

Forest Health

Introduction

A healthy forest is one in which biological or non-biological influences do not seriously threaten management goals now or in the future (Smith et al. 1994). Two examples of biological influences are insects and disease pathogens; an example of a non-biological influence is drought. A healthy forest is generally characterized as resilient to disturbances, and rich in species and landscape diversity (Joseph et al. 1991; Monnig and Byler 1992). The level of damage from insects and diseases is often considered an indicator of the relative health of a forest, when compared to historical damage levels.

The current concept of forest health takes into account the ecological complexities that contribute to insect outbreaks, disease epidemics, and widespread forest declines or diebacks. Its study involves many disciplines, especially those concerned with the physiological condition of trees, the functioning of forest ecosystems, and the ecology of insects and pathogens (Kolb et al. 1994; Wagener 1994). Restoring or maintaining forest health is usually accomplished through silvicultural manipulation of the forest at the stand or landscape level. Such manipulations can help sustain healthy, productive forests and keep damage from pests to acceptable levels.

The Klamath-Lake District state forests are in relatively good health compared to other eastern Oregon forests that have been experiencing insect and disease epidemics. This subsection describes insect and disease situations that presently occur on the state forests, as well as forest conditions that could lead to unacceptable levels of damage. Pest problems are often related to overstocking and imbalances in species composition. These stand conditions are also discussed in Section III, under the heading “Forest Products — Timber.”

The Oregon Department of Forestry is the lead agency in monitoring the health of Oregon’s forests and developing integrated pest management strategies for use on state managed forests (ORS 527.310 and ORS 634.122). To fulfill these responsibilities, the Department conducts annual aerial surveys and special ground surveys to detect and map areas infested with insects and pathogens. It also provides technical assistance on pest management activities implemented on state owned forest land. Here’s how this subsection is organized.

Major Headings	Topics
• Forest diseases	Root diseases, dwarf mistletoe, rust diseases, decays, foliage diseases, effects of drought, summary of important diseases by tree species
• Forest insect pests	List of commercial tree species, with information on the complex of pests affecting each species
• Management of forest health	General recommendations for managing forest health
• Management recommendations for diseases	Specific strategies, listed by tree disease
• Management recommendations for insects	Specific strategies, listed by insect

Forest Diseases

On the Klamath-Lake District state forest lands, the most important diseases affecting trees are caused by pathogens native to North America, with the exception of white pine blister rust. These native pathogens are an integral part of forest ecosystems, and have varying influences on forest vegetation. Pathogens kill trees, cause growth loss, decay wood, contribute to blowdown, increase susceptibility to insects and environmental stress, and significantly alter the species composition, tree cover, stocking, and structural diversity of stands (Baker 1988).

The effects of native pathogens on ecosystems can be viewed as positive, negative, or neutral depending on management objectives. Root diseases kill trees and reduce wood production, but the resulting canopy gaps may provide important wildlife habitat. Dwarf mistletoes decrease tree growth but provide food and habitat for certain animals, particularly birds. Wood decay fungi destroy wood, but the hollow trees provide habitat for numerous birds and mammals. A healthy forest is not necessarily one that is free of diseases or other pests, but one that fluctuates within a range of conditions that permits achieving overall ecosystem management goals.

Introduced pathogens, in contrast to native pathogens, may have a very unbalanced effect on forests. Because of the lack of co-evolved tolerance in host trees, introduced pathogens can have unusually dramatic effects on forests. An example is white pine blister rust, which has nearly eliminated western white pine from many western ecosystems (Scharpf 1993).

Although most diseases and the type of damage they cause are not new, the *amount* of damage they cause may well have changed since the turn of the century. Many current landscapes in the Klamath-Lake District reflect the effects of fire exclusion and harvesting practices on stand species composition, stand structure, and competition for nutrients and water. Several areas are dominated by shade-tolerant and fire-intolerant tree species, particularly white fir, which are generally more susceptible to diseases than seral species (Filip 1994). In addition to changes in

Key Terms

Host — An organism on or in which another organism (called a parasite) lives for nourishment or protection.

Inoculum — Material such as bacteria, viruses, or spores that implant themselves in another organism, infecting that organism and causing disease.

Pathogen — Any agent that can cause disease.

Saprophyte — Any organism that lives on decaying organic matter, such as some fungi and bacteria.

species composition resulting from fire exclusion and selective harvesting, the absence of fire has allowed an increase in the density of trees and shrubs. Because of their increased abundance, plants compete for limited site resources, which can induce stress or less than optimum growing conditions for trees. The recent drought conditions of the past eight years have exacerbated these effects.

Root Diseases

Armillaria Root Disease

Armillaria root disease, caused by *Armillaria ostoyae*, is by far the most damaging root disease on the Klamath-Lake District. *A. ostoyae* causes mortality, growth loss, decay, and loss of silvicultural options. It is particularly damaging in certain areas of Sun Pass State Forest.

All conifers can be infected by *A. ostoyae*, but there is considerable variability in resistance among conifer species. On the Klamath-Lake District, grand fir, Douglas-fir, and sugar pine all appear highly susceptible; but ponderosa pine, incense cedar, lodgepole pine, and hardwoods appear very resistant. Resistant species are killed occasionally by the pathogen, usually when inoculum levels are very high or other stresses (such as drought or nutrient imbalance) reduce resistance.

A. ostoyae is long-lived and can survive in roots or stumps of dead trees for decades. Sites remain infested until the fungus dies out or is mechanically removed. Factors that stress trees, such as compaction, drought, or root injury, increase the severity of armillaria root disease (Filip and Schmitt 1990; Shaw and Kile 1991).

A. ostoyae is a very efficient saprophyte, readily colonizing dead root systems. Stumps created during harvesting provide a food base from which the pathogen can grow and attack nearby uninfected roots. Small patches of salvage harvest often create the ideal situation for the fungus to spread into adjacent parts of the stand (Shaw and Kile 1991).

Sun Pass was surveyed by aircraft in 1988 to map location of armillaria root disease patches. The disease occurred in obvious patches in the mixed conifer climax cover type and was concentrated in the northwest corner of Sun Pass (maps are on file at the Klamath-Lake District office). Very little armillaria root disease has been observed in either the ponderosa pine or lodgepole pine cover types. The disease also occurs on scattered trees or small groups of trees throughout the forest, where it has not developed into expanding disease centers. The different behaviors can be related to variations within the fungus, population site factors, and stand composition (McDonald et al 1987; Shaw and Kile 1991).

Occurrence and severity of armillaria root disease has probably increased in recent decades for several reasons, listed below and on the next page.

1. Exclusion of fire has allowed a proliferation of shade-tolerant tree species, which are highly susceptible to the disease.
2. Selective logging of ponderosa pine has allowed an increase in susceptible tree species, particularly true fir.

3. Improper salvage logging on armillaria-infested sites has encouraged a build-up of inoculum.
4. Overstory removal (diameter limit cuts) has resulted in conversion to white fir and Douglas-fir, both of which are highly susceptible.
5. Overstocking has allowed more efficient root to root spread and a build-up of inoculum. There is also some evidence that fire, which is currently excluded, may have had a suppressive effect on *A. ostoyae* (Reaves et al. 1984).

The effects of *A. ostoyae* on timber production are generally negative. The disease also severely limits silvicultural options. Overall long-term productivity likely will be reduced even if resistant species are established, because they will experience some growth loss and mortality. Infested sites generally will have a higher silvicultural maintenance cost to keep the desired species composition and stocking levels, and may require additional monitoring efforts compared to uninfested stands.

Sites infested with *A. ostoyae* are characterized by an abundance of snags, down logs, and a generally open appearance, unless salvage logging has occurred. This structural and biological diversity might be considered a positive effect under certain objectives.

Several areas on Sun Pass that are infested with *A. ostoyae* have been harvested during the past ten years. These harvests removed susceptible trees and improved stand density, while favoring (or establishing) resistant species. Monitoring the effectiveness of these activities will provide a basis for future silvicultural decisions.

Annosum Root Disease

Annosum root disease is caused by the fungus *Heterobasidion annosum*. Two strains of the fungus occur in southern Oregon near the Klamath-Lake District: the s-group, and the p-group. The s-group attacks primarily true firs, and the p-group attacks primarily ponderosa pine (Hessburg et al 1994). Although the p-group has been documented on federal land in Klamath County, it has not been observed on the state forests. However, the s-group does occur on the Klamath-Lake District, and will be the focus of the following comments.

H. annosum has two means of spread: by growing from root to root across root contacts, and by windblown spores that germinate and grow into freshly cut stump surfaces or wounds that expose wood. Disease usually develops in a stand after harvesting when fresh stumps are colonized and the fungus grows throughout the root system and into neighboring trees via root contacts. The result is slowly expanding disease patches. Colonization of trunk wounds usually results in decay and not the development of disease centers.

Annosum root disease usually occurs at very low levels in unmanaged stands. Disease occurrence increases as the number of partial cut entries increase, particularly in mixed conifer stands (Schmitt et al 1984). On the Klamath-Lake District, Annosum root disease presently is not common and damage appears very low. However, continued partial cutting in true fir is expected to increase occurrence of this disease (Schmitt et al 1991).

Annosum root disease is strongly associated with the fir engraver beetle (*Scolytus ventralis*). During non-drought years, the beetles preferentially attack root-diseased trees, and the resulting mortality is considered a result of this pest complex. Increases in the occurrence of

annosum root disease could result in increased mortality from this complex, whereas the disease alone may not have caused a noticeable impact (Herter et al 1975; Lane and Goheen 1979; Miller and Partridge 1974). As with armillaria root disease, annosum root disease results in true fir snags and down woody material, and can be considered beneficial at certain levels. Because *H. annosum* is a decay fungus, butt logs often contain substantial decay, and infected trees often blow down.

Other Root Diseases

Schweinitzii root and butt rot, caused by *Phaeolus schweinitzii*, has been observed on the Klamath-Lake District in Douglas-fir, true fir, sugar pine, and ponderosa pine. It is most common in very old trees. The fungus causes a brown cubical decay of roots and butt in mature and overmature trees, and can predispose a tree to failure during heavy wind (Aho 1982). Hollow butts could provide habitat for certain wildlife species. Tree mortality from *P. schweinitzii* is rare on Klamath-Lake District, and the disease therefore is of minor concern.

Laminated root rot, caused by *Phellinus weirii*, is a regionally important root disease of conifers, particularly the true firs and Douglas-fir, but it has not been observed on Klamath-Lake District.

Black stain root disease, caused by *Leptographium wagnerii*, is very damaging to ponderosa and sugar pine in the Sierra range of California, and recently has been observed in ponderosa pine on the Malheur National Forest in Oregon. It has not been observed in or near Klamath-Lake District.

Dwarf Mistletoe

Dwarf mistletoes are parasitic seed plants in the genus *Arceuthobium* that infect many conifer species by means of forcibly discharged seeds. They cause tree mortality, growth loss, deformation of tree form and crown structure, and reduced seed production (Hawksworth and Wiens 1972). Infected trees are predisposed to damage from other stressors such as drought and bark beetles (Weir 1977). Dwarf mistletoes are probably responsible for the greatest tree growth loss on Klamath-Lake District. However, they can have positive effects by providing food and habitat for certain wildlife species (Sever et al 1991; Bull and Henjum 1990).

Dwarf mistletoes are very host-specific. Each dwarf mistletoe species usually causes significant damage only in a single tree species (with a few exceptions). Four species of dwarf mistletoe are known to occur on Klamath-Lake District. They are listed below, and discussed in detail in the next several pages.

1. Western dwarf mistletoe (*Arceuthobium campylopodum*): primarily infects ponderosa pine.
2. American dwarf mistletoe (*Arceuthobium americanum*): primarily infects lodgepole pine.
3. White fir dwarf mistletoe (*Arceuthobium abietinum* f.sp. *concoloris*) infects white and grand fir.
4. Douglas-fir dwarf mistletoe (*Arceuthobium douglasii*). Douglas-fir dwarf mistletoe occurs only in the Bear Valley tract.

A survey conducted by the Oregon Department of Forestry in 1976 indicated broad distribution of dwarf mistletoe throughout the ponderosa and lodgepole type islands, and a localized occurrence of white fir dwarf mistletoe. That survey also reported sugar pine dwarf mistletoe (*Arceuthobium californicum*) in one type island, but the validity of that observation has been questioned (Weir 1980). Red fir dwarf mistletoe (*Arceuthobium abietinum f.sp. magnificae*) likely occurs at the north end of Sun Pass near the Crater Lake National Park boundary, but this has not been verified.

Although limited long-distance spread occurs (Nicholls et al 1984), the most important type of spread of dwarf mistletoe is from infected overstory trees to susceptible understory trees. The severity of mistletoe infection increases most rapidly in single species overstocked stands with multiple canopy layers (Parmeter 1978; Scharpf and Parmeter 1976). However, in even-aged stands on good sites, where densities allow rapid height growth, infected host trees can grow vigorously, provided mistletoe is confined to the lower crown (Roth and Barrett 1985; Barrett and Roth 1985).

During the 1990 inventory of the Klamath-Lake District state forests, all trees tallied were given a Dwarf Mistletoe Rating (DMR) using the Hawksworth six class system (Hawksworth 1977). The amount of growth reduction depends on the amount of infection, and is correlated well with the DMR (Hawksworth and Johnson 1989). The Forest Vegetation Simulator, which was used to model stand growth on the Klamath-Lake District, uses the DMR to modify growth of infected trees and to simulate intensification of the disease over time.

Western Dwarf Mistletoe

Western dwarf mistletoe (*A. campylopodum*) occurs throughout the ponderosa pine type on Klamath-Lake District at various levels of intensity (Weir 1980). In areas with high levels of infection (DMR 5-6), pine volume growth could be less than 50 percent of normal, and significant mortality of older trees could be occurring (Hawksworth and Geils 1990). In addition, heavily infested stands may have a higher risk of catastrophic fire because infested trees are often short, and contain large brooms and pitchy branches that serve as fuel ladders to the canopy (Koonce and Roth 1980; Parmeter 1978). Heavily infected trees produce large brooms that may provide habitat for bird and animal species (Sever et al 1991; Bull and Henjum 1990).

Western dwarf mistletoe is very host-specific, and although it can infect some other conifer species, significant damage occurs only on ponderosa pine. This species of mistletoe thrives in stands with a dominant component of ponderosa pine. Spread and intensification of this dwarf mistletoe are highest in multi-storied stands of pine with infected overstory trees (Hawksworth and Scharpf 1984).

In some areas on Klamath-Lake District, damage from dwarf mistletoe has increased as result of selective harvesting without sanitation and the development of overstocked stands. However, current management includes sanitation and selection of resistant tree species during partial cutting or thinning, which should improve stand health in many situations.

Historically, western dwarf mistletoe was maintained on many sites because frequent low-intensity ground fires perpetuated its primary host, ponderosa pine. However, fires also reduced the amount of dwarf mistletoe as fires torched brooms in lower branches and killed heavily broomed overstory trees, which resulted in less inoculum in the overstory (Alexander and Hawksworth 1975). The exclusion of fire can allow intensification of dwarf mistletoe by allowing the survival of large numbers of susceptible understory trees that would otherwise have been killed by fire (Tinnin 1984).

High levels of resistance to mistletoe infection exist within native populations of ponderosa pine in Oregon, which may offer some future management opportunities (Scarpf and Roth 1992).

American Dwarf Mistletoe

The most severe infestations of American dwarf mistletoe occur in the northeast and northwest portions of Sun Pass State Forest (Weir 1980). Heavily infected trees suffer severe growth loss and produce dense brooms that may offer habitat to some bird or animal species. Clearcut harvests have reduced the dwarf mistletoe population in some areas.

In the lodgepole pine climax series, the amount of dwarf mistletoe is correlated with the bark beetle/fire cycles characteristic of the series. When fire patterns left scattered islands of infested trees, invasion of the new stand was rapid. After large intense fires (or large clearcuts), invasion was slower, and originated from the edge of the stand or from long distance transport of seeds by birds and mammals (Nicholls et al 1984; Hawksworth and Johnson 1989). The suppression of fire, coupled with bark beetle outbreaks that killed larger trees and left smaller infested trees, often created a stand structure conducive to dwarf mistletoe intensification (Alexander and Hawksworth 1975). Occurrence of American dwarf mistletoe should decrease as existing lodgepole stands come under management.

White Fir Dwarf Mistletoe

White fir dwarf mistletoe is less obvious than the other mistletoes because the plants are small and do not cause large brooms. However, the associated canker fungus, *Cytospora abietinum*, causes branch flagging, which can be highly noticeable (Filip 1984). White fir dwarf mistletoe is not widespread in Sun Pass, and is concentrated in the north-central portion (Weir 1980). It also occurs on the Yainax Butte tract.

White fir dwarf mistletoe causes significant growth loss in true fir (Filip 1984), and infested trees are more susceptible to attack by fir engraver than uninfested trees (Stevens and Hawksworth 1984). With continued fire exclusion and a proliferation of true fir, dwarf mistletoe occurrence is expected to increase in white fir.

