The Lick Creek Demonstration — Forest Renewal Through Partial Harvest and Fire

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Abstract—*The Lick Creek Demonstration Site on the Pomeroy Ranger District, Umatilla National Forest, is a Joint Fire Science Program sponsored project to create a demonstration of the effects of fuels management on forest health. The project was initiated in 2001 and involved the integration of two levels of partial harvest with prescribed fire, a burn only treatment and an untreated control treatment. Biomass utilization was incorporated into the burn preparation following harvest. Objectives of the treatments were to improve stand composition and structure, reduce fuel levels, and enhance wildlife habitat. Units were harvested in 2001. Prescribed fire as applied in 2004. Monitoring of fuels and stand attributes was implemented in 2005. Harvest reduced overstory canopy coverage as much as 70%. Understory tree layers remained intact through the harvest but were significantly affected by the prescribed burn. Herbage production increased in areas of moderate fire intensity but showed little response in areas of high fire intensity. Less than 1% mortality was evident in 2005 among leave trees in the treatment units but tree conditions indicate future higher mortality. Fuels reduction was the most uniform in the commercial yarding treatments but was highly varied in the burn only treatments. Contractor revenue profits from the harvest and biomass fuel were modest and dependent on the provision of service contracts by the USFS Pomeroy Ranger District in addition to the release of the products to the contractors for independent sale.*

Introduction

In 2000, the Joint Fire Science Program (JFSP) requested grant proposals for development of fuels management demonstration sites throughout the United States. The sites were to provide the public and research interests opportunity to observe the effects of fuels management involving prescribed fire on wildland ecosystems. The Pomeroy Ranger District of the Umatilla National Forest in southeastern Washington, in conjunction with Washington State University, received a grant from the JSFP to initiate the development of the Lick Creek Demonstration Site in the northern Blue Mountains of southeastern Washington. The project period was originally set for a three-year period from FY 2001 through FY 2003. The last of the project components was completed in 2005.

The overall goal of the Lick Creek project was to develop a demonstration of the application and effects of selective, partial harvest on mid-succession forest stands in combination with prescribed fire to enhance forest condition, amenities, and reduce wildfire hazard. Frequent and timely monitoring of the demonstration site would provide documentation to substantiate, clarify, and

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explain anticipated ecological relationships and treatment effects throughout the demonstration site. The demonstration was to provide opportunity for general public examination and for the Pomeroy Ranger District to begin a long-term monitoring study of a fuels management strategy applied throughout the District.

Efforts to achieve public understanding and support of forest practices to rectify forest health issues is a priority in the Pomeroy Ranger District because of the sensitivity of the forest landscapes and the multiple interests in the public lands of the District. Successful implementation of any forest practice in the District is predicated on public support. The Lick Creek Demonstration is intended to show how forest practices can enhance forest landscapes for tree growth, wildlife habitat, and reduction of wildfire hazard.

The purpose of this proceedings paper is to provide a synopsis of the character and development of the demonstration site.

Objectives

The specific objectives of the project were (1) to implement four levels of viewable silvicultural and fuels management stand treatment on the Lick Creek site in a replicated manner, (2) prepare documentation of the treatments and treatment effects for public review, (3) initiate a long-term monitoring study of the site to document treatment effects to include response of leave trees, and (4) to assess the economic viability of small diameter timber harvest as a means of accomplishing silvicultural and fuels management objectives. The treatments would represent prescription strategies currently employed by District staff to address management of stand structure, species composition, and fuel conditions in mid-successional forest stands.

Site Location and Pretreatment Vegetation Character

The Lick Creek Demonstration Site lies within the Blue Mountains Physiographic Province of southeastern Washington (Fig. 1). The site is located in the eastern portion of the Pomeroy Ranger District of the Umatilla National Forest and centered at longitude 117.4833°, latitude 46.2333°. The general terrain of the area is a deeply dissected plateau to the south and east of the Snake River Canyon that traverses through southeastern Washington. The specific site terrain is a steep, dissected canyon slope between 4100-5100 ft elevation with aspects spanning northwest to northeast. Slopes average 50 to 60% across the entire site. The area is within the rain shadow cast by the central Blue Mountains ridge, thus is within a dry subhumid climate. Total annual precipitation is ±35 inches with effective moisture varying according to topographic and soil conditions.

