INVENTORY AND EVALUATION OF SELECTED OLD GROWTH PONDEROSA PINE STANDS, COTTONWOOD RESOURCE AREA, IDAHO

by

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Abstract

Pinus ponderosa is a long-lived, early- to mid-seral species in plant associations within the *Abies grandis*, *Pseudotsuga menziesii*, and *Pinus ponderosa* series. Once abundant and widespread, old growth *Pinus ponderosa*-dominated forest has declined due to a century of fire exclusion, livestock grazing, and selective harvesting within accessible stands. The loss of seral old growth *Pinus ponderosa* is a concern for wildlife habitat and maintenance of biological diversity.

This report summarizes the inventory of old growth *Pinus ponderosa*-dominated forest stands located on Bureau of Land Management lands in west central Idaho. A comparison of applicable old growth forest criteria is provided. Old growth forest attributes of stands within the study area typically exceed criteria provided in formal definitions. The ecology and wildlife use of *Pinus ponderosa*-dominated forest is reviewed in relation to the stands observed within the study area. Additional literary resources, not referred to in the text, are summarized in an annotated and indexed bibliography. Approaches to restoration of old growth stands are identified based on groups of stands with similar growth potential, seral status, and stand structure. The use of non-commercial thinning, followed by pile burning, and prescribed understory burning is identified for many old growth stands within the study area. Old growth sites are prioritized for conservation and restoration activities based of criteria for rarity, richness, representativeness, and viability. Four sites are identified as having the highest priority.

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Introduction

Pinus ponderosa is a long-lived, early- to mid-seral species in plant associations within the *Abies grandis*, *Pseudotsuga menziesii*, and *Pinus ponderosa* series (Steele et al. 1981; Cooper et al. 1991). In pre-settlement times, frequent, low-intensity fires in *Pinus ponderosa*-dominated forest maintained relatively open, old growth forest stands (Evans 1991 as cited by Agee 1996; Arno et al. 1995; Crane and Fischer 1986; and many others). Fire played an important ecological role in this vegetation by controlling the density of understory tree regeneration and favoring the growth of relatively few, large, dominant, fire tolerant trees; reducing tree susceptibility to disease; and favoring the growth and diversity of understory herbaceous species (Barrett 1988; Crane and Fischer 1986; Agee 1996).

The National Biological Service has identified seral old growth *Pinus ponderosa* forest as one of the most threatened ecosystems in the United States, with an estimated decline of 70 - 84 % (Noss et al. 1995). Once abundant and widespread (Losensky 1992), old growth *Pinus ponderosa*-dominated forest has declined due to a century of fire exclusion, livestock grazing, and selective harvesting within accessible stands (Steele et al. 1986; Hamilton 1993; Covington and Moore 1994; Sloan 1994; Agee 1996). The loss of seral old growth *Pinus ponderosa* is a concern for wildlife habitat and maintenance of biological diversity (Everett et al. 1994; Morgan 1994; Arno et al. 1995; Groves et al, 1997). Given this high level of decline, human activities that influence the distribution, abundance, and quality of old growth *Pinus ponderosa*-dominated forest must be critically evaluated.

Principal old growth forest attributes are the density of large diameter, old trees; the presence of tree decadence; and the presence and size of snags and coarse woody debris. Though these ecological attributes describe the life breath critical to species habitats, they also serve an important administrative function in ongoing debates regarding the management of forested lands. Old growth forest definitions that have potential baring in Idaho are provided by Green et al. (1992), Hamilton (1993), Hopkins et al. (1992a and b), and Williams et al. (1992).

Questions that provide the impetus for this study include: What are stand structural conditions of remnant stands of *Pinus ponderosa*-dominated old growth forest in west central Idaho? Where are the greatest opportunities for the conservation and restoration of *Pinus ponderosa*-dominated old growth forest? How do old growth definitions - derived from the north, south, and west - apply to stands in west central Idaho? The objectives of the study are: (1) inventory and prioritize sites on Bureau of Land Management lands within west central Idaho for the conservation and restoration of old growth *Pinus ponderosa*-dominated forest; (2) develop preliminary management guidelines to enhance and protect the biological values of selected stands; and (3) as needed, contribute to the resolution of old growth forest definitions.

Study Area and Methods

The study area includes Bureau of Land Management lands on the Cottonwood Resource Area, Upper Columbia-Salmon Clearwater Districts, in west central Idaho. Sites with high potential for the conservation or restoration of old growth *Pinus ponderosa*-dominated forest were identified using aerial photography and existing survey and reconnaissance data. Vegetation stands at each site were delineated based on stand environmental features (topography and elevation) and apparent structure and composition (using aerial photography interpretation). In order to optimize the balance between the geographic scope of the study and the need to acquire quantitative information, the intensity of field reconnaissance efforts were stratified within stand delineations.

Quantitative and qualitative data was taken to characterize current stand conditions. Qualitative data consists of descriptive field narratives regarding composition, structure, and function. This data is linked to and supported by quantitative data. Intensive quantitative sampling occurred to best represent site conditions, but was limited to selected reference stands within each site. Both data types are geo-referenced.

Within selected reference stands nested 0.10 and 0.25 acre fixed area plots were used to sample stand composition and structure and measure environmental parameters. Plots were placed within forest patches that are homogeneous in structure and composition. Habitat type (and phase), tree canopy cover, basic environmental parameters (slope aspect, gradient, and horizon; elevation; and micro- and macro-topography), and fuel class were determined on a standard 0.1 acre circular ecology plot.

The density and size distribution of live, standing dead, and dead and down trees were sampled on nested 0.10 and 0.25 acre fixed area plots. Trees with diameter at breast height (dbh) $\geq$ 5 but < 21, and dbh $\geq$ 21 inches were tallied by status (live, standing dead, or dead and down), species, and size class on 0.10 and 0.25 acre plots, respectively. Tree canopy height was determined for each recognizable canopy layer. A limited number of selected trees within each stand were aged using an increment core.

Results and Discussion

Eighteen forested plant associations were observed at 17 sites within the study area. Forest stands range from highly productive associations that occur on relatively cool, moist sites to low productivity sites that occur on warm, dry sites. Nearly all permutations of seral status and structural class were observed within the study area. Sites visited within the study area are listed in Table 1. The plant associations observed within the study area are summarized in Table 2.

The remainder of this section is organized into two subsections. In the first, concerning old growth forest ecology, I discuss work related to the classification and description of old growth and how these criteria apply to stands observed within the study area. This is followed by a general discussion of the role of fire disturbance in the maintenance of *Pinus ponderosa*-dominated old growth and the influence of decades of fire exclusion in these stands. Next is a discussion of wildlife habitat relations. I provide a brief summary of information related to each plant association observed in the study in three final tertiary sections, one each for the three plant association series observed in the study area.

The second subsection is devoted to discussion of the sites within the study area. First I describe the stands observed within each site and potential approaches to the maintenance or restoration of *Pinus ponderosa*-dominated old growth. This is followed by a discussion of site conservation priorities.

Tables and figures related to the discussion are located in appendices 1 and 2, respectively.

OLD GROWTH FOREST ECOLOGY

<u>Old growth classification and description</u>--Early work on old growth primarily concerned *Tsuga heterophylla* plant associations of the maritime Pacific Northwest. In this historic work recognition and description of forest stand structure dominated by large trees (a condition which necessarily comes with old age) was often un-necessarily linked to late-seral conditions. The term ‘old growth’ and ‘late-seral’ (also referred to as, 'late successional') are often used synonymously (e.g., see Forest Ecosystem Management Assessment Team 1993). The classic six vegetative structural stages (grass-forb, shrub-seedling, pole-sapling, young, mature, and old growth) (Thomas et al. 1979; Moir and Dieterich 1988) are also reflective of this synonymy of structure and succession. Initially there was little recognition of mid-seral, disturbance-maintained old growth forest conditions (Green et al. 1992).

Old growth is a dynamic structural condition that is associated with mid- and late-seral stages (Rust 1990). Wider recognition of mid-seral old growth forest stand conditions has grown out of a national effort to describe old growth forest attributes. Old growth forest definitions that have baring on stands within the study area are provided by Green et al. (1992), Hamilton (1993), Hopkins et al. (1992a and b), and Williams et al. (1992). Minimum criteria for each of these definitions is summarized in Table 5. The applicability of each definition to the associations observed in the study area is summarized in Table 6.

These definitions are mostly based on natural potential vegetation. The notable exception is the work by Hamilton (1993), which is based on Society of American Foresters (SAF) cover types (Eyre 1980). Definitions based on cover types are intuitively attractive, especially in the context of conserving old growth dominated by *Pinus ponderosa*. That is, the Interior Ponderosa Pine cover type (SAF 237) is the focus of interest. These definitions, however, in the absence of knowledge of the plant association (i.e., the natural potential vegetation), do not provide for understanding of the fundamental ecological processes that contribute to the maintenance of old growth conditions and the value of these stands for wildlife habitat (Haufler 1994; Agee 1996; Haufler et al. 1996; Rust 1997).

The Interior Ponderosa Pine, SAF 237, old growth criteria, for example, may (depending on stand seral status) apply to 75 percent of the plant associations observed in the study area (Table 6). The criteria could apply to an ecological breadth ranging from warm, moist *Abies grandis/Acer glabrum* stands in which fire events are relatively infrequent and severe to hot, dry *Pseudotsuga menziesii/Calamagrostis rubesens* stands in which fire events are relatively frequent. Stands grouped within the Interior Ponderosa Pine, SAF 237, old growth criteria will all have *Pinus ponderosa* as the most abundant overstory species but will differ widely in ecological composition, structure and function. The old growth criteria developed by Green et al. (1992), Hopkins et al. (1992a and b), and Williams et al. (1992), however, apply to groups of plant associations that develop through similar ecological processes and possess similar functional capacities, for example in the development and maintenance of mid-seral old growth characteristics.

Data collected in old growth stands within the study area are summarized in Table 7. The summaries of observed stand conditions incorporate all of the plots for which a given definition apply. Since there is considerable overlap in the application of the various definitions to the plant associations observed (Table 6) any one plot may contribute to the summary for several different definitions.

With few exceptions, stands sampled within the study area (and identified as old growth in the field) meet the criteria that may apply. In the two stands where the Interior Douglas fir, SAF 210 (high productivity) (Hamilton 1992) criteria apply there were fewer large diameter trees (11.2 trees $\geq$ 21 dbh per acre) than needed ($\geq$ 15 trees $\geq$ 24 dbh per acre). Due to differences in the size classes that I employed and criteria for minimum log diameters, it is not possible to say with certainty that the number of logs observed meet the diameter criteria for Grand fir, SAF 213; Interior Douglas fir, SAF 210 (low productivity); and Grand fir/white fir series, low - moderate productivity. All of the stands sampled possess variation in stand structure. At least two stem size classes and canopy layers are present in all stands. Initial data for the age of oldest trees on plots was time consuming to collect and of questionable reliability (e.g., due to stem decay). Age data was not systematically collected and is not summarized here.

Old growth-ness is difficult to describe in highly reliable, discrete terms. For example, it is difficult to characterize the stochastic events that may give rise to lower or higher densities of logs or snags, the presence of broken tree tops, or variability in tree diameters. Old growth criteria set forward by Green et al. (1992), Hamilton (1992), Hopkins et al. (1992a and b), and Williams et al. (1992) must be view as guidelines. They are *minimum* guidelines for the identification of stands with potential old growth characteristics. Old growth criteria are not management benchmarks.

Data summarized in Table 7 provide a reasonable reference for old growth stand structural conditions within the study area. Except for those cases identified above, values for the density of large diameter trees, snags, and logs far exceed those identified in the minimum criteria provided by Green et al. (1992), Hamilton (1992), Hopkins et al. (1992a and b), and Williams et al. (1992). These values, not the minimum guidelines, should be evaluated and updated as the development of new information allows and employed as benchmarks for the management and conservation of old growth.

<u>Old growth forest dynamics</u>--Disturbance is "any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability, of the physical

environment" (Pickett and White 1985). A *disturbance regime* is characterized by the type (or causal agent, e.g., fire, wind, or flooding), frequency or predictability (the number, or probability, of events per time period), extent and magnitude, timing, and the coupling of multiple disturbance and stress factors. Disturbance effects plant community composition and structure through the differential response of individual species. The principle disturbance factor influencing the stand structure, composition and distribution of old growth *Pinus ponderosa* is fire.

A fire disturbance regime is a generalized description of the role fire plays in an ecosystem (Agee 1993). Prominent methods for classifying fire disturbance regimes are based on the characteristics of disturbance, the dominant or potential vegetation, or the severity of effects. Heinselman (1973 as cited by Agee 1993) and Agee (1981) classify fire regimes on the basis of the nature of disturbance events, for example: no natural fire, infrequent light surface fire, frequent light surface fire, etc.... Fire groups (e.g., Crane and Fischer 1986) are based on the characteristics of the potential natural vegetation. Agee (1990) provides a classification of fire regimes that is based on fire severity. In this approach the regime is defined in terms of the stem basal area removed by fire; ranging from 20 percent in low severity to 70 percent in high severity regimes. Fire severity may also be related in terms of tree mortality. In practice, since they are mutually supporting, these different approaches are often used in combination.

Some take exception to the apparent anthropomorphism of terms in discussion of fire disturbance, for example, “stand replacing wildfire event” or “increased risk of catastrophic wildfire” . The commonly used terms, *stand replacing* versus *stand maintaining* fire are based in a fire severity approach to the description of fire disturbance regimes. A *stand replacing* fire causes 100 percent (or near) mortality in trees (thus resulting in the initiation of a new stand of trees). A *stand maintaining* fire causes selective mortality, for example, only in small diameter, understory trees (thus maintaining the dominance of the overstory trees).

The term *catastrophic* or *catastrophe* is derived from the classic literature in disturbance ecology (Pickett and White 1985). Harper (1977) differentiates between disturbance events that occur frequently within the life cycle of the affected organism versus those that occur infrequently within successive generations of the affected organism. He called the frequent disturbance events, *disasters*, and the infrequent events, *catastrophes*. Harper (1977) hypothesizes that disasters, in an evolutionary sense, increase fitness through selection, while catastrophes decrease fitness.

The fire disturbance regime describes multiple events over long periods of time. A single fire event may be characterized by the elements of fire behavior (known as the fire behavior triangle): weather, topography, and fuels. While the fire behavior triangle is most often used to predict the behavior of an event, it is also useful to understand or reconstruct past events.

Elevation, slope, aspect, slope position and physiography are topographical features that contribute to fire behavior. Elevation effects temperature and the length of the fire season. Slope gradient influences the rate of spread and fire intensity. Due to radiant and convective heat transfer, the rate of fire spread is faster on steep slopes, compared to gentle slopes. The point of ignition in relation to slope position also influences the rate of spread and intensity. An ignition in an upper slope position will result in a backing or flanking fire. Ignition in a lower slope position will result in a heading fire. Slope aspect influences air temperature and fuel moisture. The physiography of the landscape contributes to the local distribution of wind and the relative positioning of fuels.

Fuels are a dynamic ecosystem component. The amount of fuel present is a function of site productivity, decomposition rates, and disturbance history. As the moisture content of fuel decreases the flammability of the fuel increases. If fuel moisture is above certain limits (termed the moisture of extinction), combustion will not occur. The rate of heat and moisture transfer depends on the fuel surface area/volume ratio. Small fuel particles have high surface area/volume ratios and great ability to gain and lose heat and moisture. Large logs have low surface area/volume ratios and gain and lose heat and moisture over comparatively longer time periods. Thus, with varying drying periods and the associated effect on fuel moisture, varying proportions and components (e.g., leaf litter versus coarse woody debris) of the total live and dead biomass are available for combustion. The arrangement and density of fuel influences the supply oxygen to the fuel. Tightly packed fuel has a low level of aeration and is less flammable. Loosely packed fuel is well aerated and comparatively more flammable.

Several decades of fire exclusion in old growth *Pinus ponderosa* stands have resulted in significant alteration in characteristics and placement of fuels (Barrett 1988; Sloan 1994). Fire suppression has resulted in the accumulation of surface and ladder fuels. These changes alone threaten the viability of *Pinus ponderosa*-dominated old growth forest as pre-settlement low- and moderate-severity fire regimes have been converted to present day moderate- and high-severity fire regimes.

The consequences of fire exclusion in old growth *Pinus ponderosa* stands are generally proportional to site productivity. On sites where *Pinus ponderosa* is seral, significant increases in the density of understory shade-tolerant tree regeneration have occurred giving rise to multilayered stand structures that were relatively uncommon in presettlement times (Steele et al. 1986; Hamilton 1993; Johnson 1994; Sloan 1994; Arno et al. 1995; Arno et al. 1997). Exasperated by removal of *Pinus ponderosa* through selective harvesting or increased understory regeneration resulting from livestock grazing, these conditions have occurred more rapidly and to a greater extent on more productive sites compared to less productive sites. With the lengthening of fire return intervals, large, old *Pinus ponderosa* are increasingly susceptible to invasion by insects and disease incidence due to intensified competition for water and nutrients resulting from increased understory stem density of more competitive, shade-tolerant tree species (Everett et al. 1994; Morgan 1994; Agee 1996; O'Hara 1996).

<u>Wildlife habitat relations</u>--Old growth *Pinus ponderosa* provides habitats for a diverse range of species. All the wildlife species life forms identified by Thomas et al. (1979) are expected to utilize old growth for reproduction and feeding except one: birds that reproduce in deciduous trees and feed in trees, bushes, or the air (life form 9) do not reproduce in old growth *Pinus ponderosa*. Of all the life form groups identified by Thomas et al. (1979) *Pinus ponderosa*-dominated old growth is most important to groups of animal species that reproduce in coniferous forest, on large limbs, or in tree-stem cavities and feed in trees, bushes, or the air (life forms 10 - 14, Table 6a). Of all the species that use *Pinus ponderosa*-dominated old growth, species that reproduce on the ground and feed on the ground and species that reproduce in coniferous forest, on large limbs, or in tree-stem cavities and feed in trees, bushes, or the air (life forms 5, 10, 11 and 13 - 15)are the most prominent users (Table 6b).

Pinus ponderosa-dominated old growth is particularly important in providing key cavity-nesting and thermal cover habitats. Warren (1989) lists ten species that may select *Pinus ponderosa*-dominated old growth as preferred breeding and feeding habitat: northern goshawk, white-headed woodpecker, pileated woodpecker, Williamson's sapsucker, white-breasted nuthatch, pygmy nuthatch, Townsend's warbler, silver-haired bat, California myotis, and fisher. A prominent species in the current discussion of *Pinus ponderosa*-dominated old growth, however, is the flammulated owl (Hayward and Verner 1994).

The habitat requirements (Bull and Meslow 1977; Harris 1983; Bull and Holthausen 1993), diet (Beckwith and Bull 1985; Torgersen and Bull. 1995); and ecology (Bull et al. 1986; Bull 1987; Mellen et al. 1992) of pileated woodpecker are well known and documented.

The white-headed woodpecker prefers open-canopied old growth *Pinus ponderosa* stands with relatively low stem density (Moore and Fredricks 1991). The birds create cavity nests in standing dead trees, 3 - 25 feet above ground. Large diameter snags allow the excavation of larger cavities, which can result in larger clutch sizes and provide better insulation for eggs and young. Ligon (1973), Bull (1983), Milne and Hejl (1989), Ohmann et al. (1994), and Bull et al. (1986) also summarize observations on the ecology of the white-headed woodpecker.

In this region flammulated owls are principally associated with old growth *Pinus ponderosa* stands. The owl prefers open, high canopied forest stands with low density of shrub cover. Flammulated owl avoids dense, early- to mid-seral stands. Nesting sites are often adjacent open grassland. Flammulated owls often nest in abandoned woodpecker cavities, in dead, large-diameter *Pinus ponderosa*. A large volume of literature is available on the ecology of the flammulated owl. Hayward and Verner (1994) provide a relatively recent compilation of knowledge of the owl. Local studies (relevant to west central Idaho) regarding the owl are documented by Hayward (1986), Hayward and Garton (1988), Powers et al. (1996), Groves et al. (1997), Bull et al. (1989), Atkinson and Atkinson (1990), Moore and Frederick (1991), Shepherd and Servheen (1992), and Shepherd (1996).

<u>Grand fir series</u>--Four plant associations within the *Abies grandis* series were observed in the study area (Table 3). These associations represent the most productive sites within the study area that have potential to support mid-seral old growth *Pinus ponderosa*. The *Abies grandis* associations observed within the study area are all classified by Crane and Fischer (1986) in Fire Group Six. This group represents a broad range of native fire disturbance regimes. From relatively cool, moist stands that are resistant to low intensity fire and are characterized be infrequent, high-intensity stand-replacing fire; to warm, dry stands that are maintained through time by frequent, moderate to low intensity fire. Fire maintained *Abies grandis* forest stands that have developed through relatively frequent, low intensity fire are most susceptible to disruption of the fire disturbance regime (whether by chance or management related factors). As these plant associations include the most productive fire maintained stands, structural changes in response to the removal of fire are most rapid.

Abies grandis/Acer glabrum

<u>Distribution</u>: *Abies grandis/Acer glabrum* is described by Steele et al. (1981) for the Idaho Batholith and Blue Mountains ecoregional sections. Johnson and Simon (1987) describe similar communities (they identify as *Abies grandis/Acer glabrum* and *Abies grandis/Acer glabrum-Physocarpus malvaceus*) for the Blue Mountains section. In Idaho, the plant association is known to occur primarily in the West, Cuddy, Seven Devil, and western Salmon River Mountains. The montane forest community occurs at moderate elevations (3800 - 6400 ft) on mid- to lower-slope positions on north- to east-facing slopes.

<u>Ecology</u>: *Abies grandis/Acer glabrum* sites are highly to very highly productive. *Ponderosa pine* and *Pseudotsuga menziesii* are competitive, long-lived early-seral tree species and may dominate stands for several hundred years. Steele et al. (1981) describe two phases of the plant association, the *Physocarpus malvaceus* and *Acer glabrum* phases. The *Physocarpus malvaceus* phase occurs on relatively warm, dry sites. The *Acer glabrum* phase occurs on more moist sites and is the more productive of the two phases.

Abies grandis/Acer glabrum stands provide important forage and cover habitat for mule deer and elk. Mid- and late-seral, large tree-dominated stands provide critical elk winter range thermal cover.

Few detailed fire history studies regarding the association have been conducted. Crane and Fischer (1986) hypothesize that open, parklike stands dominated by *Ponderosa pine* and *Pseudotsuga menziesii* were favored in pre-settlement times under a disturbance regime of relatively frequent, low-intensity fire. These conditions likely mostly occurred in the *Physocarpus malvaceus* phase of the association. Individual large- and very large-sized *Pinus ponderosa*, in stands located in the N. Fork Payette and Little Salmon river drainages, often show evidence of 3 - 5 historic fire events; suggesting a fire return interval of less than 50 - 60 years. With longer fire return intervals (perhaps due to stochastic factors effecting fire ignition and spread) these sites will support high intensity fire as ground and ladder fuels accumulate rapidly on these relatively productive sites.

<u>Occurrences</u>: *Abies grandis/Acer glabrum* stands were observed primarily at the Little Salmon site; the association also occurs at Corral Creek and Sheep Creek. Occurrences are primarily the

Physocarpus malvaceus phase. Stand structural condition and seral status range from (early) late-seral, medium tree *Abies grandis*-dominated to mid-seral, giant tree *Pinus ponderosa*-dominated (Figure 1). Of all sites visited within the study area, the greatest densities of giant *Pinus ponderosa* were observed at the Little Salmon site. These trees are within an especially significant stand of mid- to late-seral old growth. Large tree dominated old growth *Abies grandis/Acer glabrum, Physocarpus malvaceus* is also present at the Little Salmon site. The structure of these stands is depicted in Figures 1a and 1b.

To a large extent, *Abies grandis/Acer glabrum* stand structure and composition in Little Salmon stands has been influenced by historic partial cut harvest and fire exclusion. Partial cut harvest practices have resulted in a mosaic of dispersed (low to moderate density) remnant large- and very large-sized *Pseudotsuga menziesii* and *Pinus ponderosa* and moderate to high density medium-sized *Abies grandis*, *Pseudotsuga menziesii*, and (to less of an extent) *Pinus ponderosa* (Figure 1c). On these sites, restoration of *Pinus ponderosa*-dominated old growth will likely require manipulation of fast growing, competitive *Abies grandis* sapling-, pole-, and medium-sized trees.

Abies grandis/Spiraea betulifolia

<u>Distribution</u>: *Abies grandis/Spiraea betulifolia* is described by Steele et al. (1981) and Cooper et al. (1991) from the Blue Mountains and Idaho Batholith ecoregional sections of Idaho. The plant association is incidental in the Bitterroot Mountains and Okanogan Highlands sections within Idaho. Johnson and Simon (1987) describe the association from the Blue Mountains section in Oregon. In Idaho the plant community is known from the Cuddy, West, Seven Devil, and western Salmon River Mountains.

<u>Ecology</u>: The plant association occurs at lower elevation (2800 - 5200 ft) on benches and upper-slope positions with south- to west-facing aspects. The association represents a warm, dry extreme of the *Abies grandis* series (Cooper et al. 1991; Johnson and Simon 1987; Steele et al. 1981).

Crane and Fischer (1986) classify the association in Fire Group Six, though this is among the drier, less productive associations in the group. Repeated fire in these stands maintains the structural dominance of large diameter *Pinus ponderosa* and *Pseudotsuga menziesii*. In their work in the Wallowa Mountains of Oregon, Johnson and Simon (1987) did not observe any late seral stands of the association.

<u>Occurrences</u>: Stands of *Abies grandis/Spiraea betulifolia* were observed at the Corral Creek, Denny Creek, Little Salmon, Upper Eagle, and West Upper Eagle sites. Prominent seral and structural conditions are mid-seral, medium-sized *Pinus ponderosa*-dominated; mid-seral giant *Pinus ponderosa*-dominated; and late-seral, large-sized *Abies grandis*-dominated.

Figure 2 depicts the structural contrast between mid-seral old growth stands in which large- and giant-*Pinus ponderosa* are dominant and mid-seral, medium tree-dominated stands. Fire has been excluded in all stands within the study area for approximately 50 - 75 years. Based on available information, the fire return interval in these stands is approximately 50 - 80 years. Thus the period of fire exclusion in *Abies grandis/Spiraea betulifolia* within the study area has lapsed at least one fire return interval. Fire exclusion has likely influenced the abundance of all pole-sized trees and *Pseudotsuga menziesii* and *Abies grandis* medium-sized trees (Figure 2). Partial-cut harvesting of large and giant *Pinus ponderosa* and *Pseudotsuga menziesii* appears to have had the additional effect of increased abundance of seedling-sized *Pseudotsuga menziesii* and *Abies grandis* regeneration (Figure 2).

Abies grandis/Calamagrostis rubescens

<u>Distribution</u>: *Abies grandis/Calamagrostis rubescens* is described by Steele et al. (1981) from the Blue Mountains and Idaho Batholith ecoregional sections of Idaho. Johnson and Simon (1987); Topic and Halverson (1988); and Lillybridge et al. (1995) describe the community for the Blue Mountains of Oregon and the central Eastern Cascades. The association is most abundant in the central Eastern Cascades. In Idaho the forest community occurs primarily in the western Salmon River Mountains and the eastern

Seven Devil Mountains. The plant association occurs with a sporadic distribution throughout its range; often as inclusions within other more prominent plant associations.

Ecology: The association occurs on gentle, convex ridge spurs in mid- to upper-slope positions, on southwest- to northwest-facing slopes at (4100) 5200 to 6100 feet elevation (Steele et al. 1981; Johnson and Simon 1987; Lillybridge et al. 1995).

Abies grandis/*Calamagrostis rubescens* sites are moderately to highly productive. Representative mid-seral occurrences are characterized by an open structure of large diameter *Pinus ponderosa* and *Pseudotsuga menziesii*; the presence of abundant *Calamagrostis rubescens* and *Carex geyeri* growing in a near continuous sward; and patches of dense *Abies grandis*, *Pinus ponderosa*, and *Pseudotsuga menziesii* understory regeneration. *Abies grandis* appears to require overstory cover of *Pinus ponderosa* and *Pseudotsuga menziesii* for establishment on these relatively warm, dry sites (Lillybridge et al. 1995).

Crane and Fischer (1986) classify the association in Fire Group Six, though this is perhaps the driest, least productive association in the group. Fire return intervals are estimated for some stands to be as low as 10 years (Crane and Fischer 1986); but probably range from 15 to 30 years on most sites (Johnson and Simon 1987; Lillybridge et al. 1995). As *Abies grandis* is not able to become established on early seral sites; frequent, low intensity fire maintains structural dominance of large diameter *Pinus ponderosa* and *Pseudotsuga menziesii*. Late-seral *Abies grandis*-dominated stands are not usually observed.

Frequent, low intensity fire also benefits the growth of *Calamagrostis rubescens* and *Carex geyeri*. The plant association provides excellent elk spring/fall transition range.

Occurrences: *Abies grandis*/*Calamagrostis rubescens* was observed at the Benton Meadow and West Upper Eagle sites. Large *Pinus ponderosa* and *Pseudotsuga menziesii* have been selectively harvested at both sites. Though stand structure and composition has been altered by previous harvest activities and the exclusion of fire, portions of these stands retain old growth forest components (Figure 3). As a disturbance regime of relatively frequent, low-intensity fires is naturally coupled with relatively high productivity, these sites are among the most severely impacted by the cumulative effects of high-grade harvest activities and fire exclusion. Approximately three - six fire return intervals have lapsed during the current period of fire exclusion. This has given rise to a higher than expected (if the natural disturbance regime prevailed) abundance of pole-, medium-, and large-sized *Abies grandis* and pole-sized *Pseudotsuga menziesii* (Figure 3).

Douglas-fir series--Nine plant associations within the *Pseudotsuga menziesii* series were observed within the study area (Table 3). These associations occur on low to moderately productive sites. The plant associations are classified by Crane and Fischer (1986) in Fire Groups Two through Five. The *Pseudotsuga menziesii* plant associations observed in the study area in which *Pinus ponderosa* is a dominant species in early- to mid-seral stands, and form *Pinus ponderosa*-dominated old growth are classified by Crane and Fischer (1986) in Fire Groups Two and Three.

Fire Group Three includes warm, dry *Pseudotsuga menziesii* plant associations in which *Pinus ponderosa* is the dominant overstory species in early- to mid-seral stands and is co-dominant with *Pseudotsuga menziesii* in late-seral stands. Relatively frequent, low intensity fire, on these moderately productive sites, maintains open stands of large diameter *Pinus ponderosa* with patchy *Pseudotsuga menziesii* understory regeneration and a patchy mosaic of understory shrub, grass, and herb cover. This fire disturbance regime functions to thin understory tree regeneration, favoring the structural and compositional dominance of *Pinus ponderosa* in the overstory and reducing the development of pole-sized ladder fuels. A fuel load of 10 tons/acre is typical for mid-seral stands in this group of plant associations (Fischer and Bradley 1987). Fire return intervals range from 10 to 20 years (Crane and Fischer 1986). As ground and ladder fuels accumulate during fire-free periods, these stands become increasingly susceptible to stand-replacing fire.

Fire Group Two includes *Pseudotsuga menziesii* and *Pinus ponderosa* plant associations that form forest/grassland ecotonal woodlands. A frequent, low intensity to infrequent, low intensity fire regime is characteristic of these low to moderately productive sites. Frequent to infrequent, low intensity fire in these plant associations functions to reduce tree encroachment into grassland and thin understory tree regeneration, favoring the structural and compositional dominance of *Pinus ponderosa* and reducing the development of pole-sized ladder fuels. On moderately productive sites, fire return intervals range from 10 to 18 years. On low productive sites the fire return interval in this group may be as long as 50 years as sufficient fuels are not present to carry fire or are broken by rock outcrop or bare soil.

Pseudotsuga menziesii/Physocarpus malvaceus

Distribution: *Pseudotsuga menziesii/Physocarpus malvaceus* is described by various authors for most ecological regions of the Northern Rockies, Wallowa Mountains, Blue Mountains, and eastern North Cascades (Daubenmire and Daubenmire 1968; Pfister et al. 1977; Steele et al. 1981 and 1983; Williams and Lillybridge 1983; Johnson and Simon 1987; Mauk and Henderson 1984; Cooper et al. 1991; Johnson and Clausnitzer 1992; Williams et al. 1995). *Pinus ponderosa* is consistently an important species, however, only in stands of the plant association described in the Idaho Batholith, Blue Mountains, and Bitterroot Mountains ecoregional sections (Steele et al. 1981; Johnson and Simon 1987; Cooper et al. 1991). Stands described by Johnson and Simon (1987) are most similar to the *Calamagrostis rubescens* and *Pinus ponderosa* phases described by Steele et al. (1981), as compared to the *Physocarpus malvaceus* and *Smilacina stellata* phases described by Steele et al. (1981) and/or Cooper et al. (1991).

Ecology: The widespread, well distributed plant association occurs on steep slopes with varying aspects. The *Calamagrostis rubescens* phase occurs principally on southeast- to southwest-facing slopes. Other phases of the association have an affinity for more northerly aspects. In the Idaho Batholith, Seven Devils, and Wallowa Mountains the plant association occurs in warm, mild habitats of the lower- to mid-elevation (2500 - 5800 ft) montane forest zone.

Crane and Fischer (1986) classify the *Calamagrostis rubescens* and *Pinus ponderosa* phases in their Fire Group Three. Fire return intervals on these relatively warm, dry phases of the plant association range from 22 to 13 years (Steele et al. 1986).

Occurrences: *Pseudotsuga menziesii/Physocarpus malvaceus* was observed at the Corral Creek, Deer Creek Mine, Little Salmon, Pardee, Partridge Creek, Sheep Creek, Upper Eagle, W Fork Lake Creek, Wapshilla Ridge, and Warm Springs sites. Observed stand seral and structural conditions include nearly all permutations of mid- and late-seral status with medium to giant tree dominated structure (Table 3). Figure 4 provides a comparison of mid- and late-seral old growth and mid-seral medium tree-dominated stands in the *Calamagrostis rubescens* and *Pinus ponderosa* phases.

The period since the last fire event ranges between 80 and 115 years in these stands; approximately 3 - 5 fire return intervals have lapsed. In old growth stands fire exclusion has contributed to the increased abundance of pole- and medium-sized *Pseudotsuga menziesii*. Mid-seral, medium tree dominated stands were generated both through fire disturbance and harvest activities (Figure 4).

Pseudotsuga menziesii/Symphoricarpos albus

Distribution: *Pseudotsuga menziesii/Symphoricarpos albus* is also a widespread plant association in the Northern Rocky Mountains, Wallowa Mountains, Blue Mountains, and eastern North Cascades (Daubenmire and Daubenmire 1968; Pfister et al. 1977; Steele et al. 1981 and 1983; Williams and Lillybridge 1983; Johnson and Simon 1987; Cooper et al. 1991; Johnson and Clausnitzer 1992; Williams et al. 1995). In Idaho the association is most abundant in the western Salmon River and Seven Devil mountains, within the Idaho Batholith and Blue Mountain ecoregional sections. Here the association occurs on canyon side slopes and ridgetops, on warm, dry gentle to moderately steep slopes, in lower- to upper-slope positions (3200 - 5100 ft elevation) (Steele et al. 1981; Johnson and Simon 1987). The association occurs as dispersed, relatively small stands. Adjacent associations are often *Pinus ponderosa*/*Festuca idahoensis* in lower slope positions and *Pseudotsuga menziesii/Physocarpus malvaceus* in upper slope positions.

Ecology: *Pinus ponderosa* is a prominent species in the western distribution of the association. The abundance of *Pinus ponderosa* is a key difference between the *Pinus ponderosa* and *Symphoricarpos albus* phases (Steele et al. 1981). Stands described by Johnson and Simon (1987) and Johnson and Clausnitzer (1992) appear most similar to the *Pinus ponderosa* phase. Open, parklike stands dominated by large diameter *Pinus ponderosa* are (historically) maintained by low intensity, frequent fire. The natural fire return interval was estimated as 13 -16 years for stands located in the upper Salmon River canyon (Crane and Fischer 1986). As ground and ladder fuels accumulate during fire-free periods, these stands become increasingly susceptible to stand-replacing fire.

Occurrences: The association was observed at the Deer Creek Mine, Sheep Creek, W Fork Lake Creek, and Wapshilla Ridge sites. All of the stands are the *Pinus ponderosa* phase except one observed at Sheep Creek. Stands in this phase are mid-seral old growth dominated by large *Pinus ponderosa*. Approximately 2 - 5 fire return intervals have lapsed in these stands in the last 30 - 80 years of fire exclusion. Seedling and sapling *Pinus ponderosa* and sapling *Pseudotsuga menziesii* are abundant in the understory.