Douglas-Fir Dwarf Mistletoe

Douglas-fir dwarf mistletoe occurs only in the Bear Valley tract. The pathogen causes large visible brooms that act as nutrient and water sinks, which can severely impact growth and survival of Douglas-fir. Heavily infested trees often exhibit top-kill and branch dieback. The large dense brooms offer habitat for birds and animals, providing nesting, roosting, and hiding cover (Bull and Henjum 1990). In this respect, Douglas-fir dwarf mistletoe might be considered beneficial and desirable.

Rust Diseases

White Pine Blister Rust

White pine blister rust is caused by the fungus *Cronartium ribicola*, which was introduced from Europe into British Columbia in 1910. By 1930 the disease had spread south through Oregon and into California. Because the pathogen did not co-evolve with white and sugar pines, it encountered little resistance and decimated both white and sugar pines throughout their range (Kimmey and Wagener 1961).

C. ribicola has a complex life cycle that involves five different spore stages and two different host plants. The primary hosts are the five-needle pines, and the secondary hosts are plants of the gooseberry family (*Ribes spp.*). Only spores produced on *Ribes* can infect pines.

The amount of damage sustained by sugar pine depends on several factors, including proximity to *Ribes* plants, microclimate, rainfall, and temperature. *Ribes* is commonly associated with sugar pine, and is particularly abundant in moist areas (DeNitto 1986). Rainfall and temperature exert strong influence on whether or not infection of pine occurs. Many years may pass without conditions suitable for infection, but in years where conditions are particularly favorable, infection and subsequent damage can be very high (Mo-Mei and Cobb 1991; Kimmey and Wagener 1961). Years in which high infection rates occur are often referred to as wave years. Based on observations of the occurrence of rust cankers and abundance of *Ribes*, it appears that rust hazard generally is very low on Klamath-Lake District state forests. However, moist stream bottoms likely offer a relatively higher hazard than other sites, and management activities and weather can significantly alter rust hazard (DeNitto 1986).

Resistance in sugar pine is attributed mainly to a single dominant major gene (referred to as major gene resistance, or MGR), although other mechanisms also exist. MGR is the most important mechanism because it is highly heritable, which allows propagation of resistant trees. However, this gene occurs very infrequently in the natural sugar pine population near Sun Pass and on other Klamath-Lake District lands, occurring in only 1 in 100 individuals (Kinloch 1992).

One race of *C. ribicola* that occurs in the vicinity of Happy Camp, in northern California, can attack and kill sugar pine that have major gene resistance. However, this strain has not been found in Oregon (Kinloch and Dupper 1987).

Although mature sugar pine may either escape infection or exhibit some age-related resistance, young sugar pine are particularly susceptible to the disease. As a consequence, replacing trees lost to natural causes or harvesting can be difficult, which jeopardizes the future of sugar pine as an important minor component of Klamath-Lake District ecosystems. Special measures such as hazard rating, pruning, and planting resistant seedlings will be necessary to ensure its continued presence in various ages and sizes.

In 1992, the Department of Forestry, in cooperation with the U.S. Forest Service Dorena Tree Improvement Center, established a study to assess the performance of sugar pine seedlings that have varying degrees of resistance to white pine blister rust. Information from this study

will also provide some information about how to assess rust hazard. The Klamath-Lake District has also collected seed from apparently rust-resistant forest trees on Sun Pass, and is having this seed tested for resistance at the Dorena Tree Improvement Center in Cottage Grove, Oregon.

Western Gall Rust

Western gall rust is a disease of two- and three-needle pines caused by the fungus *Endocronartium harknessii*. It damages trees by either killing seedlings directly, or by causing stem deformation, which can result in wind breakage or loss of wood quality. It is a native pathogen, and spreads directly from pine to pine by airborne spores.

On the Klamath-Lake District, lodgepole and ponderosa pine are affected, but the disease is most common on lodgepole pine. Infection rates tend to be highest on rapidly growing trees and damage is often greatest in even-aged, well-spaced plantations (Finck et al 1991). Because this is a native pathogen, some resistance exists within the population of pines.

Decays

Several decay fungi affect the tree species on Klamath-Lake District state forests. The most common and most important decay is rust red stringy rot, caused by the fungus *Echinodontium tinctorium*, often referred to as Indian paint fungus. It primarily affects white and red fir. Indian paint fungus spreads when airborne spores released from conks infect host trees through small branchlet stubs formed on suppressed understory trees. As the infected tree expands in diameter, the infections become encased and remain dormant for many years. The decay process is stimulated by mechanical injuries, frost cracks, or insect attacks that occur near the dormant infections (Filip et al 1983).

The highest rates of Indian paint fungus infection and decay occur in uneven-aged stands in which white fir develops under a closed canopy. Overstory removals and the exclusion of ground fires favor increased occurrence of the disease. Trees greater than 150 years old tend to have more decay than younger trees, and large wounds result in more decay than small wounds. Decay caused by this fungus can be stimulated by fir engraver beetle attacks.

Indian paint fungus is the primary cause of cull white fir trees on Klamath-Lake District, but decay in standing live trees and down logs also provides roosting and nesting opportunities for a variety of wildlife species. Frequency and amount of decay can be reduced through management. However, overly aggressive management could have a negative impact on habitat availability for certain wildlife species.

Heterobasidion annosum is the most common wound-invading decay organism in white and red fir. Its occurrence and severity is directly related to the amount of tree wounding that occurs in a stand. *Phellinus pini*, also called white speck or red ring rot, can be damaging in Douglas-fir, but occurs at very low levels on Klamath-Lake District. Brown cubical rot, caused by *Phaeolus schweinitzii*, causes a butt rot in most conifers, but appears to be of minor importance on Klamath-Lake District.

Foliage Diseases

Numerous foliar pathogens attack conifers on Klamath-Lake District state forests. However, most are of little economic or ecologic importance. These pathogens typically increase in abundance during years when conditions are conducive to disease development, then quickly subside. Some examples include *Lophodermium spp.* and *Lophodermella spp.* on pines, and *Rhabdocline spp.* on Douglas-fir.

One disease, Elytroderma needle blight of ponderosa pine (caused by *Elytroderma deformans*), can have a significant impact on tree growth because the pathogen grows into the twig, where it can persist and deform branches. The most noticeable symptom is compact upward-turning witches brooms at branch ends (Childs 1968).

On moist cool microsites that favor infection, *E. deformans* can cause growth reductions in excess of 50% in mature trees. Young trees can be permanently stunted and deformed. Heavily infected trees are also subject to bark beetle attack (Childs 1968). Although not clearly documented, there may be resistant individuals within the population of ponderosa pine.

Effects of Drought

The effects of drought on trees are cumulative. Several years of subnormal moisture can severely compromise tree vigor and the associated ability to withstand attacks by pathogens and insects. Similarly, the effects of overstocking will be magnified during drought years. As a result, tree mortality usually increases during and shortly after a drought period. An example of this is the current mortality on Klamath-Lake District state forests caused by the fir engraver, mountain pine beetle, and armillaria root disease.

Summary of Important Diseases, by Tree Species

White Fir

Across most Klamath-Lake District lands, white fir is currently the tree species most damaged by disease. It is highly susceptible to both armillaria and annosum root diseases. Indian paint fungus causes extensive decay, particularly in trees more than 120 years old. Dwarf mistletoe and the associated *Cytospora* canker are damaging in some locations. White fir is very susceptible to decay following mechanical injury. Periodic harvests that create stumps and wounds on residual trees would probably increase the amount of decay and the occurrence of annosum root disease in the future (Filip and Schmitt 1990).

Douglas-Fir

Douglas-fir appears very susceptible to armillaria root disease on Klamath-Lake District lands. In the Bear Valley tract, dwarf mistletoe is its most damaging disease. In trees older than 150 years, brown cubical butt rot (*P. schweinitzii*) and red ring rot (*P. pini*) may occur.

Sugar Pine

The most important diseases of sugar pine on Klamath-Lake District state forests are white pine blister rust and armillaria root disease. Sugar pine is highly susceptible to *Armillaria* and is severely damaged on infested sites. Although hazard for blister rust damage is generally low, damage during wave years could be severe, particularly in young trees. Sugar pine is sensitive to moisture stress (drought effects), and mortality from *Armillaria* and bark beetles appears to increase during drought years. Other diseases of sugar pine are of minor importance.

Ponderosa Pine

The disease most damaging to ponderosa pine on Klamath-Lake District lands is western dwarf mistletoe, which occurs throughout the pine type. The disease causes growth loss and mortality, reduces wood quality and seed production, and predisposes trees to bark beetle attack. In many areas past logging practices have allowed dwarf mistletoe to increase in severity, as infected trees were retained in the overstory and sites became overstocked. Recent activities have included sanitation thinning and well-reasoned tree selection, which have improved the situation in many areas.

Ponderosa pine is one of the conifers most resistant to armillaria root disease, and is favored in *Armillaria*-infested sites. However, it is occasionally damaged in *Armillaria* disease patches, usually when inoculum density is high, or when other stress occurs.

Numerous other diseases affect ponderosa pine, and some, particularly foliage diseases, can be very noticeable (Hepting 1973). However, none have been particularly important on the Klamath-Lake District.

Lodgepole Pine

The two most important diseases of lodgepole pine on Klamath-Lake District lands are American dwarf mistletoe and western gall rust. Lodgepole pine appears to have some resistance to armillaria root disease, and is a desirable species in areas infested with *A. ostoyae*.

Red Fir

Dwarf mistletoe and stem decay (particularly *E. tinctorium*) are the most important diseases of red fir. Although red fir is susceptible to annosum root disease, it has not been observed in red fir on Klamath-Lake District lands.

Incense Cedar

The most common and damaging disease of incense cedar is heart rot caused by *Polyporus amarus*, which can account for significant cull in logs. Other diseases, such as *Gymnosporangium* rust and leafy mistletoe (*Phoradendron sp.*), can be conspicuous, but are seldom damaging (Hepting 1971). Incense cedar appears resistant to armillaria root disease (Filip 1977), and therefore might have some utility in areas affected by root disease.

Black Cottonwood

The most important diseases of cottonwood are stem cankers and foliage diseases, which can be particularly damaging to young trees. Damage is most severe when stock is poorly suited to the local environment. Cottonwood is very susceptible to decay following wounding.

Quaking Aspen

Aspen is frequently decayed by *Phellinus tremulae*, which causes a soft yellowish decay of the central core of the trunk. Aspen is very prone to decay following wounding.

Forest Insect Pests

Aerial survey records spanning nearly fifty years indicate that bark beetles are the insects most commonly associated with tree mortality in eastern Oregon. Bark beetles act as natural thinning agents for overstocked stands (too many trees per acre), and they initiate the release of nutrients locked in fallen and diseased trees. Over the last decade in Klamath County, tree mortality from bark beetle attacks has increased dramatically (Oregon Department of Forestry, 1969-1994). The three figures on the next two pages depict the trends graphically. Factors predisposing stands to bark beetle outbreaks are overstocking, disease, weather damage, and drought. Recurring drought coupled with bark beetle outbreaks are the major natural disturbance affecting forest health in Klamath County (see “Climate” and “Biodiversity” earlier in Section III).

A human-made factor contributing to stand overstocking and bark beetle outbreaks is fire suppression on forest land. Fire control has increased the survival of all young trees and allowed tree species once excluded by fire to colonize drier sites (see “Vegetation” and “Biodiversity” earlier in Section III). Both drought and the cumulative effects of fire suppression are responsible for the major bark beetle outbreak now occurring in white fir stands. During the past decade, the level of white fir mortality in Klamath County has exceeded historic norms and developed into a major forest health problem, particularly from the standpoint of fuels build-up and the potential for catastrophic fire.

In addition to bark beetles, defoliating insects such as the Modoc budworm, Douglas-fir tussock moth, and black pine leaf scale also occur in Klamath County (Oregon Department of Forestry, 1969-1994). These insects feed on the foliage of conifers during outbreaks lasting several years. Typical defoliator outbreaks reduce tree growth, damage tree form, and in some instances cause tree mortality.

Each tree species has a complex of insects that may interfere with management objectives, particularly commodity production. These insects are often referred to as pests. On the pages following the three graphs, there is a list of the commercial tree species on Klamath-Lake District, with a discussion of the complex of insect pests affecting each species. Stand conditions that promote pest activity are also discussed.

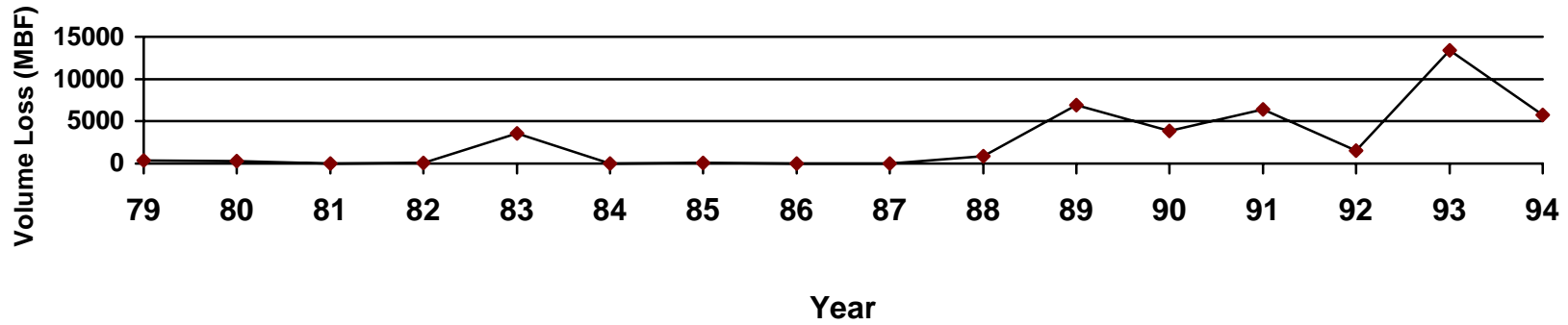


Figure III-5. Fir Engraver Damage to White Fir in Klamath County

The most important bark beetle attacking white fir is the fir engraver beetle (*Scolytus ventralis*).

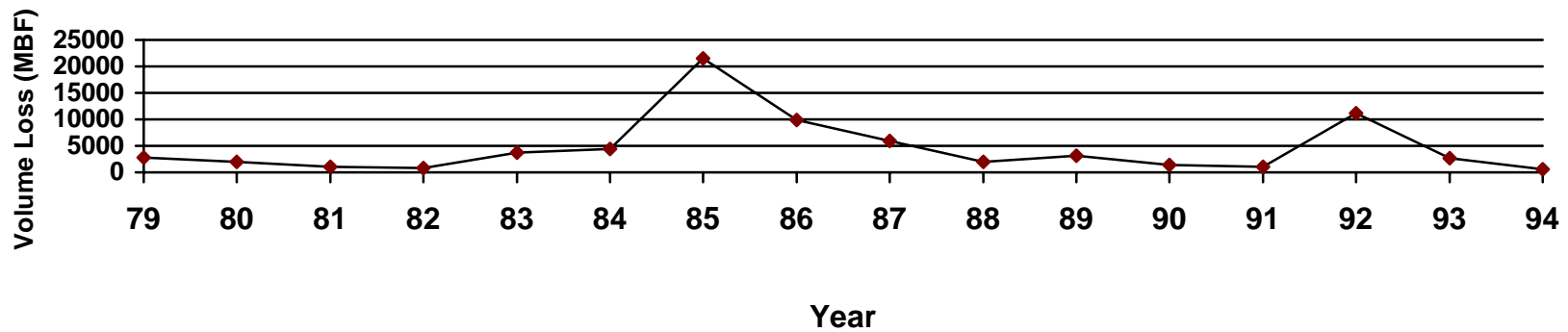


Figure III-6. Mountain Pine Beetle Damage to Ponderosa Pine in Klamath County

The mountain pine beetle (*Dendroctonus ponderosae*) is one of the three major bark beetles attacking ponderosa pine.

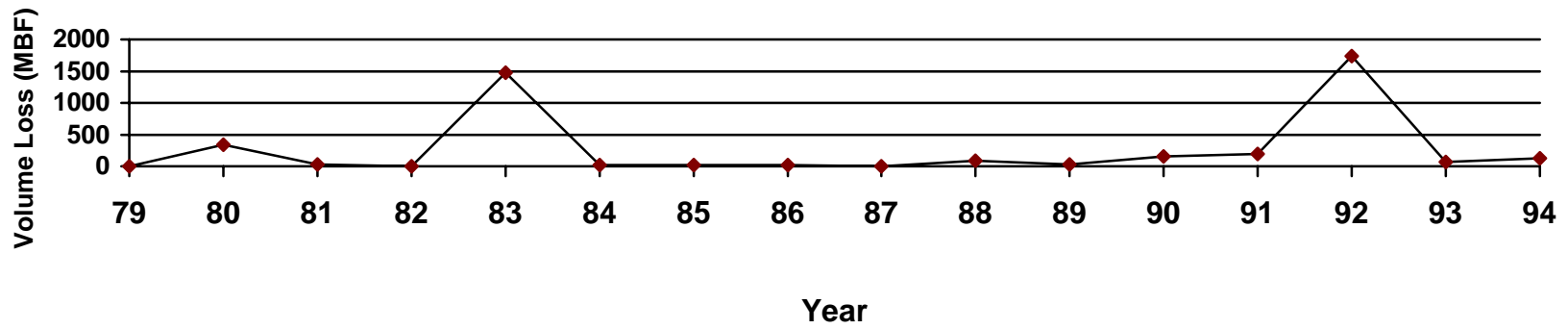


Figure III-7. Mountain Pine Beetle Damage to Sugar Pine in Klamath County

Mountain pine beetle (*Dendroctonus ponderosae*) is the most important insect pest of sugar pine.