The vegetation of the site is a mosaic of forest stands interspersed with grassland sites on side-ridges and shallow soils (Fig. 2). Generally, two distinct zones of vegetation are distinguishable across the site. An upper canyon wall zone of the Douglas-fir/snowberry (*Pseudotsuga menziesii/Symphoricarpos albus*) and Douglas-fir/ninebark (*Pseudotsuga menziesii/Physocarpus malvaceus*) plant associations covers from 1/4 to 1/3 of the site slope surface (Johnson and Clausnitzer 1992). The width of this zone is dependent on

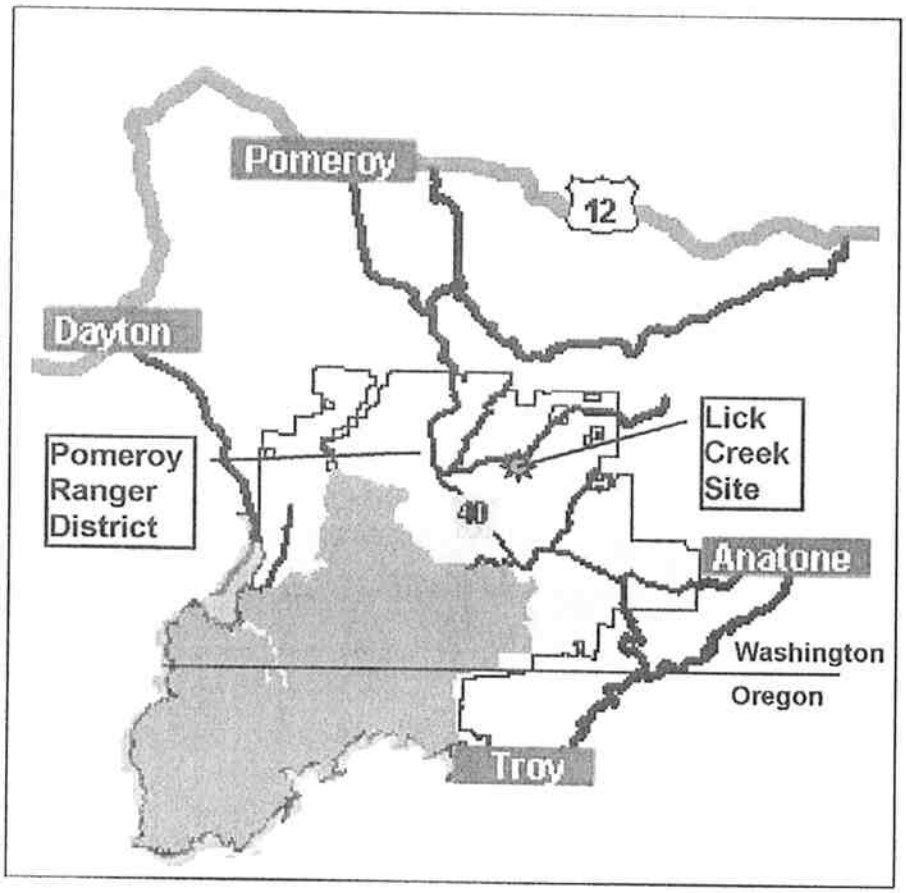

Figure 1—Location of the Lick Creek Demonstration Site in the Pomeroy Ranger District, Umatilla National Forest, southeastern Washington.

Figure 2—Pre-harvest photograph of the Lick Creek Demonstration Site looking east along the face of the site in 2000.

slope surface configuration with the narrowest portions associated with concave surfaces and the broadest portions associated with convex surfaces. The lower ⅔ to ¾ of the canyon wall is dominated by the grand fir/twinflower (*Abies grandis/ Linnaea borealis*) plant association. Ponderosa pine (*Pinus ponderosa*) and western larch (*Larix occidentalis*) are the seral conifer tree species throughout the site.