Pseudotsuga menziesii/Spiraea betulifolia

Distribution: *Pseudotsuga menziesii/Spiraea betulifolia* is described from sites located in the Wallowa Mountains east to the southern Bitterroot Mountains and Beaverhead Mountains (western Yellowstone Plateau) and south to the Boise Mountains (Pfister et al. 1977; Steele et al. 1981 and 1983; Johnson and Simon 1987; Cooper et al. 1991). The association is most common in the western Salmon River and Boise mountains and the eastern Wallowa Mountains. It occurs on dry, gentle to steep, south-facing slopes in upper-slope positions at 3000 to 6000 feet elevation.

Ecology: *Pinus ponderosa* is an important species only within the western range of the plant association, which is represented by the *Pinus ponderosa* phase. Stands described by Johnson and Simon (1987) in the Wallowa Mountains are most similar to *Pinus ponderosa* phase described by Steele et al. (1981). In these stands *Pinus ponderosa* is a long-lived seral species that is seldom excluded by *Pseudotsuga menziesii*. Steele et al. (1986) estimate the fire return interval as 10 years for a stand located in the Boise Mountains.

Occurrences: *Pseudotsuga menziesii/Spiraea betulifolia* was observed at Sheep Creek and Wapshilla Ridge. All of the stands observed are the *Pinus ponderosa* phase. The stand at Sheep Creek is late seral, dominated by giant *Pinus ponderosa*. Within this stand, the age of medium-sized *Pseudotsuga menziesii* understory regeneration and the age of fire scars of large *Pinus ponderosa* suggest a 22 - 38 year fire return interval. The Wapshilla Ridge stands are both mid-seral, medium tree dominated and mid-seral, large tree dominated. Mean stem density on mid- and late-seral old growth stands is 146 tpa. Approximately 19 tpa large diameter ($\geq$ 21 inches dbh) trees are present. Fire exclusion on these sites has likely resulted in a greater abundance of pole- and medium-sized *Pseudotsuga menziesii* and *Pinus ponderosa* (Figure x).

Pseudotsuga menziesii/Carex geyeri

Distribution: The *Pseudotsuga menziesii/Carex geyeri* plant association occurs with a patchy, disrupted distribution. The plant association is described by Pfister et al. (1977), Steele et al. (1981), Johnson and Clausnitzer (1992), Williams and Lillybridge (1983), Lillybridge et al. (1995), and Topik et al. (1988) for sites located in the central Northern Rockies, Blue Mountains, and eastern Cascades. The association is well represented in the ecoregional sections of central Idaho. Steele et al. (1981) describe three phases of the association. *Pinus ponderosa* is only an important species in the western range of the association. In the Northern Rockies this includes only the range of the *Pinus ponderosa* phase. *Pinus ponderosa* does not occur in the eastern phases of the association (Steele et al. 1981).

Ecology: The *Pseudotsuga menziesii/Carex geyeri*, *Pinus ponderosa* phase occurs on dry aspects in all slope positions, from 3700 to 6300 feet elevation. The phase is grouped in Fire Group Three. Steele et al. (1986) estimate the fire return interval as 10 years for a stand located in the Boise Mountains.

Occurrences: Stands of the plant association were observed at the Benton Meadow and Little Salmon sites. Stands at both sites are mid-seral, medium tree dominated. Stands are degraded by recent selective harvest activities. A *Pinus ponderosa* stump at the Little Salmon site (on private, Section 13, SW1/4 SW1/4) shows four fire events (at approximately 67, 102, 121, and 147 ybp). The tree was approximately 205 years old at the time of harvesting.

Pseudotsuga menziesii/Symphoricarpos oreophilus

Distribution: *Pseudotsuga menziesii/Symphoricarpos oreophilus* is described from the eastern North Cascades, Okanagon Highlands, Blue and Wallowa mountains, central Northern Rockies, and the northern Great Basin (Pfister et al. 1977; Steele et al. 1981 and 1983; Williams and Lillybridge 1983; Mauk and Henderson 1984; Johnson and Simon 1987; Johnson and Clausnitzer 1992; Williams et al. 1995). While the association is wide ranging, stands are sporadically distributed. The association is most abundant in the eastern portion of its range, in the Challis Volcanics ecoregional section and south and east.

Ecology: The association occurs on gentle to moderately steep, southeast to west-facing slopes on ridgebrow and upper-slope positions, at the upper elevational limit of the *Pseudotsuga menziesii* series (4300 - 5300 ft.) (Johnson and Simon 1987).

The association often occurs at the interface of forest and grassland (e.g., adjacent to both *Pseudotsuga menziesii/Physocarpus malvaceus* and *Festuca idahoensis*- dominated grassland). These habitats provide important wildlife cover and forage habitats. Low snow accumulations (due to wind transfer and slope aspect) and the presence of important browse species contribute to the value of these sites as deer and elk winter range. Many sites are degraded by heavy livestock use. The association is classified in Fire Group Two by Crane and Fischer (1986).

Occurrences: Stands of the plant association were observed at Frye Point, Upper Eagle, and Wapshilla Ridge. These stands are typically degraded by selective timber harvest and livestock grazing. At Frye Point mid-seral stands are dominated by medium-sized *Pinus ponderosa*. The small stand located on Wapshilla Ridge is mid- to late-seral old growth with a relatively high density of understory *Pinus ponderosa* and *Pseudotsuga menziesii* understory regeneration. One small stand that possesses old growth characteristics is located at Upper Eagle.

Pseudotsuga menziesii/Calamagrostis rubescens

Distribution: The *Pseudotsuga menziesii/Calamagrostis rubescens* association is relatively abundant throughout much of its range. It is one of the most well represented and well distributed plant associations within the *Pseudotsuga menziesii* series. The plant association is described in the eastern North Cascades, Okanagon Highlands, the Blue and Wallowa mountains, central Northern Rockies, and the northern Great Basin by Pfister et al. (1977), Steele et al. (1981 and 1983), Williams and Lillybridge (1983), Mauk and Henderson (1984), Johnson and Simon (1987), Johnson and Clausnitzer (1992), Cooper et al. (1991), and Williams et al. (1995). The association occurs on gentle to steep, south- to southwest-facing slopes on upper-slope and ridgebrow positions at elevations ranging from 4100 to 6000 feet.

Ecology: *Pinus ponderosa* is an important seral species primarily in the central geographical (i.e., in the Blue Mountains east to west-central Montana) and lower elevational portion of the range. Of the three phases described by Steele et al. (1981), *Pinus ponderosa* is only an important species in the *Pinus ponderosa* phase. This phase of the plant association is classified in Fire Group Three (Crane and Fischer 1986). Representative mid-seral stands are characterized by an open structure of large diameter *Pinus ponderosa* and the presence of abundant *Calamagrostis rubescens* and *Carex geyeri* growing in a near continuous sward.

Occurrences: Stands of the *Pinus ponderosa* phase of the association were observed at Deer Creek Mine and Partridge/Elkhorn. Mid-seral old growth at both sites is dominated by *Pinus ponderosa*. On the two plots within the association, mean stem density is 160 tpa, with approximately 24 tpa large diameter (≥ 21 inches dbh) trees. Self-thinning and low intensity fire in the relatively dense understory has resulted in large numbers of pole-sized dead and down and standing dead. An average of 4 large diameter (≥ 21 inches dbh) logs were observed on the two plots. A likely consequence of historic and relatively recent selective harvesting within these stands is the loss of large diameter standing dead. The availability and characteristics of fine fuels within both stands has historically been influenced by livestock grazing.

Pseudotsuga menziesii/Agropyron spicatum

Distribution: *Pseudotsuga menziesii/Agropyron spicatum* is described from sites located in the central Northern Rocky Mountains and eastern North Cascades (Pfister et al. 1977; Steele et al. 1981; Cooper et al. 1991; Lillybridge et al. 1995). In Idaho, the plant association is moderately abundant in the Blue Mountains, Idaho Batholith, and Challis Volcanics ecoregional sections.

Ecology: These low productivity sites occur on steep, south- to west-facing slopes, usually below 3800 feet elevation. *Pinus ponderosa* is an important long-lived seral species in stands located in the Blue Mountains and Idaho Batholith sections. The association is grouped in Fire Group Two (Crane and Fischer 1986).

Occurrences: Stands of the association were observed at Corral Creek, Deer Creek Mine, and Pardee. Mid-seral, medium tree *Pinus ponderosa*-dominated stands are present at all of the sites. In these stands low to moderate densities of medium- and large-sized *Pinus ponderosa* are often associated with extreme densities of seedling- and sapling-sized *Pinus ponderosa* (mostly) and *Pseudotsuga menziesii* (to less of an extent). Stem data were collected at one plot at Pardee. On this plot there are approximately 608 tpa. Over 90 percent of these stems (560 tpa) are seedling- and sapling-sized. These stands have been degraded by selective harvesting and livestock grazing.

Late- and mid-seral large tree-dominated stands of *Pseudotsuga menziesii/Agropyron spicatum* also occur at Pardee. The mid-seral stands occur as inclusions within larger areas of *Pinus ponderosa/Agropyron spicatum*. Stem density is approximately 420 tpa with 16 tpa large diameter (≥ 21 inches dbh) trees. Few large snags and logs are present.

Pseudotsuga menziesii/Festuca idahoensis

Distribution: *Pseudotsuga menziesii/Festuca idahoensis* is described from sites located in the central Northern Rocky Mountains (Pfister et al. 1977; Steele et al. 1981; Cooper et al. 1991). In Idaho, the plant association is common in the Blue Mountains, Idaho Batholith, and Challis Volcanics ecoregional sections.

Ecology: These low productivity sites occur on steep, north- to east-facing slopes, on mid- to lower-slope positions and benches, at lower forest elevations (3000 - 6500 ft.). While the association is most abundant in the eastern portion of its range, *Pinus ponderosa* is an important long-lived seral species only in the western portion. This western portion of the range is represented by the *Pinus ponderosa* phase described by Steele et al. (1981). The association is grouped in Fire Group Two (Crane and Fischer 1986).

Occurrences: Stands of *Pseudotsuga menziesii/Festuca idahoensis* were observed at Frye Point, Partridge Creek, Upper Eagle, Wapshilla Ridge, and Warm Springs. All of the occurrences are the *Pinus ponderosa* phase. The relatively small stands range from mid- to late-seral and are medium and large tree-dominated. Mid- and late-seral old growth stands occur at Partridge Creek and Warm Springs. These are open woodlands with clustered large and giant *Pinus ponderosa*. Patchy, high density *Pinus ponderosa* and *Pseudotsuga menziesii* regeneration occurs in the shaded understory of large-tree clusters. Stem data were collected on one plot located at Partridge Creek. Approximately 377 tpa were present with 17 tpa large diameter ($\geq$ 21 inches dbh) trees. A dispersed, low density of large-sized logs and standing dead is present.

Ponderosa pine series--Two plant associations within the *Pinus ponderosa* series were observed at sites included in the study: *Pinus ponderosa/Agropyron spicatum* and *Pinus ponderosa/Symphoricarpos oreophilus*. Both plant associations are described by Crane and Fischer (1986) within Fire Group Two (see discussion above, with *Pseudotsuga menziesii* series). This series is widely distributed in the Pacific Northwest. *Pinus ponderosa*-dominated forest stands, however, of the *Abies grandis* and *Pseudotsuga menziesii* series are more common.

Pinus ponderosa/Agropyron spicatum

Distribution: *Pinus ponderosa/Agropyron spicatum* is described from sites located in the Blue Mountains, Wallowa Mountains, and central Northern Rocky Mountains (Steele et al. 1981; Johnson and Simon 1987; Cooper et al. 1991; Johnson and Clausnitzer 1992). The association occurs with a sporadic distribution; with peaks of abundance in the Blue Mountains, Salmon Mountains, and Boise Mountains.

Ecology: These very open, small stands usually occur within mosaics of woodland and grassland on steep, convex, south-facing slopes at lower timberline (3200 - 4700 ft.).

Occurrences: One late-seral old growth stand of the association was observed at Pardee. Large *Pinus ponderosa* occur in clusters within the woodland. Patchy, high density *Pinus ponderosa* seedling and sapling regeneration occurs in the shaded understory of large-tree clusters. Stem data were collected on one plot. Total stem density is 416 tpa with 16 tpa large diameter ($\geq$ 21 inches dbh) trees. Dispersed large-sized logs and snags are present.

Pinus ponderosa/Symphoricarpos oreophilus

Distribution: *Pinus ponderosa/Symphoricarpos oreophilus* is described from the Blue Mountains, Seven Devil Mountains, and Boise Mountains by Steele et al. (1981) and Johnson and Clausnitzer (1992). The Blue Mountain stands are significantly compositionally distinguished by the presence of *Juniperus occidentalis*, which is absent in Seven Devil Mountains and Boise Mountains stands.

Ecology: The plant association occurs on steep, south-facing slopes on ridges and upper slope positions (4400 - 5600 ft. elevation); often at the interface between forest and mountain shrublands or grassland.

Occurrences: One small stand of the association was observed on Wapshilla Ridge.

SITE CONSERVATION AND RESTORATION RECOMMENDATIONS

Stand maintenance and restoration--Restoration of fire dependent plant communities is a major focus of the development and application of ideas related to ecosystem management (Mutch et al. 1993; Johnson 1994; Everett et al. 1994; Arno 1996a; Barbour and Skog 1997). In these dry *Abies grandis*, *Pseudotsuga menziesii*, and *Pinus ponderosa* ecosystems the disruption of natural frequent, low intensity disturbance has given rise to widespread conditions where the application of manipulative approaches has potential for ecological restoration (Arno 1996b; Fiedler 1996; Barbour et al. 1997). Current market conditions and new technological developments increase the administrative attractiveness and economic feasibility of harvesting small diameter trees from the understories of old growth stands degraded by fire exclusion (Willits et al. 1996; Fiedler et al. 1997; Everett and Baumgartner 1997; Salwasser and Bollenbacher 1997).

The use of stand manipulative silvicultural practices in the restoration of *Pinus ponderosa*-dominated old growth for the purpose of conservation and the maintenance of wildlife habitats is, however, unproven and limited by prevalent agency management culture, mechanical and administrative operations, and the drive to attain economic feasibility. For example, in a study of the utilization of small diameter trees in the improvement of wildlife habitat, Willits et al. (1996) refer to four different silvicultural regimes, but fail to provide an indication of the operational meaning of these regimes (i.e., what is *thinning*?, what is *group selection*?). Mechanical and logistical limitations of standard manipulative approaches may surreptitiously disenable attainment of initial project objectives. For example, if it is necessary to harvest a number of large diameter (≥ 21 inches dbh) *Pinus ponderosa* trees to cover the cost of repairing the road that will be used to haul the logs that are cut to reduce ladder fuels, will the project still meet an objective of conserving *Pinus ponderosa*-dominated old growth or restoring old growth dependent wildlife habitats? If it is necessary to fell any snags in a management unit due to standard timber sale contractual limitations, will the timber sale serve the interest of conserving *Pinus ponderosa*-dominated old growth or restoring old growth dependent wildlife habitats?

Past attempts to manage for the restoration of *Pinus ponderosa*-dominated old growth have failed due to the merging of silvicultural and habitat conservation objectives that are partially mutually beneficial and partially mutually exclusive. It is important to recognize that in all the generations of Euro-American settlers, not a single old (≥ 200 years), large diameter (≥ 21 inches dbh) *Pinus ponderosa* has been cultivated from seed by the hand of man; nor a snag; nor a log; nor a stand of trees, snags and logs. Old growth *Pinus ponderosa* is a non-renewable resource. Management objectives for the conservation and restoration of *Pinus ponderosa*-dominated old growth forest must be clear and unrestricted by the panacea of multiple benefits and resource objectives (e.g., the economical production of wood fiber commodities).

Benton Meadow

A variety of different forested plant associations and seral and structural conditions are present within the vicinity of the Benton Meadows administrative site on the Peter T. Johnson Wildlife Mitigation unit of Craig Mountain WMA. The primary focus here are *Abies grandis/Calamagrostis rubesens* stands located on the knob east of the administrative site. These mid-seral stands provide an example of conditions that are repeated throughout the wildlife management area. The stands were partial cut relatively recently. The result of these harvest activities are residual patches of large-tree (i.e., old growth) structure within a matrix of medium-tree dominated structure. High density (680 - 880 tpa) seedling, sapling, and pole regeneration occurs in the understory of patchy medium- and larger-sized trees.

Restoration activities to promote the development of *Pinus ponderosa*-dominated old growth on this site (and similar sites) should focus on controlling *Abies grandis* and *Pseudotsuga menziesii* competition with *Pinus ponderosa* natural regeneration. This could be accomplished by following activities: (1) thin all seedling-, sapling-, and pole-sized *Abies grandis*; (2) thin all seedling- and sapling-sized *Pseudotsuga menziesii*; (3) selectively thin pole-sized *Pseudotsuga menziesii* to reduce competition with *Pinus ponderosa* but to allow *Pseudotsuga menziesii* growth where *Pinus ponderosa* medium-sized trees and larger are absent. Retain all medium-sized and larger trees for snag and log recruitment. Hand pile and burn thinned stems. Pile burning should balance the consumption of fuel with protection of understory vegetation and soil resources. Maintain low intensity pile burns by pulling off some 10 hour fuels and all 100 hour fuels and greater. Protect the site from fire until current *Pinus ponderosa* sapling cohort has attained sufficient size to survive light understory prescribed burning.

Corral Creek

The site encompasses a mosaic of grassland and forest vegetation in a range of seral and structural conditions. PSME/PHMA, PHMA is prominent on west- to northwest-facing slopes. These stands are primarily late-seral and dominated by medium-sized *Pseudotsuga menziesii*. Stand structure ranges from open individual medium-sized *Pseudotsuga menziesii* with few saplings (and poles) and abundant shrub cover to dense clusters of medium- and pole-sized *Pseudotsuga menziesii*. Few dispersed large-sized *Pseudotsuga menziesii* and *Pinus ponderosa* are present. Due to extreme slope gradients and abundant, tall understory shrub cover, these sites probably never maintain old growth *Pinus ponderosa*. Rather, fire appears to occur with intense behavior resulting in high mortality leaving few remnant large *Pinus ponderosa*.

Mid-seral, *Pinus ponderosa*-dominated old growth PSME/PHMA, CARU is prominent on south- to east-facing slopes. These forest stringer stands form a mosaic with *Festuca idahoensis/Agropyron spicatum, Balsamorhiza sagittata*. PSME/PHMA, PHMA and PSME/PHMA, PIPO are also present. The stands are dominated by relatively dense (24 tpa) large diameter (> 21 inch dbh) *Pseudotsuga menziesii* and *Pinus ponderosa*. Approximately 20 and 30 tpa medium-sized, 70 - 80 year old *Pseudotsuga menziesii* and *Pinus ponderosa*, respectively, are present in the understory. The understory shrub/forb layer is characterized by an open sward of *Calamagrostis rubescens* with patchy clumps of *Physocarpus malvaceus*. Deer sign is often abundant. Numerous bedding sites are often present within the interior of forest stringers. These relatively high quality old growth stand conditions should be maintained through the judicious use of prescribed fire. More work is needed at the site to determine specific fire return intervals and historic fire behavior patterns.

Stands in upper-slope and ridge crest positions within the site have been selectively harvested. Mid-seral PSME/AGSP stands located on south-facing upper-slope positions in the very headwater of Corral Creek should be protected from fire to protect sapling-sized *Pinus ponderosa* and promote the replacement of harvested large diameter *Pinus ponderosa*.

Ridge crest stands are predominantly mid-seral medium tree-dominated ABGR/ACGL, PHMA with inclusions of ABGR/SPBE and PSME/PHMA, CARU. Currently about 7 tpa large diameter remnant *Pseudotsuga menziesii* and *Pinus ponderosa* occur with a dense understory of 607 tpa seedling-, sapling-, and pole-size *Abies grandis*, *Pseudotsuga menziesii*, and *Pinus ponderosa* regeneration. Approximately 127 tpa medium-sized 50 year old *Abies grandis*, *Pseudotsuga menziesii*, and *Pinus ponderosa* are also present. Prior to harvest these stands supported approximately 21 tpa large diameter *Pseudotsuga menziesii* and *Pinus ponderosa*. The open, large tree-dominated stand structure likely served an important ecological role as a ridge crest fuel break prior to the suppression of wildfire and selective harvest activities.

Restoration activities on these ridge crest sites should focus on controlling *Abies grandis* and *Pseudotsuga menziesii* competition with *Pinus ponderosa* natural regeneration. Hand thinning should be followed by the use of prescribed fire. Hand thinning should: (1) remove all seedling-, sapling-, and pole-sized *Abies grandis*; (2) remove all seedling- and sapling-sized *Pseudotsuga menziesii*; (3) selectively thin pole-sized *Pseudotsuga menziesii* to reduce competition with *Pinus ponderosa* but to allow *Pseudotsuga menziesii* growth where *Pinus ponderosa* medium-sized trees and larger are absent. Retain all medium-sized and larger trees for snag and log recruitment. Hand pile and burn thinned stems. Pile burning should balance the consumption of fuel with protection of understory vegetation and soil resources. Maintain low intensity pile burns by pulling off some 10 hour fuels and all 100 hour fuels and greater.

Protect the sites from fire until current *Pinus ponderosa* sapling cohort has attained sufficient size to survive light understory prescribed burning.

Deer Creek Mine

The site encompasses a rough ridgespur knob which juts off the gentle plateau of Larabee Meadows south toward the Deer and Eagle creek drainages. A range of different *Pseudotsuga menziesii* plant associations are present on south- to west-facing slopes. Associations within the *Abies grandis* series occur on east-facing slopes within the site. Stands of mid-seral *Pinus ponderosa* old growth PSME/CARU, PIPO; PSME/PHMA, CARU; and PSME/SYAL, PIPO are present. Approximately 26 tpa large diameter ($\geq$ 21 inches dbh) *Pinus ponderosa* are within these old growth stands. Understory *Pseudotsuga menziesii* regeneration is intense and patchy. About 463 tpa seedling-, sapling- and pole-sized *Pseudotsuga menziesii* (and few *Pinus ponderosa*) are densely clustered in the understory. Medium-sized *Pinus ponderosa* occur with a density of approximately 30 tpa. Evidence of a history of low intensity fire abounds within the site. Portions of the old growth stands have been selectively harvested. Understory grass and forb cover is locally sparse, suggesting a history of intensive livestock grazing. Mid-seral medium tree stands occur as inclusions within the old growth. These stands appear to have been generated by stand replacing fire behavior as no cut stumps or logs are present.

Restoration activities within these stands should focus on the reintroduction of the native frequent, low intensity fire disturbance regime. Some hand thinning prior to the use of prescribed fire may be necessary to reduce the abundance of ladder fuels. Prescribed burning should occur in Fall to protect against a potential reduction in bunch grass abundance.

Denny Creek

The site occurs on basalt plateau breaks on the western edge of the Salmon River Mountains. *Pinus ponderosa*-dominated old growth ABGR/SPBE occurs interspersed with basalt talus. Old growth stands are both mid- and late-seral. Approximately 24 tpa large diameter trees are present. Understory regeneration is moderate with approximately 207 tpa seedling-, sapling-, and pole-sized *Abies grandis*, *Pseudotsuga menziesii*, and *Pinus ponderosa*. Medium-sized *Abies grandis*, *Pseudotsuga menziesii*, *Pinus contorta*, and *Pinus ponderosa* occur with a density of about 116 tpa. Medium-sized *Abies grandis* and *Pseudotsuga menziesii* are 75 to 85 years old. One fire scar was dated as 94 year old. Large diameter *Pinus ponderosa* typically show 2 -3 fire events. Prior to selective harvest activities the density of large diameter trees within these relatively productive old growth stands was approximately 34 tpa.

Restoration activities to promote the maintenance of *Pinus ponderosa*-dominated old growth on this site should focus on (1) controlling *Abies grandis* and *Pseudotsuga menziesii* competition with *Pinus ponderosa* regeneration and (2) the reduction of ladder fuels. Prescribed understory burning could occur now in stands on south-facing slopes in the northern portion of the site. In other locations, however, hand thinning, followed by pile burning, is probably required prior to the use of prescribed understory fire. Hand thinning should remove all seedling-, sapling-, and pole-sized *Abies grandis* and *Pseudotsuga menziesii*.

Little Salmon

The site occurs in the upper Little Salmon River drainage, on the western edge of the Salmon River Mountains. The site encompasses the most productive old growth *Pinus ponderosa* stands within the study area. ABGR/ACGL, PHMA stands range from mid- to late-seral and from medium to giant tree dominated. Stands of mid-seral old growth ABGR/SPBE and PSME/PHMA, CARU are also present.

The most outstanding mid-seral giant old growth occurs at the site. In these ABGR/ACGL, PHMA and ABGR/SPBE stands 34 tpa large ($\geq$ 21 inches dbh) diameter *Pinus ponderosa* are present, one-half of which exceed 32 inches dbh. The density of understory *Abies grandis*, *Psuedotsuga menziesii*, and *Pinus ponderosa* seedling, sapling, and pole regeneration is low, approximately 68 tpa. Coincidentally there are also about 68 tpa medium sized trees per acre, again including *Abies grandis*, *Psuedotsuga menziesii*, and *Pinus ponderosa*. Maintenance of these high quality old growth stands may be achieved through the reintroduction of native moderately frequent, low intensity fire disturbance.

Approximately 30 tpa large diameter *Pinus ponderosa* are present within mid-seral large tree ABGR/ACGL, PHMA and PSME/PHMA, CARU stands. As with the giant old growth, the density of understory regeneration is low, about 47 tpa. Approximately 77 tpa medium-sized *Psuedotsuga menziesii* and *Pinus ponderosa* are present. Similar stem densities occur within late-seral large tree PSME/PHMA, CARU stands. *Psuedotsuga menziesii* is codominant with *Pinus ponderosa* with equal numbers of large diameter trees occurring at a density of 30 tpa. *Psuedotsuga menziesii* and *Pinus ponderosa* understory is more intense, compared to the mid-seral stands, with approximately 130 tpa. Medium-sized trees are also more abundant with 95 tpa. Restoration activities within these mid- and late-seral *Pinus ponderosa* old growth stands should focus on the reintroduction of the native moderately frequent, low intensity fire disturbance regime. Some hand thinning prior to the use of prescribed fire may be necessary to reduce the abundance of ladder fuels.

Large areas of the Little Salmon site have been intensively selectively harvested. While these stands are seriously degraded, good potential for the restoration of *Pinus ponderosa* dominated old growth exists. Remnant large diameter *Pinus ponderosa* are relatively numerous. The challenge presented by these stands is that removal of large diameter seral and shade intolerant overstory *Pinus ponderosa* has resulted in the extensive regeneration of late-seral and shade tolerant *Abies grandis.* Approximately 6 tpa large diameter *Pinus ponderosa* are present within these mid-seral medium tree ABGR/ACGL, PHMA stands. *Abies grandis* and *Psuedotsuga menziesii* seedling-, sapling-, and pole-sized regeneration occurs with a density of about 115 tpa. Approximately 120 tpa medium-sized *Abies grandis*, *Psuedotsuga menziesii*, and *Pinus ponderosa* are present. Only a small fraction (~ 15 tpa) of these trees are *Pinus ponderosa*.

Restoration of these more degraded sites should first focus on controlling *Abies grandis* and *Pseudotsuga menziesii* competition with *Pinus ponderosa* natural regeneration and the reduction of fuel, then on the reintroduction of moderately frequent, low intensity fire disturbance. Hand thinning should be followed by the use of prescribed fire. Hand thinning should: (1) remove all seedling-, sapling-, and pole-sized *Abies grandis*; (2) remove all seedling- and sapling-sized *Pseudotsuga menziesii*; (3) selectively thin medium-sized *Abies grandis* and pole-sized *Pseudotsuga menziesii* to reduce competition with *Pinus ponderosa* but to allow *Pseudotsuga menziesii* growth where *Pinus ponderosa* medium-sized trees and larger are absent. Hand pile and burn thinned stems and limbs. Pile burning should balance the consumption of fuel with protection of soil resources. Maintain low intensity pile burns by pulling off 100 hour fuels and greater. Protect the sites from fire until current *Pinus ponderosa* sapling cohort has attained sufficient size to survive light understory prescribed burning.

N Fork Rattlesnake

The site encompasses mid-seral medium tree stands of PSME/FEID, PIPO and PSME/PHMA, PIPO. These stands were heavily harvested in the recent past. Residual stand components are minimal and barely provide a basis for the restoration of old growth characteristics. Large diameter trees are present, though the density is very low (well below 10 tpa). The density of medium-sized trees is also low. The density of seedling-, sapling-, and pole-sized *Pinus ponderosa* and *Pseudotsuga menziesii* is approximately 300 tpa. Opening of the forest canopy on these sites has resulted in high cover of tall shrubs.

Restoration of medium-tree-dominated stands to *Pinus ponderosa*-dominate old growth will require hand thinning of seedling-, sapling- and pole-sized *Pseudotsuga menziesii* regeneration. Hand pile and burn resultant 10 hour fuels. Protect these sites from fire until current *Pinus ponderosa* sapling cohort has attained sufficient size to survive light understory prescribed burning.

Pardee

Occurs on steep slopes above the Clearwater River. The site encompasses the lowest elevation old growth *Pinus ponderosa* within the study area and the only *Pinus ponderosa* plant associations surveyed within the study area. Old growth stands are principally PIPO/AGSP with inclusions of PSME/AGSP and PSME/PHMA, PHMA. Approximately 16 tpa large diameter *Pinus ponderosa* are present within these mid- and late-seral stands. Understory regeneration is patchy with dense clusters (~340 tpa) of seedlings, saplings, and poles. Pole-sized *Pinus ponderosa* were aged as 25 years old and were not charred. Adjacent medium-sized *Pinus ponderosa* were, however, charred indicating that the last fire event within the sampled stand was 25 - 30 years ago.

Approximately 8 tpa large diameter *Pinus ponderosa* are present within mid-seral medium tree PSME/AGSP stands. As with old growth stands, understory regeneration is patchy with dense clusters (~580 tpa) of *Pinus ponderosa* and *Pseudotsuga menziesii* seedlings, saplings, and poles. About 20 tpa, 25 - 30 year old, medium-sized *Pinus ponderosa* are present.

Restoration of these mid- and late-seral stands should focus on the reintroduction of the native frequent, low intensity fire disturbance regime. Some hand thinning prior to the use of prescribed fire may be necessary in mid-seral and medium tree stands to reduce the abundance of ladder fuels. Prescribed burning should occur in Fall to protect against a potential reduction in bunch grass abundance. Livestock grazing should be eliminated from the site to allow restoration of bunch grass abundance and fine fuel loads.

Partridge Creek

The site is located in lower Partridge Creek, upstream from its confluence with Salmon River. Highly dissected terrain gives rise to a fine mosaic of dense forest, open woodland, and grassland. Mid-seral *Pinus ponderosa*-dominated old growth stands are primarily PSME/FEID, PIPO and PSME/PHMA, CARU. Mid-seral medium tree PSME/PHMA, PIPO is present on north-facing slopes within the site.

Pinus ponderosa-dominated old growth PSME/FEID, PIPO is extremely open. Large diameter *Pinus ponderosa* are clustered in groups with a stem density of 17 tpa. Moderately intense understory regeneration is restricted to shaded large-tree clusters. Density of *Pinus ponderosa* and *Pseudotsuga menziesii* seedlings, saplings, and poles is 300 tpa. Approximately 32 tpa large diameter *Pinus ponderosa* are present within mid-seral PSME/PHMA, CARU stands. Understory tree regeneration is low. About 10 tpa medium sized *Pinus ponderosa* are present.

Restoration of these mid-seral old growth stands should focus on the reintroduction of the native frequent, low intensity fire disturbance regime. Livestock grazing should be eliminated from the site to allow restoration of bunch grass abundance and promote the associated development fine fuel beds needed for the maintenance of the frequent, low intensity fire regime. Prescribed burning should occur in Fall to protect against a potential reduction in bunch grass abundance. Care should be taken to evaluate the effect of burning on the abundance of exotic species on the site including *Bromus tectorum* and *Verbascum thapsus*.

Partridge/Elkhorn

The site encompasses a ridge crest system of the Salmon River breaks. *Abies grandis* and *Pseudotsuga menziesii* associations are present in a range of different seral and structural conditions. Mid-seral *Pinus ponderosa*-dominated old growth stands occur within a mosaic of mid- and late-seral pole-, medium tree-, and large tree-dominated stands. Approximately 20 tpa large diameter *Pinus ponderosa* are present in these old growth stands. Understory regeneration occurs with moderate density, approximately 200 tpa are present, most of which are clustered seedling-, sapling-, and pole-sized *Pinus ponderosa*. *Abies grandis* and *Pseudotsuga menziesii* understory regeneration may also be present, depending of the plant association and site conditions. Approximately 50 tpa medium-sized *Pinus ponderosa* are present.

These old growth forest stands occur at the interface of woodland stands of hot, dry west-facing slopes and closed montane to subalpine forest of cool, moist east-facing slopes. That is, these ridgetop old growth *Pinus ponderosa* stands occur at the interface of a relatively low-severity and a moderate- to high-severity fire regime. In presettlement times these stands appear to have functioned as a natural fuel break.

Restoration of these mid-seral old growth stands should focus on the reintroduction of the native frequent, low intensity fire regime. Livestock grazing should be eliminated from *Pseudotsuga menziesii* stands to allow restoration of bunch grass abundance and promote the associated development fine fuel beds needed for the maintenance of a frequent, low intensity fire regime. Prescribed burning should occur in Fall to protect against reduction in bunch grass abundance. Care should be taken to evaluate the effect of burning on the abundance of exotic species on the site.

Sheep Creek

The site occurs on the breaklands of the Little Salmon River drainage. *Abies grandis* and *Pseudotsuga menziesii* associations are present in mid- to late-seral and medium- to large-tree-dominated conditions. Partial cut and clear cut harvest units are also present. Old growth stands within the site are mid-seral PSME/PHMA, CARU and PSME/SPBE, PIPO in which *Pinus ponderosa* is dominant and late-seral PSME/PHMA, CARU; PSME/PHMA, PIPO; and PSME/SPBE, PIPO in which *Pinus ponderosa* is codominant with *Pseudotsuga menziesii*. Approximately 30 tpa large ($\geq$ 21 inches dbh) diameter trees are present within these stands. Understory regeneration is light with approximately 54 tpa *Pinus ponderosa* (22 percent) and *Pseudotsuga menziesii* (78 percent) seedlings, saplings, and poles. About 40 tpa medium-sized *Pinus ponderosa* and *Pseudotsuga menziesii* are present, most of these (65 percent) are *Pseudotsuga menziesii*. Shrub and herbaceous cover on these rocky ridgespur sites is typically characterized by a sward of grass with patchy low shrubs. *Calamagrostis rubescens* is well represented to abundant. *Spiraea betulifolia*, *Physocarpus malvaceus*, and/or *Holodiscus discolor* are typically common to well represented. Large, old *Pinus ponderosa* within the site often show 2 - 3 fire scars.

Partial cut activities within the site removed primarily large and very large *Pinus ponderosa*. These stands still posses sufficient number of large diameter live trees, but are deficient in logs and snags. *Bromus tectorum*, *Dactylus glomerata*, and *Verbascum thapsus* are present within old road prisms.

Restoration of these mid- and late-seral old growth stands should focus on the reintroduction of the native frequent, low intensity fire regime. Thinning prior to prescribed burning does not appear necessary at this time. Livestock grazing should be eliminated from the site for several years before and after prescribed fire to allow restoration of grass abundance and promote the associated development fine fuel beds needed for the sustained maintenance of frequent, low intensity fire. Care should be taken to evaluate the effect of burning on the abundance of exotic species on the site.

Upper Eagle

The site encompasses a relatively wide range of plant associations and structural and seral conditions. Variability on the site is due to the highly dissected topography and widely contrasting historic fire disturbance regimes of north- versus south-facing slopes. Much of the site has been selectively harvested in the recent or more distant past. Intensive livestock grazing and exotic grass seeding has severely altered understory species composition on the site.

Remnant, partially degraded mid-seral old growth stands are present. These are typically *Abies grandis* sites on which *Pseudotsuga menziesii* is codominant with *Pinus ponderosa*. Including stands that have been partial cut relatively recently, approximately 28 tpa large diameter trees are present, 52 percent of these are *Pinus ponderosa*. Understory *Abies grandis* and *Pseudotsuga menziesii* regeneration is low to moderate with an average of 174 tpa seedlings, saplings, and poles. About 31 tpa medium-sized trees are present, 18 percent of these are *Pinus ponderosa*; the remainder are *Pseudotsuga menziesii*.