Ponderosa Pine

Competition between trees for light, moisture, and nutrients is critical in determining the growth, vigor, and survival of pines. As trees increase in size, fewer and fewer can be supported by the resources available on a given acre of ground (Peet and Christensen, 1987). Before the turn of the century, fire acted as a natural thinning agent in young ponderosa pine stands (Weaver 1943). Without the benefit of periodic thinnings, ponderosa pine stands quickly increase in susceptibility to bark beetles (Eaton 1941, Sartwell and Stevens 1975). Tree diameter growth slower than 1.0 inches per decade is typical of ponderosa pine susceptible to bark beetle attack (Sartwell 1971). Studies in ponderosa pine stands have identified basal areas of 120-150 square feet per acre with a risk of bark beetle infestation (Sartwell and Stevens 1975, Larsson and others 1983, Schmid and Mata 1992). During drought, overstocked stands of ponderosa pine are also vulnerable to high levels of tree mortality from bark beetles (Miller and Keen 1960). Ponderosa pine is the major component of most pine stands occurring on state-managed forest land (see “Vegetation” earlier in Section III). At present, many of these ponderosa pine stands can be classified as overstocked and at risk from bark beetle infestations.

The major bark beetles attacking ponderosa pine are the mountain pine beetle (*Dendroctonus ponderosae*), the western pine beetle (*Dendroctonus brevicomis*), and the pine engraver beetle (*Ips pini*). The mountain pine beetle most frequently infests ponderosa pines with a DBH (diameter breast height) greater than 8 inches that are located in overstocked stands (Sartwell and Stevens 1975). Site class has a major influence on the character of tree killing by the mountain pine beetle (Sartwell 1971). See the “Background Information” box below for an explanation of site class. On Site Class III areas, mountain pine beetle infestations constitute a thinning from below. Tree killing is essentially indiscriminate in regard to diameter classes on Site Class IV areas. On Site Class V or poorer areas, however, beetle attacks act as a thinning agent from above.

Background Information

Site class is a measure of an area’s relative capacity for producing timber or other vegetation. It is measured through the site index. The site index is expressed as the height of the tallest trees in a stand at an index age (King 1966). In this document, an age of 50 years is used. Site indexes for Klamath-Lake District state forests are given in Table III-2, on page III-12. The 5 site classes are defined below.

- Site class I — 135 feet and up
- Site class II — 115-134 feet
- Site class III — 95-114 feet
- Site class IV — 75-94 feet
- Site class V — Below 75 feet

The western pine beetle has 2-3 generations per year in eastern Oregon and is a significant pest of pines with a DBH greater than 6 inches (DeMars and Roettgering, 1982). This beetle is noted for killing large old growth ponderosa pine and was responsible for much of the mortality in bald eagle nest trees around the shore of Klamath Lake from 1990-1993. Overstocked stands of ponderosa pine growing on harsh sites are considered at particular risk for western pine beetle infestations. High risk sites on Klamath-Lake District occur where ponderosa pine is growing in association with western juniper, incense cedar, or mountain mahogany. Western pine beetle outbreaks often develop during drought periods (Miller and Keen, 1960).

Like the other ponderosa pine bark beetles, the pine engraver beetle can act as a thinning agent in overstocked stands. Typically the trees attacked are sapling or pole-sized pine down to 2-8 inches in diameter; the trees may have been damaged by wind, snow breakage or fire. Pine engraver beetles are especially aggressive in drought years and kill the tops of older pines, while the lower boles are attacked by other species of bark beetles. Populations of this beetle can build up rapidly under favorable conditions since there are 2-3 generations per year (Sartwell and others, 1971). The pine engraver beetle can also be a pest in managed ponderosa pine stands. A problem develops when beetle populations breed in thinning slash and attack leave trees.

Defoliating insects have not been significant pests of ponderosa pine in Klamath County. However, there have been localized outbreaks of black pineleaf scale (*Nuculaspis californica*) and the pine needle scale (*Chionaspis pinifoliae*) in the vicinity of Keno and Klamath Lake. The repeated loss of older needles as a result of scale feeding causes the tree's crown to deteriorate. Eventually the effects of defoliation or bark beetle attacks kill badly infested trees. Scale outbreaks are often associated with environmental conditions that are detrimental to the scale's complex of natural enemies. These conditions include accumulations of dust on foliage from roads and insecticide drift from nearby vector control or orchard operations (Ferrell 1986a). Drought conditions may also favor scale outbreaks. Tree mortality from scale infestations often occurs in overstocked stands of pole-sized pines with poor live crown ratios.

White Fir

The current drought has been associated with a dramatic increase in white fir mortality on the Klamath-Lake District. Similar tree mortality on the nearby Modoc National Forest has been correlated with white fir growing on pine or pine-associated sites that receive 20-30 inches of annual precipitation (USDA Forest Service 1994). The most important bark beetle attacking white fir is the fir engraver beetle (*Scolytus ventralis*). During 1993 fir engraver infestations occurred on over 180,000 acres of Klamath County forest land (Oregon Department of Forestry, 1969-1994). Endemic fir engraver populations infest trees weakened by root disease or injury. Fir engraver outbreaks occur in the year following a period of subnormal precipitation or logging activity (Ferrell 1973). Logging activity increases the probability of fir engraver attacks because the beetles can breed in fresh slash and emerge the following year to attack leave trees with low vigor. Recent data suggests that stands with high basal areas and a large component of white fir suffer greater mortality

from fir engraver attack during periods of drought. In drought-related outbreaks it is often the dominant or codominant trees that are killed (Ferrell and others, 1994). Tree symptoms from fir engraver attacks are variable and include dead branches, top kill, and complete tree mortality (Ferrell 1986b). Fir engraver attacks that do not produce tree mortality cause scars that persist for years. Old attack scars are associated with defects such as stain, ringshake, and decay, which reduce the value of white fir for solid wood markets (Struble 1957). Pockets of white fir that are dead and dying from fir engraver beetle attack are scattered throughout Klamath-Lake District lands. Some mixed pine and white fir stands in the Yainax Butte area have high levels of white fir mortality.

The most common defoliating insect associated with white fir in Klamath County is the Modoc budworm (*Choristoneura viridis*). Between 1982 and 1987 a Modoc budworm outbreak defoliated up to 210,000 acres of white fir stands (Oregon Department of Forestry, 1969-1994). Defoliation was observed on state forest lands in the Yainax Butte area. Modoc budworm outbreaks normally last from 3 to 4 years. This insect's feeding is concentrated in the new foliage located in the tops of white fir. Impact studies indicate that about 10% of defoliated trees suffer top kill, and radial growth loss is confined to the upper bole where defoliation is taking place. White fir mortality from Modoc budworm infestations has not been detected (Ferrell, 1980a).

The Douglas-fir tussock moth (*Orgyia pseudotsugata*) is potentially the most serious defoliator of white fir, and it has a history of outbreaks in Klamath County. One historic outbreak area is located 20 miles north of Klamath Falls and east of Highway 97 on Chiloquin Ridge. The last tussock moth outbreak took place in 1978 on Bryant Mountain located east of Klamath Falls. State forest lands that are east of Highway 97 and have a large white fir component are at the greatest risk of infestation. Outbreaks develop explosively with both new and old foliage consumed, starting in the upper crown and working downward. Uneven-aged stands of white fir growing on pine or pine-associated sites are the most susceptible to damage (Wickman and others, 1981). Tree mortality, top kill, and a reduction in radial growth have been documented during the course of a four year tussock moth outbreak in white fir. In heavily defoliated areas, 50% of the understory trees (six inches DBH and under) were killed. Following the tussock moth outbreak, attacks by cambium feeders such as the fir engraver beetle often continue to cause mortality among damaged white fir trees. (Wickman 1963).

Lodgepole Pine

The largest bark beetle outbreaks in eastern Oregon involve the mountain pine beetle (*Dendroctonus ponderosae*) infesting lodgepole pine stands. Trees attacked during these outbreaks usually have a DBH greater than 7 inches. Drought is not important to the development of these outbreaks, and infested acres in Klamath County have actually declined during the current drought. Mountain pine beetle outbreaks are sustained by lodgepole pine stands having basal areas in excess of 100 square feet per acre and containing a high proportion of trees with a DBH greater than 8 inches (Mitchell and others 1983, Preisler and Mitchell 1993). Unlike the mountain pine beetle outbreaks in ponderosa pine, site class appears to make little difference in the pattern of tree mortality (Mitchell

1989). Only a small proportion of Klamath-Lake District state forests consist of the pure lodgepole pine stands old enough to be susceptible to mountain pine beetle infestations at this time.

Sugar Pine

Sugar pine is a small but significant component of mixed conifer stands found on Klamath-Lake District. By far the most important insect pest of sugar pine is the mountain pine beetle, *Dendroctonus ponderosae* (Struble 1965). Once trees reach a DBH of at least 6 inches they are susceptible to beetle attack. Some mortality is occurring in small diameter sugar pine on Sun Pass State Forest, mostly in overstocked mixed conifer stands. Trees infected with white pine blister rust are often killed by mountain pine beetle attack. Sugar pine is considered more susceptible than ponderosa pine to mountain pine beetle attacks (Mitchell 1989). Drought conditions in Klamath County have increased sugar pine mortality from beetle attack (Oregon Department of Forestry, 1969-1994). Since sugar pine is highly susceptible to mountain pine beetle infestation, maintaining large trees for seed production, wildlife benefits, and timber will require active stocking control.

Incense Cedar

The cedar bark beetles (*Phloeosinus* spp.) are the only significant insect pest of incense cedar. These beetles normally infest the limbs, tops, and boles of weakened and dying trees. However, during drought periods these beetles become more aggressive and kill apparently healthy cedar (Furniss and Carolin, 1977). Scattered mortality in incense cedar from bark beetle attacks has been reported in Klamath County during the current drought. In most cases tree mortality is occurring at elevations under 5,000 feet on poorer sites. Since incense cedar is a very minor component of stands on Klamath-Lake District, insects affecting this tree do not pose a significant threat to management objectives.

Douglas-Fir

Douglas-fir has a very limited occurrence in Klamath County and historically has few insect problems. It is likely that most tree mortality involving insects will be associated with conditions reducing tree vigor such as root disease or drought. Bark beetles that attack stressed trees include the Douglas-fir beetle (*Dendroctonus pseudotsugae*) and the Douglas-fir engraver (*Scolytus unispinosus*). The flatheaded fir borer (*Melanophila drummondi*) also attacks and kills apparently healthy Douglas-fir growing on dry sites (Furniss and Carolin, 1977).

Red Fir

Red fir is confined to high elevation areas of Sun Pass that receive more than 30 inches of precipitation per year. Trees that have poor crowns from dwarf mistletoe infections and the canker disease *Cytospora* are particularly vulnerable to wood borer attacks. Infestations by

the rounded fir borer (*Tetropium abietis*) and flatheaded fir borer were associated with 80% of the red fir mortality (Ferrell 1980b, Furniss and Carolin 1978). These insects mine the cambial area much like a bark beetle. Root disease and the shock that results when stands are opened up during harvest operations can reduce tree vigor and predispose trees to beetle attack. The fir engraver beetle also infests red fir, but less frequently than white fir occurring on drier sites.

Management of Forest Health

Strategies to improve or maintain forest health must consider all components of the forest ecosystem. Because soil, water, animals, vegetation, and human activities are interdependent, whatever affects one of these will also affect the others either directly or indirectly. Strategies to improve forest health and reduce impacts of pests must be based in the ecology of these systems, and must be tailored to individual stands, situations, and objectives.

Forest health is somewhat synonymous with forest insects and diseases. Unhealthy forests are characterized by dead trees, dead branches, loss of foliage, and numerous other symptoms of disease or insect damage. Insects and diseases are normal components of Klamath-Lake District ecosystems. These ecosystems have been altered by fire suppression and harvesting, and the role of insects and diseases has also been altered.

Much improvement in forest health can be achieved by applying existing silvicultural treatments and technologies. New approaches to management should be explored, and existing methods monitored closely to ensure that the best strategies are used.

Management objectives for Klamath-Lake District lands vary over the forest and often differ from one stand to the next. These objectives will influence the desired future condition. Some objectives could involve preserving or creating unhealthy trees or snags in order to provide wildlife habitat. This would increase biodiversity and create the stability and resilience that is needed to maintain the long-term health of the forest. However, even though stand objectives may differ, some general strategies form the basis of maintaining a healthy forest.

In the next few pages, general approaches are described for achieving forest health goals and solving forest health problems. Pest damage is considered to be an indicator of forest health. Therefore, the strategies to achieve forest health goals aim to keep the effects or impacts of pests to acceptable levels. It is expected that the levels of effects that managers find to be acceptable will vary over time and in different locations, as objectives and constraints change.

Integrated Pest Management

The Department of Forestry is mandated to employ Integrated Pest Management (IPM) as described in ORS 527.310 to 370. The law states that “The State Forester shall implement the Integrated Pest Management process as provided in ORS 527.315 on department-managed lands...” IPM is not a strategy, but a coordinated decision-making process that uses the most appropriate of all reasonably available means, tactics, or strategies, blended together to minimize the impact of forest pests in an environmentally sound manner to meet site-specific management objectives.

Components of the IPM process are listed below.

1. Define the management unit.
2. Define the site-specific management objectives.
3. Establish detection and monitoring systems for pests or damage.
4. Evaluate pest conditions in the management unit.
5. Establish pest population or damage thresholds, and take action only when exceeded.
6. Develop potential strategies and evaluate them with the following criteria:
 - a) Effectiveness
 - b) Operational feasibility
 - c) Cost-effectiveness
 - d) Ecological soundness
 - e) Environmental impact
 - f) Management objectives for the site
7. Implement the selected strategy.
8. Monitor and evaluate results of the activity.
9. Maintain current and accurate records.
10. Structure program so it can be adjusted to accommodate changes or varying situations.

Adaptive Ecosystem Management

Adaptive ecosystem management is a continuing learning process based on reiterative experimentation on a large scale that integrates biological, political, and social values (Everett et al 1994). It begins with designing, selecting, and implementing sets of actions based on current information. Subsequent steps include monitoring progress and evaluating results of the actions. The information gained is then used to adjust goals, redirect management, and redesign actions, which are then implemented and evaluated. A key point of this approach is that it deals with uncertainty by increasing the opportunities to redirect management as new information becomes available.

Decisions must be made despite rudimentary or incomplete understanding of the forest ecosystem. Understanding can be improved by monitoring the effects of silvicultural activities on forest health, using a predetermined set of criteria. These criteria could be mortality rates, growth rates, amount of defect, pest populations, etc.

Monitoring

Suggested monitoring items are listed below.

Aerial Surveys

Statewide aerial surveys for pest damage are conducted annually by the Department of Forestry's Insect and Disease section and the U.S. Forest Service. These surveys provide data on pest trends and identify potential salvage areas. Special surveys are conducted as needed. For example, a special aerial survey in 1988 mapped armillaria root disease patches. Aerial surveys allow planning and management at a scale larger than individual stands or sale areas.

Ground Surveys

Ground surveys are employed to quantify specific insect and disease concerns, usually at the stand level. Ground surveys are generally used for root diseases, which generally occur in discrete areas or patches. They may be used to provide early detection of potential pests such as black stain root disease, or to assess hazard for white pine blister rust.

Stand Exams and Resource Inventories

Pest information and damage is recorded as part of periodic stand exams. This information allows estimation of pest abundance, mortality rates, and tree survival. Information on specific pests such as dwarf mistletoes has been useful (Weir 1980), and provides stand level and forest-wide information. Information is also entered into simulation models that can incorporate certain pest effects. Periodic resampling allows evaluating the effects of management at the forest level. Continued determination of the causes of mortality will increase the chances of early detection of new pests.

Trapping

Trapping for certain insect pests, such as the Douglas-fir tussock moth, allows population trends to be monitored and provides early warning of outbreaks. The Klamath-Lake District has been monitoring the tussock moth population through trapping for many years. The district will cooperate with other agencies in detection trapping for potentially damaging exotic pests.

GIS (Geographic Information System)

An important part of monitoring is the long-term tracking of damage levels and pest populations. By incorporating pest-related information into the GIS, high hazard areas can be identified and silvicultural experiments monitored.

Silvicultural Treatments

Silvicultural activities are the principal tools for maintaining a healthy forest. Silvicultural treatments promote tree vigor, diversity, and long-term productivity.