The existing vegetation over the site prior to treatment generally reflected a mid-successional state (Fig. 3). Most of the area supported a sparse component of 100+ year-old trees of ponderosa pine, western larch, and Douglas-fir that formed an upper overstory layer with canopy cover ranging from 5-15%. Tree heights were 90 ft with average d.b.h. ranging from 20 to 32 inches. The majority of the leave trees in the harvest treatments were in this particular cohort. The bulk of the forest canopy was a deep mid-story tree layer composed predominantly of Douglas-fir (67%) and grand fir (24%) with sparse ponderosa pine (6%) and western larch (3%). Average height of trees within this layer ranged from 45 to 50 ft and averaged 9 to 11 inches d.b.h. Most of the merchantable timber came from this mid-story layer. A distinct third cohart of smaller trees with 3 to 6 inches d.b.h. occurred in the lower portion of the layer between 20 and 40 ft. These smaller trees composed 53% of the total tree density of the layer, and in combination with an understory layer of junvenile trees less than 3 inches d.b.h. and under 10 ft in height, formed the greatest barrier to light penetration to the ground surface.

Figure 3—Example of pre-harvest stand conditions in the Lick Creek Demonstration Site.

History of the Site

The Problem

The Lick Creek site was selectively harvested through several entries during the 1960's and early 1970's for large diameter sawlogs by means of a skyline system. No additional harvest or fuels treatment have occurred on the site since that time. There is no evidence of wildfire in the immediate drainage area of the site in the past 100+ years so the site represents a fire exclusion location. Stand development since the 1960's progressed to mid-successional stages of overstocked, nearly closed stands of small diameter, shade-tolerant Douglas-fir and grand fir. Competition from these shade-tolerant species reduced the abundance of shade-intolerant ponderosa pine and western larch. In addition, surface and ladder fuels were accumulating to the point of creating a severe surface and crown wildfire hazard (Fujishin 1998).

The drainage lies directly above a major Rocky Mountain elk winter range in the Asotin Creek watershed adjacent to the Snake River and is a significant part of a spring elk calving area and summer range for elk herds that utilize the Asotin Creek winter range. Stand closure of forests within the Lick Creek drainage was reducing the diversity and abundance of the understory and detrimentally affecting the quality of elk and wildlife habitat (Lorentz 1997).

The Solution

The prescription for stand management on the Lick Creek site revolved around the principal objectives of opening stands, shifting the balance of species composition to favor ponderosa pine and western larch, and reducing fuel loading (Bott 1998). Selective harvest and thinning from below combined with prescribed fire was prescribed to accomplish the objectives The efficacy of these practices was considered to be well established (Agee 1996, Applegate and others 1997, Graham and others 1999, Williams and others 1993). Multiple entries over time with prescribed fire after harvest was thought necessary in order to ultimately achieve the objectives of the prescription (Martin 1998). The treatment effects of the combined practices were also expected to enhance wildlife habitat in general, and more specifically, the elk habitat of the site that is a central concern to several local public interest groups. Untreated wildlife leave units were integrated into the treatment design to serve a wildlife cover and travel corridors. Non-hazardous snags where left standing and a buffer zone was designated along the bottom of the Lick Creek drainage to protect watershed values and provide additional undisturbed wildlife cover.

Two primary concerns were identified in the development of the Lick Creek Demonstration prescription and are reflected as inclusions in the project objectives. These were (1) the effects of fire on leave trees and (2) the economic viability of small diameter timber harvest.

The mortality of large leave trees from prescribed fire across the Lick Creek site was a major concern (Martin 1998). Several recent studies have confirmed that mortality of trees from a prescribed fire increases as the depth of the duff layer around the base of the tree and the diameter of tree bole increases (Ryan and Frandsen 1995, Hille and Stephens 2005, Stephens and Finney 2002, Thies and others 2006). Documentation of the leave tree post-burn responses was designated as a priority element in the monitoring of the demonstration site.