Restoration of these mid-seral old growth stands should focus on the reintroduction of the native frequent, low intensity fire regime. Thinning prior to prescribed burning does not appear necessary at this time. Livestock grazing should be eliminated from the site (especially after prescribed fire) to allow restoration of grass abundance and promote the associated development fine fuel beds needed for the sustained maintenance of frequent, low intensity fire.

W Fork Lake Creek

This site is located on the south-facing breakland and ridgespur slopes of the West Fork of Lake Creek. The site is roaded and extensively harvested. Much of the site is dominated by medium-sized trees with dispersed large diameter *Pinus ponderosa*. Approximately 10 percent of the (197 acre) site is (somewhat degraded) mid-seral old growth dominated by *Pinus ponderosa*. Within the PSME/PHMA, CARU and PSME/SYAL, PIPO stands about 24 tpa large diameter *Pinus ponderosa* are present. Approximately 165 tpa seedling-, sapling-, and pole-sized *Pinus ponderosa* are present in the understory of stands sampled. *Pseudotsuga menziesii* is also present to well represented in the understory. About 45 tpa medium-sized *Pinus ponderosa* are present. Approximately 14 tpa large diameter *Pinus ponderosa* were removed from these old growth patches during partial cut harvest activities of the early 1960's.

Medium-tree-dominated stands at the site were not sampled. Residual stand components provide a basis for the restoration of old growth characteristics. Large diameter trees are present, though the density is low (well below 10 tpa). The density of medium-sized trees is also low. The density of seedling-, sapling-, and pole-sized *Pinus ponderosa* and *Pseudotsuga menziesii* is equal to twice that of sampled old growth stands. Opening of the forest canopy on these sites has resulted in high cover of tall shrubs.

Restoration and maintenance of current old growth at the site should focus on the reintroduction of the native frequent, low intensity fire disturbance. Hand thinning of dense clusters of sapling- and pole-sized understory regeneration prior to the use of prescribed fire is desirable to reduce the abundance of ladder fuels and increase the numbers of residual pole-sized *Pinus ponderosa*.

Restoration of medium-tree-dominated stands to *Pinus ponderosa*-dominate old growth will require hand thinning seedling-, sapling- and pole-sized *Pseudotsuga menziesii* regeneration. Hand pile and burn resultant 10 hour fuels. Protect these sites from fire until current *Pinus ponderosa* sapling cohort has attained sufficient size to survive light understory prescribed burning.

Warm Springs

The site occurs within the upper slopes of the breaks on the lower Salmon River. Mid-seral and late-seral *Pinus ponderosa*-dominated old growth stands of PSME/FEID, PIPO; PSME/PHMA, CARU; and PSME/PHMA, PIPO are present. The density of large diameter *Pseudotsuga menziesii* and *Pinus ponderosa* within these old growth stands ranges from 24 to 61 tpa. The average density was approximately 47, the highest value observed at any site. The density of understory seedling, sapling, and pole *Pseudotsuga menziesii* regeneration is moderate with approximately 160 tpa. About 20 tpa medium-sized *Pseudotsuga menziesii* and *Pinus ponderosa* are present, the majority (83 percent) of these are *Pseudotsuga menziesii*. Mid-seral shrub- and pole-dominated stands of PSME/PHMA, CARU and PSME/PHMA, PIPO are also present within the site. These stands were generated by stand replacing fire.

Restoration and maintenance of old growth stands at the site should focus on the reintroduction of the native frequent, low intensity fire disturbance. Hand thinning does not appear to be required prior to the use of prescribed fire. Livestock grazing should be eliminated from the site for several years before and after planned prescribed burning to allow restoration of grass abundance and promote the associated development fine fuel beds needed for the sustained maintenance of frequent, low intensity fire. Care should be taken to evaluate the effect of burning on the abundance of exotic species on the site including *Bromus tectorum*, *Bromus japonicus*, *Tragopogon dubius* and *Verbascum thapsus*.

West Upper Eagle

This site, located on the eastward breaks above Eagle Creek, provides an example of partial cut harvested stands prevalent on Craig Mountain. Contrasting harvested and unharvested large tree dominated stands are present. The unharvested stand is mid- to late-seral ABGR/CARU old growth dominated by *Pinus ponderosa*. Approximately 60 tpa large diameter trees are present; 73 percent are *Pinus ponderosa*. The understory is relatively open with 110 tpa seedling-, sapling-, and pole-sized *Abies grandis* (mostly) and *Pseudotsuga menziesii*. About 20 tpa medium-sized *Abies grandis* and *Pseudotsuga menziesii* are present. Restoration and maintenance of this old growth stand should focus on the reintroduction of moderately frequent, low intensity fire disturbance.

Contrasting harvested stands are ABGR/SPBE and ABGR/VAGL. Approximately 15 tpa large diameter *Abies grandis* and *Pseudotsuga menziesii* are present. Understory regeneration is intense with approximately 413 tpa seedling-, sapling-, and pole-sized *Abies grandis*, *Pseudotsuga menziesii*, and *Pinus ponderosa* (62 percent). About 37 tpa medium-sized *Abies grandis* and *Pseudotsuga menziesii* are present. An average of 22 tpa large diameter *Pseudotsuga menziesii* and *Pinus ponderosa* were harvested from these stands.

Restoration activities to promote the development of *Pinus ponderosa*-dominated old growth on this site (and similar sites) should focus on controlling *Abies grandis* and *Pseudotsuga menziesii* competition with *Pinus ponderosa* natural regeneration. Understory thinning is required prior to the use of prescribed understory burning. Hand thinning should: (1) remove all seedling-, sapling-, and pole-sized *Abies grandis* and *Pseudotsuga menziesii*; (2) selectively remove sapling-sized *Pinus ponderosa* growing in vicinity of pole-sized *Pinus ponderosa*; (3) selectively remove medium-sized *Abies grandis* and *Pseudotsuga menziesii* to reduce competition with *Pinus ponderosa* but to allow *Pseudotsuga menziesii* growth where *Pinus ponderosa* poles are absent. Retain all large-sized trees for snag and log recruitment. Hand pile and burn thinned stems. Pile burning should balance the consumption of fuel with protection of understory vegetation and soil resources. Maintain low intensity pile burns by pulling off some 10 hour fuels and all 100 hour fuels and greater. Protect the sites from fire until the current *Pinus ponderosa* sapling cohort has attained sufficient size to survive light understory prescribed burning. Assure that livestock grazing is eliminated from the site (especially for several years before and after prescribed burning) to allow restoration of grass and low shrub abundance and promote the associated development fine fuel beds needed for the sustained maintenance of frequent, low intensity fire.

<u>Site conservation priorities</u>--To effective conserve wildlife populations and habitats the representative and functional quality of ecosystems must be maintained on all public lands. Outstanding, pristine ecosystem occurrences, however, provide a distinctive conservation opportunity. Through special management designations sites encompassing pristine, exemplary ecosystem occurrences may serve as ecological reference areas to provide a baseline against which the effects of management may be monitored and evaluated (USDI Bureau of Land Management 1992).

Rarity, richness, representativeness, and viability are criteria often applied in assessing the significance of ecological sites and setting priorities for site conservation (Margules 1986; Andrews 1993; Grossman et al. 1994; Bursik and Moseley 1995). Rarity is a relative measure of the number of occurrences of an association (incorporating an assessment of the natural, versus current, abundance of the association). Richness is simply the number of different associations present at a site. Representativeness is an expression of the condition and quality of stands within in a site (how well does the site represent pristine conditions). Viability is an assessment of the capability of the site to sustain the biological elements present. Viability incorporates defensibility (the extent to which a site can be protected from external anthropogenic factors) and is often most objectively estimated by the size of the site.

The rarity of associations observed in the study area is summarized in Table 7. Plant associations observed in the study area are listed with global and state rarity ranks and the conservation priority ranks (The Nature Conservancy 1982) derived from an assessment of natural area needs within the forested ecoregional sections of Idaho (Rust 1997). Based on the results of this study the four modifications of state rank are proposed: ABGR/SPBE, S3 to S2; PIPO/AGSP, S3 to S2; PSME/AGSP, S3 to S1; and PSME/PHMA, PHMA, S5 to S3. A composite scalar of ecological significance, *biodiversity significance*, (The Nature Conservancy 1996) is derived from element global and state ranks (as listed in Table 7) and element occurrence ranks (as listed in Table 6) .

Conservation priority ranks for *Pinus ponderosa* old growth sites within the study area are summarized in Table 8. The validity of biodiversity significance ranks applied here are influenced by a the following factors: (1) the criteria (Table 8, footnote 13) are biased toward species occurrences and (2) plant community global ranks are currently relatively unsettled due to the level of experience in assessing global ranks and the availability of information. The biodiversity significance ranks appear to undervalue the significance of these *Pinus ponderosa*-dominated old growth sites. Three estimates of viability are given: the total size of the site, the sum of A and B ranked stands, and the sum of A and B ranked mid- and late-seral, large and giant tree stands. A conservation priority rank is derived for each site as the mean of each site's ranks for richness and viability (as represented by the three acreage values). Little Salmon, Partridge/Elkhorn, Sheep Creek, and Warm Springs are identified as the highest priority sites for conservation action using these methods. These sites should be evaluated further for consideration of research natural area designation.

Concluding Summary

Pinus ponderosa is a long-lived, early- to mid-seral species in plant associations within the *Abies grandis*, *Pseudotsuga menziesii*, and *Pinus ponderosa* series. Prior to aggressive wildfire suppression programs, frequent, low-intensity fires in *Pinus ponderosa*-dominated forest maintained relatively open, old growth forest stands. Fire plays an important ecological role in this vegetation by controlling the density of understory tree regeneration and favoring the growth of relatively few, large, dominant, fire tolerant trees; reducing tree susceptibility to disease; and favoring the growth and diversity of understory herbaceous species. Once abundant and widespread, old growth *Pinus ponderosa*-dominated forest has declined due to a century of fire exclusion, livestock grazing, and selective harvesting within accessible stands. The loss of seral old growth *Pinus ponderosa* is a concern for wildlife habitat and maintenance of biological diversity.

This report summarizes the inventory of old growth *Pinus ponderosa*-dominated forest stands located on Bureau of Land Management lands in west central Idaho. A comparison of applicable old growth forest criteria is provided. Old growth forest attributes of stands within the study area typically exceed criteria provided in formal definitions. These observations reinforce the need to recognize that old growth definitions are minimum stand criteria, not management benchmarks. Rather, structural attributes provided in this study provide, with limitations, potential stand structural benchmarks.

Literary resources concerning the ecology, conservation, and management of *Pinus ponderosa*-dominated old growth forest are abundant. The ecology and wildlife use of *Pinus ponderosa*-dominated forest is reviewed in relation to the stands observed within the study area. Additional literary resources, not referred to in the text, are summarized in an annotated and indexed bibliography.

Manipulative approaches to the restoration old growth *Pinus ponderosa*-dominated forest seem promising but are mostly unproven or not fully oriented to conservation of wildlife habitats. Management of remnant stands of *Pinus ponderosa*-dominated old growth should be based on recognition of fundamental non-renewability. Approaches to restoration are identified for each site based on groups of stands with similar growth potential, seral status, and stand structure. The use of non-commercial thinning, followed by pile burning, and prescribed understory burning is identified for many old growth stands within the study area.

Old growth sites are prioritized for conservation and restoration activities based of criteria for rarity, richness, representativeness, and viability. Four sites are identified as having the highest priority. These sites should be evaluated further for consideration of research natural area designation.

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Sitename	County	USGS Quad	Legal Description	Minimum Elevation	Maximum Elevation
Benton Meadow	Lewis	Frye Point	T 32 N, R 4 W; Section 14	4600	4900
Corral Creek	Lewis	Frye Point Limekiln Rapids	T 32 N, R 4 W; Section 31	3400	5200
Deer Creek Mine	Lewis	Hoover Point	T 32 N, R 3 W; Section 33	3600	4120
Denny Creek	Idaho	Pollock	T 23 N, R 1 E; Section 34	4800	6000
Frye Point	Lewis	Frye Point	T 31 N, R 4 W; Section 14	4800	5080
Little Salmon	Adams	Indian Mountain	T 21 N, R 1 E; Sections 13 & 24	3600	5200
N Fork Rattlesnake	Idaho	Pollock	T 23 N, R 1 E; Section 33	3600	4800
Pardee	Idaho	Woodland Sixmile Creek	T 34 N, R 2 E; Section 7	1200	2200
Partridge Creek	Idaho	Patrick Butte	T 24 N, R 3 E; Section 31	2840	4320
Partridge/Elkhorn	Idaho	Kelly Mountain Riggins Hot Springs Patrick Butte Hershey Point	T 24 N, R 3 E; Section 32	4400	5720
Sheep Creek	Idaho	Pollock	T 23 N, R 1 E; Section 14	4920	6600
Upper Eagle	Lewis	Frye Point	T 32 N, R 4 W; Section 35	4800	5000
W Fork Lake Creek	Idaho	Riggins Hot Springs Patrick Butte	T 24 N, R 2 E; Section 32	3600	5000
Wapshilla Ridge	Lewis	Wapshilla Creek	T 30 N, R 4 W; Section 22	3800	4600
Warm Springs	Idaho	Riggins Hot Springs	T 24 N, R 2 E; Section 26	3600	5800
West Upper Eagle	Lewis	Frye Point	T 32 N, R 4 W; Section 33	5000	5200

Table 2. Summary of plant associations observed at old growth sites within the study area. Plant associations are listed with the author(s) who recognize the association and the acronym used in the text of this report.

Plant Association	Author[1]	Acronym
Abies grandis/Acer glabrum		--
Acer glabrum phase	2	ABGR/ACGL, ACGL
Physocarpus malvaceus phase	2	ABGR/ACGL, PHMA
Abies grandis/Calamagrostis rubescens	2	ABGR/CARU
Abies grandis/Physocarpus malvaceus		--
Physocarpus malvaceus phase	1	ABGR/PHMA, PHMA
Abies grandis/Spiraea betulifolia	1, 2	ABGR/SPBE
Abies grandis/Vaccinium globulare	1, 2	ABGR/VAGL
Pinus ponderosa/Agropyron spicatum	1, 2	PIPO/AGSP
Pinus ponderosa/Symphoricarpos oreophilus	2	PIPO/SPBE
Pseudotsuga menziesii/Acer glabrum		--
Acer glabrum phase	2	PSME/ACGL, ACGL
Pseudotsuga menziesii/Agropyron spicatum	1, 2	PSME/AGSP
Pseudotsuga menziesii/Calamagrostis rubescens	(1)	--
Pinus ponderosa phase	2	PSME/CARU, PIPO
Pseudotsuga menziesii/Carex geyeri	(1)	--
Pinus ponderosa phase	2	PSME/CAGE, PIPO
Pseudotsuga menziesii/Festuca idahoensis	(1)	--
Pinus ponderosa phase	2	PSME/FEID, PIPO
Pseudotsuga menziesii/Physocarpus malvaceus		--
Calamagrostis rubescens phase	2	PSME/PHMA, CARU
Physocarpus malvaceus phase	1	PSME/PHMA, PHMA
Pinus ponderosa phase	2	PSME/PHMA, PIPO
Smilacina stellata phase	1	PSME/PHMA, SMST
Pseudotsuga menziesii/Spiraea betulifolia	(1)	--
Pinus ponderosa phase	2	PSME/SPBE, PIPO
Pseudotsuga menziesii/Symphoricarpos albus	(1)	--
Pinus ponderosa phase	2	PSME/SYAL, PIPO
Symphoricarpos albus phase	2	PSME/SYAL, SYAL
Pseudotsuga menziesii/Symphoricarpos oreophilus	2	PSME/SYOR

[1] 1. Cooper et al. 1991
2. Steele et al. 1981
Parantheses indicate that the author recognizes the association but not the phase. In stands within the study area plant association was identified to the level of phase for all associations for which phases have been identified.

Table 3. Summary of old growth criteria for definitions applicable to *Pinus ponderosa*-dominated stands within west central Idaho.

Definition[2]	Live Trees						Dead Trees			
							Standing		Down	
	Minimum Age	DBH	TPA	Variation[3]	Number of Canopy Layers[4]	Presence of decedance[5]	DBH(HT)	TPA	Diameter[6]	Pieces/ acre (length)
Grand fir, SAF 213 (a)	≥ 200	≥ 24	≥ 15	≥ 2	≥ 2	evident	20(20)	≥ 2	≥ 12	2(25)
Interior Douglas fir, SAF 210 (high productivity) (a)	≥ 200	≥ 24	≥ 15	≥ 2	≥ 2	evident	20(20)	≥ 1	≥ 12	≥ 0(25)
Interior Douglas fir, SAF 210 (low productivity) (a)	≥ 200	18	10 (5)	≥ 2	≥ 2	≥ 2 (15)	16 - 10	0 - 3	≥ 15	4(≥ 8)
Interior ponderosa pine, SAF 237 (mid-seral sites) (a)	200	24	≥ 10	≥ 2	2	n/a	20(20)	≤ 1	12	0(16)
Interior ponderosa pine, SAF 237 (late-seral sites) (a)	200	24	≥ 5	≥ 2	1	n/a	n/a	infreq.	n/a	infreq.
Old growth type 1 (b)	150	> 21	8	M	sgl/mtl	0 - 30 %	9	0 - 7	M	
Old growth type 4 (b)	150	> 21	10	M	sgl/mtl	0 - 28 %	9	1 - 3	M	
Grand fir/white fir series, low - moderate productivity (c)	150	21	10	yes	2	yes	14	1	12	5

Letter codes following definition title refer to author as follows: (a) Hamilton 1993; (b) Green et al. 1992; (c) Hopkins et al. 1992a; (d) Hopkins et al. 1992b; (e) Williams et al. 1992.

Presence of variation in stand structure. Hamilton (1993) provides the number of different size classes (6 inche dbh) present. Green et al. (1992) estimate the extent of variation in tree diameters for trees > 5 in. dbh (L, low [0-20%]; M, moderate [21-40%]; and H, high [>40%]). Hopkins et al. (1992a and b) and Williams et al. (1992) indicate the presence (yes) or absence (no) of variability in stem structure.

Green et al. (1992) indicate the presence of a single (sgl) canopy layer versus multiple (mtl) canopy layers.

Green et al. (1992) estimate the percent of trees (> 5 in dbh) with dead or broken tops. Values are otherwise trees per acre with deformed tops or bole or root decay.

Green et al. (1992) estimate the probability that abundant down woody debris is present (L, low [0-20%]; M, moderate [21-40%]; and H, high [>40%]).

Grand fir/white fir series, high productivity (c)	150	21	15	yes	2	yes	14	1	12	5
Interior Douglas-fir series (d)	150	21	8	yes	1	2	12	1	12	2
Ponderosa pine series (low productivity) (e)	150	21	10	yes	1	---	14	3	---	0
Ponderosa pine series (moderate - high productivity) (e)	150	21	13	yes	1	---	14	3	---	0

Table 4. Summary of the applicability of old growth definitions to plant associations observed within the study area.

DEFINITION[7]\PLANT ASSOCIATION (see below):	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Grand fir, SAF 213 (a)	+[8]	+	x	+	+	+	x	x																
Interior Douglas fir, SAF 210 (high productivity) (a)	x	+	x	+	+	+	x	x																
Interior Douglas fir, SAF 210 (low productivity) (a)												+	x	+	+	+	+	+	+	+	+	+	+	x
Interior ponderosa pine, SAF 237 (a)	+	x	x		x	+	x			x	x	+	x	x	x	x	+		x		x	x		x
Old growth type 1 (b)										x	+	+	x	+	+	+	+	x	+	x	+	+	+	+
Old growth type 4 (b)	+	+	+	+	x	x	x	x	x															
Grand fir/white fir series (low - medium productivity) (c)			x		+		+	x																
Grand fir/white fir series (high productivity) (c)	+	+		+		+																		
Interior Douglas-fir series (d)												+	+	+	+	+	+	+	+	+	+	+	+	x
Ponderosa pine series (low productivity) (e)										x	+													

1 ABGR/ACGL, ACGL
2 ABGR/ACGL, PHMA
3 ABGR/CARU
4 ABGR/COOC
5 ABGR/LIBO, LIBO
6 ABGR/PHMA, PHMA
7 ABGR/SPBE
8 ABGR/VAGL

9 ABLA/STAM, LIGL

10 PIPO/AGSP
11 PIPO/SYOR

12 PSME/ACGL, ACGL
13 PSME/AGSP
14 PSME/CAGE, PIPO
15 PSME/CARU, PIPO
16 PSME/FEID, PIPO
17 PSME/PHMA, CARU
18 PSME/PHMA, PHMA
19 PSME/PHMA, PIPO

20 PSME/PHMA, SMST
21 PSME/SPBE, PIPO
22 PSME/SYAL, PIPO
23 PSME/SYAL, SYAL
24 PSME/SYOR

Letter codes following definition title refer to author as follows: (a) Hamilton 1993; (b) Green et al. 1992; (c) Hopkins et al. 1992a; (d) Hopkins et al. 1992b; (e) Williams et al. 1992.

X - the author specifically cites the given association. + - the given old growth definition is interpreted in this report as potentially applying to the given association.

Table 5. Summary of old growth stand structure observed within the study area. Data are summarized for all plots for which a given old growth definition may apply. Thus data for one plot may be summarized for several definitions. The total number of plots is 62.

Definition[9]	Number of Plots	Live Trees (≥ 21 inches dbh) TPA (±SD)	Dead Trees					
			Standing (TPA[hieght])[10]			Down (TPA)		
			MT	LT	VT	MT	LT	VT
Grand fir, SAF 213 (a)	2	16.2 (± 0)	--	2.0 (100)	--	10.0	--	--
Interior Douglas fir, SAF 210 (high productivity) (a)	2	11.2 (± 1.0)	4.2	6.1	--	4.2	8.1	--
Interior Douglas fir, SAF 210 (low productivity) (a)	5	36.6 (± 14.2)	12.0	4.1 (2)	--	16.0	2.4	--
Interior ponderosa pine, SAF 237 (mid-seral sites) (a)	31	27.1 (± 11.2)	1.8	1.4 (44)	0.4 (4)	8.8	3.5	--
Interior ponderosa pine, SAF 237 (late-seral sites) (a)	1	16.2	--	--	--	--	--	--
Old growth type 1 (b)	24	28.2 (± 12.4)	4.4	0.8 (2)	0.2	7.4	2.2	--
Old growth type 4 (b)	21	25.0 (± 13.4)	4.7	3.4 (50)	0.4 (4)	10.7	4.2	--
Grand fir/white fir series, low - moderate productivity (c)	14	23.5 (± 13.0)	7.0	2.9 (45)	0.6 (4)	10.4	2.9	--
Grand fir/white fir series, high productivity (c)	7	27.9 (± 13.4)	--	4.4 (60)	--	11.4	6.9	--
Interior Douglas-fir series (d)	23	28.7 (± 12.4)	4.6	0.9 (2)	0.2	7.7	2.3	--
Ponderosa pine series (low productivity) (e)	1	16.2	--	--	--	--	--	--

Letter codes following definition title refer to author as follows: (a) Hamilton 1993; (b) Green et al. 1992; (c) Hopkins et al. 1992a; (d) Hopkins et al. 1992b; (e) Williams et al. 1992.

Values for density are absolute means. Values for hieghts are relative means.

Table 6. Summary of wildlife use of *Pinus ponderosa*-dominated old growth and related habitats (adapted form Thomas et al. 1979). The ponderosa pine and mixed conifer communities identified by Thomas et al. (1979) are considered to usually supporting *Pinus ponderosa*-dominated old growth (see their Figure 10, page 24). The mixed conifer community may include some sites dominated by *Pseudotsuga menziesii* and (rarely) *Abies grandis*. a) The relative importance of old growth to each life form is estimated as the percent of the total number of species assigned to each life form (summarized from Appendix 10 of Thomas et al. 1979). b) The relative use of each old growth community for reproduction (R) or feeding (F) is estimated by life form as the percent of total number of species reported to use the old growth communities (summarized from Appendices 10 and 11 of Thomas et al. 1979). c) Summary of animal species life forms idenified by Thomas et al. (1979; adapted from their Table 1, page 27).

a)

Life form	Number of species	Relative use by life form (percent)			
		Ponderosa pine		Mixed conifer	
		R	F	R	F
2	9	33	33	44	44
3	45	9	9	13	11
4	32	16	31	16	22
5	48	13	33	10	27
6	7	14	43	0	0
7	30	13	30	13	27
8	6	17	33	17	33
9	4	0	25	0	25
10	14	50	93	86	93
11	24	42	79	67	79
12	7	71	71	71	86
13	13	62	62	69	77
14	37	57	62	62	62
15	40	33	40	38	43
16	10	30	50	30	50

b)

Life Form	Relative use by plant community (percent)			
	Ponderosa pine		Mixed conifer	
	R (91)	F (137)	R (108)	F (132)
2	3	2	4	3
3	4	3	6	4
4	5	7	5	5
5	7	12	5	10
6	1	2	0	0
7	4	7	4	6
8	1	1	1	2
9	0	1	0	1
10	8	9	11	10
11	11	14	15	14
12	5	4	5	5
13	9	6	8	8
14	23	17	21	17
15	14	12	14	13
16	3	4	3	4

c)

Life form	Reproduction	Feeding	Example species
1	in water	in water	bullfrog
2	in water	on the ground, in bushes, or in trees	western toad
3	on ground around water	on the ground, and in bushes, trees, or water	common garter snake
4	in cliffs, caves, rimrock, or talus	on the ground or in the air	common raven, big-horn sheep, bobcat
5	on the ground without specific association with water, cliff, rimrock, or talus	on the ground	sage grouse, elk, mule deer
6	on the ground	in bushes, trees or in the air	common nighthawk
7	in bushes	on the ground, in water, or the air	American robin
8	in bushes	in trees, bushes, or the air	American goldfinch
9	primarily in deciduous trees	in trees, bushes, or the air	cedar waxwing
10	primarily in coniferous trees	in trees, bushes, or the air	golden-crowned kinglet
11	in deciduous or coniferous trees	in trees, bushes, on the ground, or in the air	evening grosbeak
12	on very thick branches	on the ground or in water	great blue heron
13	in own hole excavated in tree	in trees, in bushes, on the ground, or in the air	pileated woodpecker, white-headed woodpecker
14	in a hole made by another species or in a natural hole	on the ground, in water, or the air	American kestrel, flammulated owl
15	in a burrow underground	on the ground or under it	Columbia ground squirrel, black bear
16	in a burrow underground	in the air or in the water	bank swallow

Table 7. Summary of forested stands delineated at *Pinus ponderosa*-dominated old growth inventory sites.

Site	Plant Association	Occurrence Type	Occ. Rank[1]	Size (acres)
Corral Creek	ABGR/ACGL, PHMA	mid-seral, medium tree	C	11.9
	PSME/AGSP	mid-seral, medium tree	C	19.3
	PSME/PHMA, CARU	mid-seral, large tree	A	113.1
	PSME/PHMA, PHMA	late-seral, medium tree	A	117.5
Deer Creek Mine	ABGR Series	mid-seral, large tree	B	20.2
	PSME/AGSP	mid-seral, medium tree	B	2.8
	PSME/CARU, PIPO	mid-seral, large tree	B	2.8
	PSME/PHMA, CARU	mid-seral, large tree	B	4.6
	PSME/SYAL, PIPO	mid-seral, large tree	B	26.6
Denny Creek	ABGR/SPBE	late-seral, large tree	BC	5.5
	ABGR/SPBE	mid-seral, large tree	A	10.1
	ABGR/SPBE	mid-seral, large tree	BC	16.5
	ABGR/SPBE	mid-seral, large tree	D	25.7
	ABGR/VAGL	late-seral, medium tree	D	27.5
Little Salmon	ABGR/ACGL, PHMA	late-seral, large tree	A	36.8
	ABGR/ACGL, PHMA	late-seral, large tree	C	65.9
	ABGR/ACGL, PHMA	late-seral, medium tree	C	214.9
	ABGR/ACGL, PHMA	late-seral, medium tree	CD	73.5
	ABGR/ACGL, PHMA	mid-seral, giant tree	A	28.5
	ABGR/ACGL, PHMA	mid-seral, large tree	A	42.2
	ABGR/SPBE	mid-seral, giant tree	A	18.4
	PSME/PHMA, CARU	late-seral, large tree	A	19.2
	PSME/PHMA, CARU	mid-seral, large tree	A	57.8
N Fork Rattlesnake	PSME/FEID, PIPO	mid-seral, medium tree	D	22.7
	PSME/PHMA, PIPO	mid-seral, medium tree	D	23.9
Pardee	PIPO/AGSP	late-seral, large tree	BC	92.7
	PSME/AGSP	undesignated	CD	20.2
	PSME/AGSP	late-seral, large tree	CD	92.7
	PSME/AGSP	mid-seral, medium tree	CD	36.7
	PSME/PHMA, PHMA	undesignated		17.4
	PSME/PHMA, PHMA	mid-seral, medium tree	B	23.0

Site	Plant Association	Occurrence Type	Occ. Rank[1]	Size (acres)
Partridge Creek	PSME/FEID, PIPO	mid-seral, large tree	A	23.0
	PSME/PHMA, CARU	mid-seral, large tree	A	43.1
	PSME/PHMA, PIPO	mid-seral, medium tree	A	20.2
	SYAL/FEID	not applicable	A	8.3
Partridge/Elkhorn	ABGR/VAGL	late-seral, large tree	A	156.1
	ABGR/VAGL	mid-seral, medium tree	A	23.0
	PSME/CARU, PIPO	mid-seral, large tree	AB	31.2
	PSME/PHMA, CARU	mid-seral, large tree	A	51.4
	PSME/PHMA, CARU	mid-seral, medium tree	A	11.0
	PSME/PHMA, CARU	mid-seral, pole tree	A	40.4
	PSME/PHMA, PIPO	late-seral, large tree	A	54.1
	PSME/PHMA, PIPO	mid-seral, medium tree	A	46.9
Sheep Creek	ABGR/ACGL, ACGL	late-seral, large tree	A	22.0
	ABGR/ACGL, ACGL	mid-seral, medium tree	CD	20.2
	PSME/PHMA, CARU	late-seral, large tree	A	5.5
	PSME/PHMA, CARU	mid-seral, large tree	BC	21.1
	PSME/PHMA, PIPO	early-seral, shrub-herb	D	45.0
	PSME/PHMA, PIPO	late-seral, large tree	A	45.9
	PSME/PHMA, PIPO	mid-seral, medium tree	A	3.7
	PSME/SPBE, PIPO	late-seral, large tree	A	33.1
	PSME/SPBE, PIPO	mid-seral, large tree	A	8.3
Upper Eagle	ABGR/LIBO, LIBO	late-seral, medium tree	A	11.9
	ABGR/PHMA, PHMA	mid-seral, large tree	BC	17.4
	ABGR/PHMA, PHMA	mid-seral, pole tree	D	14.7
	ABGR/SPBE	late-seral, medium tree	C	6.4
	ABGR/SPBE	mid-seral, large tree	BC	10.1
	PSME/FEID, PIPO	mid-seral, medium tree	B	51.4
	PSME/PHMA, PIPO	late-seral, large tree	A	5.5
	PSME/SPBE	mid-seral, medium tree	B	10.1

Site	Plant Association	Occurrence Type	Occ. Rank[1]	Size (acres)
W Fork Lake Creek	PSME/FEID, PIPO	mid-seral, medium tree	C	4.6
	PSME/PHMA, CARU	mid-seral, large tree	B	7.0
	PSME/PHMA, CARU	mid-seral, medium tree	C	39.5
	PSME/PHMA, PHMA	mid-seral, medium tree	C	128.4
	PSME/SYAL, PIPO	mid-seral, large tree	B	13.2
	PSME/SYAL, PIPO	mid-seral, medium tree	C	4.6
Warm Springs	ABGR/PHMA, PHMA	late-seral, large tree	A	7.3
	PSME/FEID, PIPO	late-seral, large tree	A	42.2
	PSME/FEID, PIPO	mid-seral, large tree	B	8.3
	PSME/FEID, PIPO	mid-seral, large tree	C	26.6
	PSME/PHMA, CARU	early-seral, shrub-herb	A	35.8
	PSME/PHMA, CARU	mid-seral, large tree	B	43.2
	PSME/PHMA, PIPO	early-seral, shrub-herb	A	101.9
	PSME/PHMA, PIPO	late-seral, large tree	A	14.7
	PSME/PHMA, PIPO	mid-seral, large tree	A	58.8
	PSME/PHMA, PIPO	mid-seral, large tree	B	91.8
	PSME/PHMA, PIPO	mid-seral, pole tree	B	7.3

1. Occurrence Ranks:

    A - Pristine condition. Evidence of post-industrial human-caused disturbance is absent. Exotic species are absent.
    B - Little evidence of post-industrial human-caused disturbance is present. Stand composition and structure is predominantly natural. Exotic species are only common (≤ one percent cover).
    C - Post-industrial human-caused disturbance is apparent. Stand composition and structure is altered. Exotic species are well represented to abundant (5 - 25 percent cover).
    D - Evidence of post-industrial human-caused disturbance is prevalent. Stand composition and structure is altered. Native species are present, but are in peril of loss. Increasers dominate the stand. Invader species are a significant compositional component.
    F - Native stand composition, structure, and function are significantly altered. Re-establishment of native stand composition, structure, and function will require large energy inputs.

Table 8. Summary of the rarity of plant associations observed within the study area. Plant associations are listed alphabetically with the global rank, state rank, and natural area conservation priority. Global ranks and natural area conservation priorities are assigned only at the association level, but apply also to the phases of the association. State ranks are applied at the phase level. Natural area conservation priorities are assigned for two ecoregional sections (McNab and Avers 1994): M332A, Idaho Batholith and M332G, Blue Mountains.

Plant Association	Global Rank	State[11] Rank	Conservation Priority[12] M332A	M332G
Abies grandis/Acer glabrum	G3		2	4
Acer glabrum phase		S2		
Physocarpus malvaceus phase		S2		
Abies grandis/Calamagrostis rubescens	G4?	S2	2	1
Abies grandis/Physocarpus malvaceus	G3G4		4	2
Physocarpus malvaceus phase		S3		
Abies grandis/Spiraea betulifolia	G3	S2*	4	4
Abies grandis/Vaccinium globulare	G3	S3	4	4
Pinus ponderosa/Agropyron spicatum	G4	S2*	4	3
Pinus ponderosa/Symphoricarpos oreophilus	G3	S1	4	2
Pseudotsuga menziesii/Acer glabrum	G4?		4	3
Acer glabrum phase		S3		
Pseudotsuga menziesii/Agropyron spicatum	G4	S1*	4	1
Pseudotsuga menziesii/Calamagrostis rubescens	G5		4	4
Pinus ponderosa phase		S3		
Pseudotsuga menziesii/Carex geyeri	G4?		4	1
Pinus ponderosa phase		S4		
Pseudotsuga menziesii/Festuca idahoensis	G4		4	2
Pinus ponderosa phase		S2		
Pseudotsuga menziesii/Physocarpus malvaceus	G5		4	4
Calamagrostis rubescens phase		S2?		
Physocarpus malvaceus phase		S3*		
Pinus ponderosa phase		S4		
Smilacina stellata phase		S5		
Pseudotsuga menziesii/Spiraea betulifolia	G5		4	2
Pinus ponderosa phase		S5		
Pseudotsuga menziesii/Symphoricarpos albus	G5		4	4
Pinus ponderosa phase		S3		
Symphoricarpos albus phase		S3		
Pseudotsuga menziesii/Symphoricarpos oreophilus	G5	S3	4	4

[11] An asterisk (*) designates state ranks that are proposed for revision based on the results of this study.

[12] From Rust 1997

Table 9. Summary of conservation priority ranking of *Pinus ponderosa*-dominated old growth inventory sites. All stands included in this summary are considered representative as they are A or B ranked.