- **Maintain appropriate stocking levels.**

Overstocking can result in high levels of pest-caused damage. Bark beetles in particular can devastate overstocked stands. Thinning can greatly reduce bark beetle losses, and should be done as stand improvement even if not a commercial operation. Similarly, tree stress associated with overstocking can increase susceptibility to and damage from diseases such as armillaria root disease and dwarf mistletoes. Thinning young stands promotes vigorous growth and is recommended in several situations where armillaria and/or dwarf mistletoes are present (Barett and Roth 1985).

- **Favor appropriate species.**

Prescribed burning, thinning, and selective harvesting can reduce the numbers of undesirable species. White fir that encroach onto pine sites because of fire suppression are often highly damaged by fir engraver beetles. White fir, Douglas-fir, and sugar pine are highly damaged in areas affected by armillaria root disease, while the resistant ponderosa pine, incense cedar, and lodgepole pine are favored on these sites. In multi-species stands with dwarf mistletoe, often only one species is damaged. Because each dwarf mistletoe is specific to one host, proper selection can prevent increasing damage, while improper choices can exacerbate the disease.

- **Maintain stand structure.**

Even when a stand has the desired species, stand structure can influence pest damage. Dwarf mistletoe damage increases most rapidly in multi-storied stands of a single tree species, particularly when the overstory is infested. However, if a stand can be manipulated into a relatively uniform layer with good stocking, damage can be mitigated by rapid tree growth and the inherent slow spread of the disease.

- **Maintain a diversity of tree species.**

In addition to favoring tree species that are resistant to pests, a diversity of species and genotypes within a species will offer some security from unknown pests or environmental extremes and reduce the risk of catastrophic losses. In general, a diverse forest will be better able to survive an unexpected extreme event than a single species forest.

- **Take advantage of genetic variation within tree species.**

Favor pest-resistant individuals during partial cuts, either as seed trees or leave trees. Unless diseased trees are desirable, which may be the case with either dwarf mistletoe or stem decay, remove them during partial cuts to favor individuals with some apparent resistance. For example, resistance to white pine blister rust and western gall rust are under strong genetic control, so long-term resistance in a stand can be improved by removing diseased individuals and allowing the more resistant individuals to remain in the natural breeding population.

- **Plant disease-resistant seedlings.**

Blister rust-resistant sugar pine seedlings are currently available in limited quantities and should be increasingly available as more resistant trees are located and propagated. Sugar pine planting should be done with resistant stock, particularly if local rust hazard is high. Pruning is also recommended to prevent the development of lethal cankers on sapling sugar pine.

- **Minimize injury to trees during stand management, by using appropriate logging systems.**

Direct mechanical injury to trees is a major contributor to stem decay, especially in true fir. Measures to reduce injury to trees during logging appear in the decay section detailed below.

- **Avoid damage to soils, which can cause tree stress and increase susceptibility to pests.**

Tree stress can be caused by soil compaction and other kinds of soil damage that injure tree roots, impede water infiltration, and inhibit gas exchange in roots. Several diseases, particularly armillaria root disease and canker diseases, can become damaging on stressed trees. Bark beetles such as the fir engraver also show preference to attacking trees under stress.

- **When planting, use seedlings that are well-suited to the site and avoid unnecessary planting stress.**

Improper planting can result in considerable stress and increase a tree's susceptibility to certain pests. Planted seedlings in many cases are more susceptible to armillaria root disease than naturally established seedlings. Poorly planted trees also show increased damage from armillaria root disease.

Preventing Build-Ups of Pest Populations

- **Salvaging / sanitizing infested stands.**

Harvesting dead and dying trees during the period from fall through early spring removes bark beetle populations along with the timber. Care must be taken not to exacerbate armillaria root disease in certain areas.

- **Managing slash accumulations from January to July.**

Whenever possible, avoid large accumulations of true fir and pine slash from January to July. Slash produced during these months provides breeding material for bark beetles that often attack live trees. If slash accumulations are unavoidable, treat slash to promote rapid drying.

- **Stump treatments with Borax to prevent annosum root disease.**

Annosum root disease occurs at low levels on Klamath-Lake District. Treatment of conifer stumps greater than 12 inches in diameter immediately after falling can prevent the invasion of *H. annosum* into uninfested stands.

Hazard Trees

Tree failure in recreational areas poses a risk of personal injury or property damage to recreation users. Most tree hazards result from tree defects or soil conditions that contribute to tree failure. In developed recreation sites, tree hazard should be evaluated and managed to reasonably protect users.

Specific Management Recommendations for Diseases

The Department of Forestry's Insect and Disease section has recommended the following strategies to minimize the impacts of the most important diseases on Klamath-Lake District.

Armillaria Root Disease

Because *Armillaria* is an opportunistic pathogen that takes advantage of tree stress, stocking control to reduce density-related susceptibility is important. Stand management activities that reduce stress from moisture competition, logging injury, and site disturbance are encouraged and should reduce losses from *Armillaria*. There is some evidence that over the long run, ground-based harvesting systems will result in more losses to *Armillaria* than cable-based logging systems (personal communication, C.L. Schmitt, 1994). The probable explanation is that the root disturbance, soil compaction, and tree injury are greater with ground-based systems, and these conditions favor development of *Armillaria*. In root disease patches, salvage is not recommended unless the salvage includes treating the area to ensure adequate stocking of highly resistant species in the residual stand. Stumps created by harvesting infected trees allow a build-up of *Armillaria* inoculum, which can result in significant mortality in leave trees. When possible, favor natural regeneration over planting because planted trees appear slightly more susceptible to *Armillaria* than natural regeneration.

Currently, armillaria root disease is very damaging in a few areas on Klamath-Lake District. Many of these areas have been surveyed and mapped. Strategies for these areas are listed below and on the next page.

1. Locate and map diseased areas and place the information in a permanent database or GIS.
2. Favor the most resistant species, which on Klamath-Lake District are ponderosa pine, incense cedar, and lodgepole pine. Sugar pine, white fir, and Douglas-fir are highly susceptible to *Armillaria* on Klamath-Lake District lands. *Armillaria* varies in pathogenicity among sites, and although ponderosa pine is generally resistant on Klamath-Lake District, each situation must be evaluated to assess the best species for that situation.
3. Maintain adequate density to prevent stress, which favors development of armillaria root disease.
4. Minimize site disturbance and tree damage in partial cuts — the resulting stresses generally result in an increase in damage from armillaria root disease.

5. When regenerating openings, plant a mixture of resistant species and favor natural reproduction over planted trees, because planted trees tend to suffer more damage from *Armillaria* than naturals.
6. Avoid frequent small salvage harvests because stumps allow for an increase in inoculum and the site disturbance favors disease development.
7. Partial harvest only when a sufficient stocking of resistant species will remain — otherwise clearcut and plant resistant species.
8. Carefully evaluate objectives for the stand and consider diseased areas as potential wildlife habitat reserves.
9. Thin stands to promote good vigor of crop trees. Do not leave residual susceptible trees within about 30 to 50 feet of disease patches.
10. Use the FVS (Forest Vegetation Simulator — an updated version of Prognosis) western root disease model to compare alternatives.

Annosum Root Disease

Annosum root disease is currently at very low levels on Klamath-Lake District, but has a potential to cause losses in white fir and ponderosa pine. The strategy for this disease emphasizes prevention.

1. In white fir stands, avoid frequent commercial harvests because stumps provide a focus or starting point for the disease.
2. Keep white fir rotations less than 120 years.
3. Consider treating stumps of white fir and ponderosa pine with powdered borax to prevent colonization by *H. annosum*.
4. Map occurrence in both pine and fir, and monitor for trends in disease.
5. Use the FVS Annosum root disease model to evaluate management alternatives and estimate impacts of the disease on management.

Black Stain Root Disease

Black stain root disease is a potential problem on young ponderosa pine and possibly sugar pine. It is capable of long-distance spread by bark beetles and could appear suddenly (Harrington and Cobb 1988). Careful investigation of causes of mortality in young trees, particularly in thinning operations, should provide for early detection of this potentially damaging disease.

Decays

Most decays become damaging on Klamath-Lake District lands as a result of wounding during logging or fire injury. Older trees tend to have more decay than younger trees. Stress can be identified by using indicators of decay. Infected trees can either be selectively removed or retained, depending on objectives. The guidelines below and on the next page can help prevent excessive decay in stands (Filip et al 1983).

1. Keep rotations less than 150 years unless inspections reveal a very low occurrence of decay.
2. Maintain good tree vigor through stocking control — young vigorous trees have a strong ability to compartmentalize decay.
3. Select crop trees that have large crowns, few injuries or decay indicators, and a relatively high growth rate.
4. Do not manage understory white fir that is more than 50 years old. These old suppressed trees pose a high risk of developing rust red stringy rot (Indian paint fungus).
5. Minimize wounding by:
 - a) restricting logging season to when bark is tight
 - b) matching size of equipment to the situation
 - c) designating permanent skid trails and leaving bump trees or cull logs along edges
 - d) matching log length to leave tree spacing
 - e) using directional falling
 - f) limbing and topping trees before skidding, cutting branches flush to avoid injury to residuals during skidding
 - g) removing slash near crop trees to prevent fire injury to bole, which can lead to decay

White Pine Blister Rust

Although rust hazard is low on Klamath-Lake District, wave years are possible. The blister rust strategy is to ensure an adequate supply of well-adapted rust-resistant seedlings, avoid high hazard areas, and prune sapling trees to reduce the number of lethal cankers. Collection of seed and screening for resistance gives us some bargaining power to exchange seed with BLM or U.S. Forest Service, thereby broadening the genetic base of sugar pine.

Dwarf Mistletoe

Strategies depend in a large part on management objectives. Recreation, wildlife, watershed, and visuals may need no action. Several strategies are appropriate if fiber production is a primary objective. Stands should be surveyed to assess severity of mistletoe infection (using the dwarf mistletoe rating, DMR) and the species present. Because dwarf mistletoes generally are host-specific, most strategies rely heavily on manipulation of stand species composition.

To reduce impacts on tree survival and fiber production, severely infested single species stands should be regenerated either by clearcutting or seed tree/shelterwood systems. Clearcuts must be “cleancuts”, removing all advanced reproduction (which may be infected). In seed tree/ shelterwood cuts in which overstory trees are infected, the overstory must be removed before the regeneration is 10 years old or 3 feet tall. Adjacent stands should be sanitized to within 50 to 100 feet of the harvest unit to prevent re-invasion.

In stands with moderate to light infection (DMR less than 3), selective thinning can maintain acceptable growth rates in crop trees. Thinning should target removal of the most heavily infected trees, and retention of non-host species. In general, trees should be retained only when the top half of the live crown is free of infection. In single species stands,

thinning to create an even-aged or even-canopied condition can reduce rate of intensification of dwarf mistletoe. On good sites that can support at least 10 inches of height growth per year, thinning even-aged moderately infested ponderosa pine stands is recommended (Barrett and Roth 1985). Underburning can be used to reduce the stocking of infected understory trees. If individual infected trees must be kept for wildlife trees, non-host trees should be encouraged within a 50 foot radius of the infected tree. Similarly, patches of infected trees can be isolated from other areas using physiographic features such as streams, canyons, outcrops, or roads.

Specific Management Recommendations for Insects

The Department of Forestry's Insect and Disease Section has recommended the following strategies to minimize the impacts of the most important insect problems on Klamath-Lake District.

Mountain Pine Beetle

The mountain pine beetle has several host trees on Klamath-Lake District state forests, including lodgepole pine, ponderosa pine, and sugar pine. Ponderosa pine is not susceptible to attack unless it is at least 8 inches in DBH, and lodgepole and sugar pine are only attacked after reaching 6 inches in DBH. For all these species the key to preventing beetle infestations is stocking control. With the exception of sugar pine, there are published guidelines on stocking levels that minimize the potential for beetle infestations.

For ponderosa pine, the most useful guidelines relate site to a maximum basal area above which significant beetle damage can be expected (Meyer 1961, Sartwell 1971, Barrett 1979). Severe damage by mountain pine beetle can be prevented by maintaining ponderosa pine stand densities under the maximum basal areas shown in the table below. See the "Background Information" box on page III-82 for an explanation of site class and site index.

Site Class	Site Index	Maximum Basal Area¹
III	110	160
IV	90	140
V	70	120

1. These maximum basal areas represent conditions where stand growth and vigor are already poor and are not guidelines for thinning.

Unlike mountain pine beetle outbreaks in ponderosa pine, site class appears to make little difference in the pattern of tree mortality in lodgepole pine stands (Mitchell 1989). Also, the basal area at which lodgepole stands become susceptible to beetle infestations is less clearly defined than for ponderosa pine. In general, lodgepole stands with basal areas of 44-100 square feet per acre have low susceptibility to mountain pine beetle infestations (Mitchell

and others, 1983; McGregor and others, 1987). In addition, Oregon State University has published thinning guidelines covering both lodgepole pine and ponderosa pine (Pitman and others, 1982). These guidelines use an average DBH after thinning and recommended distances, maximum and minimum, between trees of that size.

Sugar pine is highly susceptible to mountain pine beetle attack in overstocked stands. In the absence of specific stocking guidelines for sugar pine, it is recommended that the guidelines on maximum basal area for ponderosa pine on that site be used for determining the appropriate stocking of sugar pine.

While the threat of mountain pine beetle attack is obvious in pure pine stands, mixed conifer stands also require stocking control if the pine component is to be preserved (Eaton 1941, Miller and Keen 1960, Sartwell and Dolph 1976). To maintain the pine component in a mixed conifer stand on poorer sites, it is advisable to reduce the basal area to that recommended for a pure pine stand. On better mixed conifer sites, focusing management on trees other than pines may be the best strategy for capturing the site's capacity to produce wood (Mitchell 1989). Keep in mind that without periodic stand disturbance from fire or management activities, it is impossible to maintain a significant pine component in mixed conifer stands.

Either pine or mixed conifer stands with active mountain pine beetle infestations can benefit from immediate stocking reductions. By aggressively thinning stands with active beetle infestations, the microclimate of the stand is altered so that conditions are unattractive to the beetles. In recently thinned lodgepole stands, even trees with low vigor have a better chance of avoiding beetle attacks than in overstocked stands (Amman and others, 1988). While the data supporting this prescription were gathered in lodgepole pine stands, it is reasonable to extend this management recommendation to ponderosa and sugar pine. When thinning ponderosa or lodgepole pine stands, it is important to avoid accumulating thinning slash from January to June, in order to prevent a build-up of pine engraver beetle populations and possible attacks on leave trees.

An effective tool for reducing localized beetle populations is salvaging pines currently infested with mountain pine beetle before the beetle flight in July. Dead pines with red crowns do not contain developing mountain pine beetle broods. Currently infested trees, those containing beetle brood, will have green or yellow crowns and have numerous pitch tubes on the bole. Salvage operations for reducing beetle populations must remove the infested trees before the beetle flight in July. Salvage of infested trees is of short-term benefit, but reducing stocking levels is the only method of long term control (Amman and others, 1985).

Western Pine Beetle

Besides being a significant pest in old growth ponderosa pine, western pine beetle also attacks second growth trees from 6 to 18 inches in DBH. As with mountain pine beetle, stocking reduction is the key to preventing western pine beetle infestations (DeMars and Roettgering, 1982). There is only one published data set on the effects of thinning young

ponderosa pine to reduce western pine beetle infestations (California Pest Council, 1993). In this study, thinning reduced beetle attacks on 70-80 year old ponderosa pine growing on Site Class II or better locations. The study's recommendation is to thin pine stands to 55-70% of normal basal area. Normal basal area is defined as the basal area at which the stand is fully stocked with trees. In most cases the thinning recommendations for prevention of mountain pine beetle infestations should also provide protection from western pine beetle. Thinning stands to 55% of normal basal area is recommended on high risk sites, where ponderosa pine is growing in association with western juniper, incense cedar, or mountain mahogany. High risk sites with overstocked stands of ponderosa pine are very susceptible to western pine beetle infestations during drought periods (Miller and Keen 1960, Oregon Department of Forestry 1969-1994).

Salvage of beetle-infested trees may be beneficial when the area of tree mortality is small (DeMars and Roettgering, 1982). The salvage of infested trees is best accomplished between November and March, when there is a high likelihood that trees contain brood. Beetle flight and new attacks can occur any time between April and October. To be effective, all green trees with pitch tubes as well as trees with yellow or red crowns should be removed from the site. The pitch tubes produced by the western pine beetle are typically located in bark crevices and are much smaller and less conspicuous than those produced by the mountain pine beetle. Salvage of western pine beetle-infested trees may suppress beetle populations in the short-term, but the only long-term solution is to reduce tree susceptibility through stocking control.

Pine Engraver Beetle

The pine engraver beetle is attracted to and breeds in fresh ponderosa and lodgepole pine slash with a diameter greater than 2 inches. As engraver beetle populations are attracted to slash, adjacent crop trees are frequently attacked. Thinning operations can be conducted at any time in pine stands where trees are less than 3 inches DBH. However, to avoid leave tree mortality in stands where trees are more than 3 inches DBH, do not create slash from January to June (Dolph 1965, Sartwell and others 1971). If slash creation is unavoidable from January to June, the amount of suitable breeding material can be reduced by trampling slash with heavy equipment (knocking off the bark), or bucking up large diameter pieces (do not remove branches) and scattering them in open areas to facilitate rapid drying.