The majority of the merchantable sawlog trees on the Lick Creek site grade as small diameter timber (5-9 inches d.b.h.), raising questions about the profitability of such a harvest to logging contractors and their interest in undertaking this kind of harvest option. Selective harvest and thinning of small diameter stands is being increasingly considered in the Interior Northwest as a means of reducing wildfire hazard, redistributing tree growth, and re-directing stand development (Wagner and others 1997, Baumgartner and others 2002). But questions remain about the financial viability of such harvest from the standpoint of product marketability and revenue and harvest costs (Johnson 1997, Wagner and others 1997). Harvest costs are affected by tree size and utilization with harvest costs inversely proportional to tree size—small-diameter trees result in small piece sizes with low volumes and are more costly to handle (Stokes and Klepac 1997). Johnson (1997) stated that an economical harvest of small trees is difficult to attain for two reasons—the cost per unit of volume to move the material increases dramatically as diameter of the volume decreases, and the value of the unit volume decreases as piece size decreases. Harvest costs increase with reduced road accessibility and conditions, less steeper and more complex terrain, smaller trees and higher density stands, limited opportunity to use less expensive mechanical yarding, and greater hauling distance. Ultimately, the availability of stable markets for multiple wood products from the harvest will dictate net profit from the harvest (Johnson 1997, Stokes and Klepec 1997). Documentation and evaluation of harvest and fuels treatment costs and product revenues to assess economic viability of the silvicultural and fuels management strategy was included as a primary objective of the project.

Methods

Treatment Design and Installation

The site was divided into three treatment units with wildlife habitat units left between some of the treatment units within the site boundaries (Fig. 4). A 150 ft buffer zone was maintained of at the bottom of the slope between the treatment units and Lick Creek. Each unit was divided into four subunits to replicate the treatment. The following four treatments were installed in each unit—two levels of harvest, a control, and a burn only treatment (Table 1). The replication subunits range in size from 6 to 17 acres, the size being dictated by uniformity of pre-harvest conditions and the facilitation of harvest and prescribed burning operations.

Treatment Schedule

Treatment planning, the timber cruise, and pre-logging stand inventory were conducted in 2000 and 2001. Harvest of the site was completed during the winter of 2001-2002. Preburn inventory was conducted in 2002-2003. Slash piles were removed from the site by means of chipping and selected pile burns in the fall of 2003. The prescribed burn of the treatment units was conducted in September and October 2004. The first year of post-burn monitoring was completed in the summer and fall of 2005.

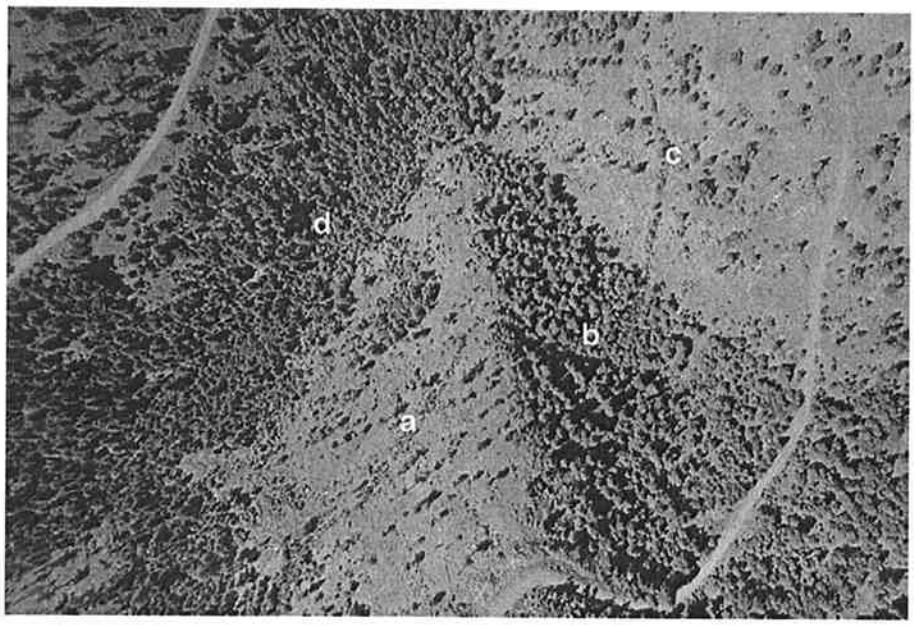

Figure 4—Aerial view of treatments at mid-elevation within the Lick Creek Demonstration Site showing fuels yarding (a, c) on a wildlife leave unit (b) above Lick Creek (d). Permanent monitoring plots are distributed near the center of each unit from top to bottom.