Site	Richness (number of plant associations with A or B occurrences by occurrence type)	Viability			Bio-diversity[13] Significance Rank	Conservation Priority Rank[14] (composite richness and viability rank [a low value implies a high priority])
		Size	Size (A and B ranked stands)	Size (A and B ranked mid- and late-seral, large and giant tree)		
Corral Creek	2	261.8	230.6	113.1	3	M (5.4)
Deer Creek Mine	5	57.0	46.8	46.8	4	M (7.5)
Denny Creek	1	85.3	10.1	10.1	4	L (10.4)
Little Salmon	6	557.2	202.9	202.9	2	H (2.9)
N Fork Rattlesnake	--	46.6	--	--	5	L (12.0)
Pardee	1	282.7	23.0		4	M (8.6)
Partridge Creek	4	94.6	94.6	66.1	3	M (7.1)
Partridge/Elkhorn	7	414.1	360.0	238.7	3	H (2.2)
Sheep Creek	6	204.8	118.5	114.8	2	H (4.6)
Upper Eagle	4	127.5	78.9	5.5	5	M (7.6)
W Fork Lake Creek	2	197.3	20.2	20.2	5	M (8.4)
Warm Springs	9	437.9	411.3	266.3	3	H (1.2)

[13] Biodiversity significance rankings (from The Nature Conservancy 1996):

1. Outstanding significance, such as the only known occurrence of any Element, the best or an excellent (A-ranked) occurrence of a G1 Element, or a concentration (4+) of high-ranked (A- or B-ranked) occurrences of G1 or G2 Elements. Site should be viable and defensible for targeted Elements and ecological processes contained.
2. Very high significance, such as one of the most outstanding occurrences of any community Element (regardless of its Element rank). Also includes areas containing any other (B-, C- or D-ranked) occurrence of a G1 Element, a good (A- or B-ranked) occurrence of a G2 Element, an excellent (A-ranked) occurrence of a G3 Element, or a concentration (4+) of B-ranked G3 or C-ranked G2 Elements.
3. High significance, such as any other (C- or D-ranked) occurrence of a G2 Element, a B-ranked occurrence of a G3 Element, an A-ranked occurrence of any community, or a concentration (4+) of A- or B-ranked occurrences of (G4 or G5) S1 Elements.
4. Moderate significance, such as a C-ranked occurrence of a G3 Element, a B-ranked occurrence of any community, an A- or B-ranked or only state (but at least C-ranked) occurrence of a (G4 or G5) S1 Element, an A-ranked occurrence of an S2 Element, or a concentration (4+) of good (B-ranked) S2 or excellent (A-ranked) S3 Elements.
5. Of general biodiversity interest or open space.

[14] H, High; M, Moderate; and L, Low. Composite values are calculated as the mean of each site's rank for richness and viability (as represented by three acreage values).

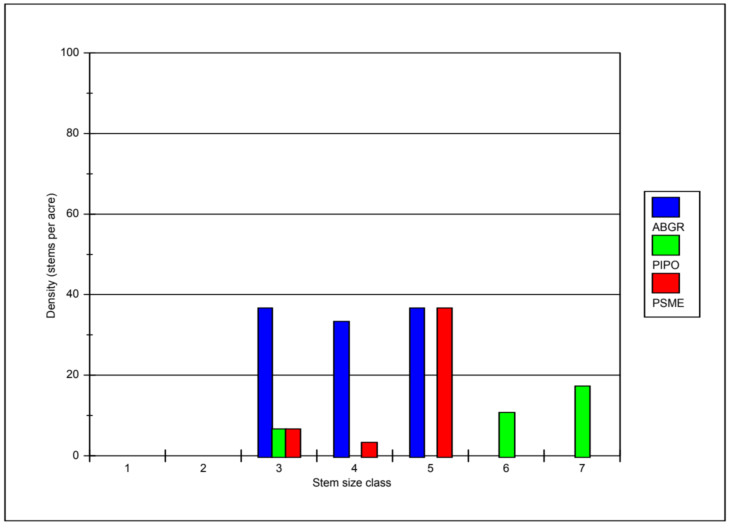
Appendix 2. Figures 1 - 4.

Figure 1. Stem structure of *Abies grandis/Acer glabrum, Physocarpus malvaceus* stands.

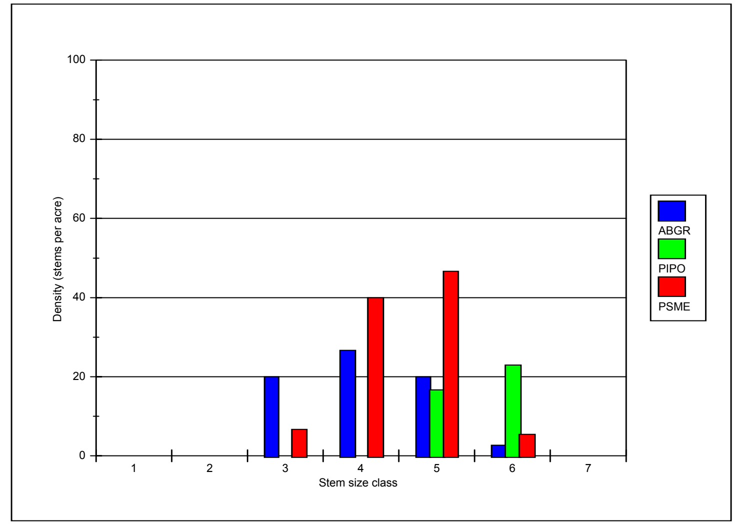
Figure 2. Comparison of structural conditions in mid-seral old growth versus mid-seral medium tree dominated *Abies grandis/Spiraea betulifolia* stands.

Figure 3. Stem structure observed in mid-seral old growth *Abies grandis/Calamagrostis rubescens*.

Figure 4. Comparison of stand structural conditions in *Pseudotsuga menziesii/Physocarpus malvaceus Calamagrostis rubescens*.



a.



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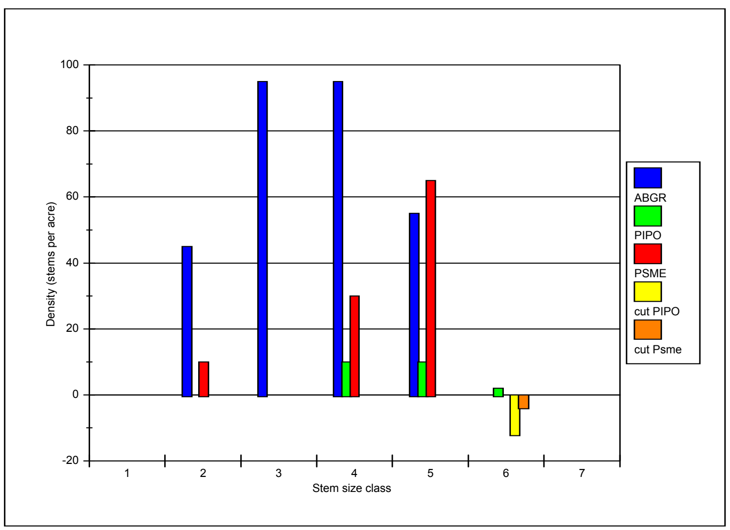
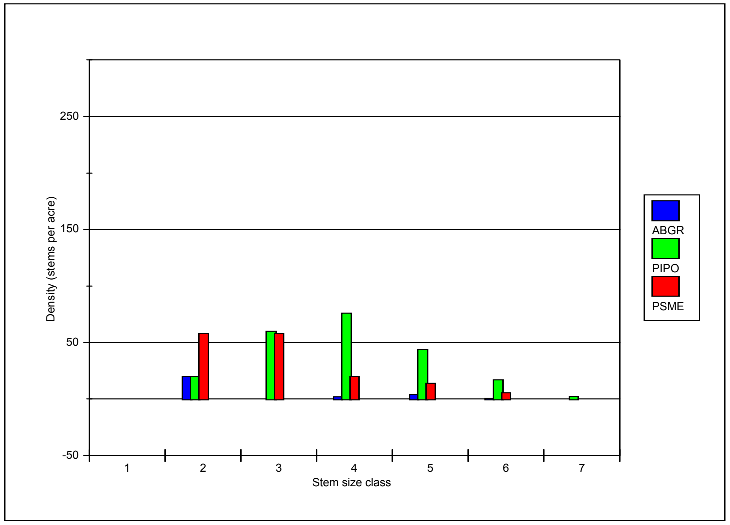


c.

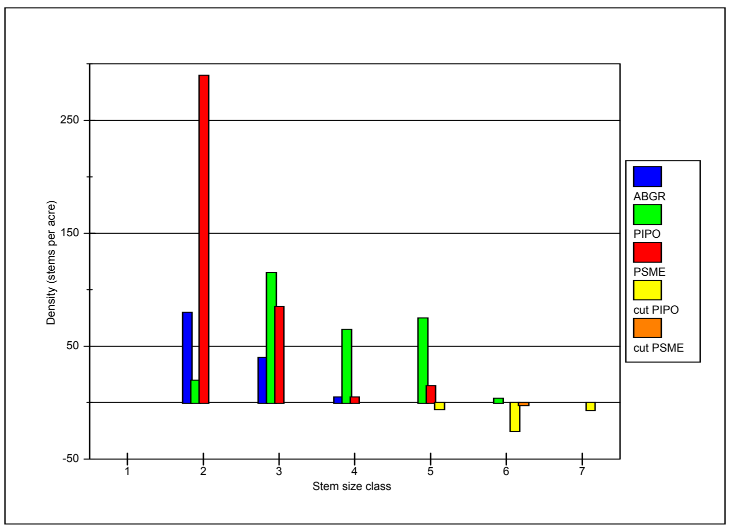
Figure 1. Stem structure of *Abies grandis/Acer glabrum, Physocarpus malvaceus* stands: a) giant tree dominated, mid-seral old growth (live trees, N = 3); b) large tree dominated mid- and late-seral old growth (live trees, N = 3); and c) medium tree dominated mid-seral stands (live and cut trees, N = 2).



a.

Figure 2. Comparison of structural conditions in (a) mid-seral old growth (N = 5) versus (b) mid-seral medium tree dominated (N = 2) *Abies grandis/Spiraea betulifolia* stands (to the left).

Figure 3. Stem structure observed in mid-seral old growth *Abies grandis/Calamagrostis rubescens* (below).



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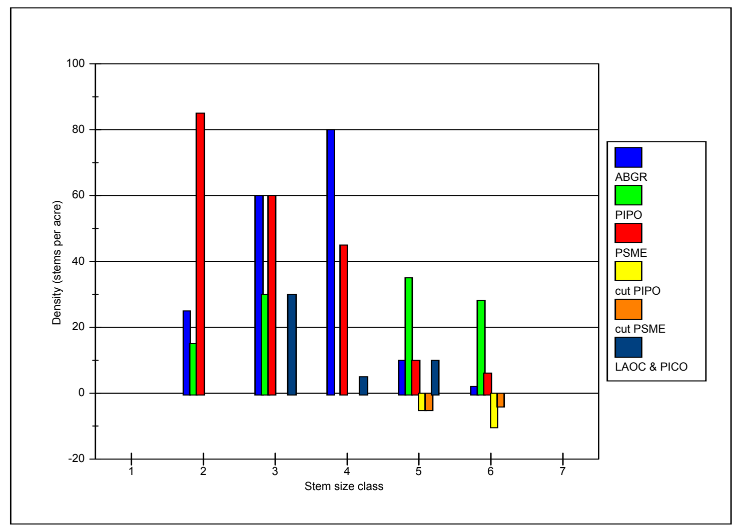
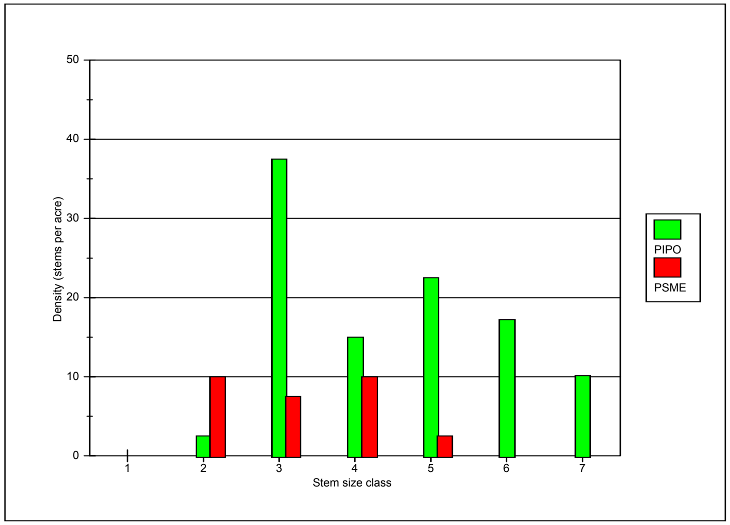
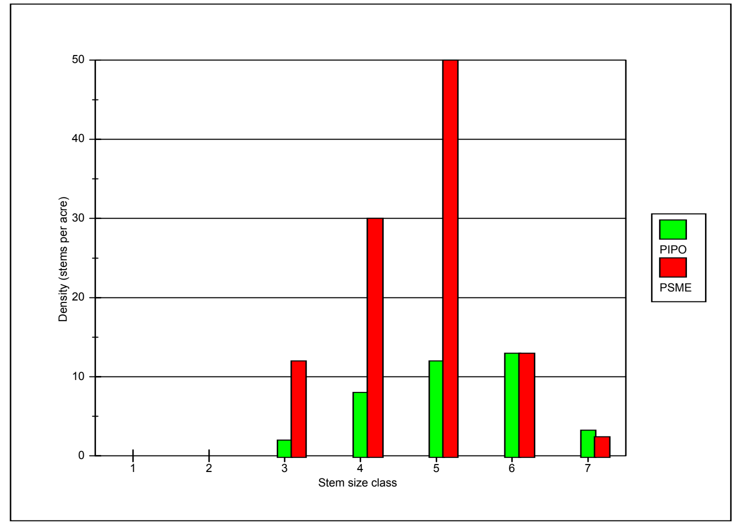
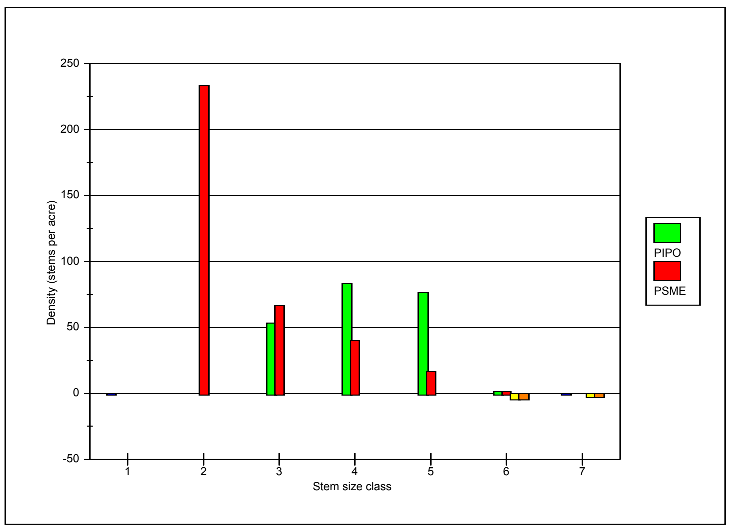




a.



b.



c.

Figure 4. Comparison of stand structural conditions in *Pseudotsuga menziesii/Physocarpus malvaceus Calamagrostis rubescens*: a) mid-seral old growth (N = 4), b) late-seral old growth (N = 5), and c) mid-seral medium tree dominated stands (N = 3) (note that the vertical axis is three times that of a) and b)).

Appendix 3. Annotated Bibliography. Literary resources relating to the conservation, description, management, and habitat use of old growth forest dominated by *Pinus ponderosa* are listed (with abstract information) alphabetically by author. Citations and abstracts are taken from Idaho Conservation Data Center (1997). The bibliography is followed by a keyword index.

Agee, J. K. 1981. Fire effects on Pacific Northwest forests: flora, fuels, and fauna. Conference Proceedings, Northwest Forest Fire Council 1981, Portland, Oregon, November 23 - 24, 1981.

No abstract is provided.

Agee, J. K. 1994. Fire and weather disturbance in terrestrial ecosystems of the eastern Cascades. USDA Forest Service, Pacific Northwest Research Station, Gen. Tec. Rep. PNW-GTR-320. 52 p.

Fire has been an important ecological process in eastside Cascade ecosystems for millennia. Fire regimes ranged from low severity to high severity, and historically fore return intervals ranged from less than a decade to greater than 300 years. Fire history and effects are described for grassland and shrubland ecosystems, and a range of forest communities using the following broad groupings: ponderosa pine, Douglas-fir/white fir/grand fir, lodgepole pine, western hemlock/western redcedar, and subalpine fir/mountain hemlock. The riparian zones within these communities may be more or less impacted by fire. The effects of extreme weather events, including unusual temperature, wind, or moisture have generally had less significant impact than fire. Management practices, including fire suppression, timber harvesting, and livestock grazing, have altered historical fire regimes, in some cases irreversibly. The management issues for the 1990's include both management and research issues, at a grand scale with which we have little experience. Ecosystem and adaptive management principles will have to be applied.

Agee, J. K. 1996. Fire in the Blue Mountains: a history, ecology, and research agenda. In: R. G. Jaindl and T. M. Quigley, editors. Search for a solution: sustaining the land, people, and economy of the Blue Mountains. American Forests, Washington D.C.

Fire has been an important disturbance process for millennia in the Blue Mountains. Suppressing all wildfires, removing certain tree species, and grazing have altered historical fire frequencies, intensities, and extent. The author provides introductory background material on fire as a disturbance agent, fire regimes, fire adaptions of plants, fire behavior, and fire effects. Fire regimes, fire effects, and the effects of management of fire in each of the following series (or groups) is discussed in detail: grasslands, shrublands, and western juniper; ponderosa pine; Douglas-fir and grand fire; and subalpine fir and mountain hemlock series. The author outlines an agenda for research concerning natural fire regimes and the restoration of fire on the landscape.

Alexander, R. R. 1985. Major habitat types, community types, and plant communities in the Rocky Mountains. USDA Forest Service General Technical Report RM-123. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Co. 105 pp.

Habitat types, community types, and plant communities in the Rocky Mountains in which interior Pinus ponderosa, interior Pseudotsuga menziesii, interior Abies concolor, Picea pungens, Populus tremuloides, Pinus contorta, Picea engelmannii, and Abies lasiocarpa occur are tabulated. Included are the name, location, site, successional status, principal tree and understory associates, and the authority.

Alexander, R. R. 1988. Forest vegetation on national forests in the Rocky Mountain and Intermountain Regions: habitat types and community types. USDA Forest Service General Technical Report RM-162. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 47 pp.

Habitat types and community types and their phases for the major forest tree species in the Rocky Mountain and Intermountain regions are tabulated. Included are the name(s), general location, elevation, relative site, successional status, principal tree and undergrowth associates, and the authority.

Arno, S. F. 1980. Forest fire history in the northern Rockies. Journal of Forestry 78: 460-465.

Recent fire-scar studies in the northern Rocky Mountains have documented forest fire history over the past few centuries. They reveal that in some forest types fire maintained many-aged open stands of seral trees. In other types, major fires caused replacement of the strands. Often, however, fires burned at variable intensities, creating a mosaic of stands differing in composition and structure.

Arno, S. F. 1985. Ecological effects and management implications of Indian fires. Pages 81-86 in J. E. Lotan, B. M. Kilgore, W. C. Fischer, and R. W. Mutch, technical coordinators, Proceedings-Symposium and Workshop on Wilderness Fire. USDA Forest Service General Technical Report INT-182. Intermountain Forest and Range Experiment Station, Ogden, UT.

Current evidence suggests Indian fires substantially augmented those set by lightning in grassland, shrubland, and certain low-elevation forest types for a millennium before settlement by Euro-Americans. In some large areas Indian fires apparently had a marked and continuing influence on vegetation. Managers of wilderness and other natural areas should assess the probable effects of past Indian fires on their ecosystems and consider this information in developing management alternatives.

Arno, S. F., D. G. Simmerman, and R. E. Keane. 1985. Forest succession on four habitat types in western Montana. USDA Forest Service General Technical Report INT-177. Intermountain Forest and Range Experiment Station, Ogden, UT. 74 pp.

Presents classifications of successional community types on four major forest habitat types in western Montana. Classifications show the sequences of seral community types developing after stand-replacing wildfire and clearcutting with broadcast burning, mechanical scarification, or no follow-up treatment. Information is provided for associating vegetational response to treatment.

Arno, S. F., D. G. Simmerman, and R. E. Keane. 1986. Characterizing succession within a forest habitat type - an approach designed for resource managers. USDA Forest Service Research Note INT-357, Intermountain Research Station, Ogden, UT. 8 pp.

Describes a method for developing a general-purpose ecological model of community types and successional relationships within a forest habitat type (potential vegetation). This model is based upon data collected from a large number of seral stands, and it is intended for use in land management and planning. The successional model has a framework of structural stages subdivided into community types based on overstory and undergrowth composition. The usual pathways or directions of succession between community types are identified. To aid prediction of vegetational development after different treatments, the model shows apparent relationships among posttreatment vegetation and the original vegetation, site characteristics, and kind of treatment. This method was used in developing successional classifications (models) of four major forest habitat types in western Montana (Arno and others 1985).

Arno, S. F., J. H. Scott, and M. G. Hartwell. 1995. Age-class structure of old growth ponderosa pine/Douglas-fir stands and its relationship to fire history. USDA Forest Service Research Paper INT-RP-481. Intermountain Research Station, Ogden, UT. 25 pp.

Describes age structure of nine old growth ponderosa pine/Douglas-fir stands in western Montana. Interprets the influence of past fires and 20th century fire exclusion on stand structure. Gives implications for management to restore and maintain these forests for multiple resource values.

Arno, S. F., and G. E. Gruell. 1983. Fire history at the forest-grassland ecotone in southwestern Montana. Journal of Range Management 36(3): 332-336.

The history and influence of fires was studied at the forest-grassland ecotone in high valleys of southwestern Montana. Investigations were focused upon several sites having early landscape-photographs and modern retakes that allow for detection of vegetational changes. Fire intervals were determined for these sites by analyzing fire scars on trees. Prior to 1910, mean fire intervals at Pseudotsuga forest-grassland ecotones were 35 to 40 years, and probably shorter in the grassland proper. No fires were detected on the study areas after 1918. Photographic comparisons and field inspections show a substantial increase in mountain big sagebrush (Artemisia tridentata ssp. vaseyana) and conifers since 1910.

Arno, S. F., and G. E. Gruell. 1986. Douglas-fir encroachment into mountain grasslands in southwestern Montana. Journal of Range Management 39(3): 272-276.

A study of plant succession in relation to disturbance history was conducted in Douglas-fir (Pseudotsuga menziesii var. glauca (Beissn.) Franco) forest and fescue (Festuca L. spp.) grassland communities along the eastern slope of the Continental Divide in Montana. The objective was to obtain ecological information needed for assessing management alternatives aimed at enhancing big game habitat and livestock forage. Fire history was reconstructed through analysis of fire scars and age classes of trees. Sizes and ages were inventoried in sapling stage, pole stage, and mature forest stands. Results indicate that prior to 1890 fires occurring every few decades favored grassland and confined tree growth to rocky or topographically moist sites. Since 1890 fires have been rare as a result of livestock grazing (which removes fine fuels), fire suppression, and cessation of ignitions by Native Americans. Lack of fire allowed extensive areas of Douglas-fir "invasion" now of pole size to become established in former grasslands between 1890 and 1915. Widespread invasion of sapling size trees occurred between 1941 and 1955, when seed crops apparently coincided with unusually favorable moisture conditions. For management of these areas, the authors recommend use of prescribed fire in conjunction with timber harvesting to enhance declining forage productivity for big game and livestock.

Arno, S. F., H. Y. Smith, and M. A. Krebs. 1997. Old growth ponderosa pine and western larch stand structures: influences of pre-1900 fires and fire exclusion. USDA Forest Service, Intermountain Research Station, Research Paper INT-RP-495. 20 p.

Historically, as a result of frequent fires, seral ponderosa pine and western larch trees dominated old growth stands in the Northern Rocky Mountains. The authors present detailed data on age structure and fire history of two remnant old growth stands on the Lolo National Forest in western Montana. These stands occupy contrasting sites; one is codominated by ponderosa pine and larch while the other is larch without ponderosa pine. The authors compare age structure of eleven stands that represent a broad range of sites historically characterized by frequent fire regimes. These stands are located in western Montana, on the Bitterroot, Flathead, and Lolo National Forests. Three of the stands on moderately moist site types were distinctly even-age. These reflected a variable fire regime of frequent nonlethal fire and infrequent stand replacement fires. Seven of the stands, including the driest sites and two moist sites with comparatively frequent fires, had highly uneven-age structures. The remaining stand, on a moderately dry site, had an intermediate age structure: uneven-aged but with on very abundant age class. The authors interpret causal factors possibly linked to these variations in age structure, including aboriginal burning.|Ten of the 11 stand have now experienced an unusually long interval without fire (75 to 105 years). Related changes in stand structure between 1900 and the 1990's include large increases in basal area per acre (+50 to +150 percent) and in stand density index per acre (+60 to +200 percent) except for two stands that have experienced large amounts of overstory mortality. The authors discuss implications for management to perpetuate old growth ponderosa and larch.

Atkinson, E. C., and M. L. Atkinson. 1990. Distribution and status of flammulated owls (Otus flammeolus) on the Salmon National Forest. Cooperative Challenge Cost Share Project, Salmon National Forest and Idaho Natural Heritage Program, Idaho Department of Fish and Game. 25 pp. plus appendices.

Nocturnal call surveys were conducted on the Salmon National Forest from early May to late July, 1990, to determine the distribution of Flammulated Owls. Sixty-seven territorial male owls were located in Douglas fir, ponderosa pine, and mixed coniferous stands. Densities were highest on the North Fork Ranger District. Territorial males were clumped in their distribution with apparently suitable habitat unoccupied. One nest cavity was discovered in a Douglas fir snag; the young fledged between 19 and 22 July. Two groups of fledglings were located, one of which was verified as Flammulated Owls.

Axelton, E. A. 1974. Ponderosa pine bibliography II. 1966-1970. USDA Forest Service General Technical Report INT-12. Intermountain Forest & Range Experiment Station, Ogden, UT. 63 pp.

This bibliography of Pinus ponderosa updates through 1970, "Ponderosa pine bibliography through 1965" by Elvera A. Axelton, 1967, USDA Forest Service Research Paper INT-40, 150 pages, Illustrations. A subject index is supplied.

Baker, F.S. and C.F. Korstian. 1922. Is Douglas fir replacing western yellow pine in central Idaho? J. Forestry 20:755-764.

No abstract is provided.

Baker, W. L. 1988. Size-class structure of contiguous riparian woodlands along a Rocky Mountain river. Physical Geography 9(1): 1-14.

Trees in 7 diameter-classes in 57 contiguous 0.1 ha plots, were tallied along a 10 km stretch of the Animas River in southwestern Colorado. The age, height above water, and elevation for each plot as well as the valley width and aspect at each plot location were determined. Detrended correspondence analysis (DCA) and two-way indicator species analysis (TWINSPAN) were then used to analyze these data. Age of the stand and its height above the water were significantly correlated with the first DCA axis, while only height above the water was significantly correlated with the second axis. Populus angustfolia and Pinus ponderosa have seedlings and saplings in stands <60 years old, but only large stems in older stands. Abies concolor and Populus tremuloides have seedlings and saplings only in stands >60 years old. Picea pungens and Pseudotsuga menziesii have seedlings and saplings in stands of all ages. A strict successional interpretation of the overall time-trends fails, because "succession" changed after 1927-1931. Current structure has been influenced by climatic and hydrologic effects on tree regeneration, by floods, and possibly by the unusual particle size of 1927 flood deposits. Vegetation structure on this 10 km river reach may be inherently unstable, because it is determined more by the timing and character of recent large-scale disturbances than by a repeating successional process.

Barbour, M. G., and W. D. Billings, editors. 1988. North American terrestrial vegetation. Cambridge University Press, New York. 434 pp.

Introductory text for North American terrestrial vegetation. Includes chapters on the following: 1) Arctic tundra and polar desert biome, 2) the boreal forest, 3) forests of the Rocky Mountains, 4) Pacific Northwest forests, 5) Californian upland forests and woodlands, 6) chaparral, 7) Intermountain deserts, shrub steppes, and woodlands, 8) warm deserts, 9) grasslands, 10) deciduous forest, 11) vegetation of the southeastern coastal plain, 12) tropical and subtropical vegetation of Meso-America, 13) alpine vegetation.

Barbour, R. James and Kenneth E. Skog. 1997. Role of wood production in ecosystem management. Proceedings of the Sustainable Forestry Working Group at the IUFRO all Division 5 conference, Pullman, Washington, July 1997.

The presentations at this symposium discussed concepts of ecosystem management and sustainability as viewed by various levels of government and private land managers. The theme was to integrate ecology, silviculture, forest operations, wood products, and economics to find ways to develop healthy sustainable ecosystems under financially sound management practices. Speakers discussed ways to manage disturbance to create landscapes with the desired level of diversity and resilience to fire, disease, and insects. Others identified technical aspects of improving the options fro producing wood and promoting healthy ecosystems. The feasibility of the various modes of forest operation were considered along with methods of to evaluate the financial aspects of activities in different stand types. Lastly, the concept of sustainability was discussed, both in theory and through case studies. A full paper is present for the majority of presentations; an abstract is included for others. Articles of note include:

Everett, R. L. and D. M. Baumgartner. Disturbance management and resource product availability.

Fiedler, C. E., D. E. Keegan, and S. F. Arno. Utilization as a component of restoring ecological processes in ponderosa pine forests.

Barbour, R. J., S. Tesch, J. McNeel, S. A. Willits, R. D. Fight, A. Mason, and K. Skog. Objectives and study design of the Colville Study: silviculture, ecology, utilization, and economics of small-diameter densely stocked stands.

Salwasser, H. and B. Bollenbacher. The role of wood removals in implementation of ecosystem management on Federal lands: a multifaceted perspective.

Barrett S. W., and B. M. Kilgore. 1985. Wilderness fire history studies in the northern Rockies. Page 315 in J. E. Lotan, B. M. Kilgore, W. C. Fischer, and R. W. Mutch, technical coordinators, Proceedings-Symposium and Workshop on Wilderness Fire. USDA Forest Service General Technical Report INT-182. Intermountain Forest and Range Experiment Station, Ogden, UT.

Two fire history studies were initiated in Northern Rocky Mountain Wilderness Areas. The first study, in Glacier NP, was begun in 1982 to determine past fire frequencies as a prerequisite to fire management planning. The 270 fire scar samples obtained from a 60,000 ac study area in the NFK of the Flathead River Basin revealed 66 fire years form the 1470's to 1960. Preliminary results indicate that large fires were relatively frequent from at least 1655 to 1926 and that many apparently were underburns in the area's predominantly lodgepole pine forests. The second study was begun in 1983 in central Idaho's River of No Return Wilderness. 75 samples have obtained from the first of several small study areas in the area's relatively dry ponderosa pine/Douglas fir forests. These first samples are from an area adjacent to the wilderness. In 1984, samples will be taken from sites within the wilderness.

Barrett, S. W. 1980. Indian fires in the pre-settlement forests of western Montana. Pages 35-41 in USDA Forest Service General Technical Report RM-81. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Presents preliminary results of a two-year study examining the pattern of Indian fires in western Montana's lower elevation forests. Interviews and historic journals were used to reconstruct the characteristics of aboriginal burning. Fire scar data from paired stands indicate substantial differences in fire frequency between Indian habitation zones and remote areas before 1860. Fire frequency between paired stands varied during the settlement period (1861-1910), and fire frequency has been markedly reduced in most stands since the advent of organized fire suppression after 1910.

Barrett, S. W. 1988. Fire suppression's effects on forest succession within a central Idaho wilderness. Western Journal of Applied Forestry 3(3): 76 - 80.

In south-central Idaho, firescar and tree regeneration patterns in the Salmon Fiver Breaks portion of the Frank Church River of No Return Wilderness suggest that primarily surface fires occurred frequently in semiarid ponderosa pine forests. Efficient fire suppression since about 1935 has markedly reduced area fire frequency and has altered fuel succession, contributing to recent crown fire behavior in north- and east-facing stands. Prescribed fires might now be difficult to contain in these communities, but burning would help return fuels to pre-1935 conditions.

Barrett, S. W. 1993. Fire regimes on the Clearwater and Nez Perce National Forests, north-central Idaho. Unpublished report on file at Idaho Department of Fish and Game, Conservation Data Center, Boise, ID. 21 pp.

During the summer of 1993, fire history sampling was conducted in several analysis areas on the Clearwater and Nez Perce NFs in north-central Idaho. The goal was to determine fire regime patterns for major forest types in order to aid the development of strategies for ecosystem management. Several representative sample areas were chosen to determine pre-1900 fire history and to determine possible effects of post-1900 fire suppression: 1) a relatively high elevation old growth forest dominated by lodgepole pine and subalpine fir, adjacent to the northeastern portion of the Selway-Bitterroot Wilderness; 2) a low elevation red cedar and grand fir mesic forest in the NFK Clearwater River drainage; and 3) a warmer and drier zone of Douglas fir and grand fir in the SFK Clearwater River drainage. Following data analysis, results from this sampling were factored into a previous fire regimes model that resulted from work in and around the Selway-Bitterroot Wilderness. Since north-central Idaho contains a wide range of vegetation types and also represents a major north-south transition zone between relatively dry and relatively moist forest types in Idaho, the fire regimes model presented in this report is somewhat preliminary, pending possible addition of future data and an upcoming classification for Inland Northwest forests.

Barrett, S. W., S. F. Arno, and J. P. Menakis. 1997. Fire episodes in the inland northwest (1540-1940) based on fire history data. USDA Forest Service, Intermountain Research Station, General Technical Report INT-GTR-370. 17 p.

Information from fire history studies in the Northwest United States was used to identify and map "fire episodes" (5 year periods) when fire record were most abundant. Episodes of widespread landscape-scale fires occurred at average intervals of 12 years. Mean annual acreage burned was calculated based on estimated areas on historical vegetation types with their associated fire intervals from the fire history studies. An average of about 6 million acres of forest and grass and shrubland burned annually within the 200 million acre Columbia River Basin study region, and especially active fire years probably burned twice this much area. Fore comparison, the largest known fire years since 1900 have each burned 2 million to 3 million acres in the region. The authors also compare the occurrence of regional fire episodes to drought cycle defined by tree-ring studies.

Barrows, J.S., E.W. Mogren, K. Rowdabaugh, and R. Yancik. 1977 The role of fire in ponderosa pine and mixed conifer ecosystems. Final report, Cooperative report between the National Park Service & Rocky Mountain Forest and Range Experiment Station, Ft.Collins. 101p.

No abstract.

Becker, D. M. 1984. Reproductive ecology and habitat utilization of Richardson's merlins in southeastern Montana. Unpublished thesis, University of Montana, Missoula. 62 pp.

Reproductive ecology, food habitat utilization, and eggshell quality of Richardson's merlins (Falco columbarius richardsonii) in southeastern Montana were examined. Breeding activity spanned five months. Clutch size, brood size, and fledging success at active nests were similar (P >0.05) among four years. Birds comprised >90% of individual prey items, and 61% of avian species were typically associated with predominantly open habitats. Horned larks (Eremophila alpestris), lark buntings (Calamospiza melanocorys), and vesper sparrows (Pooecetes gramineus) collectively comprised 57% of all prey. Home ranges of three breeding male merlins encompassed approximately 13, 23 and 28 sq. km, and each male traveled a maximum of 8 to 9 km from his nest. These home ranges encompassed five physiognomic habitat types. Percentages of total observations by habitat type indicated greatest use of sagebrush and grassland habitats. Sagebrush, riparian, and ponderosa pine habitats were used more (P <0.05) than expected, but grasslands and agriculture habitats received less (P <0.05) use than expected. Comparisons of Montana eggshells with pre-pesticide (pre-1946) eggshells indicated 12% and 20% reductions in eggshell weight and eggshell thickness indices, respectively. These reductions were significant (P<0.01). Seven organochlorine compounds were detected in eggs collected on the study area. The overall management goal should be maintenance of a viable merlin population and the habitat features essential for its continued existence. Management recommendations include limiting alteration of ponderosa pine sideslope habitat, restricting activities from 10 March through 20 July, rescheduling activities, establishing 400 m zones of no disturbance surrounding nests, limiting loss of prairie habitat and sagebrush removal, limiting use of organochlorine compounds, reviewing potential impacts of activities prior to their occurrence, and maintaining confidentiality of nest locations.

Blair, G. S., and G. Servheen. 1993. Species conservation plan for the white-headed woodpecker (Picoides albolarvatus). Nez Perce National Forest, Grangeville, and Idaho Department of Fish and Game, Lewiston. 27 pp plus appendices.

Summarizes range, distribution, and life history information; habitat use; food habits; and seasonal movements. Discusses impacts of management practices, recommends a monitoring strategy and management guidelines, and suggests areas where research is needed to develop sound management practices.

Block, W. M. and D. M. Finch, technical editors. 1997. Songbird ecology in southwestern ponderosa pine forests: a literature review. USDA Forest Service, Rocky Mountain Forest and Range Experimental Station, Gen. Tec. Rep. RM-GTR-292. 152 p.