Fir Engraver Beetle

The fir engraver beetle sustains endemic populations by attacking trees in root disease pockets (Lane and Goheen, 1979). In areas where root disease is detected, beetle populations can be reduced by following root disease control strategies. Logging activity can contribute to fir engraver infestations by leaving true fir slash greater than 4 inches DBH, which provides breeding sites for the beetles (Ferrell 1973). When thinning predominantly fir stands, avoid creating slash from January to July, when it can provide

breeding material for fir engraver populations. Frequently the shock of opening up true fir stands temporarily lowers tree vigor and makes trees vulnerable to attack for several years. Perhaps the most important factor discouraging the active management of white fir on the Klamath-Lake District is its extreme susceptibility to fir engraver attacks during periods of drought (Ferrell 1973). One study has found that under the current drought, white fir growing on sites receiving 20-30 inches of precipitation annually can suffer high levels of tree mortality (USDA Forest Service 1994). There are no silvicultural prescriptions that can insure the survival of predominantly white fir stands on pine or pine-associated sites during periods of drought. For this reason white fir should remain a minor component of stands managed for timber production on the Klamath-Lake District.

Salvage of beetle-infested trees can be used to reduce local fir engraver populations. Dead and dying fir containing beetle brood should be removed before beetle flight begins in June. During a salvage operation, trees should be removed when they have a dead or fading top constituting 10% or more of the live crown. Trees with fading tops are usually infested by the fir engraver and have a high probability of dying in the near future.

Defoliators

Damage from defoliator outbreaks, such as top-kill, usually takes several years to develop and is more severe among intermediate and suppressed trees (Wickman 1963). Both aerial and ground surveys are useful in mapping the spread of an outbreak and predicting future levels of defoliation. A general strategy for mitigating the effects of a defoliator outbreak is to maintain vigorous growing stands of trees with healthy crowns. Healthy trees are more resistant to damage by defoliators and are quicker to recover when the outbreak subsides (Carlson and others, 1985).

A specific strategy for the Modoc budworm and the Douglas-fir tussock moth is to reduce the stocking of white fir, their primary host (Mason and Wickman, 1988). Keeping white fir a minor component of stands can virtually eliminate the negative impact of a defoliator outbreak on state forest lands. If necessary, defoliator outbreaks can be suppressed using one of several insecticides registered for use on forest land.

Outbreaks of black pineleaf or pine needle scale may occur over hundreds of acres of forest land, usually where pesticide from mosquito suppression projects drifts over ponderosa pine stands. If a scale outbreak persists for several years, trees are weakened to a point where they are susceptible to bark beetle attack. Salvage logging of trees with deteriorating crowns will be helpful in reducing the risk of bark beetle infestations. Scale infestations can also be treated with a well-timed insecticidal spray (Ferrell 1986a).

The Human Context

Land Use Classifications

The land use classification system applies to all the Klamath-Lake District state forest lands, regardless of ownership. The appropriate land owner, either the State Land Board or the Board of Forestry, must approve any significant land use reclassifications. Minor changes such as correcting boundaries or changing the land use subclassification do not require approval.

In addition, the Department of Forestry must comply with state-wide land use planning goals and acknowledged city and county comprehensive plans and land use regulations. (See Appendix C for more information about these goals and the definition of “acknowledged” plans.) When land use classifications are updated, the District Forester will review state forest land use designations with affected local governments and request their comments on the compatibility of land use designations with the comprehensive plan (OAR 629-20-040 (4)).

State forest lands are classified into two main categories: Production and Nonproduction. These are further subdivided into more detailed classifications. Tables III-6 to III-9 show the acreages by land use for all Klamath-Lake District state forest lands, and for each of the major blocks.

Production Lands

Production lands are those areas where timber production is the primary use.

Nonproduction Lands

Nonproduction lands are classified into three main categories: Special Use, Conservancy, and Noncommercial. In turn, each of these categories has several subclassifications. Timber production is not the primary use on these lands. Timber harvest may occur only under special circumstances, as noted in the discussion on the next page.

Special Use Lands — Timber harvest will occur in these areas when it does not interfere with the designated special use of these lands.

- **Service use lands** — Two research sites totaling 63 acres host plantations of genetically improved ponderosa pine. The Department of Forestry uses data from the plantations to produce genetically improved seedlings for tree planting.
- **Farm use lands** — These areas are nonforested areas mingled with forest land that have been included in grazing lease areas.
- **Extraction use lands** — This area is a rock pit in Sun Pass State Forest. The Department of Transportation has a permanent easement for the use of this pit.
- **Transmission use** — These are power and natural gas line right-of-ways.

Conservancy Lands — These areas have been determined to have a primary use that is non-revenue-producing.

- **Protective conservancy, critical wildlife habitat** — These are areas of high value to wildlife and fish. Timber harvest is not precluded, but will be done only to improve fish or wildlife habitat at the request of Oregon Department of Fish and Wildlife biologists. These areas are discussed in detail earlier in Section III, in the subsection “Wildlife and Fish.”
- **Scenic conservancy** — One 40 acre parcel along Highway 140 adjacent to Upper Klamath Lake falls into this category. This parcel consists primarily of rock outcrop and talus slopes. Scenic values in these areas preclude timber production. Harvesting may be allowed in certain cases, such as salvaging, as long as scenic values are protected.

Extensive Management Lands — These are very marginal forest lands that are not included in the production land base, but which can be entered for salvage to correct some forest health problem.

Noncommercial Lands — These are non-forested areas that have had no commercial or other prevailing uses.

**Table III-6. Land Use Classifications
for Klamath-Lake District Lands**

Land Use	Acres	Percent
Production Lands	31,590	95%
Nonproduction Lands	1,578	5%
Protective conservancy — critical wildlife habitat	396	
Scenic conservancy — highway corridor	40	
Extensive management	43	
Noncommercial — dry meadow	18	
Noncommercial — noncommercial body of water	17	
Extraction use — rock	18	
Farm use — forest range	933	
Service use — tree improvement	63	
Transmission use — powerline	50	
Total Acres	33,168	100%

Table III-7. Land Use Classifications for North Block		
Land Use	Acres	Percent
Production Lands	22,389	98%
Nonproduction Lands	458	2%
Protective conservancy — critical wildlife habitat	359	
Noncommercial — dry meadow	18	
Extraction use — rock	18	
Service use — tree improvement	63	
Total Acres	22,847	100%

Table III-8. Land Use Classifications for Southwest Block		
Land Use	Acres	Percent
Production Lands	4,462	94%
Nonproduction Lands	281	6%
Scenic conservancy — highway corridor	40	
Extensive management	43	
Farm use — forest range	190	
Transmission use — powerline	8	
Total Acres	4,743	100%

Table III-9. Land Use Classifications for East Block		
Land Use	Acres	Percent
Production Lands	4,739	85%
Nonproduction Lands	839	15%
Protective conservancy — critical wildlife habitat	37	
Noncommercial — noncommercial body of water	17	
Farm use — forest range	743	
Transmission use — powerline	42	
Total Acres	5,578	100%

Forest Products: Timber

The Klamath-Lake District state forest lands contain 31,590 acres of land designated primarily for use as timber production land. As of 1993, it was estimated that the standing volume on these lands was approximately 302 MMBF, with approximately 263 MMBF on Board of Forestry land and 39 MMBF on Common School Forest lands. See the “Key Terms” box on the next page for the definition of MMBF and other terms used in this subsection.

Information relevant to the timber resource can be found in several other places in Section III. The “Geology, Topography, and Soils” subsection has information about site productivity. The “Vegetation” subsection describes climax forest vegetation and plant communities, and the “Biodiversity” subsection discusses how past and current timber management practices have shaped current habitat and biodiversity conditions. Finally, the “Forest Health” subsection discusses how forest insect and disease pests interact with the timber resource. The remainder of this subsection covers the four topics listed below.

1. The timber program and the basis for state forest management policies.
2. The current management plan.
3. Current timber management practices.
4. The timber inventory and timber management analysis conducted for this plan.

The Timber Program

Policies for managing state forests are based upon the Oregon Constitution and statutory direction. These legal and policy mandates are discussed in some detail in Appendix C. These policies are summarized by the following two statements for the two types of land we manage.

Common School Forest Lands are managed “to generate the greatest amount of revenue in the long run for the Common School Fund consistent with sound techniques of land and timber management. Consideration is given to the need to protect soils, water, fish and wildlife habitat, recreational opportunities, and other forest values as long as this need does not significantly detract from the generation of revenue in the long run.” (Oregon Board of Forestry 1995b)

Board of Forestry Lands are managed “to provide a sustained contribution to the people of Oregon by the production of timber in a cost-effective and environmentally sound manner while providing recreational opportunities and considering soils, water, fish and wildlife habitat, and other forest values. A major portion of revenue derived from these lands is distributed to counties for further distribution to local taxing districts.” (Oregon Board of Forestry 1995b)

The Klamath-Lake District's timber program has carried out these policies by generating revenue to benefit county governments, local taxing districts, and the Common School Fund. Timber production has been the main revenue-generating activity on the Klamath-Lake District state forest lands.

On Board of Forestry Lands, 36.25% of timber sale revenues are retained for Department management costs. The Department of Forestry manages Common School Forest Lands under a contract with the State Land Board. Timber sale revenues are placed directly into the Common School Fund, and management expenses are in turn paid from the Common School Forest Revolving Fund. The Department of Forestry's management services include timber sale preparation and administration, forest inventory, intensive forest management, and associated overhead costs.

The timber program is guided by the principle of sustained yield, which ensures that the Common School Fund, counties, and local taxing districts will benefit from a perpetual source of revenue from a managed forest.

Key Terms

Basal area — The area of the cross-section of a tree stem near the base, generally at breast height (4.5 feet above the ground) and including the bark. The basal area per acre is the total basal area of all trees on that acre.

Cohort — Within a stand, a group or a layer of trees that regenerated after a single disturbance, such as a fire or timber harvest; the group or layer of trees is an even-aged component of the stand.

GIS — Geographic information system; a computer system that stores and manipulates spatial data, and can produce a variety of maps and analyses.

MMBF — Million board-feet. A board foot is the amount of wood equivalent to a piece of wood one foot by one foot by one inch thick.

Stand — A term used in this plan to designate a contiguous area of land in the same vegetative series and having the same management history.

Sustained yield — A timber harvest level for the next decade that can be maintained or increased through future planning decades without significant declines. Sustained yield has been calculated on an acreage basis for this plan.

Current Management Plan

The Eastern Region State Forests are currently being managed under the 1978 Timber Resource Inventory, Analysis, and Plan for Eastern Oregon Area State Forests (Oregon Department of Forestry 1978), which was billed as a 30 year plan. This plan focused on timber management, but also considered wildlife and other environmental concerns. Under the 1978 plan, timber harvest is calculated by regulating the basal area per acre on a stand by stand basis, and is controlled on an acreage basis. In other words, annual harvest objectives are stated in terms of acres to be treated annually. Volume can vary annually depending upon the nature of the stands selected to be treated each year. The 1978 plan called for the harvest of 1,010 acres per year for the first decade, and 1,080 acres per year for the second decade. The plan assumed that these harvests would be primarily selective harvests using an uneven-aged system. Projected average harvest levels were 7.4 MMBF per year the first decade, and 7.7 MMBF per year the second decade.

During the recession of the early 1980s, prices and demand for timber were low, and state forest revenue projections indicated the need for cost cuts. In response, significant staff reductions were made in the Klamath-Lake District's state lands management unit. In addition, by the mid-1980s, it was recognized that the 1978 plan was becoming inadequate, and the harvest objective was reduced pending the development of a new plan. (See "The Eastern Region Planning Process" in Section I.) As a result, the harvest objectives have not been met since the earliest years of the plan. Over the past 7 years, an average of 564 acres per year have had harvest treatment. Another change during the early 1980s was the beginning of a major mountain pine beetle epidemic in the vast lodgepole pine stands of central Oregon. The decision was made to harvest the lodgepole pine stands in the Sun Pass area before the epidemic was projected to hit in the early 1990s. This decision represented a further departure from the 1978 plan, which assumed that most harvest would use the uneven-aged system.

Current Timber Management Practices

The state currently uses two silvicultural systems in managing the Klamath-Lake District state lands. In the ponderosa pine, Douglas-fir, and white fir forest zones, uneven-aged management is generally used. In the lodgepole pine forest zone, even-aged systems such as seed tree and clearcutting are used. These two systems are described below as currently practiced on the Klamath-Lake District. See the "Background Information" box on page III-107 for more information on these two silvicultural systems.

Uneven-Aged Management

Stands in the ponderosa pine and white fir forest zones are scheduled for treatment based on the level of stand density, with overstocked stands being scheduled first. The objectives of this treatment are listed on the next page.

1. Create a healthy, insect and disease-resistant stand by reducing stocking levels in all size and age classes and by altering species composition. Altering species composition usually means favoring a residual stand with a large ponderosa pine component, while retaining some level of all naturally occurring tree species for biodiversity.
2. Create or retain an uneven-aged stand structure capable of sustained timber output through periodic partial cut entries.
3. Establish a viable cohort of ponderosa pine regeneration.
4. Enhance wildlife habitat through sustained recruitment of wildlife trees, snags, down woody debris, and cover areas; and maintenance of early seral areas for forage production.
5. Maintain soil productivity through management of compaction and slash, woody debris, and the duff layer.

Treatment is accomplished in two stages. The first stage is a timber sale, which reduces density and alters species composition in the sawlog-size trees, and creates openings and understocked areas for new seedlings. Numerous small openings are formed as a result of group selections of less desirable species such as white fir and lodgepole pine, or group selections to treat insect and disease infestations such as bark beetle and root rot pockets. The openings range from less than a tenth of an acre, to a few openings as large as several acres. Even-aged groups of ponderosa pine, sugar pine, and Douglas-fir are usually thinned from below to provide good growth rates and resistance to insect attack. Groups of large trees of the desirable species are marked to leave individual trees based on tree quality, ability to survive and grow to the next entry, and need for seed trees and future wildlife trees. Large, high defect white firs are left whenever possible as present and future wildlife trees, snags, and down woody debris.

The second stage consists of post-harvest precommercial thinning and interplanting. The thinning has the objective of reducing density in the sub-sawlog-sized material and favoring healthy trees of desirable species. The larger openings are generally interplanted if it is felt that an insufficient number of desirable seed trees exist in the immediate vicinity to ensure adequate regeneration. In smaller openings with sufficient seed trees, natural regeneration is relied on.

A few mixed conifer stands scheduled for long-term uneven-aged management occasionally require special treatment in order to correct some silvicultural problem such as an insect or disease infestation, or a species composition imbalance. In this case, parts of these stands may meet clearcut definitions. However, this kind of intermediate treatment is viewed as necessary to return the stand to a healthy, uneven-aged condition. For example, there are currently some stands where nearly all trees of desirable species were removed in the past. The residual stands consist primarily of high defect white fir, and will require small patch clearcutting and interplanting to return them to a desirable condition. As another example, there is a large area in Sun Pass State Forest severely infected with *Armillaria* root disease (see “Forest Health” for details on this disease). Much of this area has a large component of species such as white fir and sugar pine that are highly susceptible to *Armillaria*. Ponderosa pine and lodgepole pine are the only two native conifer species resistant to this disease. In these root rot areas, it will be necessary to remove susceptible species, resulting in understocked areas, and then to interplant with resistant species.

Background Information

Even-Aged Vs. Uneven-Aged Management

Most of the Eastern Oregon Region's state forests have an "uneven-aged" structure with trees of many species, sizes, and ages. In limited areas where clearcutting or seed tree harvesting has occurred, the trees are mostly the same age, or "even-aged."

Selective harvesting, which is used to maintain or improve uneven-aged stand structure, has become the preferred silvicultural method in most areas of the Eastern Region state forests. Even-aged management is also a viable practice. However, its use has been limited to circumstances where ecological conditions, insects, or disease make selective harvesting less attractive.

There are numerous reasons for favoring uneven-aged management. The first is historic: prior harvesting practices left a stand structure that is easily adapted to uneven-aged management. (Refer to Section III, "Biodiversity", for a historical perspective.) The gentle terrain makes selective harvesting economical with ground-based equipment. Uneven-aged management has other advantages, which are listed below.

- Continuous site occupation by trees results in higher timber production.
- The continuous forest cover is visually pleasing, and has greater public acceptance.
- Reforestation costs are lower, and seedlings are sheltered from extreme conditions.
- Biodiversity and wildlife habitat are maintained.

However, successful implementation requires a commitment to staffing, training, and administration. Success depends on:

- Adequate staffing with foresters skilled in writing prescriptions, selecting trees for harvest, and supervising operations.
- Close attention to stand structure. Improper selection could create an imbalance of tree sizes and species, and has long-term implications for growth, regeneration, and forest health.
- Not allowing a dense understory of tolerant (shade-dependent) tree species to form. Small openings (¼ to 2 acres) are needed to regenerate intolerant species, and stocking control (thinning) is needed throughout the rest of the stand.
- Prevention of damage to residual trees. Accomplished through appropriate logging systems, incentives for loggers, and close monitoring of harvest operations.