Table 1—Replicate (3) treatments implemented on the Lick Creek Demonstration Site, Blue Mountains, Pomeroy Ranger District, Umatilla National Forest.

Treatment	Description
Control	No harvest, no prescribed burn - stand left in original state.
Prescribed burn only	No harvest, prescribed burn of stand in its original state.
Commercial yarding - prescribed burn	All trees unmarked as leave trees that were 6 inches d.b.h. or greater that had a minimum 8 foot long piece to a 3 inch top were cut and removed to the landings, whole tree yarding was not required but generally done to improve efficiency of operation; post-harvest prescribed burn was applied. Objective of treatment was to leave a greater quanity of fuel in place on the units.
Fuels yarding - prescribed burn	All trees unmarked as leave trees that were 3 inches d.b.h. or greater that had a minimum 8 foot long piece to a 3 inch top were cut and removed to the landings; whole tree yarding was required; down material meeting the cutting specifications for commercial yarding (6+ inches d.b.h.) were cut and yarded; post-harvest prescribed burn was applied. Objective of treatment was to minimize fuel accumulations on the units.

Harvest

A total of 85 acres of the site were harvested in a 40-day period, commencing in mid December 2001. Winter logging in the Blue Mountains is at risk of being stopped at any time because of severe storm conditions and snow accumulation. Fortunately, severe weather conditions never developed until after the harvest had been completed in late January, 2002, allowing harvest to proceed with minimal snow cover.

Yarding was conducted for 74% of the harvest area with gravity feed skyline system utilizing a skyline yarder and a motorized support carriage. Ground-based yarding with a tracked skidder was conducted over the remaining 26% of the harvest area. Whole tree yarding was required as part of the treatment prescription to minimize fuel loading on the site.

A stationary, pull-through, motorized, radio-controlled delimber was used to process the whole trees that were yarded to the landing. After delimbing, the trees were sorted according to merchantable (sawlog) or unmerchantable (tonwood, fiber wood), cut to specified lengths, and piled into decks for loading. One-hundred loads were hauled from the site—51 sawlog loads, 33 tonwood loads, and 16 fiber loads.

The total yield of the harvest averaged 27.14 tons per acre for the 85-acre harvest area of the Lick Creek Site. Yield was portioned as follows - sawlog (1171 t, ~ 194 gross mbf), tonwood (761 t), fiber wood (374 t).

Chipping for Biomass Fuel

Whole tree removal from the harvest site meant that large slash piles accumulated at the landings at the top of each unit. These piles were large, ranging from 1.41 tons/acre to 4.67 tons/acre and were considered a hazard to the conduct of the prescribed burn because of their location and potential to initiate escape fire. Removal of the piles proceeded in the late fall of 2003 through a service contract to a local contractor to chip the slash for sale as biomass fuel. Because of limited road access, the chipper was stationed at a site that provided access to haul trucks. Slash from the piles was transported by trucks to the chipper for processing. Slippage of some slash piles down the steep slopes of the site made some of the slash inaccessible to loaders. This material was pile burned after the slash chipping had been completed. A total of 33 piles yielded 482.44 dry t of chipped wood for sale as biomass fuel.