This publication reviews and synthesizes the literature about ponderosa pine forests of the Southwest, with emphasis on the biology, ecology, and conservation of songbirds. Critical bird-habitat management issues related to succession, snags, old growth, fire, logging, grazing, recreation, and landscape scale are addressed. Overviews of the ecology, current use, and history of Southwestern ponderosa pine forests are also provided. This report is one of the outcomes of the *Silver vs. Thomas* court-settlement agreement of 1996. It is intended for planners, scientists, and conservationists in solving some of the controversies over managing forests and birds in the Southwest.

Boise National Forest. 1995. Resources at risk: a fire-based hazard/risk assessment for the Boise National Forest. Draft. Unpublished report. 10 pp.

Severe wildfires have burned nearly 33% of the ponderosa pine forest on the Boise NF over the past six years. Ponderosa pine forests are mow among the endangered and threatened ecosystems in the US. The historic fire regime - one marked by non-lethal, surface fires that removed dense understories of saplings or pole-sized trees and increased nutrient availability - has changed. The altered fire regime now results in catastrophic, stand-replacing fires that kill large areas of forest and return it to grass and shrub-dominated landscapes. Preliminary analysis shows the remaining ponderosa pine forest on the Boise NF could be lost within the next 20 years to severe, stand-replacing wildfire. In partnership with U of I, the Boise NF has developed a GIS-based "hazard/risk assessment" model that determines where the forest ecosystems are most at risk to severe, large wildfires burning outside the historical range of variability (HRV), and what important resources are at risk to these fires. The hazard/risk model links five submodels - forested vegetation outside HRV, fire ignition, wildlife habitat persistence, watershed hazard (erosion potential), and fish persistence - to estimate where severe wildfires would deplete late-successional habitat needed by old-growth dependent and other wildlife species, accelerate levels of erosion and sedimentation that are naturally high, and increase the risk of extinction of identified fish species. The hazard/risk assessment is most appropriately used to approximate the size and extent of the fire-based ecosystem problem on the Forest - the result of excluding fire from fire-adapted ponderosa pine ecosystems. It is intended to "nest" between the large-scale analysis undertaken as part of the Upper Columbia River Basin Assessment, and the site-specific evaluation performed for project-level analysis.

Bradley, A. F., W. C. Fischer, and N. V. William. 1992. Fire ecology of forest woodlands in Utah. General Technical Report INT-287. Ogden, UT: USDA Forest Service, Intermountain Research Station. 128 pp.

Provides information on fire as an ecological factor in forest habitat types, and in pinyon-juniper woodland and oak-maple brushland communities occurring in Utah. Identifies Fire Groups based on fire's role in forest succession. Describes forest fuels and suggests considerations for fire management.

Bradley, A. F., W. C. Fischer, and N. V. William. 1992. Fire ecology of the forest habitat types of eastern Idaho and western Wyoming. General Technical Report INT-290. Ogden, UT: USDA Forest Service, Intermountain Research Station. 92 pp.

Provides information on fire as an ecological factor in the forest habitat types occurring in eastern Idaho and western Wyoming. Identifies Fire Groups based on fire's role in forest succession. Describes forest fuels and suggests considerations for fire management.

Brawn, J. D., and R. P. Balda. 1983. Use of nest boxes in ponderosa pine forests. Pages 159-164 in J. W. Davis, G. A. Goodwin, and R. A. Ockenfels, technical coordinators, Snag habitat management: proceedings of the symposium. Northern Arizona University, Flagstaff. USDA Forest Service Technical Report RM-99.

Use of nest boxes by secondary cavity nesting birds was assessed on 3 study plots in northern Arizona's ponderosa pine forests from 1980 to 1982. Sixty boxes were installed on each of the 8.0 ha plots. Box use as nest sites increased, overall, from 5% to 31% during the 3 breeding seasons. Differences in percent use between plots were related to the availability of natural nest sites in snags. To date, 6 species have nested in the boxes. Nest attempts were 73% successful. The employment of nest boxes as a management tool may become more viable if current trends in land use practices persist.

Brawn, J. D., and R. P. Balda. 1988. Population biology of cavity nesters in northern Arizona: do nest sites limit breeding densities? Condor 90: 61-71.

Breeding densities of secondary (i.e., nonexcavating) cavity-nesting birds are often assumed to be limited by availability of nest sites. This assumption was investigated for species breeding in northern Arizona's ponderosa pine forests. In 1979, nest boxes were installed on three treatment plots that differed in habitat structure. Breeding densities of six species were monitored through the 1983 breeding season. The effect of nest boxes was evaluated by comparing breeding densities on three treatment plots from 1980 to 1983 with (1) pretreatment densities (1973-1975, 1979) and with (2) densities on control plots from 1980 to 1983. Variation in the importance of nest-site limitation among treatment plots was observed. Overall breeding densities (all species combined) increased significantly on only two treatment plots. Individual species' responses were influenced by habitat structure, and breeding densities of only three species were apparently limited by nest sites before boxes were installed--violet-green swallows, pygmy nuthatches, and western bluebirds. A given species' breeding density in northern Arizona is nest-site limited if it is locally common and reliant on dead trees for nest sites. Availability of food or foraging substrate and territoriality may determine an upper limit to breeding densities if nest sites are in ample supply.

Brown, J. K., R. W. Mutch, C. W. Spoon, and R. H. Wakimoto, technical coordinators. 1995. Proceedings: symposium on fire in wilderness and park management; 1993, March 30-April 1; Missoula, MT. General Technical Report INT-GTR-320. Ogden, UT: USDA Forest Service, Intermountain Research Station. 283 pp.

Includes 75 papers dealing with fire in wilderness and park management. The general themes are attaining wilderness management goals, addressing management constraints, and implementing programs. Papers address topics such as air quality, community and political concerns, prescribed fire, fire effects, fire ecology, fire danger, fire suppression, the media, and public opinion.

Bryan, T., and E. D. Forsman. 1987. Distribution, abundance, and habitat of great gray owls in south central Oregon. The Murrelet 68: 45-49.

During a field survey in 1984-1985, great gray owls (Strix nebulosa) were located at 63 sites in south central Oregon, with both a male and female at 25 sites, individual males at 36 sites, and individual females at two sites. Eleven nests were located, including 10 in old platform nests built by diurnal raptors and one in a cavity in a large snag. The authors concluded that great gray owls were widely distributed in south central Oregon, but were common only in a few areas where there were concentrations of appropriate habitat. Of the 63 sites where owls were located, 61 were in forests adjacent to meadows. Associations of lodgepole pine (Pinus contorta) or lodgepole pine and ponderosa pine (P. ponderosa) predominated at 59 sites, and mixed conifer associations predominated at four sites. The authors suggest that great gray owls are declining in numbers in south central Oregon as a result of habitat loss and recommend protection of existing nest sites and erection of artificial platforms.

Bull, E. L. 1980. Resource partitioning among woodpeckers in northeastern Oregon. Unpublished dissertation, University of Idaho, Moscow. 109 pp.

Examines nesting and feeding habitat of 8 species of coexisting woodpeckers in conifer forests in northeastern Oregon to determine degree of resource partitioning among these woodpeckers. Tree diameter was an important factor in nest selection site.

Bull, E. L. 1983. Longevity of snags and their use by woodpeckers. Pages 64-67 in J. W. Davis, G. A. Goodwin, and R. A. Ockenfels, technical coordinators, Snag habitat management: proceedings of the symposium. Northern Arizona University, Flagstaff. USDA Forest Service Technical Report RM-99.

In northeastern Oregon, 50% of the ponderosa pine (Pinus ponderosa) snags and 38% of the lodgepole pine (P. contorta) snags were standing 8 years after being killed by the mountain pine beetle (Dendroctonus ponderosae). Trees greater than 50 cm dbh stood longer than smaller trees. Woodpeckers excavated cavities in 15 of the 186 ponderosa pine snags 3 to 8 years after the trees died.

Bull, E. L. 1987. Ecology of the pileated woodpecker in northeastern Oregon. Journal of Wildlife Management 51(2): 472-481.

On the Starkey Experimental Forest in northeastern Oregon pileated woodpeckers nested in dead ponderosa pine (73%), dead western larch (25%), or live grand fir (2%). The diameter at breast height (dbh) of 105 nest trees averaged 84 cm, and nest height averaged 15 m. Fifty-five percent of nest trees had broken-off tops. At 67% of the nest sites the surrounding stand was Grand Fir Forest Type. Trees used for roosting were similar to nest trees but had been dead longer. Juveniles dispersed an average of 3.4 km from where they were raised to where they later nested.

Bull, E. L. 1989. Great gray owl: Strix nebulosa. Pages 82-83 in T. W. Clark, A. H. Harvey, R. D. Dorn, D. L. Genter, and C. Groves, eds., Rare, sensitive, and threatened species of the Greater Yellowstone Ecosystem. Northern Rockies Conservation Cooperative, Montana Natural Heritage Program, The Nature Conservancy, and Mountain West Environmental Services. 153 pp.

This article is a brief description of the range, habitat, life history and ecology, and conservation needs of the great gray owl.

Bull, E. L. 1989. Pileated woodpecker: Dryocopus pileatus. Page 87 in T. W. Clark, A. H. Harvey, R. D. Dorn, D. L. Genter, and C. Groves, eds., Rare, sensitive, and threatened species of the Greater Yellowstone Ecosystem. Northern Rockies Conservation Cooperative, Montana Natural Heritage Program, The Nature Conservancy, and Mountain West Environmental Services. 153 pp.

This article is a brief description of the range, habitat, life history and ecology, and conservation needs of the pileated woodpecker.

Bull, E. L., A. L. Wright, and M. G. Henjum. 1989. Nesting habitat of flammulated owls in Oregon. 10 pp.

Survey of 33 flammulated owl nests in northeastern Oregon. Important nesting habitat included large-diameter, dead trees with cavities as large as flicker cavities, located on ridges and upper slopes in mature ponderosa pine and Douglas-fir or grand fir with ponderosa pine overstory.

Bull, E. L., J. G. Henjum, and R. S. Rohweder. 1989. Diet and optimal foraging of great gray owls. Journal of Wildlife Management 53(1): 47-50.

Pellets were collected at 58 great gray owl nests in northeast Oregon during 1982-1986. Voles and northern pocket gophers made up 52% and 29%, respectively, of prey numbers during the breeding season. Males maximized the return for their energy expenditure by eating smaller prey at the point of capture and taking the larger prey to the nest.

Bull, E. L., M. G. Henjum, and R. S. Rohweder. 1988. Home range and dispersal of great gray owls in northeastern Oregon. Journal of Raptor Research 22(4): 101-106.

The average maximum distance radio-tagged adult great gray owls traveled from their nest sites was 13.4 km. Average size of home range was 67.3 square km. Maximum dispersal distance of juvenile great gray owls from natal sites averaged 18.3 km, and home range averaged 139 square km. Three juvenile owls had an average home range of 167 square km their first year of life and 13 square km their second year of life. Over 90% of radio-tagged owls dispersed to areas with less snow during the winter.

Bull, E. L., M. G. Henjum, and R. S. Rohweder. 1988. Nesting and foraging habitat of great gray owls. Journal of Raptor Research 22(4): 107-115.

During 1982-1986, 46 great gray owl nests were located in northeastern Oregon. Twenty-five of these nests were on stick platforms, 11 were on artificial platforms, and 10 were on broken-topped dead trees. Mean dbh and height of trees containing stick nests were 58 cm and 30 m, respectively, and the majority (76%) of the nests were in live western larch. Broken-topped dead trees with nests averaged 11 m tall and 78 cm dbh. Forest types in which nests were found included Douglas-fir - grand fir (50%), western larch - lodgepole pine (29%), ponderosa pine - Douglas-fir (15%), and ponderosa pine (7%). Nesting males foraged primarily in mature, open stands (11-59% canopy closure) of ponderosa pine or Douglas-fir.

Bull, E. L., M. G. Henjum, and R. S. Rohweder. 1989. Reproduction and mortality of great gray owls in Oregon. Northwest Science 63(1): 38-43. Proof of forthcoming article.

Population characteristics of great grey owls in northeastern Oregon were observed from 1982 to 1986 for information needed to manage this species. Of 64 nesting attempts, 77% of the pairs raised young. Mean brood size was 2.3 (SD = 0.87, range = 1.5). Annual probability of survival of adult nesting females and males was 0.84 (CL = 0.70-1.00) and 0.91 (CL = 0.78-1.00), respectively. Probabilities of young owls surviving their first 12, 18, and 24 months of life were 0.53 (CL = 0.44-0.75), 0.39 (CL = 0.24-0.65), and 0.31 (CL = 0.16-0.57), respectively. This baseline information on reproduction and survival is essential to the management of populations of great gray owls.

Bull, E. L., R. S. Holthausen, and D. B. Marx. 1990. How to determine snag density. Western Journal of Applied Forestry 5(2): 56-58.

Results of study to determine an accurate and efficient method of quantifying snag density, based on five study areas (3,000-4,000 ac each) in mixed coniferous forest on the Wallowa-Whitman National Forest in northeastern Oregon.

Recommends using 1-ac plots or factor-5 plots to determine snag density in a large area (several thousand acres) where the known snag density is 0.7-2 snags/ac.

Bull, E. L., S. R. Peterson, and J. W. Thomas. Resource partitioning among woodpeckers in northeastern Oregon. USDA Forest Service Research Note PNW-444. Pacific Northwest Research Station, Portland. 19 pp.

Eight species of woodpeckers coexist in conifer forests in northeastern Oregon: norther flicker; yellow-bellied and Williamson's sapsuckers; and pileated, hairy, white-headed, three-toed, and black-backed woodpeckers. Tree diameter was the most important factor considered in selection of nest trees by northern flickers, Williamson's sapsuckers, and pileated and hairy woodpeckers. These species partitioned the nest habitat by occupying different forest stands or conditions of nest trees. Pileated woodpeckers occurred in grand fir stands and nested in snags dead 10 or more years. The same stands were used by Williamson's sapsuckers which nested in live or recently dead trees. Northern flickers and hairy woodpeckers nested in ponderosa pine forests but flickers used larger snags. Foraging habitat and strategies differed. Only the pileated woodpecker excavated extensively dead wood -- particularly in downed wood and in grand fir forests. Northern flickers fed on the ground in open forests or grasslands. Live trees were used by Williamson's sapsuckers and white-headed woodpeckers. Sapsuckers drilled sapwells in Douglas-fir and the white-headed woodpecker gleaned on ponderosa pine trunks and ate seeds. The remaining 3 species foraged by scaling, but the three-toed woodpecker fed exclusively in lodgepole pine stands. The hairy and black-backed woodpeckers scaled on similar trees in ponderosa pine stands. Hairy woodpeckers occasionally foraged on limbs and cones; black-backed woodpeckers used neither. Theoretically, nesting should have occurred when maximum food was available; however, hairy and black-backed woodpeckers, species most similar in their feeding habitat and strategies, fledged their young the earliest and the latest, respectively. This temporal separation could reduce competition.

Bull, E. L., and E. C. Meslow. 1977. Habitat requirements of the pileated woodpecker in northeastern Oregon. Journal of Forestry 75(6). 3 pp.

Nesting, feeding, and territorial activities of the pileated woodpecker were observed in the spring and summer of 1973 and 1974 in northeastern Oregon. The 13 nests found in a 28,000-acre area were in ponderosa pine and western larch snags greater than 23 inches dbh. Pileated woodpeckers fed primarily in dead wood in snags, logs, and naturally created stumps. Both nest trees and feeding sites were in concentrations of snags and in the most dense forest types. Minimum nesting territories were estimated at 320 acres.

Bull, E. L., and J. H. Hohmann. 1994. Breeding biology of northern goshawks in northeastern Oregon. Studies in Avian Biology 16: 103-105.

Ten of 25 historical northern goshawk (Accipiter gentilis) nest stands in Wallowa County had active nests in 1992. Young fledged at 10 of 12 nests at an average of 1.4 young per successful nesting attempt, or 1.2 young for all nests. Incubation occurred in late April and May, and nestlings were present in June and July. The earliest and latest fledging dates were 22 June and 27 July; the mean fledging date was 8 July. All nests were in old growth or remnant old growth stands; however, most of the stands searched were old growth. Nest trees averaged 65 cm diameter at breast height and 34 m tall. Diet determined from prey remains consisted of 58.5% birds and 41.5% mammals.

Bull, E. L., and M. G. Henjum. 1990. Ecology of the great gray owl. USDA Forest Service General Technical Report PNW-GTR-265. Pacific Northwest Research Station, La Grande, Oregon. 39 pp.

From 1982 to 1986, the authors studied 24 adult pairs and 107 juvenile great gray owls in northeastern Oregon. Forty-nine nests were located; 16 were used more than once, so 71 nesting attempts were observed. Seventy-eight percent of these nesting attempts were successful in raising 1 to 5 young (mean = 2.2). The nests were on stick platforms, on top of broken-off dead trees, and on artificial wooden platforms. Nest trees occurred in a variety of habitats, although most were in mature or older, unlogged stands of mixed conifer. Diet by biomass consisted mainly of northern pocket gophers (67%) and voles (27%). The size of the home range for 16 adult owls and 19 juveniles averaged 67 square kilometers and 157 square kilometers, respectively. Management practices enhancing habitat for great gray owls include providing artificial nest platforms, protecting existing nest platforms and large-diameter dead trees, providing dense tree cover around or adjacent to the nest, and providing perches for recently fledged young.

Bull, E. L., and R. S. Holthausen. 1993. Habitat use and management of pileated woodpeckers in northeastern Oregon. Journal of Wildlife Management 57(2): 335-345.

Home range size and habitat used by pileated woodpeckers were determined to provide essential information for proper management of the species in northeastern Oregon. Twenty-three pileated woodpeckers fitted with transmitters were followed for 5-10 months (June-March) during 1989-90. Mated pairs (n=7) ranged over smaller areas (x=407 ha) than birds (x=597) whose mates had died (n=9). Habitat use within home ranges was not random. Stands with old growth, grand fir, no logging, and > than or = to 60% canopy closure were used more (P<0.01) than expected, and all other types of stands were used less than expected. From June until March, 38% of the observations of foraging were on downed logs, 38% on dead trees, 18% on live trees, and 6% on stumps. The authors recommend that management for pileated woodpeckers in northeastern Oregon include increasing density of snags for nesting and foraging, increasing density of downed logs in foraging areas, and increasing management areas from the existing 121 ha to 364 ha of forest. Within these areas, we recommend that 75% be in grand fir forest type; 25% be old growth with the remainder mature stands; at least 50% have > than or = to 60% canopy closure; and at least 40% be unlogged with the remainder in mature stands.

Busing, R. T., C. B. Halpern, and T. A. Spies. 1995. Ecology of pacific yew (Taxus brevifolia) in western Oregon and Washington. Conservation Biology 9(5): 1199-1207.

Taxus brevifolia, a subcanopy tree or shrub in forests of the Pacific Northwest, has been harvested intensively in recent years. With management concerns as an impetus, the researchers examined the distribution and population dynamics of Taxus based on data from the mountains of western Oregon and Washington. Surveys of natural forests, long-term studies of forest recovery following logging, and census data on marked trees in forest stands support the hypothesis that Taxus is a widespread but predominantly late-successional species. Sensitive to fire and slow to recover from disturbance on many sites, Taxus attains maximal basal area and adult stem density in old forests. Colonization of Taxus is often slow in potentially suitable habitats. Conservation of Taxus at the landscape level may require large, unmanaged reserves and maintenance of patches of old forest within managed forests. Long rotations (centuries) between harvest events will enhance the long-term viability of the species. Practices designed to accelerate the development of old-growth forest structure will not benefit Taxus and other species requiring long disturbance-free intervals for recovery.

Cholewa, A. F. 1977. Successional relationships of vegetational composition to logging, burning, and grazing in the Douglas fir/Physocarpus habitat type of northern Idaho. Unpublished thesis. University of Idaho, Moscow. 60 pp.

Description and ordination of seral communities within the PSME/PHMA habitat type to develop a secondary successional sequence.

Cooke, W. B. 1955. Fungi, lichens and mosses in relation to vascular plant communities in eastern Washington and adjacent Idaho. Ecological Monographs 25(2): 119-180.

This study was undertaken to discover what differences there might be in species composition, relative abundance, substratum preference, and spring and autumn appearance of the fruit bodies of macroscopic fungi in six associations of four major vegetation zones. Lichens and bryophytes were studied in the same series of plots to determine the extent to which the distribution of these plants is correlated with the grassland, shrub and forest communities under observation.

Cooper, S. V., K. E. Neiman, and D. W. Roberts. 1991. Forest habitat types of northern Idaho: a second approximation. USDA Forest Service General Technical Report INT-236. Intermountain Research Station, Ogden. 143 pp.

The addition of more than 900 plots to the Daubenmire's original 181-plot database has resulted in a refinement of their potential natural vegetation-based land classification for northern Idaho. A diagnostic, indicator species-based key is provided for field identification of the eight climax series, 46 habitat types, and 60 phases. Recognized syntaxa are described by occurrence, environment, vegetation, and management implications.

Cooper, S. V., P. Lesica, R. L. DeVelice, and J. T. McGarvey. 1995. Classification of southwestern Montana plant communities with emphasis on those of Dillon Resource Area, Bureau of Land Management. Montana Natural Heritage Program, Helena, Montana. 152 pp.

Plots were taken throughout Dillon Resource Area to document within/without exclosure vegetation contrasts. Using a combination of objective numerical techniques, two-way indicator species analysis and detrended correspondence analysis and subjective construction of synthesis and constancy/coverage tables 60 community types were identified and described.

Costello, D. F. and H.E. Schwan. 1946. Conditions and trends on ponderosa pine ranges in Colorado. USDA Forest Service Mimeograph. 33 pp.

No abstract is provided.

Covington, W. W. 1994. Implications of Ponderosa Pine/Bunchgrass ecological systems. Pages 92-97 in Covington, W. W., and L. F. DeBano, technical coordinators. 1994. Sustainable ecological systems: implementing an ecological approach to land management. 1993 July 12-15; Flagstaff, AZ. USDA Forest Service, General Technical Report RM-247. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 363 pp.

When viewed from a conservation biology perspective, postsettlement outbursts of ponderosa pine trees in ponderosa pine/bunchgrass ecosystems not only reduce biological diversity but also lead to nonadaptive catastrophic processes. These changes, in conjunction with parallel decreases in natural resource conditions, are compelling reasons for beginning ecological restoration treatments designed to establish landscape conditions which more closely approximate the conditions which these ecosystems have experienced over evolutionary time.

Covington, W. W. and M. M. Moore. 1994. Southwestern ponderosa forest structure, changes since Euro-American settlement. Journal of Forestry 1: 39 - 47.

No abstract is provided.

Covington, W. W., R. L. Everett, R. W. Steele, L. L. Irwin, T. A. Daer, and A. N. D. Auclair. 1993. Historical and anticipated changes in forest ecosystems of the Inland West of the United States. Pages 1-55 in R. N. Sampson, and D. Adams, editors. Assessing forest ecosystem health in the Inland West. Proceedings of the American Forests Scientific Workshop. November 15-19, 1993, Sun Valley, ID. Journal of Sustainable Forestry.

Euro-American settlement of the Inland West has altered forest and woodland landscapes, species composition, disturbance regimes, and resource conditions. Public concern over the loss of selected species and unique habitats (e.g. old-growth) has caused us to neglect the more pervasive problem of declining ecosystem health. Population explosions of trees, exotic weed species, insects, diseases, and humans are stressing natural systems. In particular, fire exclusion, grazing, and timber harvest have created anomalous ecosystem structures, landscape patterns, and disturbance regimes that are not consistent with the evolutionary history of the indigenous biota. Continuation of historical trends of climate change, modified atmospheric chemistry, tree density increases, and catastrophic disturbances seems certain. However, ecosystem management strategies including the initiation of management experiments can facilitate the adaptation of both social and ecological systems to these anticipated changes.

Covington, W. W., and L. F. DeBano, technical coordinators. 1994. Sustainable ecological systems: implementing an ecological approach to land management. 1993 July 12-15; Flagstaff, AZ. USDA Forest Service General Technical Report RM-247. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 363 pp.

This conference brought together scientists and managers from federal, state, and local agencies, along with private-sector interests, to examine key concepts involving sustainable ecological systems, and ways in which to apply these concepts to ecosystem management. Session topics were: ecological consequences of land and water use changes, biology of rare and declining species and habitats, conservation biology and restoration ecology, developing and applying ecological theory to management of ecological systems and forest health, and sustainable ecosystems to respond to human needs. A plenary session established the philosophical and historical contexts for ecosystem management.

Crane, M. F., and W. C. Fischer. 1986. Fire ecology of the forest habitat types of central Idaho. USDA Forest Service General Technical Report INT-218. Intermountain Research Station, Ogden, UT. 86 pp.

Discusses fire as an ecological factor for forest habitat types occurring in central Idaho. Identifies "Fire Groups" of habitat types based on fire's role in forest succession. Considerations for fire management are suggested.

Crawford, R. C. 1989. National Natural Landmark theme study, phase III, ponderosa pine/deciduous shrub recommendation, Mary Minerva McCroskey Memorial State Park, Idaho. Unpublished report prepared for the U.S. Department of the Interior, National Park Service. 12 pp.

Document presenting supporting evidence for designation of Mary Minerva McCroskey Memorial State Park as a National Natural Landmark.

Crawford, R. C., J. S. Kagan, and R. K. Moseley. 1989. Final Report, Phase II, 1989 National Natural Landmark Project, Columbia Plateau Natural Region Ecological Themes; Including the following ecological theme site evaluations: Ponderosa Pine, Grand Fir, Low Sagebrush, Stiff Sagebrush, Salt Desert Shrub, and Montane, Subalpine, and Alpine parklands and Wetlands. Unpublished report prepared for the U.S. Department of the Interior, National Park Service, Pacific Northwest Region, Seattle, WA. 91 pp.

No abstract is provided.

Cunningham, J. B., R. P. Balda, and W. S. Gaud. 1980. Selection and use of snags by secondary cavity-nesting birds of the ponderosa pine forest. USDA Forest Service Research Paper RM-222. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 15 pp.

One factor limiting the population size of secondary cavity-nesting birds in ponderosa pine is the number of suitable nesting cavities. Snags in the pine forest provide a large number of species with nesting and roosting sites. To maintain secondary cavity nesters at their natural population level, a density of 5.2 snags per hectare is recommended for mature ponderosa pine. Other management recommendations are made.

Currie, P. O. 1975. Grazing management of ponderosa pine- bunchgrass ranges of the central Rocky Mountains: the status of our knowledge. USDA Forest Service Res. Paper RM-159.Rocky Mountain. Forest and Range Experiment Station, Fort Collins.24 pp

No abstract is provided.

Daubenmire, R .F. 1943. Soil temperature versus drought as a factor determining lower altitudinal limits of trees in the Rocky Mountains. Botanical Gazette 105(1): 1-13.

Seed germination was investigated in ABLA, PIEN, PSME, PIPO, and PIED from seed sources in Idaho and Colorado. In general the lower the altitudinal distribution of a species, the greater the tolerance of seedlings to heat, but not drought.

Daubenmire, R. F. 1943. Vegetational zonation in the Rocky Mountains. The Botanical Review 9(6): 325-393.

An overview of the vegetation of the northern Rocky Mts. from the basal plains to the alpine zone.

Daubenmire, R. F. 1952. Plant geography of Idaho. Pages 1-17 in Davis, R. J., Flora of Idaho.

A contribution to the 1952 Flora of Idaho by Daubenmire on the plant geography of Idaho.

Daubenmire, R. F. 1968. Soil moisture in relation to vegetation distribution in the mountains of northern Idaho. Ecology 49(3): 431-438.

Soil drouth is of major ecological importance from steppe through Ponderosa pine and Douglas fir forests in foothills. It appears to be of minor importance in middle elevation forests with local drouth producing montane grasslands.

Daubenmire, R. F. 1969. Ecologic plant geography of the Pacific Northwest. Madrono 20: 111-128.

An introduction to the natural vegetation of the Pacific Northwest for the use of botanists from other areas attending the XI International Botanical Congress in Seattle in 1969.

DeStefano, S., and E. C. Meslow. 1993. Status, distribution, and habitat of northern goshawks in eastern Oregon--an interim report. No. G7 in Cooper Ornithological Society, compiler. Abstracts of the sixty-third annual meeting of the Cooper Ornithological Society, Sacramento, CA. Abstract.

In 1992 a three-year study of northern goshawks and other forest raptors was begun by conducting nest surveys on three National Forests in eastern Oregon. Density study areas (DSA) of about 9,000 ha were dominated by lodgepole pine (Pinus contorta), ponderosa pine (P. ponderosa), and mixed conifers on the Fremont, Malheur, and Wallowa-Whitman NFs, respectively. Taped goshawk calls were broadcasted to elicit responses from nesting raptors, and study areas were searched thoroughly according to established protocols modified to deal with the often steep, roadless terrain. During surveys, 98 goshawk responses were recorded, and 20 nests or territories were identified within the DSAs; an additional 15 nests were found outside the DSAs. Nest densities were highest in ponderosa pine and lowest in lodgepole pine. A latitudinal trend in productivity was observed, with highest productivity occurring in the south (Fremont) and lowest productivity in the north (Wallowa-Whitman). Prey remains indicated a higher occurrence of mammals than birds from the Malheur and Fremont, but avian prey predominated in remains from the Wallowa-Whitman. Nests of 11 other raptor species were also found.

Dietz, D. R., D. W. Uresk, H. E. Messner, and L. C. McEwen. 1980. Establishment, survival, and growth of selected browse species in a ponderosa pine forest. USDA Forest Service Research Paper RM-219. Rocky Mountain Forest and Range Experiment Station. 11 pp.

Information is presented on establishment, survival and growth of seven selected browse species in a ponderosa pine forest over a 10-year period. Methods of establishment included hand seeding and planting bare-root and containerized stock. Success of methods differed with shrub species. Elaeagnus commutata is referenced.

Dixon, R. D., E. L. Bull, and E. O. Garton. 1991. Home range and habitat-use of white-headed woodpeckers in managed and unmanaged forests, central Oregon. Draft graduate study proposal, University of Idaho, Moscow. 36 pp.

White-headed woodpeckers in central Oregon will be studied to assess the impact of timber harvesting on their populations. Although Oregon represents a large portion of the woodpecker's range, information on their habits and movements is unavailable. White-headed woodpeckers inhabit mature and old-growth ponderosa pine forests in their northern range. They nest in moderately-decayed snags and often forage on large-diameter (>51 cm dbh) ponderosa pines. The removal of large pines along the east slope of the Cascades may eliminate critical white-headed woodpecker habitat. This study will obtain information on the relative abundance, home range, habitat requirements, and foraging strategies of white-headed woodpeckers in central Oregon. These variables will be compared between managed and unmanaged mature and old-growth ponderosa pine forests. Variable-width line transects will be used to determine relative abundance. Radio-telemetry will be used to obtain information on white-headed woodpecker habits and movements. The results of this study will provide management agencies with guidelines for managing white-headed woodpeckers and their habitat.

Dobkin, D. S. 1992. Neotropical migrant landbirds in the northern Rockies and Great Plains. USDA Forest Service Publication No. R1-93-34. Northern Region, Missoula, MT. Paged by section.

Identifies forest fragmentation as one reason for declines in breeding neotropical migrant species numbers in North America. Surveys management activities in USFS Region 1. Provides species accounts for 144 species of neotropical landbirds breeding in Region 1, including information about seasonal residency, habitat use, principal food habits and foraging techniques, and status and management, as well as provides regional range maps for each species and relevant citations for further information.

Everett, R. L., compiler. 1994. Volume 4: Restoration of stressed sites, and processes. USDA Forest Service General Technical Report PNW-GTR-330. Pacific Northwest Research Station, Portland, OR. 123 pp.

Portions of forest ecosystems in eastern Oregon and Washington are in poor health, are not meeting societies expectations, and have elevated hazard for fire, insects, and disease. Diversity in stream habitats and associated fisheries has declined over the last several decades in several drainage basins, requiring conservation and restoration efforts in key watersheds. Required first steps in restoring forest and aquatic ecosystems are the immediate reduction in hazard for catastrophic loss of biodiversity, site quality, resource commodities, and improved conditions for public health. To prevent loss of future options we need to simultaneously re-establish ecosystem processes and disturbance effects that create and maintain desired sustainable ecosystems, while conserving genetic, species, community, and landscape diversity and long-term site productivity. Restoration of stressed sites is site specific, but the context for the action should be defined by the desired condition(s) of the next higher landscape scale and achieve desired positive cumulative effects over time. Restoration actions should be consistent with the desired level of disturbance effects required to maintain sustainable ecosystems, and standards and guides should reflect the inherent variability associated with dynamic systems. Costs associated with restoration activities should be weighed against the foregone benefits if no action is taken. The restoration of the biological components of ecosystems should provide increased opportunities for the restoration of human cultural, social, and economic ecosystem components and increase options for resource-dependent communities.

Everett, R., P. Hessburg, J. Lehmkuhl, M. Jensen, and P. Bourgeron. 1994. Old forests in dynamic landscapes: Dry-site forests of eastern Oregon and Washington. Journal of Forestry 92(1): 22-25.

Current anomalous landscapes and disturbance regimes need to be restored to a more sustainable state if old-forest remnants are to be conserved and old-forest networks created and maintained. Moreover, any plan to sustain old forests must first address the ecological sustainability of the landscapes of which they are a part. This article describes the old forests of eastern Washington and Oregon, contrasting historic (for this article 1930-50) and current (1980-90) abundance and structure. It also offers a philosophy for conserving old-forest patches and associated landscapes.

Eyre, F. H., ed. 1980. Forest cover types of the United States and Canada. Society of American Foresters, Washington, D.C. 148 pp.

Described here are the forest cover types of the United States (exclusive of Hawaii) and of Canada. The classification is based on existing tree cover.

Ffolliott, P. F., et al., technical coordinators. 1996. Effects of fire on Madrean province Ecosystems - a symposium proceedings. 1996, March 11-15; Tucson, AZ. General Technical Report RM-GTR-289. Fort Collins, CO. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. 277 pp.

This second conference on the Madrean Archipelago/Sky Island ecosystem brought together scientists, managers, and resource specialists from government, universities, and private organizations in the United States and Mexico to explore the effects of fire on Madrean Province ecosystem, and how fire can be incorporated in an ecosystem approach to both research and management.

Finch, D. M., and P. W. Stangel, eds. 1993. Status and management of neotropical migratory birds. USDA Forest Service General Technical Report RM-229. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 422 pp.

This proceedings is the product of a National Training Workshop held at the Estes Park Center, Estes Park, Colorado, 21-25 September 1992. Invited papers discuss all aspects of management, monitoring, and conservation of neotropical migratory birds on the breeding grounds. The proceedings is divided into seven sections that range from philosophical discussions to methods and solutions for managing migratory birds in concert with other wildlife.

Finch, D.M., J.L. Ganey, W. Yong, R.T. Kimball, and R. Sallabanks. 1997. Effects and interactions of fire, logging, and grazing. Pages 103-136 in Songbird ecology in southwestern Ponderosa Pine forests: a literature review, W.M. Block and D.M. Finch, technical editors. USFS, Rocky Mountain Forest and Range Experiment Station, Gen. Tech. Rep. RM-GTR-292.

No abstract is provided.

Fischer, W. C., M. Miller, C. M. Johnston, J. K. Smith, D. G. Simmerman, and J. K. Brown. 1996. Fire effects information system: user's guide. General Technical Report INT-GTR-327. Ogden, UT: USDA Forest Service, Intermountain Research Station. 131 pp.

Provides information on a computerized fire effects information system. Describes the nature of information available from the system and how to access it with a computer. Includes a basic tutorial on how to investigate the several information retrieval options presented by the system.

Fischer, W. C., and A. F. Bradley. 1992. Fire ecology of western Montana forest habitat types. General Technical Report INT-223. Ogden, UT: USDA Forest Service, Intermountain Research Station. 95 pp.

Provides information on fire as an ecological factor in forest habitat types in western Montana. Identifies Fire Groups based on fire's role in forest succession. Describes forest fuels and suggests considerations for fire management.

Fischer, W. C., and B. D. Clayton. 1983. Fire ecology of Montana forest habitat types east of the Continental Divide. USDA Forest Service General Technical Report INT-141. Intermountain Forest and Range Experiment Station, Ogden, UT. 83 pp.

Provides information on fire as an ecological factor for forest habitat types occurring east of the Continental Divide in Montana. Identifies "Fire Groups" of habitat types based on fire's role in forest succession. Describes forest fuels and suggests considerations for fire management.

Fletcher, R. 1989. Special forests for a special owl. USDA Forest Service Forestry Research West (June): 15-17.

Fletcher reviews the possibility of using the flammulated owl as an old-growth indicator species based on the work of Reynolds and Linkhart in Colorado.