Even-Aged Management

Even-aged management is most frequently practiced in the lodgepole pine forest zone. Both clearcutting and seed tree cutting have been used and are planned for the future. Because of the high levels of dwarf mistletoe in the natural lodgepole stands, uneven-aged management would not be appropriate. Both seed tree cuts and clearcutting would retain green trees and snags at least to the levels required by the Forest Practices Act. Klamath-Lake District state forest lands contain a total of 4,149 acres in the lodgepole pine forest zone, or about 12% of the district's total land base. So far 1,295 acres have been harvested out of the total 4,149 acres in the lodgepole pine forest zone. Currently, the mountain pine beetle epidemic discussed above has declined and is no longer the driving force in harvesting decisions in this forest zone.

Timber Inventory and Analysis for The New Plan

All Eastern Region state forest lands classified for timber production use have been divided into 243 stands based on past management and forest zone. These stands were inventoried for this plan between 1989 and 1992, using the Forest Service Pacific Northwest Region Stand Exam system. Twenty stands were randomly selected in Sun Pass State Forest to be permanent plot stands. The plots in these stands were established so that they can be relocated in the future. The remaining 223 stands were inventoried using a system of temporary plots.

The next two paragraphs describe how this inventory information was used to develop an information system useful for this planning process.

An analysis was done, using the Stand Prognosis Model, on representative stands in each block on the Klamath-Lake District. For the white fir, Douglas-fir, and ponderosa pine forest zones, where uneven-aged management is practiced, general harvest instructions were developed to simulate the uneven-aged cutting currently being conducted. The analysis was designed to further fine-tune the harvest instructions for the model by determining the residual basal area per acre and reentry period that would result in the ideal combination of timber volume production, financial return, and desired silvicultural conditions for each block. For the lodgepole pine forest zone, the analysis was designed to determine the rotation age that resulted in the ideal combination of timber volume production and financial return. The fine-tuned harvest instructions resulting from the above analyses were used as broad prescriptions for the purpose of developing Prognosis runs for the remaining stands. The process for developing stand-specific prescriptions for actual stand management practices is discussed in the timber strategies in Section V.

Prognosis runs were developed for 210 of the stands using the harvest instructions discussed above. The 33 stands without Prognosis runs are young plantations less than 6 years old for which inventory data was not collected. As these stands reach 6 years of age they will be inventoried and entered into this system. For each of the 210 stands, the first harvest decade was set to occur when the stand first reached a basal area per acre at least 30 square feet higher than the target residual basal area per acre. This Prognosis run was called the optimum schedule. Prognosis runs were also made to simulate the effects of delaying harvest one decade

and, where possible, accelerating harvest one decade. These were called, respectively, the delayed and accelerated schedules. Prognosis runs were done for the three schedules for the first six decades, and the information was entered into a Paradox database. The resulting database had many uses in the planning process, including balancing and scheduling harvests, estimating the sustained yield level, estimating revenues generated, and projecting future stand structures and species composition. A GIS system was developed that had the capability to display information from the database in map format.

The inventory and subsequent analysis revealed 47 stands totaling 7,819 acres in the ponderosa pine, white fir, and Douglas-fir forest zones that are overstocked (140 square feet or more of basal area per acre) and at high risk of severe bark beetle infestation. In addition, 7 stands totaling 1,541 acres were identified as having severe *Armillaria* root rot infestation. Five of the latter stands totaling 1,260 acres have not been treated.

Special Forest Products

Current Management

Special forest products are those forest products other than timber that are collected for personal and commercial uses. Many types of special forest products are harvested on the Klamath-Lake District. Firewood, mushrooms, and cones have been the most popular of the products available. To date, these products have had little value to forest managers and landowners, so development and management has been minimal.

The Klamath-Lake District's current management policy for special forest products is to respond to public inquiries and demands for these products on an individual basis. Any harvesting or taking of special forest products on state forest lands requires the acquisition of a free use permit, with one exception. During the summer of 1994 an experimental policy was tried for mushroom harvest, requiring a fee permit when harvest was for commercial use and a free use permit for personal use. Four free use permits were issued during the season, but no commercial permits. However, because the public had limited knowledge about the new permit system, the actual number of pickers is not known.

Special Forest Products on the Klamath-Lake District

To date, no inventory has been taken of all the special forest products available on the Klamath-Lake District. The public's past requests for free use permits give some indication of what current demands are. However, some people may be collecting special forest products without permits. The products for which free use permits have been issued in the past are listed below and on the next page.

Firewood

Firewood has been one of the most actively managed forest products on the district. For many people, the collection of firewood is an important project. Some people use firewood to reduce heating bills, and others enjoy the aesthetic value of a wood fire. On the Klamath-Lake District, firewood collection is allowed in recently harvested areas. It is a way to remove logging slash and to allow people to meet their fuel wood needs. Permits are required to remove firewood from the forest and have many stipulations. For instance, firewood may only be taken from designated areas and only fallen trees may be cut. Permits are issued for personal use only. However, due to increased wood utilization and the current practice of leaving down woody material for nutrient cycling, little wood is available for firewood use.

Edible Mushrooms

Recently, the harvesting of edible mushrooms has become very popular in the area because some mushroom species have high commercial value. The total annual value of edible mushrooms exported from Oregon exceeds 6 million dollars (USDA Forest Service, date unknown (a)). In the Klamath-Lake District area, most mushroom harvesting occurs on the Winema National Forest in northern Klamath County. In 1992, the Winema National Forest issued 2,338 commercial permits, resulting in revenues of \$43,000 for the Forest Service (USDA Forest Service 1992). However, it is important to note that the Forest Service's administrative costs for the program were higher than the revenues from the permits.

Edible mushrooms are probably the most important special forest product on the Klamath-Lake District, in economic terms. It is believed that morel and matsutake mushrooms, the most valuable species, are present in Sun Pass State Forest. The mushrooms are continuing to increase in value, attracting larger numbers of people to the area, as harvesters (sellers) and buyers. With these people come both environmental and social concerns. In fact, the Winema National Forest staff receives training in gang-related issues, and there have been homicides that were attributed to the territorial conflicts of mushroom pickers. Also, very little is currently known about the environmental impact that mushroom harvesting has on the forest.

In response to the growing popularity and value of edible mushrooms, the Klamath-Lake District has implemented a trial permit system for the collection of edible mushrooms. For personal use, a free use permit is issued. For commercial use, the permit is issued at \$100 per picker. The matsutake can only be taken as a commercial product. As stated before, only four free use permits were issued in 1994, and no commercial permits. These low numbers can be accounted for in three ways. First, there was little public knowledge of the district's permit system. Second, the dry winter and spring created a poor crop of mushrooms throughout the state in 1994. Finally, the permit closure in mid-August due to high fire danger denied access to all state forest lands in the district.

The table below lists the prices paid to the picker and wholesaler in 1991 for morel and matsutake mushrooms.

Mushroom Species	Harvester Prices	Wholesale Prices
Matsutake — fresh	\$1.00-\$40.00/lb.	\$4.00-\$70.00/lb.
Morel — fresh	\$2.00-\$8.00/lb.	\$6.00-\$20.00/lb.
— dry	\$1.00-\$4.00/lb.	\$20.00-\$55.00/lb.

Source: Elliott State Forest Draft Management Plan 1993

Other Special Forest Products

Cones and other assorted special forest products are also harvested in the Klamath-Lake District. However, there is very little demand at this time for them, except for occasional requests to harvest sugar pine cones. These cones are popular because of their size — cones can be as much as two feet long. The cones are generally used in decorative arts and crafts.

Between 1990 and 1992, the Winema National Forest completed an inventory of 43 botanicals used for an assortment of products (USDA Forest Service 1992). Because of the proximity and similar landscape, it can be assumed that most of these products are also available on state forest lands in the Klamath-Lake District. Appendix N list these products and their uses. Most products were used for decorative arts and crafts, landscaping, and food and beverages.

Future Demand for Special Forest Products

As population increases in the Klamath basin, demand for special forest products is likely to increase as well. Increased knowledge about these products will also increase demand. The increased demand for edible mushrooms is potentially the most important. As growing numbers of people harvest mushrooms on federal lands, the demand for mushrooms on state lands could increase. The increasing value of edible mushrooms will also encourage more people to harvest mushrooms commercially.

Economic Values of Special Forest Products

It is difficult to measure the economic values of special forest products collected for personal use. Commercially, special forest products can play a significant role in local economies. Special forest products, both raw and finished, are increasingly being sold on national and international markets. The U.S Forest Service has estimated that the special forest products industry employs over 10,000 people in the Pacific Northwest and generates an estimated 60-70 million dollars per year for the region (USDA Forest Service, date unknown (b)). Because special forest products make a valuable contribution to the state's economy, the Forest Service actively promotes the harvesting of special forest products on national forest lands.

Special Forest Products Committee

In response to growing popularity and demand for special forest products, the Oregon Department of Forestry has established a Special Forest Products Committee. The purpose of this committee is to develop state-wide policy on special forest products found on state-managed lands. This policy will be consistent on all state-managed lands. At this time, the committee is in the early stages of establishing the goals and objectives that will be used in drafting the policy.

Recreation and Scenic Resources

Recreation resources and use on the Klamath-Lake District state forests were assessed during the summer and fall of 1994. The information here is summarized from the complete report, which is available at the Klamath-Lake District office and the Salem headquarters (Schrader 1994).

Recreation in the Region

The Klamath-Lake District state forests are a small part of the total land base of Klamath and Lake Counties. Recreation resources on the state forests are part of the regional recreation resources. By understanding the regional role of state forests, managers can make better decisions about managing recreation on state forest lands.

Klamath and Lake Counties have many recreation providers, who offer a wide range of recreational opportunities. There are two national forests, eight state parks (two in the vicinity of Sun Pass State Forest), a national park, BLM-managed lands, and many private recreation providers.

All of these landowners have different philosophies about recreation, and provide different opportunities. Crater Lake National Park is managed under a preservation mandate and provides recreational opportunities that range from highly developed to backcountry activities. The national forests and BLM lands are managed with multiple use mandates and provide a wide array of opportunities from wilderness areas to developed campgrounds. The state parks provide semi-primitive to developed campgrounds, with the main emphasis on vehicle accessibility. Private recreation providers mostly supply developed recreation.

The state forest lands are bordered by the full variety of land ownerships in the area. Sun Pass State Forest is adjacent to Crater Lake National Park, Winema National Forest, Kimball State Park, and private land. The largest piece of land in the East Block, the Yainax Butte tract, is surrounded mostly by the Fremont National Forest. In the Southwest Block, the Bear Valley tract is adjacent to several BLM parcels, and near the newly established Upper Klamath Wild and Scenic River. There are also private lands next to the Yainax Butte and Bear Valley tracts.

Each recreation provider fills a niche in the region. The opportunities on other lands and the public's recreational demands affect the recreational use that occurs on state forest lands. Any changes in the region can dramatically alter recreational demand and types of use on state lands.

Current Situation

In the past, there has been very little formal recreation management in the Klamath-Lake District. Current recreation management consists of issuing fire danger regulations and permits required for large commercial groups. No staff or funds exist to actively manage recreation sites and users in the forest.

However, the lands in the Klamath-Lake District are relatively lightly used for recreation. The most common recreational uses are camping, hunting, fishing, and snowmobiling. Most use is informal dispersed recreation, which is defined as recreational use that occurs with little or no regulation or development. In this type of recreation, users are reasonably free to choose what activity they will participate in and the location where this activity takes place.

The majority of users on Klamath-Lake District state forests are local residents. They are attracted to state forest lands because the lands are primitive and unregulated, and few other people compete for favorite sites. Overall, the highest concentration of use occurs in elk and deer hunting seasons. These seasons extend from the last week of August through the month of November.

Camping

Most people who camp on district lands enjoy other activities like horseback riding and fishing while they camp. There are no developed campgrounds in the district, and all camping is dispersed and informal. The most popular time for camping in the district is from the beginning of July through the end of hunting season.

Most camping occurs on Sun Pass State Forest and is focused along the two streams, Sun and Annie Creeks. The campsites in these areas are the most developed in the district. They consist of a cleared area, a primitive fire pit, and vehicle access from the main roads. These sites vary in size and capacity. The most popular area is along Sun Creek and Road #3. There are campsites on both the east and west side of the creek. Both sites are large and can accommodate multiple vehicles and large groups of people. On Fourth of July weekend it is not uncommon to see groups of 20 people with 2 or 3 recreational vehicles.

Another, much smaller site, is located just to the south along Sun Creek and Road #6. This site can accommodate only a small group. In the past structures have been built at this site.

The other main area for camping exists along Annie Creek on the western border of the forest. Many individual sites exist along the stream. There is one large site that can accommodate a very large group. Historically, a large group used this site for an annual camping trip. However, because of the road closure (see “Wildlife and Fish” earlier in Section III), this group chooses not to use Sun Pass for their outing. Overall, these sites receive little use because a limited number of forest visitors know the area.

There is sparse evidence of camping in both the Yainax and Bear Valley tracts. These sites have most likely been used by hunters in the past. However, there is no concentrated use of these tracts for camping.

Hunting and Shooting

Most of the recreational hunting that takes place in the Klamath-Lake District occurs during the bow and rifle seasons, which extend from the last week of August through November. However, a small amount of poaching does occur outside of hunting season. Some hunters camp for extended periods, but most enter on a daily basis.

Sun Pass State Forest lies in the Oregon Department of Fish and Wildlife's Sprague Unit, Yainax tract is in the Klamath Falls Unit, and Bear Valley tract in the Keno Unit. Within the district there are controlled hunts for deer, elk, and bear. Elk and deer hunting are the most popular hunts in the district. Hunting is the highest concentrated use that occurs on the state forests during the year, but even this is relatively minimal.

Recreational target shooting occurs at a very limited level in the district. The rural nature of the region allows for this activity to occur at numerous sites. Because of this, shooters are not drawn to state forest lands to participate in this activity.

Snowmobiling

Snowmobiling is the most popular winter activity in the district. Most use occurs on Sun Pass State Forest. Currently in Sun Pass, there is a groomed trail that is part of a larger trail system that runs from Lake of the Woods to Diamond Lake (see the recreation map). It runs entirely on the west side of old Highway 232. The trail is groomed and maintained by local snowmobile clubs. The Chiloquin Ridgeriders, Winema National Forest, and Department of Forestry work together to manage this trail system.

Outside Sun Pass State Forest, there are no other groomed snowmobile trails on district-managed lands. It is likely that very minor amounts of snowmobiling do occur on most district-managed lands.

Other Recreation Uses

The majority of recreation in the Klamath-Lake District is confined to the activities already described. However, horseback riding is becoming more popular with users of Sun Pass State Forest. Some activities that occur to a lesser degree are hiking, sightseeing, and educational tours.

Sun Pass State Forest has one developed hiking trail. It runs along the eastern edge of Sun Creek from Road #3 to Crater Lake National Park. It was originally built in 1978, but currently receives no maintenance and little use. During the winter months, some crosscountry skiers venture on to district-managed lands. However, this use is minimal. Many skiers prefer Crater Lake National Park, wilderness areas, and roadless areas.

A few visitors enjoy sightseeing from the forest roads, mainly from Highway 232. This highway bisects the forest in a north and south direction, and has many scenic overlooks to the south and west.

Department of Forestry staff occasionally lead tours for people who are interested in the management of state lands. Participants are usually members of the timber industry or environmental organizations.

Highlights from User Survey

Over the summer of 1994, interviews were conducted with visitors in the forest and representatives of local user groups. Because of the limited use, the road closure in Sun Pass Forest (see “Fish and Wildlife”), and the permit closure for fire danger in mid-August, only 5 groups with a total of 47 people were actually interviewed in the forest. All were in Sun Pass and no visitors were seen or contacted in the other forest blocks. Four of the groups listed camping as their main activity and the other group listed fishing.

The results of the interviews show that the users of the group share common interests and backgrounds. All the people interviewed were from Klamath County with the exception of one Medford resident. For all, this was not a first visit to the forest. One family has camped regularly in Sun Pass since 1937. Group size ranged from 2-20 people staying for 1-4 days. Many visitors had been involved in the timber industry in the area.

User Preferences

Current users of district lands have expressed little desire for changes in recreation management and opportunities. The users contacted prefer the primitive and remote setting of district lands. The only change suggested by current users is the installation of restrooms at the Road #3 and Sun Creek campsites. About 50% of those interviewed suggested this improvement. The other 50% preferred not having these facilities in the forest.

The recreation demand may be different if visitors from outside the county and state are considered. These visitors typically prefer a more developed recreation setting. These opportunities will be met by other recreation providers in the region.

Recreation Demands and Opportunities in the Future

The Klamath-Lake District is facing many challenges as the face of natural resource management continues to change. New concerns have appeared that may influence the way the forest is managed, and changing recreation demand is one of them.