Prescribed Burn

The burn was conducted from in a 5-day period from September 30-October 4, 2004. The burn prescription targeted reduction of fuels and understory fire-intolerant and shade-tolerant tree species on the site as the principal objectives. The principal Ignition pattern was strip head-fire over most of the site with backing fire used through heavy fuel accumulations and down very steep slopes. Flame-lengths were to be kept under 4 ft to limit fire intensity. Seven burn units are designated, combining treatment units to facilitate control and consistency in the character of the burn. Ignitions started at highest points of the site and progressed down-slope and to lower elevations within the site over the burn period. Surface fuels were typically a mosaic of grass and woody fuel patches, intermixed with live shrub and tree materials. The small live tree component was especially significant in the higher elevation units. The live shrub component was most significant in the lower elevation and environmentally warmer units. Woody fuel loading varies across the Lick Creek site according to treatment. The highest woody

fuel loadings were in the commercial yarding units harvest with fuelbeds in the Fire Behaviror Fuel Model 10 and 11 categories depending on the mix of herbaceous and live fuels and amount of overstory.

At the beginning of the burn period, temperatures (55-62 ° F) and relative humidity (38-44%) were near the lower limit of the burn prescription providing an advantage in keeping fire intensity low while still accomplishing the prescription objectives. Backing fires were ineffective under these conditions, so strip head-fire ignition was the principal means of ignition. Temperatures climbed into the low 70's and humidity dropped into the high 20's by the end of the 5-day burn period and back-firing became the principal means of fire spread. Winds occurred in the typical fall convective wind pattern and were not a factor at anytime during the burn period.

Initial estimates indicate that an average reduction of 80% was achieved in the woody fuel and ground fuel loading over the Lick Creek site.

Monitoring System

Five permanent plots are distributed within each treatment unit near the center from the top to the bottom of the unit (Fig. 4). The plots were inventoried pre- and post-burn. Pre-harvest plots were sampled in the same locality as the permanent plots but do not represent the exact location of the permanent plots. The plot is circular with a diameter of 50 m. The center of the plot is the photo point from which a radial sequence of photos is taken of the entire perimeter of the plot. Two 25-m transects from the plot center along the contour of the slope are used to collect point and microplot data for the following overstory and understory attributes: fuel loading, species composition and canopy coverage, tree density by diameter class and species, stand canopy stratification, height, and composition, and soil surface coverage and composition. A series of digital photos are taken of 1-m^2 microplots along each transect. The data is being entered and summarized in FIREMON (2006).

Summary of Preliminary Findings

Stand structure was significantly altered by harvest with reductions of overstory canopy coverage by as much as 70% in some treatments. The majority of the dominant mid-story canopy layer was eliminated by the harvest. However, a substantial amount of the understory tree layer of short and less than 3 inches d.b.h. remained intact after harvest. The prescribed burn damaged the majority of the understory layer but the full extent of the mortality was not fully expressed in the 2005 inventory. Herbage production increased dramatically in areas of moderate fire intensity but did not show a similar response in areas of high fire intensity. Less than 1% mortality was evident in 2005 in the leave tree populations across all of the harvest treatment units. A low degree of mortality is evident in the overstory of the burn only treatments but the condition of many of the trees suggest that greater levels of mortality are to be expected in coming years. Fuels reduction varied greatly among treatment replications with the most uniformity reduction in the commercial yarding treatments and the greatest variation in the burn only treatments. Contractor revenue profits from the harvest and biomass fuel were modest and dependent on the provision of service contracts by the USFS Pomeroy Ranger District in addition to the release of the products to the contractors for independent sale.

Project Sponsors

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Literature Cited

Agee, J.K. 1996. Critical stand characters for crown-fire-safe forests. pp. 52-68. In: Proc. 17th Annual Forest Vegetation Management Conference, Redding CA, Jan 16-18, 1996.

Applegate V., Dupuis V. Ablutz M., Klinkhammer S., Slaughter S., Yelczyn B., Becker R. 1997. Use of habitat types and fire regimes in landscape assessments and stand level prescriptions. pp. 36-72. In: Forest Management Into the Next Century: What Will Make It Work? Proceedings. Spokane WA: Forest Products Society and USDA For Serv.

Baumgartner D., Johnson R.L., DePuit E.J. 2002. Small diameter timber resource management, manufacturing, and markets. Proc. of Conf. held Feb. 25-27, 2002, Spokane WA. Pullman WA: WSU Extension MISC 0509.