Flint, H. R. 1925. Fire resistance of northern Rocky Mountain conifers. Pages 7-10 and 41-43 in Forest Club Annual, University of Idaho, Moscow.

A summary of the fire resistant properties of the conifers of the Northern Rocky Mountains. Includes: LAOC, PIPO, PSME, ABGR, PICO, PIMO, THPL, PIEN, TSME, TSHE, and ABLA.

Franklin, J. F., and C. T. Dyrness. 1988. Natural vegetation of Oregon and Washington. Oregon State University Press, Salem. 452 pp.

This book outlines major phytogeographic units and suggests how they fit together and relate to environmental factors, provides sources for detailed information on the environment and vegetation of the Pacific Northwest, and illustrates the major plant communities with photographs.

Frederick, G. P., and T. L. Moore. 1991. Distribution and habitat of white-headed woodpeckers (Picoides albolarvatus) in west-central Idaho. Cooperative Challenge Cost-Share Project, Payette National Forest and Conservation Data Center, Idaho Department of Fish and Game. 32 pp.

This report summarizes the results of surveys for white-headed woodpeckers on the Payette National Forest in 1991. Twenty-five variable-width line transects were surveyed between 5 April and 4 June. Fourteen detections of woodpeckers were recorded on 9 of the transects in mature and old stands of mixed ponderosa pine and Douglas-fir. Birds also foraged and nested in selectively harvested stands. Nest searches were conducted 15 June to 31 July. An estimated 9 pairs were located and 6 nests were found. All nests were in completely dead trees: 4 in broken-top ponderosa pines, 1 in a sawed-off ponderosa pine stump, and 1 in a Douglas-fir. All observations of white-headed woodpeckers were in open-canopied stands of relatively low mean tree density. Results of the study indicated a wider tolerance of nesting habitat than has been suggested in previous studies in Idaho. Recommendations for habitat management for the species are provided.

Frederick, T., C. Groves, G. Frederick, E. Atkinson, M. Atkinson, J. Shepherd, and G. Servheen. 1995. Distribution, density, and habitat of flammulated owls in Idaho. Draft of an unpublished manuscript sent to the Conservation Data Center. 20 pp.

This report summarizes the distribution and density of the flammulated owl in Idaho, as well as describes habitat features of owl calling locations. Surveys and ancillary information indicated the species is distributed throughout the montane forests of Idaho, from the southeastern portion of the state to the Canadian border. Calling densities were within the range of 0.03-1.09 owls/40 ha reported in northern California (Marcot and Hill 1980). Regional density averages were less than the estimates of 0.72 males/40 ha in eastern Oregon (Goggans 1986), 0.8 males/40 ha in Colorado (Reynolds and Linkhart 1987), and 2.1 males/40 ha in California (Winter 1974); however, differences in wind and topography, as well as individual and seasonal owl responses, can affect density estimates. Most observations or detections of flammulated owls in Idaho were in old or mature stands of ponderosa pine mixed with Douglas-fir. Exceptions were records of owls heard calling from (and in one case nesting in) pure stands of Douglas-fir or aspen, particularly in southeastern Idaho where ponderosa pine is absent. The authors also recorded instances of owls calling from monotypical stands of grand fir. Habitat analyses in western and north-central Idaho indicated flammulated owls use forest stands with mature to old ponderosa pine and Douglas-fir, multiple canopy layers, low tree densities, moderate to low canopy closure, and moderate ground cover. These habitat features are characteristic of old ponderosa pine forests. Potential threats to the owl in Idaho are wildfire and timber harvest. Little is known about the effects of fragmentation on the flammulated owl.

Goward, T. 1991. Epiphytic lichens: Going down with the trees. Pages 153-158 in S. Rautio, editor, Community action for endangered species: A public symposium on B.C.'s threatened & endangered species and their habitat. The Federation of British Columbia Naturalists and Northwest Wildlife Preservation Society. Vancouver, B.C.

Article explores the relationship between epiphytic lichens and old growth forests, concluding that the destruction of old growth forest also destroys assemblages of the lichens that have developed in the forest community.

Green, P., J. Joy, D. Sirucek, W. Hann, A. Zack, and B. Naumann. 1992. Old-growth forest types of the Northern Region. USDA Forest Service, Northern Region, R-1 SES 4/92. 60 p.

An abstract is not provided.

Groves, C. R. 1994. Effects of timber harvest on small mammals and amphibians inhabiting old-growth coniferous forests on the Clearwater National Forest, Idaho. Preliminary report. The Nature Conservancy, Boulder, CO. 24 pp.

Small mammal and amphibian abundance and species richness were sampled in five contiguous old-growth stands of coniferous forest, five smaller fragments of old-growth stands, and five clearcut areas. Sampling techniques included pitfall trapping grids with drift fences and snap-trap transects. Pitfall traps captured the greatest number of small mammal species. The greatest number of small mammal species and individuals were captured on clearcut areas.

Groves, C. R. 1994. Effects of timber harvest on small mammals and amphibians inhabiting old-growth coniferous forests on the Priest Lake Ranger District, Idaho Panhandle National Forests. Preliminary Report. The Nature Conservancy, Boulder, CO. 18 pp.

Small mammal and amphibian abundance and species richness were sampled over a three-year period using pitfall trapping grids with drift fences at 15 sites in old-growth cedar-hemlock stands, second-growth stands, and recent clearcuts. The greatest total number of small mammals was captured on clearcut sites, followed by second-growth sites. Old growth sites yielded the greatest number of amphibians.

Groves, C., T. Fredrick, G. Fredrick, E. Atkinson, M. Atkinson, J. Shephard, and G. Servheen. 1997. Density, distribution, and habitat of flammulated owls in Idaho. Great Basin Naturalist 57(2): 116-123.

From 1990 to 1992 the authors surveyed for flammulated owls (Otus flammeolus) in 3 areas in Idaho; Salmon National Forest (SNF), Payette National Forest and adjacent Hells Canyon National Recreation Area (PNF-HCNRA), and Nez Perce National Forest (NPNF). We also collected and summarized information on all historic and modern records of flammulated owls in Idaho. Flammulated owls were detected on 65% of 68 routes (2-16 km in length) surveyed at densities ranging from 0.04 to 1.25 singing males/40 ha. Owls were detected on survey routes as early as 10 May and as late as 23 July. Mean percent canopy cover estimated at owl locations on the PNF-HCNRA and NPNF study sites ranged from 52% to 64%, while shrub cover ranged from 16% to 21% and ground cover was 39% to 49%. Our surveys and summary of distributional records indicate that flammulated owls occur throughout the montane forests of Idaho in old or mature stands of open ponderosa pine (Pinus ponderosa), Douglas-fir (Pseudotsuga menziesii), and stands co-dominated by those 2 species. Fire suppression and timber harvest activity in ponderosa forests represent 2 main threats to the species' future security in Idaho. More research on the effects of various silviculture treatments on flammulated owl populations is warranted.

Gruell, G. E. 1983. Fire and vegetative trends in the Northern Rockies: interpretations from 1871-1982 photographs. USDA Forest Service General Technical Report INT-158. Intermountain Forest and Range Experiment Station, Ogden, UT. 117 pp.

Interprets changes in forest and range vegetation resulting from the absence of fire. 86 matched photographs covering the period 1871-1982 provide the basis for describing how vegetation has changed in various plant communities. These scenes show that woody vegetation has increased markedly as a result of reduced wildfire. An increase in conifers and deterioration of herbs, shrubs, and deciduous trees is resulting in loss of habitat upon which early and mid-successional wildlife species depend. Implications on wildlife and opportunities for use of cutting and prescribed fire to improve wildlife habitat are discussed.

Gruell, G. E. 1985. Indian fires in the interior west: a widespread influence. Pages 68-74 in J. E. Lotan, B. M. Kilgore, W. C. Fischer, R. W. Mutch, technical coordinators, Proceedings - Symposium and Workshop on Wilderness Fire. USDA Forest Service Intermountain Forest and Range Experiment Station, Ogden, UT.

Changes in the fire frequency has significantly influenced successional development in the Interior West. The implications for resource managers depends on whether Indian fires significantly augmented fires caused by lightning. An examination of the historical literature suggests that Indians were responsible for many fires, thus contributing to the high fire frequency that was common at the lower and middle elevations before Euro-Americans arrived. Recent photographs of Interior West areas show successional development that differs significantly from that shown in photographs taken a century earlier, when the vegetal effects of Indian fires were still evident.

Gruell, G. E. 1986. Post-1900 mule deer irruptions in the Intermountain West: Principle cause and influences. USDA Forest Service General Technical Report INT-206. Intermountain Research Station, Ogden, UT. 37 pp.

Tests hypotheses for mule deer population increases between the early 1930's and mid-1960's. Concludes that livestock grazing and absence of fire converted vast areas of grasses and forbs to woody plants favored by mule deer. Mule deer populations, therefore, irrupted between 1930 and 1965, and have since experienced a decline as plant succession moves toward shrub senescence and trees. Habitat management alternatives are discussed.

Gruell, G. E., J. K. Brown, and C. L. Bushey. 1986. Prescribed fire opportunities in grasslands invaded by Douglas-fir: State-of-the-art guidelines. USDA Forest Service General Technical Report INT-198. Intermountain Research Station, Ogden, UT. 19 pp.

Provides information on use of prescribed fire to enhance productivity of bunchgrass ranges that have been invaded by Douglas-fir. Included are fire prescription considerations and identification of the resource objective, fire objective, kind of fire needed, and fuels.

Gruell, G., S. Bunting, and L. Neuenschwander. 1985. Influence of fire on curlleaf mountain-mahogany in the Intermountain West. Pages 58-72 in J. E. Lotan and J.K. Brown, compilers. Fires's effects on wildlife habitat- symposium proceedings. USDA Forest Service, Intermountain Research Station, Ogden, UT, General Technical Report INT-186.

Comprehensive sampling of curlleaf mountain-mahogany (Cercocarpus ledifolius) on 41 sites in 5 states allowed an assessment of postfire population dynamics, differences in regeneration patterns, and critical events in stand regeneration. Historical accounts of fire, fire history studies, and early photographs provided historical perspective and contributed to interpretations. The combined quantitative and historical evidence strongly suggests that before European settlement, fire significantly influenced mahogany in the Northern Rockies by restricting its development. Euroamerican settlement apparently allowed mahogany seedlings to regenerate far in excess of former levels. The absence of fire for long periods has resulted in great variation in structure of mahogany stands. Many stands are in a declining condition because the absence of fire has allowed them to reach advanced stages of succession. In some areas, closure of mahogany crowns, excessive litter accumulation, and competition from other vegetation are inhibiting regeneration. In other areas, young vigorous mahogany predominate. These wide differences in stand conditions suggest different management strategies. Many mahogany communities would respond positively to fire, whereas others would not. Management implications are given.

Habeck, J. R. 1985. Impact of fire suppression on forest succession and fuel accumulations in long-fire-interval wilderness habitat types. Pages 110-118 in J. E. Lotan, B. M. Kilgore, W. C. Fisher, and R. W. Mutch, technical coordinators, Proceedings-Symposium and Workshop on Wilderness Fire. USDA Forest Service General Technical Report INT-182. Intermountain Forest and Range Experiment Station, Ogden, UT.

Succession and fuel characteristics are described and discussed for a series of western redcedar forests in the Selway-Bitterroot Wilderness. Natural fire cycles in these moist forests are at 100- to 400-year intervals, and modern fire suppression may not have affected the cedar forests in this wilderness. The surrounding upland forests exhibit greater cover and fuel continuity and could threaten the long-fire-interval forest types; an operational wilderness fire plan, however, has led to the burning of thousands of upland acres during the past several years.

Habeck, J. R. 1987. Present-day vegetation in the northern Rocky Mountains. Annals of the Missouri Botanical Garden 74: 804-840.

The present-day northern Rocky Mountain vegetation is the product of a long history of geologic and climatic events that have interacted with the species populations composing the regional flora. General concepts relating to the organization, classification, and dynamic nature of vegetation are reviewed. Distributional and structural features of the vegetation cover between the Colorado Rockies and the Southern Canadian Rockies are discussed. Alpine, upper timberline, subalpine, montane, lower timberline, and grassland/steppe zones are treated. Climatic, physiographic, edaphic, and geologic factors operate interactively as complex local and regional gradients in patterning the Rocky Mountain vegetation. It is likely that members of the modern Rocky Mountain flora are not in equilibrium with present-day environments but are shifting and adjusting to geographic dislocations associated with post-Pliestocene climatic alterations. Fire suppression, agriculture, domestic grazing, construction activities, timber harvesting, strip mining, species introductions, and air, soil, and water quality are having major impacts on Rocky Mountain vegetation. Present plant communities feature altered structures and compositions that may represent new ecosystem equilibria which could be irreversible under present-day climates.

Habeck, J. R. 1994. Using general land office records to assess forest succession in ponderosa pine/Douglas-fir forests in western Montana. Northwest Science 68(2): 69-78.

Original (1901 and earlier) General Land Office (GLO) records were used to quantify successional changes in Ponderosa Pine/Douglas-fir (Pinus ponderosa/Pseudotsuga menziesii) forests in western Montana following altered fire regimes, GLO bearing tree data provided the means to reconstruct presettlement forest structure in the study area: the former Fort Missoula Timber Reserve(FMTR), located in Pattee Canyon near Missoula, Montana. Tree importance values, tree density values and basal area values were estimated from the GLO survey notes and compared to forest data collected in 1992 to assess successional trends. The results show that with reduced fire influence, Douglas-fir in FMTR has made major gains in stand dominance over ponderosa pine and western larch (Larix occidentalis), especially on north aspects; on south aspects, former savanna and grassland communities have experienced conifer invasions.

Habeck, J. R., and R. W. Mutch. 1973. Fire-dependent forests in the northern Rocky Mountains. Quaternary Research 3: 408-424.

Discussion of fire ecology of forest ecosystems in northern Rockies with management implications based on fire-ecology investigations in the Selway-Bitterroot Wilderness Area and Glacier National Park.

Hall, F. C. 1977. Ecology of natural underburning in the Blue Mountains of Oregon. USDA Forest Service, Pacific Northwest Region R6-ECOL-79-001. Portland, OR. 11 pp.

Fire in Western forests has been common. Its influence on vegetation and soil has been studied in the Blue Mountain land mass of eastern Oregon and southeastern Washington. Both conflagration fire and underburning have left their mark. This paper presents evidence to document underburning frequency, the influence of fire on tree dominance, interaction effects between tree cover and ground vegetation, fire influence on genetic development of ground vegetation, influence of underburning on soil development, and implications these have had for land management.

Hamilton, R. C. 1993. Characteristics of old-growth forests in the Intermountain Region. USDA Forest Service. Intermountain Region, Ogden, UT. 86 pp.

This document includes descriptions of the ecological characteristics of old-growth for most of the Society of American Foresters cover types found within the Intermountain Region, which covers Utah, Nevada, the eastern slope of the Sierra's in California, Idaho south of the Salmon River, and Wyoming west of the Absaroka and Wind River Mountain ranges.

Hardy, C. C. and S. F. Arno, eds. 1996. The use of fire in forest restoration. USDA Forest Service, Intermountain Research Station, Gen. Tec. Rep. INT-GTR-341. 86 p.

The 26 papers presented in this document address the current knowledge of fire as a disturbance agent, fire history, and fire regimes, application of prescribed fire to ecological restoration, and the effects of fire on the various forested ecosystems of the northwestern United States. The main body of this document is organized in three sections: Assessing needs of fire in restoration, restoration of fire in inland forests, and restoration in Pacific westside forest. These papers comprise the proceedings from a general technical conference at the 1995 Annual Meeting of the Society for Ecological Restoration, held at the University of Washington, Seattle, September 14 - 16, 1995. Papers of special note include:

Agee, J. K. Fire regimes and approaches for determining fire history.

Greene, S. E. and A. Evenden. The role of fire in research natural areas in the northern Rockies and Pacific Northwest.

Arno, S. F. The concept: restoring ecological structure and process in ponderosa pine forests.

Fiedler, C. E. Silviculture applications: restoring ecological structure and process in ponderosa pine forests.

Arno, M. K. The seminal importance of fire in ecosystem management -- impetus for this publications.

Hartwell, M and P. Alabeck. Determination of fire-initiated landscape patterns: restoring fire mosaics on the landscape.

Harger, R. 1978. Managing old-growth forests as wildlife habitat: an ecosystems approach. USDA Forest Service, Northern Region, Missoula, MT. 27 pp. plus appendices.

The ecosystem approach to wildlife management provides a framework for land managers to evaluate all aspects of wildlife-related management actions. This report is concerned with the final stage of forest successional stage, and the management implications and recommendations resulting from the utilization of that successional stage.

Harvey, A. E., J. M. Geist, G. I. McDonald, M. F. Jurgensen, P. H. Cochran, D. Zabowski, and R. T. Meurisse. 1994. Biotic and abiotic processes in eastside ecosystems: the effects of management on soil properties, processes, and productivity. USDA Forest Service General Technical Report PNW-GTR-323. Pacific Northwest Research Station, Portland, OR. 71 pp.

Productivity of forest and range land soils is based on a combination of diverse physical, chemical and biological properties. In ecosystems characteristic of eastside regions of Oregon and Washington, the productive zone is usually in the upper 1 or 2 m. Not only are the biological processes that drive both soil productivity and root development concentrated in limited organic horizons, but also they have evolved historically in a natural system that includes mostly modest surface heating by periodic wildfire. This combination of properties and processes produces soils with an extremely wide range of productivity potential, but productivity can be highly sensitive to disturbances from heavy machinery or fire, when fuel accumulations are well beyond historical norms. Limited moisture-holding capacity and nitrogen storage often impose a need for carefully balancing developing vegetation with available soil resources.

Hayward, G. D., and J. Verner, eds. 1994. Flammulated, boreal, and great gray owls in the United States: a technical conservation assessment. USDA Forest Service General Technical Report RM-253. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 214 pp. plus 3 maps.

This report examines the conservation status of flammulated (Otus flammeolus), boreal (Aegolius funereus), and great gray (Strix nebulosa) owls, as well as the dynamics of important forest habitats, in order to inform management and research decisions. The insectivorous, cavity-nesting flammulated owl is a neotropical migrant requiring breeding habitat in the mountains of the western U.S., predominantly in yellow-pine (Pinus ponderosa and Pinus jeffreyi) forests. The boreal owl is a nomadic, small mammal specialist that occurs as an "island" species occupying subalpine and boreal forests. Movements among populations are probably important to boreal owl persistence, and coordinated management of disjunct populations in different FS regions may be important. Great gray owls in the western U.S. occur in mid- to high-elevation conifer forests, usually nesting in mature and older forest stands in existing raptor nests or tops of broken trees and snags. Limited research on flammulated and boreal owls indicates that their demography and life history, coupled with their fairly narrow habitat associations, make them vulnerable to habitat change. Since current forest management practices in many areas remove quality habitat for these species, persistence of these species could be in jeopardy, at least on a local basis, even in the short-term; long-term concerns are great because the habitats that seem most important to these species require one to two centuries to regenerate. The population biology of both species necessitates across-region planning to enable effective conservation planning. Based on limited information, the persistence of great gray owl populations in the U.S. over both the short and long-term seems more certain. Current knowledge of these three owl species is insufficient to produce a management-needed document of conservation strategies.

Hejl, S. J. Human-induced changes in bird populations in coniferous forests in western North America during the past 100 years. Pages 232-246 in J. R. Jehl, Jr., and N. K. Johnson, eds., A century of avifaunal change in western North America. Studies in Avian Biology No. 15.

Data on population trends for bird populations in coniferous forests in western North America over the past 100 years are few and mostly from the U.S. during the breeding season. The few community and species-specific studies do not indicate similar historic population changes for any one species across habitats. West-wide 24-year trends (Breeding Bird Surveys, BBS) were noted for 21 species; some of these changes may be caused by fire suppression or logging, the two primary ways humans have affected coniferous forests. Because most old-growth forests are gone, snag numbers are probably lower than they were historically, and fire patterns have changed, species associated with old-growth forests, snags, and burns are probably less abundant today than they were 100 years ago. Yet, such trends were not substantiated by BBS or other studies. Regional and local changes due to fire suppression and logging have occurred for many species, but many of these changes might be partially compensatory for some species when looked at from a larger scale. Uncommon species, many of which (woodpeckers, nuthatches, creeper) are likely to be those most affected by logging and fire suppression, are not sampled well by BBS. Five of the seven declining species are long- and short-distance migrants. Human-induced changes on wintering grounds may have caused these declines. If current patterns of forest use continue, species associated with old-growth, snags, burns, and interior forests will continue to decline. Allowing natural disturbance patterns (especially fire) to return to these ecosystems and retaining all ages, components, and landscape patterns of natural forests will help maintain avian populations and diversity.

Hejl, S. J. and R. E. Woods. 1991. Bird assemblages in old-growth and rotation-aged Douglas-fir/ponderosa pine stands in the northern Rocky Mountains: a preliminary assessment. In Baumgartner, D. M. and J. E. Lotan (eds.). Interior Douglas-fir: the species and its management. Proceedings of Symposium held Feb. 27-Mar. 1, 1990 in Spokane, WA. Dept. Natural Res. Sci., Washington State University, Pullman, WA.

No abstract is provided.

Hejl, S. J., R. L. Hutto, C. R. Preston, and D. M. Finch. 1995. Effects of silviculture treatments in the Rocky Mountains. Pages 220-244 in T. E. Martin and D. M. Finch, eds., Ecology and management of neotropical migratory birds: a synthesis and review of critical issues. Oxford University Press, New York.

Summarizes knowledge about the effects of silviculture practices on neotropical migrant birds in Rocky Mountain forests to suggest future research needs and to suggest how managers can make decisions based on what is currently known.

Holmgren, N. H. 1972. Plant geography of the Intermountain region. Pages 77-161 in A. R. Cronquist, A. H. Holmgren, N. H. Holmgren, and J. L. Reveal. Intermountain Flora: Vascular Plants of the Intermountain West, USA. Volume 1. Hafner Publishing Company, Inc., New York.

A discussion of the plant geography of the Intermountain west with a classification of floristic divisions and a discussion of vegetation zones.

Humphrey, R. R. 1945. Common range forage types of the Inland Pacific Northwest. Northwest Science 19(1): 3-11.

Early classification of range forage types of the Inland Pacific Northwest. Outlines the following types: Palouse bunchgrass type, ponderosa pine-grassland type, sagebrush type, bitterbrush-grass type, perennial weed types, and annual weed type.

Hutto, R. L., S. J. Hejl, C. R. Preston, and D. M. Finch. 1993. Effects of silviculture treatments on forest birds in the Rocky Mountains: implications and management recommendations. Pages 386-391 in D. M. Finch and P. W. Stangel, eds., Status and management of neotropical migratory birds. USDA Forest Service General Technical Report RM-229. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

The short-term effects of timber harvesting practices on landbird species vary widely among species. Thus, the maintenance of populations of all species will require a long-term management strategy that involves maintenance of a variety of habitats over a broad landscape.

Johnson, C. A. 1986. Early spring prescribed burning of big game winter range in the Snake River Canyon of west-central Idaho. Paper presented at the Symposium on Prescribed Fire in the Intermountain Region - Forest Site Preparation and Range Improvement, Spokane, WA, March 3-5, 1986. 10 pp.

During late February and early March of 1985, approximately 3,000 acres of mule deer, elk, and bighorn sheep winter range was prescribed burned to improve forage quality. The burn took place within the Craig Mountain Wildlife Management Area which is located in the Snake River Canyon of west-central Idaho and is approximately 20 air miles south of Lewiston, Idaho. The majority of perennial bunchgrasses had a large percentage of standing, dead, leached organic material which reduced availability and utilization of current growth. Initial monitoring results indicate that primary benefits from the burn appear to be associated with improving palatability, availability, and diet selection of high quality nutritious green forage by removing the dead standing leached material. Periodic prescribed burning can aid in the maintenance of good quality big game habitat. Other benefits of the early spring burn included earlier start growth of some plants, no kill noted of perennial plants, improved availability of fall and winter green-up of bluebunch wheatgrass (Agropyron spicatum), good mosaic pattern of burn area, improved big game distribution and use of burned areas, short time before regrowth starts on burn areas, and low logistic costs. Approximately 1,500 acres were ground-ignited with fuses and 1,500 acres were aerial-ignited with a helitorch. The project area encompassed a 6,000-acre area, with 30 to 65% of the area burned in a mosaic pattern. Total ignition and administration costs were approximately $2.00 per acre.

Johnson, C. A. 1989. Early spring prescribed burning of big game winter range in the Snake River Canyon of westcentral Idaho. Pages 151-155 in D. M. Baumgartner, D. W. Breuer, B. A. Zamora, L. F. Neuenschwander, and R. H. Wakimoto, eds., Proceedings of the Prescribed Fire in the Intermountain Region Forest Site Preparation and Range Improvement, Washington State University, Pullman.

Describes the prescribed burn in late February and early March of 1985 when approximately 3000 acres of mule deer, elk, and bighorn sheep winter range was burned to improve forage quality. The burn took place within the Craig Mountain Wildlife Management Area which is located in the Snake River Canyon of west-central Idaho.

Johnson, C. G., Jr. 1994. Forest Health in the Blue Mountains: a plant ecologist's perspective on ecosystem processes and biological diversity. USDA Forest Service General Technical Report PNW-GTR-339. Pacific Northwest Research Station, Portland, OR. 23 pp.

Natural disturbances are important to ecosystem processes. Disturbances historically have occurred in the vegetation of the Blue Mountain area of northeastern Oregon and southeastern Washington. The primary modifying events that historically have cycled through most of its plant communities are fire, grazing and browsing, insect and disease epidemics, windthrow, flooding, and erosion. Knowledge of plant successional pathways enables managers to predict the probable course of community development for a disturbance regime. Recommendations for restoring the Blue Mountains area are to reintroduce fire into the ecosystem, restore rangelands, and enhance biological diversity by practicing landscape ecological management and by emulating natural patterns on the landscape. Periodic and timely sampling after these activities is critical to assessing the results for adaptive management needs.

Johnson, C. G., Jr., R. R. Clausnitzer, P. J. Mehringer, and C. D. Oliver. 1994. Biotic and abiotic processes of eastside ecosystems: the effects of management on plant and community ecology, and on stand and landscape vegetation dynamics. USDA Forest Service General Technical Report PNW-GTR-322. Pacific Northwest Research Station, Portland, OR. 66 pp.

Paleovegetation studies have shown that vegetation has changed in composition and extent in the intermountain Pacific Northwest over the past 20,000 years. Today, both natural and human-induced disturbances have long-term influence on the structure and composition of eastside vegetation. Disturbance may enhance landscape diversity; therefore, the scale of modifying events and activities needs to shift from species and stand to the landscape level. Knowledge of plant succession is the foundation of a sound vegetation management program where the primary goal is to retard, arrest, or accelerate the natural forces of vegetation change.

Johnson, C. G., Jr., and R. R. Clausnitzer. 1992. Plant associations of the Blue and Ochoco Mountains. USDA Forest Service R6-ERW-TP-036-92. Pacific Northwest Region, Wallowa-Whitman National Forest. 164 pp. plus appendices.

The Blue and Ochoco Mountains Plant Association Classification Field Guide is provided for use by resource managers on land administered by the Forest Service of the Malheur, Ochoco, Umatilla, and Wallowa-Whitman National Forests. The descriptions focus on mid to late seral vegetation of the uplands, but also included are descriptions of early seral vegetation commonly found in the Blue and Ochoco Mountains. This is the field manual version.

Johnson, C. G., Jr., and S. A. Simon. 1987. Plant associations of the Wallowa-Snake Province, Wallowa-Whitman National Forest. USDA Forest Service R6-ECOL-TP-255A-86. Pacific Northwest Region, Wallowa-Whitman National Forest. 400 pp. plus appendices.

The Wallowa-Snake Province plant association classification pertains to those Federal lands administered by the USDA Forest Service of the Wallowa-Whitman National Forest exclusive of the Blue Mountains. This first approximation of the plant associations has focused on mid and late seral vegetation of the steppe, shrub-steppe, and forests of the Wallowa-Snake Province.

Johnson, C. G., Jr., and S. A. Simon. 1987. Plant associations of the Wallowa-Snake Province, Wallowa-Whitman National Forest. USDA Forest Service R6-ECOL-TP-255B-86. Pacific Northwest Region, Wallowa-Whitman National Forest. 272 pp. plus appendices.

The Wallowa-Snake Province plant association classification pertains to those Federal lands administered by the USDA Forest Service of the Wallowa-Whitman National Forest exclusive of the Blue Mountains. This first approximation of the plant associations has focused on mid and late seral vegetation of the steppe, shrub-steppe, and forests of the Wallowa-Snake Province. This is the field manual version.

Johnson, F. D. 1976. Payette Peninsula Natural Area, report of terrestrial survey and mapping project. 24 pp.

A summary of community and habitat types represented in a portion of Ponderosa State Park recommended of a natural area.

Johnson, F. D. 1995. Wild trees of Idaho. University of Idaho Press, Moscow. 212 pp.

Field guide to the wild trees of Idaho including native, escaped, and naturalized trees.

Jonsson, B. G. 1997. Riparian bryophyte vegetation in the Cascade mountain range, Northwest U.S.A: patterns at different spacial scales. Canadian Journal of Botany 75:744-761.

The study describes community patterns of bryophytes in stream-side forests, relates these patterns to major environmental gradients, and compares within-site factors with site level variables.

Karr, J. R., and E. W. Chu. 1994. Interim protection for late-successional forests, fisheries, and watersheds: National forests east of the Cascade crest, Oregon and Washington. The Wildlife Society, Bethesda, MD. 245 pp.

This report summarizes technical data available for each forest and synthesizes current conditions across eastside forests. Technical literature is reviewed to account for trends observed, including their association with specific human actions. Recommendations for preventing further degradation of remaining resources are presented. As interim recommendations, the need for a long-term monitoring and management planning is emphasized.

Kaufmann, M. R., W. H. Moir and R. L. Bassett. 1992. Old-growth forests in the Southwest and Rocky Mountain Regions, proceedings of a workshop; March 9 - 13, 1992, Portal, Arizona. USDA Forest Service, Rocky Mountain Forest and Range Experimental Station, Fort Collins.

Numerous papers are presented concerning the ecology, description and management of old growth forest.

Kaufman, M. R. 1996. The live fast or not: growth, vigor and longevity of old-growth ponderosa pine and lodgepole pine trees. Tree Physiology 16: 139 - 144.

Old trees of ponderosa pine (*Pinus ponderosa*) and lodgepole pine (*Pinus contorta*) were studied to determine volume growth patterns in relation to leaf area. Ponderosa pine trees varied in age from 166 to 432 years and were about 77 cm in diameter; lodgepole pine trees varied in age from 250 to 296 years and were about 31 cm in diameter. With the exception of several ponderosa pine trees less than 200 years old, trees of both species had flattened tops, heavy branches, and foliage distribution characteristically found only in the oldest trees. After trees were felled, annual volume increments were determined from cross dated radial increments measured on discs at 4-m height intervals, and leaf areas were determined based on leaf area/branch sapwood area ratios for 1/5 sections of the crown of each tree.

In ponderosa pine, three distinct volume growth patterns occurred: (1) a gradual increase in annual volume growth until felling; (2) a more rapid increase in growth to a plateau that persisted for a century of more; and (3) a rapid increase in growth followed by a generally sudden decrease in growth to less than half the earlier rates, and persisting at these lower rates for as long as seven decades. In lodgepole pine, fewer trees exhibited the sudden growth decline observed in ponderosa pine. Most short-term growth variations in ponderosa pine were synchronized among all trees, suggesting a common climatic signal. In lodgepole pine, annual variations in volume growth were slight.|Volume growth in the most recent years before felling was weakly correlated with leaf area at the time of felling (r^2=0.45) for both species). However, in both species, trees having a high volume growth rate and leaf area at the time of felling had grown slowly when young, whereas trees having low volume growth rate and leaf area at felling grew rapidly when young. Thus a wide range of early and late growth patterns can lead to old growth conditions in these species. Growth efficiencies (grams of dry matter per m^2 total leaf area) were generally higher for trees having the lowest leaf areas, and in almost all cases were below 100 g m^{-2}.

Kilgore, B. M., and G. A. Curtis. 1987. Guide to understory burning in ponderosa pine-larch-fir forests in the Intermountain West. USDA Forest Service General Technical Report INT-233. Intermountain Research Station, Ogden, UT. 39 pp.

Summarizes the objectives, prescriptions, and techniques used in prescribed burning beneath the canopy of ponderosa pine stands, and stands of ponderosa pine mixed with western larch, Douglas-fir, and grand fir. Information was derived from 12 districts in two USDA Forest Service Regions and seven National Forests in Montana and Oregon.

Krammes, J. S., technical coordinator. 1990. Proceedings - Symposium on the effects of fire management of Southwestern natural resources. November 15-17, 1988, Tuscon, AZ. USDA Forest Service General Technical Report RM-191. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 293 pp.

The proceedings is a collection of papers and posters presented at the Symposium on Effects of Fire Management of Southwestern Natural Resources held in Tuscon, AZ, November 15-17, 1988. Included are papers, poster papers, and a comprehensive list of references on the effects of fire on: plant succession, cultural resources, hydrology, range and wildlife resources, soils, recreation, smoke management, and monitoring techniques pertinent to prescribed fire management in the southwestern United States.

LaRoe, E. T., G. S. Farris, C. E. Puckett, P. D. Doran, and M. J. Mac, editors. 1995. Our living resources: a report to the nation on the distribution, abundance, and health of U.S. plants, animals and ecosystems. U.S. Department of the Interior, National Biological Service, Washington, D.C. 530 pp.

The first in a series of reports by the NBS on the status and trends of the nations plants, animals, and ecosystems. The report is broken into three parts: an introduction; distribution, abundance, and health; and special issues. The introduction provides an overview of the entire report and discusses biodiversity and gives background on the role and history of the NBS. The section on distribution, abundance and health is split into sections: species (with subsections on: birds, mammals, reptiles and amphibians, fishes, invertebrates, and plants); ecosystems (with subsections on: terrestrial, aquatic, coastal and marine, and riparian); and ecoregions (with subsections on: The Great Plains, Interior West, Alaska, and Hawaii). The section on special issues includes the following topics: global climate change, human influences, non-native species, and habitat assessments. Articles throughout the report range from a broad scale overviews to specific case studies.

Larsen, J.A. 1926. National forests of the northern district. Pp. 208-216 in V.E. Shelford, ed. Naturalist's guide to the Americas. Williams & Wilkins Co., Baltimore.

In Montana and Idaho north of the Salmon River, the natural forest types fall into altitudinal belts, the boundaries of which vary according to aspect, degree of slope and drainage courses. This article describes the habitat types as elevation increases: grassland and prairies, forest types, Engelmann spruce type, subalpine forests, and alpine forests and barrens. Descriptions of various natural areas in Idaho and Montana are also included.

Leege, T. A., and G. Godbolt. 1985. Herbaceous response following prescribed burning and seeding of elk range in Idaho. Northwest Science 59(2): 134-143.

The effects of spring-burning and seeding on herbaceous vegetation were evaluated on brush covered slopes in the grand fir/boxwood habitat type. The objective of the burn was to improve winter-spring forage for elk. There was a significant increase in forb production during the second growing season following prescribed burning. After four growing seasons, broadcast-seeded grasses, primarily orchard grass, were the only species producing substantial forage in excess of pre-burn amounts. A mixture of several grasses is recommended for broadcast-seeding immediately after burning in similar habitat types when the primary response is to increase herbaceous forage for spring utilization by elk.

Leonard, M. L., and M. B. Fenton. 1982. Habitat use by spotted bats (Euderma maculatum, Chiroptera: Vespertilionidae): roosting and foraging behaviour. Canadian Journal of Zoology 61: 1487-1491

The purpose of this study was to collect data on the foraging and roosting behavior of Euderma maculatum in the Okanagan Valley of southern British Columbia. The work was performed in the summer of 1981. Bats concentrated their foraging activity in open areas adjacent to ponderosa pine. None of the over 1000 attempted captures of prey witnessed by the authors involved E. maculatum gleaning insects from ground or foliage, and we question the idea that big-eared bats are gleaners. Some attacks on flying insects involve steep dives to the ground, presumably in response to the defensive behavior of prey. Spotted bats foraged alone, avoiding one another apparently by listening to the echolocation calls of conspecifics. Intrusion by one bat into the feeding area of another resulted in an altercation which stopped when one bat left the area. The bats roosted alone in steep cliff faces and two-radio-tagged individuals returned consistently to the same cliff face to roost.

Lesica, P., B. McCune, S. V. Cooper, and W. S. Hong. 1991. Differences in lichen and bryophyte communities between old-growth and managed second-growth forests in the Swan Valley, Montana. Canadian Journal of Botany 69: 1745-1755.