The Statewide Comprehensive Outdoor Recreation Plan (SCORP) shows that recreation demand for dispersed recreation will grow substantially in the future (Oregon State Parks and Recreation Department, 1988). According to the Winema National Forest Plan, the Forest Service estimates recreation demand will increase 30% on the Winema (USDA Forest Service, 1990b). The Fremont National Forest estimates that demand for dispersed recreation will increase 100% over the next 50 years on that forest (USDA Forest Service, 1989). The Klamath-Lake District has the potential to offer dispersed recreation.

Changes in population will also affect future demand for outdoor recreation, because demand for recreation increases at about the same rate as population. According to the Oregon State Employment Division, the population for Klamath County will increase 13% by the year 2010.

Statewide, outdoor recreation has increased dramatically over the past 20 years. A 1989 study by the Oregon Tourism Department reported a 30% statewide growth rate in travel and tourism-related business from 1975-1987. This trend has continued and is likely to do so in the future.

In light of the predicted increase in recreational demand, the Department of Forestry should monitor recreation use on the Klamath-Lake District. Valuable opportunities exist to inform the public about the nature of the working forest and the appropriate care and use of the recreational resource.

Future Recreation Opportunities

In the future, recreation use is likely to increase on Klamath-Lake District state forests. However, current use levels do not indicate the need for any additional recreational developments. Monitoring of use levels will help managers determine the right time to pursue recreational opportunities.

Currently, there is an opportunity in the realm of education. Different media could be used to inform the visitors of Sun Pass State Forest about the natural environment and what makes state forest lands unique. This information could be available at both the forest and at the district office in Klamath Falls.

Scenic Resources

Scenic qualities on state forest lands are very important to the public. For many people, this is their only contact with the forest and the agency, and the basis for their judgments about forest management. Scenic qualities are also an important part of recreation experiences.

Scenic Highways

Recently, the Oregon Legislature has established scenic regulations through the Forest Practices Act. These regulations establish scenic corridors along interstate and state highways.

On the Klamath-Lake District, these buffers have little effect. Only two parcels actually come within 150 feet of these scenic highways. The first is a 640 acre parcel in the northern section of the district. This piece is intersected by Highway 138, which is a designated Scenic Highway. The other parcel is the southwestern tip of Sun Pass State Forest near Annie Creek where it makes contact with Highway 62.

In addition, one forty acre parcel along Highway 140 in the Southwest Block has a scenic conservancy land use designation. See page III-99 for a discussion of this designation.

Uneven-aged Management

Scenic qualities are retained throughout the district, in addition to scenic highway buffers. Uneven-aged management is used on 80% of the Klamath-Lake District state forests, and as a result there are few clearcuts on the state forests. The uneven-aged management retains the continuity of the forest with no large gaps. It maintains the forest's scenic qualities for both background viewing (viewing from outside the forest), and foreground viewing (viewing from within state forest lands).

Much of the state forest land is visible in the distance from major highways. For example, from Highway 62, the south entrance into Crater Lake National Park, the entire west side of Sun Pass State Forest is visible. Although timber harvest has occurred in the past, the forest is still visually attractive.

From inside the forest, there is little evidence of timber harvest unless it is recent. After a year or two, when slash has been treated, the only visible evidence is the stumps. The standing trees left on the harvest unit allow the forest continuity to be left intact.

The management of the Klamath-Lake District state forests has maintained healthy forests with a natural appearance. The timber harvesting that occurs does little to disrupt the appearance of the forest. The forest's scenic qualities leave a positive impression about the agency and the forest with people driving through the area.

Cultural Resources

Cultural resources are objects, structures, or sites used by people in the past. They are fragile, irreplaceable, and nonrenewable. Objects that remain undisturbed in their original locations are especially significant. These objects are still in context with each other and their surroundings, and provide the most information about the culture that created them. They provide a meaningful record of past lifeways and cultures in Oregon, including past ecological conditions.

Cultural resources are valued for many reasons. Researchers value archaeological sites for the information they provide about ancient cultures. Many sites also have religious, historic, or associational values for American Indian communities. The Klamath Tribes prefer that sites remain in place undisturbed, especially those associated with burials or religious activities. Finally, some Oregon historic sites have been maintained as interpretive, recreational, or heritage sites. If interpretation of Indian history on state lands is involved, this activity would be coordinated with the Klamath Tribes.

Examples of cultural resources that might be found on state lands in eastern Oregon include railroad logging camps and equipment, seasonal use areas, lithic scatters (where stone tools were made), vision quest sites, or cremation or burial sites. See the “Key Terms” boxes on the next two pages for definitions of terms used in this subsection.

Applicable Laws

Both state and federal laws regulate management of cultural resources. Important Oregon laws include: Archaeological Sites and Historical Material; Archaeological Objects and Sites; Indian Graves and Protected Objects; and the State Historic Preservation Plan. The Oregon laws were amended and strengthened in 1993 by Senate Bill 61. Unlike federal law, Oregon statutes do not mandate archaeological surveys or mitigation of impacts by state agencies as part of conducting land management activities. However, artifacts and sites found on public lands, and in some cases private lands, must be protected from harm or removal. If a sacred object is found, the State Historic Preservation Office (SHPO) and appropriate group or tribe must be notified. American Indian cairns and graves are protected by state law anywhere in Oregon, on privately owned as well as public lands.

Information relating to the location of archaeological sites and objects is usually not released to the public unless the public interest requires the disclosure, or if the governing body of an Indian tribe requests the information.

The state and federal laws regulating cultural resource management are described in more detail starting on page III-122, following the next two pages of “Key Terms.”

Key Terms

Archaeological and historical resources — Those districts, sites, buildings, structures, and artifacts which possess material evidence of human life and culture of the prehistoric and historic past.

Archaeological object — An object that is at least 75 years old; is part of the physical record of an indigenous or other culture found in the state or waters of the state; and is material remains of past human life or activity that are of archaeological significance, including, but not limited to, monuments, symbols, tools, facilities, technological by-products and dietary by-products. (ORS 358.905)

Archaeological site — A geographic locality in Oregon, including but not limited to submerged and submersible lands and the bed of the sea within the state's jurisdiction, that contains archaeological objects and the contextual associations of the archaeological objects with: each other; or biotic or geological remains or deposits. (ORS 358.905)

Burial — Any natural or prepared physical location whether originally below, on or above the surface of the earth, into which, as a part of a death rite or death ceremony of a culture, human remains were deposited. (ORS 358.905)

Cairn — Stones piled up as a memorial or as a landmark. (This term is not defined in Oregon law.)

Funerary objects — Any artifacts or objects that, as part of a death rite or ceremony of a culture, are reasonably believed to have been placed with individual human remains either at the time of death or later.

Grave — See "Burial."

Historic artifacts — Three-dimensional objects including furnishings, art objects and items of personal property which have historic significance. "Historic artifacts" does not include paper, electronic media or other media that are classified as public records. (ORS 358.635)

Historic property — Real property that is currently listed in the National Register of Historic Places, established and maintained under the National Historic Preservation Act of 1966, or approved for listing on an Oregon register of historic places.

Human remains — The physical remains of a human body, including, but not limited to, bones, teeth, hair, ashes or mummified or otherwise preserved soft tissues of an individual. (ORS 358.905)

Indian tribe — Any tribe of Indians recognized by the Secretary of the Interior or listed in the Klamath Termination Act, 25 U.S.C. 3564 et seq., or listed in the Western Oregon Indian Termination Act, 25 U.S.C. 3691 et seq., if the traditional cultural area of the tribe includes Oregon lands (ORS 97.740).

Key Terms

LCDC — Land Conservation and Development Commission of the State of Oregon, made up of seven lay citizens appointed by the Governor and confirmed by the Oregon Senate.

Lithic reduction site (lithic scatter) — A location where prehistoric stone tools were made, usually from obsidian. The tools and weapons were used locally or traded.

Object of cultural patrimony — An object having ongoing historical, traditional or cultural importance central to the native Indian group or culture itself, rather than property owned by an individual native Indian, and which, therefore, cannot be alienated appropriated or conveyed by an individual regardless of whether or not the individual is a member of the Indian tribe. The object shall have been considered inalienable by the native Indian group at the time the object was separated from such group. (ORS 358.905)

Petroglyph — Prehistoric rock carving.

Pictograph — Prehistoric rock painting.

Recognized Indian tribe — A tribe of Indians with federally acknowledged treaty or statutory rights. The federally recognized tribes in the Eastern Oregon planning region are the Burns Paiute, the Confederated Tribes of the Umatilla Indian Reservation, and the Klamath Tribe. The Klamath Tribe includes the Klamath, Modoc, and Yahooskin Band of Snake Indians.

Sacred object — An archaeological object that is demonstrably revered by any ethnic group, religious group or Indian tribe as holy; is used in connection with the religious or spiritual service or worship of a deity or spirit power; or was or is needed by traditional native Indian religious leaders for the practice of traditional native Indian religion. (ORS 358.905)

Site of archaeological significance — Any archaeological site on, or eligible for inclusion on, the National Register of Historic Places as determined in writing by the State Historic Preservation Officer, or any archaeological site that has been determined significant in writing by an Indian tribe. (ORS 358.905)

State Historic Preservation Office (SHPO) — Oregon's SHPO was created in 1966 by federal statute. It administers the Statewide Plan for Historic Preservation and submits Oregon's nominations for the National Register of Historic Places.

Unrecognized Indian tribe — A tribe of Indians that has never been recognized by the federal government, or whose federal relations were terminated by the Klamath Termination Act or the Western Oregon Indian Termination Act.

Vision quest site — In the Klamath region, these are sites used for seeking spiritual power, often on mountain tops, rimrocks, and other outcrops. They often contain constructed rock features ranging in age from prehistoric to contemporary.

Applicable Laws (continued from page III-119)

Archaeological Sites and Historical Material (ORS 390.235-390.240) — This law describes conditions for obtaining a permit from the State Parks and Recreation Department for excavation or removal of archaeological or historical material. It defines “qualified archaeologist.”

Regulations adopted on January 3, 1995 establish procedures for issuance of archaeological permits on public and private lands (OAR 736-51-060 through 736-51-090). On public lands, a permit is needed to excavate or alter an archaeological site, to make an exploratory excavation to determine the presence of an archaeological site, or to remove any material of an archaeological, historical, prehistoric, or anthropological nature. A person who is considering a ground-disturbing project on public lands should contact the appropriate tribe to inquire about the presence of archaeological sites and objects in the project area.

Archaeological Objects and Sites (ORS 358.905-358.955) — This law contains important definitions pertaining to cultural resources (see the “Key Terms”). Archaeological sites and objects located on public land are to be protected and managed by the state as a public trust. The law prohibits knowingly and intentionally excavating, injuring, destroying, or altering an archaeological site; or removing objects without a permit. A person who “unintentionally discovers” an exposed object may retain it for personal use, except for sacred objects, human remains, funerary objects or objects of cultural patrimony.

Penalties (ORS 273.990) — Violation of ORS 390.235 (1)(a) or 358.920 is a Class B misdemeanor.

Indian Graves and Protected Objects (ORS 97.740-97.760) — American Indian cairns, burials, human remains, funerary objects, sacred objects, and objects of cultural patrimony may not be willfully removed, injured, or destroyed. If a cairn or burial site is disturbed inadvertently, e.g., by logging activities, the remains or funerary objects must be reinterred under the supervision of the appropriate Indian tribe. Any discovered human remains suspected to be native Indian shall be reported to the state police, the State Historic Preservation officer, the appropriate Indian tribe, and the Commission on Indian Services. Archaeological excavation of a cairn or burial can be undertaken with proper notice, a permit, and the consent of the appropriate Indian tribe. This is the only state law to list penalties for a violation, including payment of damages, attorney fees, or other equitable relief.

Classification of Historic Property; Historic Preservation Plan; Preservation of Property of Historic Significance (ORS 358.475-358.690) — These laws encourage the preservation, management, and enhancement of significant cultural resources in Oregon, in conformance with the federal National Historic Preservation Act of 1966. The law describes the duties of the State Historic Preservation Office (SHPO) and the State Advisory Committee on Historic Preservation. Real properties of historic significance are administered by the Secretary of State with consultation with the State Historic Preservation Office.

Statewide planning goals — Four of Oregon’s 19 state-wide planning goals refer to historic preservation: Goal 5 (open spaces, scenic and historic areas, natural resources and cultural resources); Goal 8 (recreation); Goal 15 (Willamette River Greenway); and Goal 17 (coastal shorelands). These policies apply to city and county land use planning. Under the State Land Use Planning Law, local governments are required to inventory the location, quality, and quantity of their historic resources, including archaeological sites. The Oregon Land Conservation and Development Commission coordinates planning by state and federal agencies with city and county comprehensive plans.

Federal laws — Federal laws apply to federal land and agencies such as the U.S. Forest Service, and to federally licensed or funded activities. For example, if an access road is constructed across federal land, federal cultural resource laws would be followed. Significant federal laws include the National Historic Preservation Act of 1966, the Archaeological and Historic Preservation Act of 1974, the Archaeological Resources Protection Act of 1979, and the American Indian Religious Freedom Act of 1978. The Native American Graves and Repatriation Act of 1990 governs the protection of burials and associated grave artifacts. In 1992 the Applegate Trail, a portion of the California Trail in southern Oregon, was included in the California National Historic Trail by the National Trails Act.

Federal agencies must seek and identify tribes having aboriginal or historic ties to the land, and determine the location and nature of specific sites of cultural or religious importance. Federal landowners must conduct archaeological surveys before any ground-disturbing activities, and must consider the effects of the activities on archaeological sites. Notice must be given to the appropriate American Indian tribe before excavating any site. Up to 1% of project funds may be used for recovery or preservation of archaeological resources.

The American Indian Religious Freedom Act requires that archaeological excavations on federal properties consider American Indian concerns about land, sites, and sacred objects. Federal laws, policies, and practices need to protect and preserve the inherent right of American Indians to practice their traditional religions. However, federal administrative rules do not explicitly guarantee the right to visit a sacred site; to gather plants for use in medicine, crafts or religious practices; or to hunt on federal lands for religious purposes — for example, to hunt threatened or endangered species, or out of season. The question of whether the American Indian Religious Freedom Act is binding upon state and local governments has not been tested in the courts (Commission on Indian Services 1991).

Cultural Resources on Klamath-Lake District State Forests

The following description is based on an assessment by Winema National Forest Archaeologist, Elizabeth E. Budy, done for the Klamath-Lake District (Budy 1994).

A review of information available from the Winema National Forest, Fremont National Forest, BLM, and the State Historic Preservation Office reveals the kind of cultural resources likely to be found on state lands.

Some Klamath-Lake District state forest lands are located on former Klamath Indian Reservation lands and on lands ceded by the three treaty groups — Klamath, Modoc, and Yahooskin Paiute — in 1864. Cultural resources in the vicinity of state forest lands include villages, camps, rock shelters, cremation piles and burials, obsidian quarries, stone tool making sites, peeled trees, petroglyphs, pictographs and vision quest sites. Two American Indian sites are known to be located on state forest lands. Both contain numerous rock features that represent vision questing and spirit power seeking by Klamath Indians in the ancient past, and continuing today.

Mountain tops, rimrocks, and other bedrock outcrops are likely to contain vision quest rock features, especially on the west side of Sun Pass State Forest. Klamath tribal members are especially concerned that vision quest sites be protected and that the rock features remain as they were originally placed. Like most archaeological sites, vision quest site locations must be kept confidential.

No pictographs or petroglyphs have been found on state forest lands. Rock paintings and carvings by ancient artists probably served a variety of purposes, such as marking an important resource like a spring. Some may be associated with sacred locations, and would be especially protected under state law.

No burial or cremation sites are known to be located on state forest lands. The protection of such sites is of considerable importance to American Indians, and the sites are protected by both state and federal laws.

Winter villages and seasonal hunting and plant gathering camps can sometimes be found near streams and springs and along meadow edges. Peeled trees may be found near winter village sites. Ponderosa and other trees were traditionally stripped in late winter or early spring to access the inner cambium layer for food. Sun Pass State Forest is not far from winter village sites along Wood River.

Historic sites in Klamath and Lake Counties relate to early exploration and land surveys, military actions, Indian treaties and reservations, homesteading and ranching, communication systems, fire suppression, railroad logging, stream navigation, and recreation. Historic sites known to be present or that may be found on state lands include early explorers' trails, wagon roads, features and artifacts relating to Fort Klamath, early land survey markers, and railroad logging grades, camps, features, and artifacts.

Early Euro-American explorers used several routes through the area, including the Applegate Trail and the Old Klamath Indian Trail. The Applegate Trail was used by settlers in 1846 and 1847 to cross southern Oregon. Part of the trail runs across state forest land in Bear Valley. It is now part of the California National Historic Trail. The Old Klamath Indian Trail was later developed into the Huntington and Old Fort wagon roads. Blazed trees marking the route followed by early explorers could be present in some isolated parcels of state forest lands or in Sun Pass Forest. See "History" in Section I for more information on these explorers and the historical events mentioned in the next several paragraphs.

In 1863 soldiers started construction of Fort Klamath, a military post in the Wood River Valley not far from the present-day Sun Pass State Forest. The fort was abandoned in 1889, and none of the original buildings remain today. Trash scatters and isolated artifacts are likely to be found on state lands bordering the fort, especially along Annie Creek and in the southern part of Sun Pass. Two blazed trees mark the boundary of the military hay reserve on national forest land, and similar markers may be found in Sun Pass.

