the various components of society will value these forests in the future. If processes were readily available for predicting the range of commodity and amenity values, and thus the structure, that society will desire in ponderosa pine forests of the future, management could begin to develop that structure today. Regardless of these knowledge gaps, the role of the silviculturist in guiding the development of ponderosa pine stands will remain exciting.

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