Lichen and bryophyte communities differed between managed second-growth and unmanaged old-growth grand fir forests in northwestern Montana in all three strata examined: lower canopy, trunk, and ground. Old-growth forests had larger trees, greater structural diversity, greater volumes of coarse woody debris, fewer species of vascular plants, more species of trunk epiphytes, higher beta diversity, and higher gamma diversity than second-growth forests. Although pendent fruticose lichens were common in both stand age classes, species of Alectoria were more abundant in old-growth, while second-growth was dominated by Bryoria spp. Nitrogen-fixing foliose lichens were more common in all strata of old-growth, and Lobaria pulmonaria, a common N-fixing species in old-growth, was absent in second-growth. Cladonia spp. were more numerous in second-growth forests. Nearly all species of leafy liverworts were more common in old-growth and typically occurred on rotting wood. Many of these liverworts were absent from second-growth. Results suggest that many species of lichens and bryophytes find optimum habitat in old-growth forests and that these species will become less common as silviculture practices continue to convert old-growth to younger aged forests.

Ligon, J. D. 1973. Foraging behavior of the white-headed woodpecker in Idaho. Auk 90: 862-869.

Foraging behavior in white-headed woodpeckers was studied near Lake Waha in Nez Perce County, Idaho, in October, 1967, and April, June, and August, 1968 (2 days each month). From 2 to 5 individuals were watched during each time period. Parallel seasonal shifts in foraging sites of males and females were apparent. No sexual differences in feeding behavior were detected, unlike the situation in many populations of other North American woodpeckers. Possibly this is a result of climatic and vegetational features of the region.

Lillybridge, T. R., B. L. Kovalchik, C. K. Williams, and B. G. Smith. 1995. Field guide for forested plant associations of the Wenatchee National Forest. Pacific Northwest Research Station General Technical Report No. 359. United States Department of Agriculture, Forest Service, and Pacific Northwest Research Station Portland, Oregon, in cooperation with Pacific Northwest Region Wenatchee National Forest. 273 pp. plus appendices.

A classification of forest vegetation is presented for the Wenatchee National Forest. It is based on potential vegetation, with the plant association as the basic unit. The sample includes about 570 intensive plots and 840 reconnaissance plots distributed across the Wenatchee National Forest and the southwest portion of the Okanogan National Forest from 1975 through 1994. The hierarchical classification includes 10 forest series and 104 types (plant association or community type). Diagnostic keys and descriptions are presented for each tree series and type. Detailed descriptions are given for each type having at least five sample stands in the Wenatchee NF. Those descriptions include information about plant species occurrences, type distribution, environment and soils, potential timber productivity, management considerations, and relationships to other classifications. Brief descriptions are presented for miscellaneous types (those having fewer than five plots in the Wenatchee NF).

Losensky, B. J. 1994. Historical vegetation types of the Interior Columbia River Basin. Unpublished report prepared for Systems for Environmental Management INT-94951-RJVA. 108 pp.

This report was prepared for the express purpose of compiling information, reviewing available literature, researching topics related to ecosystems within the Interior Columbia Basin, or exploring relationships among biophysical and economic/social resources.

Lotan, J. E., B. M. Kilgore, W. C. Fischer, and R. W. Mutch, technical coordinators. 1985. Proceedings- Symposium and Workshop on Wilderness Fire, November 15-18, 1983, Missoula, MT. USDA Forest Service, Intermountain Research Station, Ogden, UT, General Technical Report INT-182. 434pp.

Provides information on the fire management policy, programs, and issues in parks, wildernesses, and other natural areas. In more than 100 papers, poster papers, and workshop summaries, both researchers and managers explore basic wilderness management philosophies, explain current wilderness, natural area, and fire management objectives, describe current natural fire programs, identify and discuss current management issues, present fire management planning considerations, describe operational techniques for park and wilderness fire management, and present results of current research related to fire history, fire effects, and fire use and fire ecology.

Lotan, J. E., and J. K. Brown, compilers. 1984. Fire's effects on wildlife habitat- symposium proceedings, Missoula, Montana, March 21, 1984. USDA Forest Service General Technical Report INT-186. Intermountain Research Station, Ogden, UT. 96 pp.

Compilation of 11 papers in which the impacts of fire on wildlife habitat and populations are discussed. Paper topics include wildlife and fire research; postfire succession of avifauna in the Olympics; effects on a small bird population; white-tailed deer interrelationships in northwestern Montana; bighorn sheep and fire; stone's sheep; fire ecology of antelope bitterbrush; curlleaf mountain-mahogany; aspen ecosystems; shrub succession following clearcutting and broadcast burning; and evergreen ceanothus.

Lotan, J. E., et. al. 1981. Effects of fire on flora: a state-of-knowledge review. USDA Forest Service General Technical Report WO-16. 71 pp.

This report on the state-of-knowledge effects of fire on flora summarizes the pertinent information and describes certain gaps in the knowledge. The report is organized around the major vegetation types as described by Kuchler (1966). These major geographical vegetation areas include: North Pacific maritime forests, forests of the Rocky Mountain west, Sierra coniferous forests, northern boreal forests of Alaska, southern pine forests, northeastern coniferous forests, eastern deciduous forests southern bottomland forests, pinyon-juniper woodlands, sclerophyllous hardwoods desert, prairie grasslands, and sagebrush-grasslands.

Mancuso, M., and R. Moseley. 1994. Vegetation description, rare plant inventory, and vegetation monitoring for Craig Mountain, Idaho. Unpublished report prepared for Bonneville Power Administration. 146 pp. plus appendices.

During the 1993 and 1994 field seasons, wildlife, habitat/vegetation, timber, and other resources were systematically inventoried at Craig Mountain to provide Fish and Game managers with information needed to draft an ecologically-based management plan. The results of the habitat/vegetation portion of the inventory are contained in this report. The field investigations were concentrated on, but were not limited to, Bonneville Power Administration and Idaho Department of Fish and Game lands.

Marshall, J. T. 1939. Territorial behavior of the flammulated screech owl. Condor 41: 71-78.

Success in locating, collecting, and observing flammulated owls is described. Owls were attracted by uttering imitations of their hoots, which vary between the sexes and among individuals. Calls, territories, territorial behavior, foraging behavior, and prey are discussed.

Mastrantonio, L. 1994. Methods of cutting study has unexpected benefits. Forest Research West, November 1994: 9-12.

A study started in 1937 was revisited in old growth stands on Blacks Mountain Experimental Forest in northern California to determine annual growth, what the annual "allowable cut" should be, and what the best methods are of timber harvest. Three main findings are that 1) the heavier the timber harvest, the faster the remaining trees grew in years since cutting; 2) average net wood volume was highest for the plots that had been clearcut--if wood production was the main goal, clearcutting would be the best method of harvest; and 3) there was no significant change in species composition; however, only pole sized trees were evaluated. A new long-term study, building on 50+ years of data, will explore treatments such as high and low structural diversity, grazing, prescribed fire, species diversity, soil fertility, carbon budgets, long-term productivity, role of wildfire, vegetation establishment and growth responses, entomological relationships, and pathogen response.

Mauk, R. L., and J. A. Henderson. 1984. Coniferous forest habitat types of northern Utah. USDA Forest Service General Technical Report INT-170. Intermountain Forest and Range Experimental Station, Ogden, UT. 89 pp.

Eight climax series and 36 habitat types are described. A diagnostic key is included.

McDonald, P. M. and G. O. Fiddler. 1995. Development of a mixed shrub-ponderosa pine community in a natural and treated condition. USDA Forest Service, Pacific Southwest Research Station, Research Paper, PSW-RP-224. 19 p.

On a medium site in northern California, a mostly shrub community was treated by two manual release techniques and by two herbicides to study its development in both a natural (control) and treated condition. Survival and growth of planted ponderosa pine seedlings were quantified for 8 to 11 years after initial treatment applications. Treatments included manual release in a 4-foot radius around pine seedlings one, two, and three times; grubbing the entire one-seventh acre plot two times; applying 2,4-D and Velpar herbicides to the entire plot one time; and a control. Data are presented for the most abundant species (greenleaf manzinita), second most abundant species (snowbrush), by the two species combined, and by all 10 shrub species combined. At the end of the study in 1990, manzinita was the most abundant species with 15,267 plants per acre, cover of 24,800 ft^2, and height of 5.4 feet. Ponderosa pine developed best in plots where the entire area was grubbed twice and in the Velpar-treated plots. The cost of grubbing the entire area twice was almost 1700 per acre. Applying Velpar, including the cost of the chemical, was about 100 per acre. Site preparation without subsequent release let to a brushfield similar to that present before the study began.

McLean, A. 1970. Plant communities of the Similkameen Valley, British Columbia, and their relationships to soils. Ecological Monographs 40: 403-423.

Five vegetation zones were recognized in the Similkameen Valley of southern British Columbia. These zones were largely controlled by elevation primarily as a reflection of climate. The climate becomes progressively more moist from east to west and with increasing elevation. Two habitat types were described in the Artemisia tridentata zone, three in the Pinus ponderosa zone, five in the Pseudotsuga menziesii zone, five in the Abies lasiocarpa zone, and one in the Alpine zone. Some habitat types correlated well with the soils at a great group level. The Pinus-Festuca habitat type was found mostly on Dark Gray soils, the Pseudotsuga-Festuca habitat type on a variety of soils, the Pseudotsuga-Calamagrostis habitat type on Gray Luvisols, the Festuca-Eriogonum habitat type on Black Chernozems, the Abies-Vaccinium-Calamagrostis habitat type on Dystric Brunisols, and the Abies-Vaccinium, Phyllodoce habitat type on Alpine Dystric Brunisol soils. A key for the identification of the major habitat types is included.

Milne, K. A., and S. J. Hejl. 1989. Nest-site characteristics of white-headed woodpeckers. Journal of Wildlife Management 53(1): 50-55.

Describes nest tree and site characteristics of 53 nests of the northern race, Picoides albolarvatus albolarvatus, of the white-headed woodpecker. Nests were located in a variety of habitats and in most tree species, although 89% were in pines and firs. Nests were located near the ground. Most snags used for nest cavities were in a moderate state of decay.

Moore, T. L., and G. P. Frederick. 1991. Distribution and habitat of flammulated owls (Otus flammeolus) in west-central Idaho. Cooperative Challenge Cost Share Project, Payette National Forest, Wallowa-Whitman National Forest, and Conservation Data Center, Idaho Department of Fish and Game. 28 pp. plus appendices.

This report summarizes the results of surveys for flammulated owls on the Payette National Forest and Hells Canyon Recreation Area in 1991. Surveys were conducted 22 May to 11 July. Sixty singing male flammulated owls were heard throughout the singing area. Crude density estimates ranged from 0 to 0.838 singing males per 40 hectares. Highest survey route densities were at Boulder Creek in the West Mountains, Dukes Creek in the Cuddy Mountains, and Lightning Ridge in Hells Canyon Wilderness. Regional densities were highest in Hells Canyon Wilderness and in the West Mountains. Habitat characteristics at 12 owl locations were consistent with previous studies. Flammulated owls were found in areas with mature ponderosa pine and Douglas-fir, low tree density, moderate canopy closure, and on upper slopes or ridgelines. Further research is needed to determine habitat use and nesting success in relationship to forest fragmentation. Studies of owl dispersion patterns are also needed.

Morelan, L. Z., S. P. Mealey, and F. O. Carroll. 1994. Forest health on the Boise National Forest. Journal of Forestry 92(8): 22-24.

This article outlines forest health problems (catastrophic fires, insect/disease outbreaks, overcrowded stands, etc.) on the Boise NF. An ecosystem-based management plan was adopted to improve conditions on the forest.

Morgan, P. 1994. Dynamics of Ponderosa and Jeffry pine forests. Pages 47-73 in G. D. Hayward and J. Verner, technical editors, Flammulated, boreal, and great gray owls in the United States: A technical conservation assessment. USDA Forest Service General Technical Report RM-253. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 214 pp.

Summarizes information on: forest description, human use of forest resources, presettlement forests, succession and disturbance, successional patterns, future vegetation patterns, and information needs.

Morrison, P. H. 1988. Old growth in the Pacific Northwest: a status report. The Wilderness Society, Global Printing, Inc., Alexandria, VA. 46 pp. plus appendices.

This is a status report on the old growth in the Pacific Northwest for the Wilderness Society. Topics discussed include: defining old growth forests, various study methods (assessment of Forest Service Inventory Plots, old-growth acreage in wilderness areas, data analysis, and accuracy of data), and results in each of the national forests (Mt. Baker-Snoqualmie, Olympic, Gifford Pinchot, Mt. Hood, Willamette, and Siskiyou). Several tables and figures are provided.

Moseley, B. 1992. Letter responding to Reed Noss's request for estimates of loss or degradation of ecosystems in Idaho. Dated October 1, 1992.

Moseley summarizes and estimates loss and degradation in Idaho of the following ecosystems: old-growth ponderosa pine, western juniper, Palouse prairie, maritime-like forests of the Clearwater basin, sagebrush steppe on the Snake River Plain, riverine cottonwood forests, and wetlands.

Moseley, R. and J. Lichthardt. 1996. Field notes for the Cedar Creek site (S.USIDHP*141). 1 p. plus map.

Field notes include a site survey form and map for Cedar Creek. Communities noted to occur within site include Pinus ponderosa/Symphoricarpos albus and Pseudotsuga menziesii/Physocarpus malvaceus.

Mutch, R. W., S. F. Arno, J. K. Brown, C. E. Carlson, R. D. Ottmar, and J. L. Peterson. 1993. Forest health in the Blue Mountains: a management strategy for fire-adapted ecosystems. USDA Forest Service General Technical Report PNW-GTR-310. Pacific Northwest Research Station, Portland, OR. 14 pp.

The fire-adapted forests of the Blue Mountains are suffering from a forest health problem of catastrophic proportions. A management strategy to restore forest health will require that the seral ponderosa pine and western larch stands be managed for much lower tree densities and an open coniferous understory. A combination of silvicultural partial cutting and prescribed fire on a large scale will be needed to produce the desired future condition of healthy, open parklike forests.

Muttkowski, R.A. 1926. Idaho. Pp. 249-253 in V.E. Shelford, ed. Naturalist's guide to the Americas. Williams & Wilkins Co., Baltimore.

This article gives a brief overview of Idaho. Topics covered include: general features and original biota, plant and animal communities, present biotic conditions, pollution, and natural areas.

Narolski, S. W. 1996. Forest inventory; Peter J. Johnson wildlife mitigation unit, Craig Mountain, Idaho; final report. Unpublished report prepared for USDE Bonneville Power Administration, Environment, Fish and Wildlife. 43 pp plus appendices.

A forest inventory was conducted on the 59,991-acre Peter T. Johnson Wildlife Mitigation Unit (WMU) during the summers of 1993 and 1994. The WMU, located 25 miles south of Lewiston, ID, was purchased by Bonneville Power Administration in 1992 as partial mitigation for Dworshak Dam and Reservoir. BPA transferred title of the WMU to the Idaho Department of Fish and Game in 1995 for long-term management. Much of the plateau on the WMU has been heavily logged in the past, with a high grade prescription. The majority of remaining sawtimber occurs on steep, mostly inaccessible canyonlands surrounding the plateau. Every site capable of supporting coniferous forest vegetation was inventoried by IDFG personnel, regardless of whether it was currently supporting a forest. Results of the inventory indicate that approximately 27,828 acres of the 59,991 WMU are capable of supporting a coniferous forest. The current timber volume on the WMU is estimated at 103.04 MMBF. Douglas fir provided the most volume, followed by grand fir, and Ponderosa pine. A total of 617 individual stands were delineated by forest habitat type. Douglas fir/ninebark was the most common, followed by grand fir/twinflower, and Douglas fir/snowberry. Management and monitoring actions are recommended for the long-term management of forest resources on the WMU.

Noss, R. F. 1996. What should endangered ecosystems mean to the wildlands project? Wild Earth 5(4): 20-29.

To better protect threatened or endangered species, the habitat in which those species live in need to be protected. If the habitat is healthy then the populations living within those areas should technically be healthy. This article describes a wide variety of ecosystems, how abundant they are, and the extent of their decline. Ecosystems covered include are: Southern Appalachian spruce-fir forest; longleaf pine forests and savannas; eastern grasslands, savannas, and barrens; northwestern grasslands and savannas; California native grasslands; southwestern riparian forests; coastal communities; Southern California coastal sage scrub; Hawaiian dry forests; large streams and rivers; caves and karst systems; tallgrass prairie; California riparian forests and wetlands; Florida scrub; old-growth eastern deciduous forest; old-growth forests of the Pacific Northwest; old-growth red and white pine forests; old-growth ponderosa pine forests; midwestern wetlands; and southern forested wetlands. This article also offers suggestions on how to incorporate information on endangered ecosystems into wildlands recovery efforts.

Noste, N. V., and C. L. Bushey. 1987. Fire response of shrubs of dry forest habitat types in Montana and Idaho. USDA Forest Service General Technical Report INT-239. Intermountain Research Station, Ogden, UT. 22 pp.

Contains information from diverse sources on the regeneration capabilities, response to fire, and utilization of 20 shrub species important or common to dry forest habitat types in MT and ID. Response to fire is classified by reproductive strategies and how the species persists in the stand.

Ohmann, J. L., W. C. McComb, and A. Z. Zumrawi. 1994. Snag abundance for primary cavity-nesting birds on nonfederal forest lands in Oregon and Washington. Wildlife Society Bulletin 22: 607-620.

Quantifies densities and characteristics of snags across a range of forest conditions in Oregon and Washington; assesses snag origin, whether from death of trees in the present stand or carry-over from a previous stand; uses models of snag-bird relationships to predict the role that nonfederal lands might play in providing habitat for primary cavity-nesters; and discusses implications for forest management in the Northwest.

O'Hara, K. L. 1996. Dynamics and stocking-level relationships of multi-aged ponderosa pine stands. Forest Science Monograph 33: 1 - 34.

Ponderosa pine (*Pinus ponderosa*) stands in western Montana and central Oregon were sampled to determine total leaf area index (LAI), leaf area distribution among age classes or cohorts, and stem volume increment. Stands included from one to five cohorts. LAI was assumed to represent occupied three-dimensional growing space. Within multi-aged stands, cohorts varied in their total LAI, with older cohorts generally having more LAI, or growing space, than younger cohorts. Older cohorts also produced stem volume growth more efficiently per unit of leaf area than younger cohorts. Higher individual tree leaf area, or growing space occupancy, was strongly related to increased stem volume growth in all cohorts. A general increasing relationship between growing space efficiency and number of cohorts per stand was also observed.|A model, termed PP-MASAM for Ponderosa Pine-Multi-Aged Stocking Assessment Model, was developed to assess multi-aged stocking relationships. Results indicate that residual age structures with large numbers of young trees reduce stand production compared to structures with fewer young and more old trees because they grow more slowly than older trees and will die, need to be thinned, and will not become merchantable. Stocking relationships which appeared most productive are characterized by a positive linear relationship between LAI and cohort age, and a negative linear relationship between number of trees per cohort and age. These options produced the most gross and recoverable stem volume increment, produced acceptable tree vigors, and maintained sufficient growth rates in younger cohorts to sustain the structure.|Formal stocking guidelines for uneven-aged silviculture typically define stocking and residual stand structure using diameter distributions. The most common of these procedures, the q-factor, attempts to create and maintain "balanced" sustainable structures with a negative exponential diameter distribution. These size structures designed with the q-factor approach are assumed to be sustainable and to represent equal occupancy of growing space by each diameter of age class. PP-MASAM results indicate residual size structures defined by the q-factor are no more sustainable than other structures that, for example, provide linearly increasing growing space for each older age class. The q-factor approach also perpetuates ponderosa pine size structures which are atypical of structures which developed under a typical resettlement fire regime.

Old-Growth Definition Task Group. 1986. Interim definitions for old-growth Douglas-fir and mixed-conifer forests in the Pacific Northwest and California. USDA Forest Service Research Note PNW-447, Pacific Northwest Research Station, Portland, OR. 7 pp.

Interim definitions of old-growth forests are provided to guide efforts in land management planning until comprehensive definitions based on research that is currently underway can be formulated. The basic criteria for identifying old-growth Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) and mixed-conifer forests in western Washington and Oregon and California are given.

Parker, J. 1952. Environment and forest distribution of the Palouse Range in northern Idaho. Ecology 33(4): 451-461.

A discussion of the nature of species distribution in the forests of the Palouse range, based on existing vegetation.

Parker, J. 1954. Environment and vegetation of Tomer's Butte in the forest-grassland transition zone of north Idaho Amer. Midl. Naturalist 51:539-552.

Tomer's Butte rises about 900 feet above the surrounding valley or 3,510 feet above sea level in the transition zone between grassland and forest. It is situated four miles east of the town of Moscow in Latah County, North Idaho. Today some of the grassland is cultivated and a little of the forest cut, but in spite of this there is enough conformity to original conditions to make this a place of considerable ecological interest. Although a previous study of the area has been made by Gail (1921) it is believed that certain factors in the environment have been overemphasized in their effects on the vegetation and certain others have been neglected. In order to clarify the interactions between these various factors a study of microclimate, soils, and vegetational cover was made.

Peek, J. M., D. A. Demarchi, R. A. Decmarchi, and D. E. Stucker. 1985. Bighorn sheep and fire: seven case histories. Pages 36-43 in J. E. Lotan and J. K. Brown, compilers. Fire's effect on wildlife habitat-symposium proceedings. USDA Forest Service General Technical Report INT-186. Intermountain Research Station, Ogden, UT.

Responses of seven bighorn sheep populations and habitats to prescribed fire and wildfire in southern British Columbia, Idaho, and Glacier NP ranged from no influence to increase; interacting factors such as lungworm infection, livestock grazing, and reduction in forage overrode potential benefits of subsequent increases in production and nutritive content of forages. A list of factors to be considered before prescribed fire is used in bighorn habitats is provided. Idaho studies are located along the Middle and East Forks of the Salmon River.

Peek, J. M., F. D. Johnson, and N. N. Pence. 1978. Successional trends in a ponderosa pine/bitterbrush community related to grazing by livestock, wildlife, and fire. Journal of Range Management 31(1): 49-53.

A PIPO/PUTR stage of PSME/SYAL was determined to be a product of natural fire suppression, livestock grazing, and utilization by big game.

Pfister, R. D. 1977. Ecological classification of forest land in Idaho and Montana. Pages 329-358 in Proceedings of the Ecological Classification of Forest Land in Canada and Northwestern USA, University of British Columbia, Vancouver.

Purposes of paper: 1)briefly review some of the different kinds of classifications used in ID/MT; 2)evaluate them as ecological classification; and 3) suggest improvements in classification and mapping systems.

Pfister, R. D., B. L. Kovalchik, S. F. Arno, and R. C. Presby. 1977. Forest habitat types of Montana. USDA Forest Service General Technical Report INT-34. Intermountain Forest and Range Experiment Station, Ogden, UT. 174 pp.

A land-classification system based upon potential natural vegetation is presented for the forests of Montana.

Piper, C. V., and R. K. Beattie. 1914. Flora of southeastern Washington and adjacent Idaho. The New Era Printing Company, Lancaster, PA. 296 pp.

This work is an extension of the "Flora of the Palouse Region" also published by these authors in 1901. The area covered in this book includes: Spokane, Whitman, Asotin, Garfield, Columbia and part of Walla Walla Counties in Washington, and the western portions of Kootenai, Latah, and Nez Perce counties in Idaho. The flora of the greater part of this region is Arid Transition, part of it timbered with yellow pine (Pinus ponderosa), the rest treeless and characterized by the abundance of bunchgrass (Agropyron spicatum). The bottom of the Snake River Canyon is occupied by an extension of Upper Sonoran plants such as sagebrush and other species which commonly grow with it. The highest dome of the Blue Mountains supports various Hudsonian plants such as the Subalpine fir, while a broad zone of Canadian Zone plants occupies the slopes down to the yellow pines. Conspicuous Canadian plants are White fir, Engelmann spruce, and mountain ash. The total flora of the region described consists of 20 Pteridophytes, 11 Gymnosperms, 270 Monocotyledons, and 838 Dicotyledons. Additions to this list are to be expected. The material upon which this flora is based is mainly that contained in the herbarium of the State College of Washington.

Powers, L. R., A. D. Dale, P. A. Gaede, C. Rodes, L. Nelson, J. J. Dean, and J. D. May. 1996. Nesting and food habits of the flammulated owl (Otus flammeolus) in southcentral Idaho. Journal of Raptor Research 30(1): 15-20.

In the Sublett Mountains, Cassia County, flammulated owls arrived from mid- to late May in 1991-1994. Twenty-four nesting pairs utilized 22 nesting cavities. Twenty (83%) of the nests were in dead trees and four (17%) in live trees. Thirteen (54%) nests were in broken-top Douglas-fir snags, and 11 (46%) were in trembling aspen. Mean diameter at breast height of 13 nest trees was 49.9 cm, while mean cavity height was 5.1 m. Mean entrance diameter for 11 nests was 6.8 cm. Mean hatching date at 11 of the 24 nests was 26 June (the range was 12 June through 11 July), and mean fledging date was 18 July (range was 7 July through 2 August). Mean brood size for nine nests was 2.3 young per nest (range was 2-3 young). Nightly food deliveries at nest sites peaked within the two-hour period after dark and before daylight. Mean number of nest visits by adults during the nesting stage was 93. Although lepidopterans comprised 79% and orthopterans 0.3% of the available prey within the study area in 1992, 65 food deliveries at one nest revealed 43.1% orthopteran and 9.2% lepidopteran prey. At other nest sites, lepidopterans were the prominent prey. Four banded owls returned to the same territory for two, three, and four consecutive nesting seasons.

Ream, C. H. 1981. The effects of fire and other disturbances on small mammals and their predators: an annotated bibliography. USDA Forest Service General Technical Report INT-106, Intermountain Forest and Range Experiment Station, Ogden, UT. 55 pp.

This annotated bibliography contains references on the effects of fire, logging, grazing, and spraying on small mammals and their predators. Each citation lists keywords. A brief summary of the general effects of fire on some of the more common small mammals in western coniferous forests is included.

Reynolds, R. T., et al. 1992. Management recommendations for the northern goshawk in the southwestern United States. USDA Forest Service General Technical Report RM-217. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 90 pp.

the Northern Goshawk Scientific Committee presents its findings and recommendations for conserving the northern goshawk in the southwestern United States. Present forest trends (including loss of herbaceous and shrubby understory, reductions in the amount of older forests, and increased areas of dense tree regeneration) reflect the extent of human influence on the forests. These changes may also be affecting goshawk populations. Information on goshawk nesting habitat, foraging behavior, food habits, and prey habitats was therefore synthesized to develop a description of desired forest conditions and management objectives. Key objectives of the guidelines are to provide nesting, post-fledgling, and foraging areas for goshawks, as well as habitat to support abundant populations of 14 primary goshawk prey. Thinning trees in the understory, creating small openings in the forest, and initiating prescribed fires should help produce and maintain the desired forest conditions. Other habitat elements critical for maintaining both goshawk and prey populations include abundant snags and large downed logs, woody debris, and interspersion of different tree sizes across the landscape. In addition, the majority of a goshawk's home range should be within older-aged forests. These guidelines should also benefit forest health, soil productivity, and the habitats of other old-growth-dependent plants and animals.

Reynolds, R., and B. Linkhart. 1992. Flammulated owls in ponderosa pine: evidence of preference for old growth. Pages 166-169 in [name and date of publication unknown].

In Colorado, nesting flammulated owls (Otus flammeolus) showed a preference for old trees and stands of ponderosa pine and Douglas-fir. Owls more often settled in areas dominated by older forests than young forests when they returned in the spring to nest. Flammulated owls used old trees and forest stands more often for foraging and for defending territories. Individual owls returned more often to territories composed of mosaics of stands of other tree species and ages.

Rice, P. M., R. A. Boldi, C. E. Carlson, P. C. Tourangeau, and C. C. Gordon. 1983. Sensitivity of Pinus ponderosa foliage to airborne phytotoxins: use in biomonitoring. Canadian Journal of Forest Research 13(6): 1083-1091.

Pinus ponderosa Laws. foliage from a relatively nonpolluted area (SO2<=5.2ug/m3, annual maximum average) was compared with foliage from a more polluted area (75ug/m3, annual maximum average) over a 6 year period. Total sulfur and fluoride concentrations, frequencies of basal needle injury and healthy needles, and percent needle surface area affected (chlorotic and necrotic) classified as tim necrosis, mottle, and total necrosis were substantially higher at the polluted site and were judged to be sensitive characteristics. Two years following study inception, the first 700-MW of a planned 2100-MW coal fired electric generating facility began operating in the nonpolluted area. No consistent changes were noted in the foliar characteristics measured in the nonpolluted area since power-plant-start-up, and it is concluded that the facility's emissions did not measurably impact the pine ecosystem during the early years of operation.

Rogers, P. 1996. Disturbance ecology and forest management: a review of the literature. USDA Forest Service, Intermountain Research Station, General Technical Report INT-GTR-336.

Land managers are incorporating ecosystem perspectives into their local and regional management decisions. This review of the disturbance ecology literature, and how it pertains to forest management, is a resource for forest manager and researchers interested in disturbance theory, specific disturbance agents, their interactions, and appropriate methods of inquiry for specific geographic regions. The approach is broadly interdisciplinary and includes efforts from ecologists, biologists, geographers, historians, wildlife scientists, foresters, entomologists, pathologists, hydrologists, and modelers. The author broadly defines disturbance ecology as the study of any distinct events that disrupt the function of ecosystems. These disruptions may occur over widely varying scales of time and space. Greater understanding of multiple disturbance mechanisms, and how they interact within forests, will contribute significantly to land managers' ability to work with natural systems, rather than battling against individual disturbance agents. Implication for the future of disturbance ecology based management are discussed.

Rosenberg, D. K. 1990. Characteristics of northern flying squirrel and Townsend's chipmunk populations in second- and old-growth forests. Unpublished thesis, Oregon State University, Corvallis.

The forested landscape in western Oregon has become increasingly dominated by young, second-growth forests as a result of intensive and extensive timber harvesting. There have been few investigations on how wildlife populations respond to these forests. This study compared population characteristics and habitat relationships of 2 sciurids between second- and old-growth Douglas-fir forests.

Ross, D. W., and J. D. Walstad. 1986. Estimating aboveground biomass of shrubs and young ponderosa and lodgepole pine in south-central Oregon. Research Bulletin No. 57. Oregon State University Forest Research Laboratory, Corvallis, OR. 12 pp.

Regression equations for estimating the aboveground biomass of individual plants of 10 shrub and 2 pine species were developed from data collected in south-central Oregon. Haplopappus bloomeri is referenced.

Rowdabaugh, K. M. 1978. The role of fire in the ponderosa pine-mixed conifer ecosystems. Unpublished thesis, Colorado State University, Fort Collins. 121 pp.

No abstract is provided.

Rummell, R.S. 1951. Some effects of livestock grazing on ponderosa pine forest and range in central Washington. Ecology 32:594-607.

No abstract is provided.

Rust, S. K. 1990. Process based attributes: a key to the conservation of old-growth forest communities. The Northwest Environmental Journal 6(2): 425 - 427.

Operational definitions of old-growth forest utilize forest compositional and structural characteristics. Emphasis on the community attributes of disturbance and environmental stress will be essential to work on the conservation of dedicated old-growth and in identifying the spatial and distributional requirements for the maintenance of viable old-growth forest communities. An operational definition has not been formulated for old-growth forest of the San Juan Archipelago. One of the characteristic of forest communities of Iceberg Point appears to be frequent, low intensity disturbance by fire. An important strategy for the conservation of these dedicated old-growth forest communities may be to maintain the natural frequency of fire events.

Saab, V. A., and Rich T. D. 1997. Large-scale conservation assessment for neotropical migratory land birds in the interior Columbia River basin. General Technical report PNW-GTR-399. USDA Forest Service, Pacific Northwest Research Station, Portland, OR. 56 pp.

The status and habitats of neotropical migratory land birds (NTMB) are evaluated within the interior Columbia River basin (interior basin). Objectives are to examine population trends, estimate NTMB responses to alternative management activities, and provide recommendations by habitat and species for the long-term persistence of NTMB populations. Among 132 NTMBs that breed in the interior basin, 38 species showed significant population trends over two time periods, 1968-94 (26 years), and 1984-94 (10 years). Fourteen species had significant declines over the 26-year period and 13 over the 10-year period; 13 and 12 species showed significant increases over those periods, respectively. Among 16 defined habitats, riparian vegetation was used by more species (64 percent) than any other habitat. Other habitats used by many species included young coniferous forest (38 percent) and old-growth/mature forest (35 percent). Nine habitats had more species with significantly decreasing than increasing populations (26-year period), and seven habitats had more increasing species. Five habitats (riparian, old-growth forests, shrub-steppe, grasslands, and juniper) are identified for management priorities based on declines in species, vulnerability to human activities, and habitat loss. Among the four management themes considered, more species (63) were of high concern under consumptive management than any other theme. Active and passive management themes are predicted to have negative effects on the fewest species, 23 and 16, respectively.

Sackett, S., S. Haase, and M. G. Harrington. 1994. Restoration of southwestern ponderosa pine ecosystems with fire. Pages 115-121 in Covington, W. W., and L. F. DeBano, technical coordinators. 1994. Sustainable ecological systems: implementing an ecological approach to land management. 1993 July 12-15; Flagstaff, AZ. USDA Forest Service, General Technical Report RM-247. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 363 pp.

Heavy grazing and timbering during settlement by Europeans, and a policy of fire exclusion shortly after caused extensive structural and compositional changes to the southwestern ponderosa pine ecosystem. These changes have resulted in forest health problems, such as increased insect and disease epidemics, reduced wildfire habitat, and a serious wildfire hazard. Prescribed burning can reduce heavy fuel accumulations, provide adequate sites for natural regeneration, thin dense stagnated thickets, and create an edaphic and stand environment conducive to better forest health and productivity. Although presettlement conditions may never be restored, forest condition and health can be improved by means of prescribed fire.

Sampson, R. N., D. L. Adams, S. Hamilton, S. P. Mealy, R. Steele, and D. Van de Graaff. 1994. Assessing forest ecosystem health in the Inland West. American Forests March/April: 13-16.

The forests of the Inland West that are at the greatest risk are composed of an unsustainable combination of tree species densities and age structures that are susceptible to the fire and drought regimes common to the region. This is a particular problem where the species mix has shifted dramatically away from ponderosa and other long needled pines towards firs. This species shift, attributable to a combination of logging, grazing, fire suppression, and related activities over the past century has been well documented. It is determined that the costs and risks of inaction are greater than those associated with remedial actions to improve forest health. The judicious control of tree density and species composition through prescribed fire, thinning, and other silviculture methods is critical to restoring and maintaining forest health, meaning more intensive management that is different from what has been done historically. This more intensive management must be adaptive and more responsive to local conditions and needs, with results more closely monitored to study effects and continuing changes.

Sawyer, J. O., and T. Keeler-Wolf. 1995. A manual of California vegetation. California Native Plant Society. 471 pp.

This book is the result of the collective effort of 64 scientists. Their data has been used to describe the vegetative series of California. Instructions on how to use each of the keys are provided along with selective photos. Each key contains a short description of the series, distribution, elevation, and other important comments pertaining to that series.

Schieck, J., K. Lertzman, B. Nyberg, and R. Page. 1995. Effects of patch size on birds in old-growth montane forests. Conservation Biology 9: 1072-1084.

Following habitat alteration or fragmentation, competition, parasitism, and predation from species that live in the new habitats may reduce the survival and reproductive success of species living in the original habitats. Negative influences from species that live outside the remnant patches are expected to be greater in small rather than in large remnant patches. The authors surveyed birds within remnant patches of old-growth montane forests on Vancouver Island, Canada, (1) to evaluate whether the richness and abundance of non-old-growth bird species were larger at the center of small rather than large patches and (2) to evaluate whether the opposite was true of old-growth bird species. More non-old-growth bird species were present at the center of small remnant patches of old growth than in large old-growth patches. No relationship was found, however, between patch size and richness or abundance of old-growth bird species at the center of remnant patches of old growth. This was true for old-growth species with open, cup-shaped nests and cavity nests. Old-growth birds may have been affected less in this study area than in other areas because they evolved within heterogeneous montane forests and interacted with non-old-growth species throughout their evolutionary histories or because the contrast between old-growth forests and logged areas was less than that between the forests and agricultural/urban areas that were surveyed in other studies.

Schirman, R. 1981. Seed production and spring seedling establishment of diffuse and spotted knapweed. Journal of Range Management 34(1): 45-47.