Bott K. 1998. Silvicultural prescriptions—Lick Analysis Area. Staffing paper, Lick Analysis File, Pomeroy Ranger District, Umatilla National Forest, USDA Forest Service, Pomeroy, WA.

FIREMON. 2006. Fire effects monitoring and inventory system. Online: http://firemon.org.

Fujishin M. 1998. Environmental assessment for the Lick timber sale and fire reintroduction project. Staffing paper, Lick Analysis File, Pomeroy WA: Pomeroy District, Umatilla National Forest, USDA For. Serv.

Graham R.T., Harvey A.E., Jain T.B., Tonn J.R. 1999. Effects of thinning and similar stand treatments on fire behavior in western forests. General Technical Report PNW-GTR-463. Portland, OR: USDA For. Serv., PNW For and Range Exp. Sta.

Hille M.G., Stephens S.L. 2003. Mixed conifer forest duff consumption during prescribed fires: tree crown impacts. For. Sci. 51:417-424.

Johnson L. 1997. Overview of timber harvesting technology and costs. pp. 89-94. In: Forest Management Into the Next Century: What Will Make It Work? Conference proceedings sponsored by the Forest Products Society and USDA Forest Service, Spokane, WA, November 19-21, 1997.

Johnson C.G. Jr., Clausnitzer R.R. 1992. Plant associations of the Blue and Ochoco Mountains. USDA, For. Serv., PNW Region, Wallow-Whitman National Forest, R6-ERW-TP-036-92.

Lorentz S. 1997. Vegetative conditions in the Lick Prescribed Fire Project Area. Staffing paper, Lick Analysis File, Pomeroy, WA: Pomeroy District, Umatilla National Forest, USDA Forest Service.

Martin M. 1998. Report on the fire and fuels management issues in the Lick Analysis Area. Staffing paper, Lick Analysis File, Pomeroy, WA: Pomeroy District, Umatilla National Forest, USDA Forest Service.

Maruoka K.R. 1993. A fire history survey in selected *Pseudotsuga menziesii* and *Abies grandis* stands in the Blue Mountains of Oregon and Washington. Pomeroy, WA: Pomeroy District, Umatilla National Forest, USDA Forest Service.

Ryan KC, Frandsen W.H. 1992. Basal Injury From Smoldering Fires in Mature *Pinus ponderosa* Laws. International Journal of Wildland Fire 1(2):107-118.

Stephens S.L., Finney M.A. 2001. Prescribed fire mortality of Sierra Nevada mixed conifer tree species: effects of crown damage and forest floor combustion. Forest Ecology and Management 162: 261-271.

Stokes B.J., Klepac J.F. 1997. Ecological technologies for small-diameter tree harvesting. pp. 95-101. In: Forest Management Into the Next Century: What Will Make It Work? Conference proceedings sponsored by the Forest Products Society and USDA Forest Service, Spokane, WA, November 19-21, 1997.

Thies W.G., Westlind D.J., Loewen M., Brenner G. 2006. Prediction of delayed mortality of fire-damaged ponderosa pine following prescribed fires in Eastern Oregon, USA. International Journal of Wildland Fire 15: 19-29.

Wagner F.G., Keegan III, C.E., Fight R.D., Willits S. 1997. Potential for small-diameter saw timber utilization by the current industry infrastructure in Western North America. pp. 115-120. In: Forest Management Into the Next Century: What Will Make It Work? Proceedings. Spokane WA: Forest Products Soc. and USDA Forest Service.

Wickman B.E. 1992. Forest health in the Blue Mountains: The influence of insect and disease. Gen. Tech. Rep. PNW-GTR-295. Portland, OR: USDA Forest Service, Pacific Northwest Forest and Range Experiment Station.

Williams J.T., Schmidt R.G., Norum R.A., Omi P.N., Lee R.G. 1993. Fire related considerations and strategies in support of ecosystem management. Staffing paper, Fire and Aviation Management, Washington Office, USDA Forest Service.