Annual seed production in CEDI and CEMA is reduced in dry years by a reduction in viable seeds/seed head but seed production increases in wet years by an increase in heads/flower stem. Low survival in seedlings emerging after May 15.

Schmidt, W. C., and K. J. McDonald, compilers. 1995. Ecology and management of Larix forests: a look ahead. Proceedings of an international symposium; 1992, October 5-9; Whitefish, MT. General Technical Report INT-GTR-319. Ogden, UT, USDA Forest Service Intermountain Research Station. 521 pp.

This proceedings is the product of an international symposium on the Larix species of North America, Europe, and Asia. Western larch, an important species in the Western United States and Canada, was featured. The symposium included information on ecology, management, silviculture, regeneration processes, growth, wildlife, vegetation succession, silvics, history, genetics, breeding and provenance testing, physiology, fire, insects and disease, and research needs. The proceedings illustrates the importance of Larix in the temperate forests of the Northern Hemisphere.

Scott, V. E., and J. L. Oldemeyer. 1983. Cavity-nesting bird requirements and response to snag cutting in ponderosa pine. Pages 19-23 in J. W. Davis, G. A. Goodwin, and R. A. Ockenfels, technical coordinators, Snag habitat management: proceedings of the symposium. Northern Arizona University, Flagstaff. USDA Forest Service Technical Report RM-99.

Cavity-nesting bird densities declined 53% when conifer snags were removed during a timber harvest on the Apache-Sitgreaves National Forest in Arizona. On an adjacent cut over area where snags were left standing, the cavity-nesting bird population increased 25%. Cavity-nesting bird densities on an unharvested control plot increased 32%. Birds that nested in ponderosa pine snags were affected most by snag removal. Violet-green swallows declined from 41 to 4 birds/100 acres after snags were removed, and pygmy nuthatches declined from 32 to 15/100 acres. Two species responded significantly to the reduction in basal area: white-breasted nuthatches decreased and house wrens increased. For nesting sites, cavity-nesting birds usually selected ponderosa pine (Pinus ponderosa) snags that were greater than 18 inches diameter breast high (dbh), dead 6 years and with at least 40% bark cover.

Sharp, B. E. 1992. Neotropical migrants on national forests in the Pacific Northwest: a compilation of existing information. Prepared for the USDA Forest Service. Report PB93-128825. 45 pp. plus tables and appendices.

Breeding bird survey data were analyzed for 101 neotropical migrants state-wide and on national forests in Oregon and Washington. On national forests, 16 species have declined significantly between 1968 and 1990, an additional 7 species show almost significant declines, 5 species have increased, 2 almost showed an increase, 43 species were stable on national forests, and for 28 species there were insufficient data on national forests to determine trend. State-wide, 30 species (35% of 86 species for which there were sufficient data) have either declined in the past 5 decades, or are currently declining now. In the Pacific Northwest, on national forests and/or state-wide, approximately 38 species of neotropical migrants are declining or are at low populations, and are therefore by this definition "of concern." Life history data indicate that seventeen of the declining species (45%) are associated with old-growth habitat components and 8 with riparian habitats. National forests may play a potentially critical role in assuring population viability for many of these species. Appendix D provides a brief summary of life history and habitat associations for each species.

Sharp, L. A., and K. D. Sanders. 1978. Rangeland resources of Idaho. Idaho Rangeland Committee Miscellaneous Publication No. 6. University of Idaho College of Forestry, Wildlife and Range Sciences, Moscow, ID. 74 pp.

Overview of physical and vegetation features of Idaho, Idaho land ownership and use, and issues and problems associated with rangeland use and management in the state.

Shepherd, J. F., and G. Servheen. 1992. Flammulated owl (Otus flammeolus) surveys and habitat sampling on the Clearwater, Red River and Salmon River districts, Nez Perce National Forest. Cooperative Challenge Cost Share Project, Nez Perce National Forest and Idaho Conservation Data Center, Idaho Department of Fish and Game. 23 pp.

Twenty-seven flammulated owl (Otus flammeolus) surveys were conducted on the Nez Perce National Forest from 11 May to 10 July, 1992. One hundred ten singing male flammulated owl observations were recorded on the Red River and Salmon River Ranger Districts from 15 May to 10 July, 1992 (59 on the Salmon River RD and 51 on the Red River RD). No flammulated owls were recorded on the Clearwater Ranger District. Owl density estimates ranged from 0.28 singing male flammulated owls per 40 ha for the Mackay Bar survey route on 17 May and 18 June, to 1.13 singing males per 40 ha for the Indian Creek survey route on 22 June. Habitat data indicated stand composition is dominated by ponderosa pine (Pinus ponderosa) of all age and size classes, creating multi-layered stands with moderately open canopies (52% canopy cover, SD=30). Ponderosa pine dominated 84% of the habitat plots. Ninety-two percent of habitat plots had three canopy layers.

Silver, R. D., et al. 1991. Petition for listing of the isolated regional population of northern goshawks in the southwestern United States and for designation of the critical habitat of this isolated population. 61 pp.

Petition for emergency listing of the northern goshawk as endangered in the southwestern United States. Documents population decline due to habitat loss caused by logging of mature and old-growth forests. Petition for sensitive species classification of the northern goshawk in the Intermountain Forest Region is attached.

Sloan, J. 1994. Historical density and stand structure of an old growth forest in the Boise Basin of central Idaho. Draft. Unpublished report prepared for the U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Boise, ID. 26 pp.

What used to open stands of old growth ponderosa pine are now dense stands of Douglas-fir and ponderosa pine. The forests of the Douglas-fir climax series of the 1800's typically supported between 5 and 50 trees per acre. Heavy regeneration in the early 1900's, due to livestock grazing and lack of fires, have increased the densities of these stands to as many as 900 trees per acre. Most are in the 250 to 600 trees per acre range. Densities were driven more by the number of old growth trees and open space on the plot than by habitat type. Stand basal areas were generally below 100 sq ft per acre in the 1800's but in the last decade they peaked well above 200 sq ft per acre before a large increase in tree mortality made them level off or decline. Although Douglas-fir did not mature in the stands of the 1800's, it is an important component of the same stands today. Fuel loading and fuel ladders make the danger of a stand replacing fire much greater today than it was 100 years ago and before.

Smith, J. K. and W. C. Fischer. 1997. Fire ecology of the forest habitat types of northern Idaho. USDA Forest Service, Intermountain Research Station, General Technical Report INT-GTR-363. 142 p.

This report summarizes available information on fire as an ecological factor for forest habitat and community types in northern Idaho. Habitat and community types are assigned to fire groups based on fire regimes and potential forest stand development after fire.|An introductory section discusses relationships of major species (tree, shrub, herb, and animals) for fire, general considerations for fire management, and the ecology of persistent seral communities in northern Idaho. For each fire group, the authors discuss (1) vegetation, (2) forest fuels, (3) the natural role of fire, (4) potential patterns of forest stand development after fire, and (5) fire management considerations.

Solheim, S. L., W. S. Alverson, and D. M. Waller. [1987?]. Maintaining biological diversity in national forests: the necessity for large blocks of mature forest. Society of American Foresters Ecological Commentary 87-1.

Proposes a "zoning" of forests to preserve large mature tracts of the landscape so that biological diversity can be maintained by providing sufficient habitat for all kinds of plants and animals.

Stallcup, P. L. 1968. Spatio-temporal relationships of nuthatches and woodpeckers in ponderosa pine forests of Colorado. Ecology 49(5): 831-843.

Interspecific segregation of foraging activities of nuthatches and woodpeckers was investigated from June 1964 to June 1966 in a stand of ponderosa pine. The composition and density of populations were assessed throughout the year. Location of foraging activities was quantified by measuring the length of time each species occurred in specified zones of the environment. Interspecific differences of zonation were statistically analyzed for the reproductive and non-reproductive seasons separately. White-breasted and pygmy nuthatches and hairy woodpeckers nested in the area and were sympatric throughout the year. Northern flickers and Williamson's sapsuckers nested in the area but were sympatric with the 2 nuthatches and hairy woodpecker only during the reproductive season. Red-breasted nuthatches nested at higher elevations and were sympatric with the hairy woodpecker and other nuthatches only during the non-reproductive season. Pygmy nuthatches foraged most extensively in the foliage of live pine in both seasons. White-breasted nuthatches concentrated their foraging activities on the trunks and large branches of pine. Zones used most extensively by all nuthatches were mutually exclusive in both seasons. Zones of hairy woodpeckers and Williamson's sapsuckers overlapped considerably in the reproductive season. Hairy woodpeckers foraged for arthropods on the surface of trunks and branches of living trees but more extensively for subcortical arthropods of dead trees, stumps, and logs. Williamson's sapsuckers foraged almost exclusively for ants on trunks of living pines. In the non-reproductive season, hairy woodpeckers foraged most extensively for seeds of pine cones. Williamson's sapsuckers foraged almost exclusively on phloem of trunks of living pines. Foraging activities of northern flickers were confined to the ground and thus segregated from the major zones of all other birds. Nuthatches and woodpeckers were shown to be segregated by spatial and behavioral differences of foraging activities and by temporal differences of their residential status. It is concluded that climate, available space, and competition for food were important in the evolutionary development of these interspecific differences.

Steele, R., R. D. Pfister, R. A. Ryker, and J. A. Kittams. 1981. Forest habitat types of central Idaho. USDA Forest Service General Technical Report INT-114. Intermountain Forest and Range Experiment Station, Ogden, UT. 138 pp.

A land-classification system based upon potential natural vegetation is presented for the forests of central Idaho. It is based on reconnaissance sampling of about 800 stands. A hierarchical taxonomic classification of forest sites was developed using the habitat type concept. A total of eight climax series, 64 habitat types, and 55 additional phases of habitat types are defined and described. A diagnostic key is provided for field identification of the types based on indicator species used in development of the classification.

Steele, R., S. F. Arno, and K. Geier-Hayes. 1986. Wildfire patterns in central Idaho's ponderosa pine-Douglas fir forest. Western Journal of Applied Forestry 1(1): 16-18.

Before 1895, all sample sites had average fire intervals of 10 to 22 years, implying a pattern of light to moderate surface fire. After 1895, fire intervals lengthened considerably and severe fires became relatively common.

Steele, R., S. V. Cooper, D. M. Ondov, D. W. Roberts, and R. D. Pfister. 1983. Forest habitat types of eastern Idaho-western Wyoming. General Technical Report INT-144. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT. 122 pp.

A plant community classification of potential natural forested vegetation of eastern Idaho and western Wyoming is provided.

Nine hundred, eighty samples are summarized in 58 habitat types. Forest community composition and structure is described in text and tables. Preliminary implications for natural resource management are provided, based on field observations and current information.

Stern, M. A., and G. A. Rosenberg. 1985. Occurrence of a breeding upland sandpiper at Sycan Marsh, Oregon. The Murrelet 66: 34-35.

Stern and Rosenberg document successful breeding of upland sandpipers in 1981 at Sycan Marsh, Oregon. Sycan Marsh encompasses 9,306 ha of wetland vegetation dominated by hard-stemmed bulrush, surrounded by ponderosa pine and lodgepole pine. Breeding was previously unknown at this site.

Strong, D. L., ed. 1987. Ecology in the broad sense with conservation efforts for the spotted owl. Ecology 68(4): 765-779.

This "Special Feature" includes three articles about the spotted owl, focusing on biological, economic, and conservation issues of the log-old-trees vs. the preserve-biotic-diversity conflict.

Szaro, R. C., and R. P. Balda. 1979. Effects of harvesting ponderosa pine on nongame bird populations. USDA Forest Service Research Paper RM-212. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 8 pp.

Bird species diversity and species richness in a ponderosa pine forest in Arizona were not significantly affected by forest cutting and logging except on the clearcut plot. Bird population densities were significantly increased on the silviculturally cut and irregular strip shelterwood plots and were significantly decreased on the severely thinned and clearcut plots. Guidelines are recommended to allow substantial ponderosa pine logging while maintaining bird density and diversity.

Tecle, A., W. W. Covington, and R. H. Hamre, technical coordinators. 1989. Proceedings - multi-resource management of ponderosa pine forests conference. November 14-16, 1989, Flagstaff, AZ. USDA Forest Service General Technical Report RM-185, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 282 pp.

Proceedings of a conference to discuss current issues, concerns, opportunities, and procedures in multi-resource management of ponderosa pine forests. The papers in this proceedings are grouped into six themes: 1) areal distribution, and growth of ponderosa pine forests; 2) factors affecting ponderosa pine forest resource outputs; 3) forest diseases; 4) wildlife habitat concerns; 5) modeling and integrating environmental and public concerns in ponderosa pine forest resource management; and 6) multi-resource management, decision support systems and expert systems.

Teeguarden, D. E. 1983. National policy, tradeoffs, and issues in managing old-growth forests for multiple-use benefits. Publication unknown: 320-324.

There is no specific national policy per se which requires conserving the remaining old-growth forest on public lands in the Western United States. However, five federal statutes imply strong policy direction for old-growth retention because of requirements for species diversity and limitations on timber harvests. The issue of old-growth retention to achieve species diversity and other environmental goals needs to be resolved separately from the issue of timber harvest scheduling. MAI rotations may no produce greater net benefit from non-timber yields than an economic rotation. On the Six Rivers National Forest the opportunity cost involved in achieving environmental goals including species diversity can be as high as 4,427 per acre.

The Nature Conservancy, Idaho Natural Heritage Program, Oregon Natural Heritage Data Base, and Washington Natural Heritage Program. 1989. Final Report, Phase I, 1989 National Natural Landmark Project, Pacific Northwest Region, National Park Service; Including classification of the following ecological themes: Ponderosa pine, Grand Fir, Low Sagebrush, Stiff Sagebrush, Salt Desert Shrub, and Montane, Subalpine, and Alpine Parklands and Wetlands. Unpublished report prepared for the U.S. Department of the Interior, National Park Service. 91 pp.

No abstract is provided.

Thilenius, J. F. 1972. Classification of the deer habitat in the ponderosa pine forest of the Black Hills, South Dakota. USDA Forest Service Research Paper RM-91. Rocky Mountain Forest and Range Experiment Station, Ft. Collins, Colorado. 28pp

No abstract is provided.

Tomback, D. F., J. K. Clary, J. Koehler, R. J. Hoff, and S. F. Arno. 1995. The effects of blister rust on post-fire regeneration of whitebark pine: the Sundance Burn of northern Idaho. Conservation Biology 9(3): 654-664.

In the northern Rocky Mountains, whitebark pine (Pinus albicaulis) is rapidly declining as a result of previous fire exclusion policies, mountain pine beetle (Dendroctonus ponderosae) outbreaks, and white pine blister rust (Cronartium ribicola). Blister rust is potentially the most destructive agent, killing seedlings and saplings in the 25-year-old Sundance Burn in the Selkirk Range of northern Idaho, an area heavily infected by blister rust. Researchers found that the mean regeneration density of whitebark pine was significantly lower than that of two other comparably aged burns in western Montana. The low density was attributed to the severe damage to the seed source on the burn perimeter, resulting from previous infestation of mountain pine beetle and blister rust. Overall, 29% of the whitebark pine regeneration in the Sundance Burn was infected by blister rust. Age and height of seedlings were important predictors of incidence of infection, and height was the most important predictor of severity of infection. Thus, as seedlings grow larger, they present a bigger target to airborne blister-rust spores. Because of the lack of seed production in the adjacent forest and expected mortality, regeneration of whitebark pine in the Sundance Burn will be slow. In areas of northern Idaho and northwestern Montana affected by blister rust and pine beetle, prescribed fires for managing whitebark pine ecosystems should be restricted to small areas or should require plants of rust resistant seedlings.

Topik, C., N. M. Halverson, and T. High. 1988. Plant association and management guide for the ponderosa pine, Douglas-fir, and grand-fir zones of Mt. Hood National Forest. USDA Forest Service R6-Ecol-TP-004-88, Pacific Northwest Region, Portland, OR. 136 pp.

This publication describes the mixed conifer zone associations of the ponderosa pine, Douglas-fir, and grand fir series found east of the Cascade Crest on the Mt. Hood NF.

Topik, C., N.M. Halverson, and T. High. 1988. Plant associations and management guide of the ponderosa pine, Douglas-fir, and grand fir zone, Mt. Hood National Forest. USDA Forest Service R6-ECOL-TP-004-88. 136 pp.

No abstract is provided.

USDA Forest Service, Boise National Forest. 1993. Snapshot in time: repeat photography on the Boise National Forest 1870-1992. USDA Forest Service, Boise National Forest, Boise, ID. 239 pp.

There are many questions concerning how a forest changes. Through time, the landscape is altered in species composition, stand age and density. Changing landscape patterns -negative mosaics- suggest that this has been occurring for centuries (McCune 1985). This historical narrative and series of repeat photographs depicts a century of change on the Boise National Forest. Ecological conditions change with time, including the vegetation and landscape. Vegetation dynamics are both natural and person-caused. The photographic record illustrates how each has altered the vegetation. Attempts were made in every case to duplicate the original camera position as nearly as possible, as well as the time of day and season of the year. In some cases, road locations and vegetative changes required some position adjustments.

Uresk, D. W., and W. W. Paintner. 1985. Cattle diets in a ponderosa pine forest in the northern Black Hills. Journal of Range Management. 38(5): 440-442.

A cattle diet study was conducted in the northern Black Hills of South Dakota and Wyoming. Forty-eight plants were identified in cattle fecal material. Muhlenbergia racemosa was one of the grasses identified in the fecal matter.

Volland, L. A., and J. D. Dell. 1981. Fire effects on Pacific Northwest forest and range vegetation. USDA Forest Service, Pacific Northwest Region R6-Rm-067-1981. Portland, OR. 23 pp.

The objective of this publication is to provide a state-of-knowledge overview and discussion of the effects of both prescribed fire and wildfire on coniferous and non-forest flora of the Pacific Northwest. In the contents of this paper, the response of plants to burning is initially considered, followed by discussion of the reaction of the community as it aggregates the effects on its member species. The effects of fire on specific floristic ecosystems has been documented by several authors is not addressed in this paper although references are made to specific studies. Lastly, consideration is given to those subject areas where present fire-flora information for this region is still lacking or incomplete.

Walls, S. C., A. R. Blaustein, and J. J. Beatty. 1992. Amphibian biodiversity of the Pacific Northwest with special reference to old-growth stands. Northwest Environmental Journal 8(1): 53-69.

The loss of species within old-growth forests reflects the general loss in biodiversity that is occurring at an increased rate throughout the world. In the Pacific Northwest, populations of several species of amphibians have apparently become locally extinct, and the ranges of numerous species have become drastically reduced. Most of the declines have occurred in forest-dwelling species. The extinctions and range reductions of amphibians in the Pacific Northwest have occurred primarily in seemingly pristine habitat devoid of overt habitat destruction or manipulation.

Warren, N. 1989. Old growth habitats and associated wildlife species. USDA Forest Service, Northern Region. Draft copy.

A description of old growth habitats in the Northern Rockies and pileated woodpecker habitat relationships, goshawk habitat relationships, and marten habitat relationships.

Weber, W. C., and S. R. Cannings. 1976. The white-headed woodpecker (Dendrocopos albolarvatus) in British Columbia. Syesis 9: 215-220.

The white-headed woodpecker, until very recently considered to be of casual occurrence in British Columbia and in Canada, is shown to be a rare but permanent resident in some of the southern Interior valleys. There are 140 sightings between 1890 and 1974, of which 4 are documented by specimens and 7 others by photographs. Three active nests have been discovered, and there are at least 3 additional records of birds seen excavating nest-holes. Eighty-nine percent of the records are from the southern Okanagan Valley, and the remainder from the northern Okanagan Valley, the Similkameen Valley, and the Kettle Valley. In addition, there are possible sightings from near Lytton and near Fort Steele. Sightings are well-distributed throughout the year. The preferred habitat is open ponderosa pine forest, which may be partly explained by the birds' dependence on pine seeds as food. Numbers of white-headed woodpeckers in British Columbia may have increased since the early 1900s, but most of the recent increase in sightings is attributable to a larger number of observers.

Wellner, C. A. 1970. Fire history in the northern Rocky Mountains. Pages 42-46 in Proceedings of the Symposium on the Role of Fire in the Intermountain West. University of Montana and Fire Research Council. Missoula, Montana.

Historically, fires have repeatedly burned nearly every square foot of northern Rocky Mountain forests. Fire damage was especially severe during the 75 years following 1860. Prior to 1940, fire was second only to precipitation as the major factor shaping the character of forests in the region. Fires in the northern Rocky Mountains generally were catastrophic, causing heavy damage to the burned stand. As a result, forest stands tend to be even-aged. Very limited areas of Ponderosa pine and Douglas-fir ecosystems have burned periodically without destroying all the forest stand. The historic occurrence, damage characteristics, and consequences of wildfire must be considered in planning the very necessary use of fire in management of northern Rocky Mountain forests.

Wicker, E. F., and C. D. Leaphart. 1976. Fire and dwarf mistletoe (Arceuthobium spp.) relationships in the northern Rocky Mountains. Pages 279-298 in Proceedings from Montana Tall Timbers Fire Ecology Conference and Fire and Land Management Symposium, No. 14. Tall Timbers Research Station, Tallahassee, FL.

Discusses several relationships between fire and dwarf mistletoe, and suggests many ways in which fire can be used as a practical and applicable tool in the management of the forest ecosystems of the northern Rocky Mountains.

Williams, C. K., B. F. Kelley, B. G. Smith, and T. R. Lillybridge. 1995. Forested Plant Associations of the Colville National Forest. USDA, Forest Service, Pacific Northwest Research Station and Pacific Northwest Region, Colville National Forest, PNW-GTR-360. 300 pp. plus appendices.

A classification of forest vegetation is presented for the Colville National Forest in northeastern Washington State. It is based on potential vegetation with the plant association as the basic unit. The classification is based on a sample of approximately 229 intensive plots and 282 reconnaissance plots distributed across the forest from 1980 to 1983. The hierarchical classification includes 5 forest tree series and 39 plant associations or community types. Diagnostic keys are presented for each tree series and plant association or community type. Descriptions include information about plant association or community species composition, occurrences, distribution, environment, soils, forest productivity, management implications and relations to other vegetation classifications. Background information is also presented on the ecology, geology, soils, climate, and fire history of the Colville National Forest.

Williams, C. K., B. F. Kelley, B. G. Smith, and T. R. Lillybridge. 1995. Forested plant associations of the Colville National Forest. Gen. Tec. Rep. PNW-GTR-360. USDA Forest Service, Pacific Northwest Research Station, in cooperation with Pacific Northwest Region, Colville National Forest, Portland. 375 p.

A classification of forest vegetation is presented for the Colville National Forest in northeastern Washington State. It is based on potential natural vegetation with the plant association as the basic unit. The classification is based on a sample of approximately 229 intensive plots and 282 reconnaissance plots distributed across the forest from 1980 to 1983. The hierarchical classification includes 5 series and 39 plant associations of community types. Diagnostic keys are presented for each series and plant association or community type. Descriptions include information about species composition, distribution, environment, soils, forest productivity, management implications and relations to other vegetation classifications. Background information is also presented on the ecology, geology, soils, climate, and fire history of the Colville National Forest

Williams, J. T., and R. C. Rothermel. 1992. Fire dynamics in northern Rocky Mountain stand types. USDA Forest Service Research Note INT-405. Intermountain Research Station, Ogden, UT. 4 pp.

In the Northern Rocky Mountains, fire growth and potential fire severity develop differently according to the type of vegetation. The fire dynamics of grass, brush, and timber-dominated types are described, using examples, and their management implications are discussed.

Willits, S., R. J. Barbour, S. Tesch, D. Ryland, J. McNeel, R. Fight, S. Kumar, G. Myers, B. Olson, A. Mason. 1996. The Colville Study: wood utilization for ecosystem management: Preliminary results of study of product potential from small-diameter stands. USDA Forest Service, Forest Products Laboratory, Research Paper FPL-RP-559.

The Colville Study was developed in 1994 to identify and evaluate a series of management options for achieving ecosystem objectives in dense stands of small-diameter trees while also producing wood products. The Colville National Forest selected the Rocky II Timber Sale as an example of this type of stand that needed management to achieve the following goals: (1) create late successional forest structure, (2) decrease forest health risk from fire, insects, and disease, (3) improve wildlife habitat by providing large green trees and snags, and (4) improve stand aesthetics by decreasing stand density. The Colville Study was divided into four technical focus areas: silviculture and ecology, forest operations, timber conversion, and economics. Results of each technical focus area indicate that (1) vegetative management activities are necessary to achieve the ecosystem goals, (2) there are alternative harvesting systems for removing the timber in an ecologically sound manner but costs differ, (3) both species and material size are important in the recovery of wood products, and (4) financial analysis needs to incorporate all of these factors and many more to effectively evaluate the relative merchantability of different types of treatments.

Wright, H. A. 1978. The effect of fire on vegetation in Ponderosa pine forests. Texas Tech University College of Agricultural Sciences Publication No. T-9-199. Department of Range and Wildlife Management, Lubbock, TX. 21 pp.

Summarizes current knowledge about effects of fire on vegetation in ponderosa pine communities. Data is presented in an ecological format, with sections on management implications and information about the use of fire in management.

Wright, H. A. 1978. The effect of fire on vegetation in ponderosa pine forests. Texas Tech University (Lubbock) Range and Wildlife Information Series Number 2, College of Agricultural Sciences Publication No. T-9-199. 21 pp.

This paper summarizes the current knowledge about the effect of fire on vegetation in ponderosa pine communities. The data is presented in an ecological format along with sections on management implications and state-of-the-art knowledge on the use of fire to manage ponderosa pine communities.

Youngblood, A. P., and R. L. Mauk. 1985. Coniferous forest habitat types of central and southern Utah. USDA Forest Service General Technical Report INT-187. Intermountain Research Station, Ogden, UT. 89 pp.

A land classification system based on potential natural vegetation is presented for the coniferous forests of central and southern UT based on a reconnaissance sampling of 720 stands. 37 habitat types and 6 phases are described.

Keyword index to the annotated bibliography. Citations included in the annotated bibliography are listed for each selected keyword (taken from Idaho Conservation Data Center 1997).

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AMERICAN GOLDFINCH
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Appendix 4. Site old growth stand summaries and delineations.

Map A. Corral Creek - Old growth stand summary and delineation.
Map B. Deer Creek Mine - Old growth stand summary and delineation.
Map C. Denny Creek - Old growth stand summary and delineation.
Map D. Little Salmon - Old growth stand summary and delineation.
Map E. N Fork Rattlesnake - Old growth stand summary and delineation.
Map F. Pardee - Old growth stand summary and delineation.
Map G. Partridge Creek and Partridge/Elkhorn - Old growth stand summary and delineation.
Map H. Sheep Creek - Old growth stand summary and delineation.
Map I. Upper Eagle - Old growth stand summary and delineation.
Map J. W Fork Lake Creek - Old growth stand summary and delineation.
Map K. Warm Springs - Old growth stand summary and delineation.

Map A. Corral Creek - Old growth stand summary and delineation.

Stand ID	Plant Association	Seral and structural class	Rank	Size
1	PSME/PHMA, PHMA	late-seral, medium tree	A	117.5
8	PSME/PHMA, CARU	mid-seral, large tree	A	38.6
9	PSME/PHMA, CARU	mid-seral, large tree	A	38.6
10	PSME/PHMA, CARU	mid-seral, large tree	A	35.9
11	ABGR/ACGL, PHMA	mid-seral, medium tree	C	11.9
12	PSME/AGSP	mid-seral, medium tree	C	19.3

Map B. Deer Creek Mine - Old growth stand summary and delineation.

Stand ID	Plant Association	Seral and structural class	Rank	Size
1	PSME/PHMA, CARU	mid-seral, large tree	B	4.6
2	PSME/SYAL, PIPO	mid-seral, large tree	B	26.6
3	ABGR	mid-seral, large tree	B	20.2
4	PSME/AGSP	mid-seral, medium tree	B	2.8
5	PSME/CARU, PIPO	mid-seral, large tree	B	2.8

Map C. Denny Creek - Old growth stand summary and delineation.

Stand ID	Plant Association	Seral and structural class	Rank	Size
1	ABGR/SPBE	mid-seral, large tree	A	10.1
2	ABGR/SPBE	mid-seral, large tree	D	25.7
3	ABGR/VAGL	late-seral, medium tree	D	27.5
4	ABGR/SPBE	mid-seral, large tree	BC	16.5
5	ABGR/SPBE	late-seral, large tree	BC	5.5

Map D. Little Salmon - Old growth stand summary and delineation.

Stand ID	Plant Association	Seral and structural class	Rank	Size
2	ABGR/ACGL, PHMA	late-seral, large tree	C	65.9
3	PSME/PHMA, CARU	mid-seral, large tree	A	37.6
6	ABGR/ACGL, PHMA	late-seral, medium tree	CD	73.5
7	PSME/PHMA, CARU	mid-seral, large tree	A	8.3
13	PSME/PHMA, CARU	late-seral, large tree	A	12.8
14	ABGR/ACGL, PHMA	mid-seral, giant tree	A	28.5
15	ABGR/ACGL, PHMA	mid-seral, large tree	A	24.8
18	ABGR/ACGL, PHMA	late-seral, medium tree	C	214.9
19	ABGR/ACGL, PHMA	late-seral, large tree	A	13.8
20	ABGR/ACGL, PHMA	mid-seral, large tree	A	17.4
21	ABGR/ACGL, PHMA	late-seral, large tree	A	23.0
24	ABGR/SPBE	mid-seral, giant tree	A	18.4
25	PSME/PHMA, CARU	late-seral, large tree	A	6.4
26	PSME/PHMA, CARU	mid-seral, large tree	A	11.9

Map D. Little Salmon (continued).

Map E. N Fork Rattlesnake - Old growth stand summary and delineation.

Stand ID	Plant Association	Seral and structural class	Rank	Size
1	PSME/FEID, PIPO	mid-seral, medium tree	D	1.6
2	PSME/PHMA, PIPO	mid-seral, medium tree	D	9.2
3	PSME/FEID, PIPO	mid-seral, medium tree	D	15.6
4	PSME/PHMA, PIPO	mid-seral, medium tree	D	14.7
5	PSME/FEID, PIPO	mid-seral, medium tree	D	5.5

Map F. Pardee - Old growth stand summary and delineation.

Stand ID	Plant Association	Seral and structural class	Rank	Size
1	PIPO/AGSP	late-seral, large tree	BC	92.7
2	PSME/PHMA, PHMA	mid-seral, medium tree	B	23.0
4	PSME/PHMA, PHMA			5.5
5	PSME/PHMA, PHMA			4.6
8	PSME/AGSP	mid-seral, medium tree	CD	15.6
9	PSME/AGSP	late-seral, large tree	CD	92.7
10	PSME/AGSP	mid-seral, medium tree	CD	21.1
11	PSME/AGSP			6.4
12	PSME/AGSP			13.8
14	PSME/PHMA, PHMA			7.3

Map G. Partridge Creek and Partridge/Elkhorn - Old growth stand summary and delineation.

--Partridge Creek

Stand ID	Plant Association	Seral and structural class	Rank	Size
1A	PSME/PHMA, CARU	mid-seral, large tree	A	27.5
2A	SYAL/FEID		A	8.3
3A	PSME/PHMA, PIPO	mid-seral, medium tree	A	20.2
4A	PSME/PHMA, CARU	mid-seral, large tree	A	15.6
5A	PSME/FEID, PIPO	mid-seral, large tree	A	23.0

--Partridge/Elkhorn

Stand ID	Plant Association	Seral and structural class	Rank	Size
1	PSME/PHMA, CARU	mid-seral, large tree	A	36.7
2	PSME/PHMA, CARU	mid-seral, pole tree	A	40.4
3	ABGR/VAGL	mid-seral, medium tree	A	23.0
4	PSME/PHMA, CARU	mid-seral, medium tree	A	11.0
5	PSME/PHMA, PIPO	mid-seral, medium tree	A	18.4
6	PSME/CARU, PIPO	mid-seral, large tree	AB	31.2
7	ABGR/VAGL	late-seral, large tree	A	156.1
8	PSME/PHMA, PIPO	mid-seral, medium tree	A	4.6
9	PSME/PHMA, PIPO	mid-seral, medium tree	A	23.9
10	PSME/PHMA, CARU	mid-seral, large tree	A	14.7

Map G. Partridge Creek and Partridge/Elkhorn (continued).

Map H. Sheep Creek - Old growth stand summary and delineation.

Stand ID	Plant Association	Seral and structural class	Rank	Size
1	PSME/SPBE, PIPO	late-seral, large tree	A	9.2
2	PSME/PHMA, PIPO	late-seral, large tree	A	35.8
3	PSME/SPBE, PIPO	mid-seral, large tree	A	2.8
4	PSME/SPBE, PIPO	mid-seral, large tree	A	5.5
5	ABGR/ACGL, ACGL	late-seral, large tree	A	22.0
6	PSME/SPBE, PIPO	late-seral, large tree	A	23.9
7	PSME/PHMA, CARU	late-seral, large tree	A	5.5
8	PSME/PHMA, CARU	mid-seral, large tree	BC	21.1
9	PSME/PHMA, PIPO	early-seral, shrub-herb tree	D	22.0
10	ABGR/ACGL, ACGL	mid-seral, medium tree	CD	20.2
11	PSME/PHMA, PIPO	early-seral, shrub-herb tree	D	23.0
12	PSME/PHMA, PIPO	mid-seral, medium tree	A	3.7
13	PSME/PHMA, PIPO	late-seral, large tree	A	2.8
14	PSME/PHMA, PIPO	late-seral, large tree	A	7.3

Map I. Upper Eagle - Old growth stand summary and delineation.

Stand ID	Plant Association	Seral and structural class	Rank	Size
1	PSME/FEID, PIPO	mid-seral, medium tree	B	36.7
2	ABGR/SPBE	late-seral, medium tree	C	6.4
3	PSME/FEID, PIPO	mid-seral, medium tree	B	10.1
5	PSME/FEID, PIPO	mid-seral, medium tree	B	4.6
6	PSME/SPBE	mid-seral, medium tree	B	10.1
7	ABGR/SPBE	mid-seral, large tree	BC	10.1
8	ABGR/PHMA, PHMA	mid-seral, large tree	BC	17.4
9	ABGR/LIBO, LIBO	late-seral, medium tree	A	11.9
10	ABGR/PHMA, PHMA	mid-seral, pole tree	D	14.7
11	PSME/PHMA, PIPO	late-seral, large tree	A	5.5

Map J. W Fork Lake Creek - Old growth stand summary and delineation.

Stand ID	Plant Association	Seral and structural class	Rank	Size
1	PSME/PHMA, PHMA	mid-seral, medium tree	C	67.0
2	PSME/PHMA, CARU	mid-seral, medium tree	C	23.0
3	PSME/PHMA, PHMA	mid-seral, medium tree	C	36.7
4	PSME/PHMA, CARU	mid-seral, medium tree	C	16.5
5	PSME/SYAL, PIPO	mid-seral, large tree	B	13.2
6	PSME/PHMA, PHMA	mid-seral, medium tree	C	17.4
7	PSME/SYAL, PIPO	mid-seral, medium tree	C	4.6
8	PSME/FEID, PIPO	mid-seral, medium tree	C	4.6
9	PSME/PHMA, PHMA	mid-seral, medium tree	C	7.3
10	PSME/PHMA, CARU	mid-seral, large tree	B	7.0

Map K. Warm Springs - Old growth stand summary and delineation.

Stand ID	Plant Association	Seral and structural class	Rank	Size
1	PSME/PHMA, CARU	mid-seral, large tree	B	9.2
2	PSME/FEID, PIPO	mid-seral, large tree	C	26.6
3	PSME/PHMA, PIPO	mid-seral, large tree	B	49.6
4	PSME/FEID, PIPO	mid-seral, large tree	B	8.3
5	PSME/PHMA, PIPO	mid-seral, large tree	A	58.8
6	ABGR/PHMA, PHMA	late-seral, large tree	A	7.3
7	PSME/PHMA, CARU	early-seral, shrub-herb tree	A	15.6
8	PSME/PHMA, PIPO	early-seral, shrub-herb tree	A	32.1
9	PSME/PHMA, CARU	early-seral, shrub-herb tree	A	13.8
10	PSME/PHMA, CARU	early-seral, shrub-herb tree	A	6.4
11	PSME/PHMA, PIPO	early-seral, shrub-herb tree	A	69.8
12	PSME/PHMA, PIPO	late-seral, large tree	A	14.7
13	PSME/FEID, PIPO	late-seral, large tree	A	42.2
14	PSME/PHMA, PIPO	mid-seral, large tree	B	42.2
15	PSME/PHMA, CARU	mid-seral, large tree	B	34.0
16	PSME/PHMA, PIPO	mid-seral, pole tree	B	7.3