In the 1860s and 1870s the army blazed and constructed a number of military roads in the area. In the fall of 1867, Lindsay Applegate built a road over the old Klamath Indian Trail north from the Indian Agency to the present town of Bend. Blazed trees, wagon ruts, or old road beds may be preserved on state lands along Annie Creek, in Sun Pass, or in some isolated land parcels. Blazed trees and early survey monuments may be found on state forest lands, dating to the 1871 Mercer survey or to the Thiel survey of 1886.

Railroad logging took place from 1910 to the late 1940s throughout the area, including the Klamath Indian Reservation. Railroad logging grades, with ties in place, are known to occur on state lands, with associated artifacts and machinery.

Cultural Resource Assessment

Known settlement patterns and land uses in this area can be used to predict the most likely locations of cultural resources on state lands. Potential site areas would include stream bottomlands, river terraces, and stream benches as sites of villages, camps, or resource gathering and processing. Lake shores, marsh edges, lake terraces, and benches may have been used for summer or winter villages. Lithic scatter sites and other artifacts may be found on flat or gently rolling terrain within 150 meters of a water source, such as a spring, seep, pond or wet meadow.

Canyon rimrock, bedrock ledges on ridges, rock outcrops, and mountain tops, especially with open views to the horizon, are possible sites for religious power seeking. Rock features built by the power seekers may be associated with these sites.

Scab-rock flats and dry meadows, usually on flat or open ground, with non-forest vegetation, are sources of economically useful food plants (roots and seeds) and forage for game animals. Lithic scatter sites reflect short-term hunting and gathering. Rock features might also be present.

Any natural obsidian source might have been used for manufacture of stone tools. Important obsidian sources on the Winema National Forest involve eroded surface exposures of scattered pebble or cobble-sized nodules.

Fire Management

Wildfire poses a threat to many of the forest resources discussed in this plan. Timber, wildlife and fish, recreation, special forest products, and scenic qualities are some of the forest resources that are affected by wildfire. The Klamath-Lake District tries to minimize the negative affects of wildfire through two separate programs. These two programs are the Protection from Fire Program and the State Lands Program.

Protection from Fire Program

The Klamath-Lake District protects all state forest lands and private forest lands in the district. The district also protects various other county, municipal, and state-owned lands; and, under a contract, all BLM-managed land west of Highway 97. The goal of the Protection from Fire Program is to minimize the total cost and loss resulting from fire, in terms of suppression cost and damage to timber and other forest resources. To meet this goal the district responds aggressively to wildfires, suppresses fires rapidly, and reduces fires and the associated damage through various preventive programs.

The driving force behind the Protection from Fire Program is ORS Chapter 477. This statute declares preservation of forests and conservation of forest resources through the prevention and suppression of forest fires to be the public policy of the State of Oregon, and recognizes the need for a complete and coordinated forest protection system.

Essential elements of the Protection from Fire Program include: planning, prevention, detection, mobilization, initial attack, smoke management, and fuel management. Fuel management will be discussed later in this subsection under the heading “State Lands Program.”

Protection from fire is paid for by the protected landowners. Landowners pay an assessment per acre of protected forest land. The State Lands Program pays the above assessment for all lands managed by the department. The funds generated by the assessed lands in the Klamath-Lake District provide for the local base level of fire protection as well as contributions to the Emergency Fire Fund, Retardant Availability Program, and Staff and Administrative Support.

Fire protection in the Klamath-Lake District is divided into two protection units: the Klamath Unit and Lake Unit. The Klamath Protection Unit is made up of a unit forester who oversees a protection supervisor, one full-time forest officer, 26 seasonal firefighters, 4 seasonal lookouts, a seasonal dispatch coordinator, one seasonal dispatcher, a forest management specialist responsible for prevention programs, and one equipment operator. The Lake Protection Unit is headed by one unit forester, a protection supervisor, 15 seasonal fire fighters, a seasonal unit dispatcher, and a seasonal dispatcher. These two protection units also work closely with other local fire protection agencies and landowners to insure a complete and coordinated protection system.

The Klamath-Lake District Protection from Fire program also works closely with the Klamath Forest Protection Association (KFPA). This local association, made up of forest landowners in the district, provides input on the budget, advice on the protection level, program direction, and local coordination between the Klamath-Lake District and its protected landowners.

State Lands Program

While the Protection from Fire Program prevents and suppresses wildfires, the State Lands Program also works to minimize fire impact on district-managed lands by managing fuel levels. This objective is accomplished in many ways.

The uneven-aged management practiced on most of the district reduces fire hazard. The stocking reduction associated with standard uneven-aged management reduces fire hazard and fuel levels in several ways. First, decreased stocking levels increase forest health. This reduces the presence of insects and disease, which can lead to severe mortality. Second, uneven-aged management practices simulate low-intensity fire by thinning the understory and selectively removing fire-susceptible species.

A variety of tools are used to treat slash created during harvest and precommercial thinning. Our timber sale contracts usually require whole tree yarding of smaller trees, which concentrates post-harvest residue at landings where it can be burned or chipped. Occasionally, unacceptable slash accumulations still remain after whole tree yarding, and machine piling and burning is necessary in spots. Broadcast burning is frequently used after even-aged harvests in the lodgepole pine forest zone. A “slashbuster” machine has been used to crush and scatter slash after precommercial thinning. Chip/biomass sales have been used in several stands over the past few years in place of precommercial thinning. In these sales, most of the slash is used instead of being left on site. The viability of these sales is dependent on chip prices, which are volatile. Underburning has not been used on the district, but may be used in the future to meet fuel management and silvicultural objectives for certain sites.

The State Lands Program also salvages stands with severe mortality, in order to reduce fire hazard. Large stands of dead and dying material can increase fuel levels drastically. Salvage occurs to capture the value of this material as well as to reduce fire hazard. Dead trees are also left to provide wildlife habitat (see “Wildlife and Fish Strategies” in Section V).

Grazing

Livestock ranching is an important part of Eastern Oregon's economy. Both public and private lands are used for grazing. These lands vary in character, quality, and value. They often have other natural resources such as timber, water, wildlife, recreation, and minerals. State forests are managed primarily for timber, so where grazing occurs these may be thought of as "forested rangelands."

Public lands have historically supplemented the forage available to private livestock ranches. Grazing has been permitted, but not actively managed on the Klamath-Lake District and the Eastern Oregon scattered tracts. Most of these state grazing leases have been associated with federal grazing allotments. In developing a grazing policy through this long-range plan, the Department of Forestry must satisfy its fiduciary obligations and stewardship responsibilities while meshing with the rangeland programs of the Division of State Lands, the U.S. Forest Service, and the Bureau of Land Management (BLM).

Background Information

Grazing on State-Owned Lands

Grazing occurs mostly on Common School Lands that are managed by the Division of State Lands (DSL). DSL manages over 600,000 acres of rangelands in eastern Oregon. Most of these are Common School Lands located primarily in Lake, Harney, and Malheur counties. Some of DSL's grazing leases are on Common School Forest Lands (CSFL). The CSFL lands have been designated for the primary use of timber production. See the "Key Terms" box on the next page for definitions. The Department of Forestry is the primary land manager for CSFL lands, but DSL is responsible for grazing leases.

Grazing occurs on Board of Forestry (BOF) lands to a lesser extent. The Department of Forestry manages grazing as well as timber on BOF lands.

This plan addresses grazing on BOF and CSFL lands in the Klamath-Lake District. Currently, all leases are for cattle grazing. There has been some sheep grazing in the past.

Extent of Klamath-Lake District's Rangeland Resource

As measured by the Department of Forestry's land use classifications — In the Department of Forestry's land use classification system, most BOF and CSFL acreage is classified for the primary use of timber production. However, in the Klamath-Lake District, 787 acres of BOF land and 146 acres of CSFL are classified as "farm/rangeland use." This classification method indicates how much land is better suited to farm/rangeland use, but it does not reveal how much grazing could also occur on timber production land.

As measured by current grazing usage — A better estimate may be given by current grazing leases. In 1994, there were 2,397 acres of BOF and 3,164 acres of CSFL under lease in the Klamath-Lake District, for a total of 5,561 acres.

Key Terms

Definitions followed by “RMAR” are from the Division of State Land’s Rangeland Management Administrative Rules.

Allotment — Block of land granted to a permittee for exclusive grazing use.

Allotment management plan (AMP) — A plan covering a specific federal grazing allotment, developed by the federal agency managing the allotment; the AMP outlines various aspects of range management.

Animal Unit — An animal unit typically consists of one cow; or one cow and a calf less than six months old; or 1.4 yearlings; or one horse; or five sheep. (RMAR)

Animal Unit Month (AUM) — The amount of forage (approximately 800 pounds of air-dried forage) necessary to feed one animal unit for one month. (RMAR)

Common School trust lands — State lands owned by the State Land Board; the primary goal in managing these lands is the generation of the greatest amount of income for the Common School Fund over the long-term, consistent with sound techniques of land management. Common School trust lands that have been listed by the State Land Board for the primary purpose of timber production are called Common School Forest Lands (CSFL). Other Common School trust lands are designated as rangelands or for other uses.

Exchange of use — An agreement between a rancher and the BLM or Forest Service that gives the rancher permission to graze livestock on federal land in exchange for allowing the federal agency to regulate and control grazing on the rancher’s owned or leased lands that are adjacent or intermingled with the federal lands.

Isolated parcel — A parcel that is either largely surrounded by land not owned by the state, isolated from larger state-owned tracts and/or difficult or uneconomical to manage.

Livestock — Livestock are domestic animals such as beef and dairy cattle, horses, sheep, and goats kept or produced primarily for farm, ranch, or market purposes. Livestock also may include bison, llamas, emus, ostriches, and other species approved for use on a leasehold by the Division of State Lands. (RMAR)

Open range — An area wherein livestock may lawfully be permitted to run at large. (ORS 607.005(6))

Rangeland — Rangeland is state land designated and managed by the Division of State Lands for livestock grazing and/or conservation use, determined by the Division to be appropriate to the subject leasehold(s) and consistent with applicable local, state, and federal laws.

Rangeland management plan (RMP) — A written document prepared and approved by the Division of State Lands, in consultation with the lessee and other affected agencies and interests, indicating how a particular leasehold shall be managed during a specified term of a rangeland lease. (RMAR)

Quality of Rangelands and Economic Importance of Grazing

In general, Eastern Oregon's rangelands are considered to be in fair to good condition, although there is much variation in quality. The importance and benefits of grazing in the eastern Oregon state forests are fairly insignificant except where larger blocks are involved or where a smaller parcel may be an integral part of a Forest Service permit. Such a parcel may be quite important for access, meadow land, or stock water availability. Benefits will most likely require a case-by-case determination (Majors 1994).

Livestock ranching has been supported by federal public policy for many years. This policy has promoted community stability and the livelihood of ranchers who are dependent on federal rangelands (personal communication, Julie Bolton, 1994).

Grazing leases on CSFL and BOF lands are generally issued as a result of open range grazing. Financial returns to the state have been minimal. In 1994, the Klamath-Lake District's five grazing leases on CSFL and BOF lands generated about \$630 gross revenue.

Mandates and Policies for Grazing and Rangeland Management

State of Oregon Lands

Board of Forestry Lands

The Department of Forestry manages forests and grazing on property owned by the Board of Forestry. Any income from grazing leases is shared with the county where the land is located. By statute, the State Forester may permit domestic livestock grazing in order to secure the greatest permanent value to the state, as long as this use is not detrimental to the best interest of the state. (ORS 530.010; 530.030; 530.050) There are no administrative rules to regulate livestock grazing on BOF land.

Grazing leases for BOF lands are issued by foresters at the Klamath-Lake District office in Klamath Falls. Leases have been issued for as long as ten years. The leases have specified the maximum allowable AUMs and the annual rental, calculated most recently at \$2.50 per AUM. The standard lease form includes general conditions, but not specific range management requirements. Usually, the BOF lands where grazing occurs have been encircled by federal grazing allotments. The Department of Forestry has generally issued grazing leases to the federal permittees. Details on current leases are given later in this subsection, under the heading "Current Situation — Grazing Leases."

Common School Forest Lands

Common School Forest Lands are those Common School lands that have been designated for the primary use of timber production. The Department of Forestry (ODF) is the primary land manager under a contract with the State Land Board. However, grazing and

mineral leases are managed by DSL. The December 20, 1993 contract spells out the roles of ODF and DSL.

The State Land Board holds CSFL lands in trust to benefit the Common School Fund. The Land Board has a constitutional obligation to obtain the greatest amount of revenue over the long-term for the use of this land, consistent with conservation of the lands under sound techniques of land management (Division of State Lands, 1994b). A July 24, 1992 legal opinion by Oregon Attorney General Charles S. Crookham states that forests and rangelands are among the many natural resources that may offer revenue for the Common School Fund. See the heading “Attorney General’s Opinion” in Appendix C for more information on this legal opinion.

DSL is currently working on an asset management plan that will determine the best management direction for all Common School lands, including the CSFL lands.

Until July 29, 1994, DSL had no administrative rules for the rangelands they managed. Their management was based on applicable Land Board policies, Attorney General opinions, statutes, and the experience of the Division’s range managers. On July 29, 1994, the State Land Board approved a set of administrative rules that apply to all rangelands managed by DSL. The new rules were designed to promote and maintain rangeland health while fulfilling the state’s fiduciary responsibility to maximize long-term revenue from Common School Lands and their resources. Grazing fees were raised for the first time since 1979, and the rules provided for competitive bidding among ranchers and others who want to lease the lands for conservation use (Division of State Lands, 1994b). However, on February 14, 1995, the State Land Board voted to reconsider the rules and competitive bidding was later rescinded.

DSL issues leases for grazing on Common School Forest Lands. Their grazing program is administered and monitored by four resource coordinators out of DSL’s Eastern Region office at Bend. Leases have been issued for an extended number of years and some leases have had renewal rights. The leases have specified the maximum allowable AUMs and the annual rental, calculated most recently at \$2.50 per AUM on most lands. DSL’s leases have generally been associated with federal allotments. Details on current leases are given later in this subsection, under the heading “Current Situation — Grazing Leases.”

Open Range and Federal Allotments

Allotments

State and privately owned lands are often intermingled within Forest Service or BLM grazing allotments. Most allotments are for cattle grazing, although some are used for sheep. In order to hold a grazing permit, a rancher must generally own livestock and/or base property that is tied to the permit. These conditions ensure that the permittee is in the business of ranching, promote long-term land stewardship, and prevent speculative transactions in grazing permits.

Allotments are managed in accordance with the agency's forest plan standards and guidelines. In addition, some allotments may have an allotment management plan (AMP). The AMP outlines various aspects of range management such as grazing schedules, rangeland improvements (e.g. fences, corrals, water), and resource protection measures. Forest Service and BLM grazing allotments must meet NEPA (National Environmental Policy Act) requirements. Existing AMPs are currently being updated to meet NEPA criteria. Forest plan standards and guidelines that are used in lieu of an AMP must also meet NEPA requirements.

Open Range

As a general rule, all lands except incorporated cities and exempted livestock districts are considered open range under Oregon statutes. (Several provisions in Chapters 607 and 608 of the Oregon Revised Statutes, taken together, constitute Oregon's open range law.) In open range, livestock may lawfully be permitted to run at large. The owners are not liable for trespass unless their livestock injure property enclosed by an "adequate fence". In livestock districts, the legal framework is reversed: ranchers have the burden of fencing their land to prevent their livestock from trespassing on to other lands (Cook 1994).

Open range laws have been an important part of grazing policy because they provide a system for managing trespass where federal and non-federal lands are intermixed (personal communication, Bill Lindsey, 1994). Although the state's open range law allows livestock from a federal grazing allotment to run at large onto non-federal land, the opposite situation is not legal. Livestock that stray from state or private land on to federal land without a permit are in trespass.

The state Attorney General's office has supplied the following information about how open range affects the leasing of Common School lands. The vast majority of state-owned land is open range. Where a state-owned parcel is bordered (or surrounded) by lands owned by the rancher who currently leases the state parcel, that lessee has no reason to fence the state land he or she leases. However, if the state now leased such a parcel to someone else, it must be fenced. Under the open range law, unless that state parcel is enclosed by an adequate fence, the neighboring rancher lawfully could allow his or her livestock to graze the state parcel without a lease. On Common School lands, this would be contrary to the state's trust responsibilities as well as the interests of the new lessee (Cook 1994).

Sun Pass State Forest is adjacent to private pastures, but it is not in a livestock grazing district. The nearest livestock districts are south of Modoc Point and around Sprague River and Beatty (personal communication, Rodger Huffman, 1994).

Exchange of Use

BOF and CSFL lands in the Klamath-Lake District tend to be relatively small, isolated parcels. Many of the parcels are enclosed by federal grazing allotments, and because there are no fences, allotment livestock may lawfully run at large.

A person who applies for a federal grazing permit generally obtains leases for state and private lands within the allotment boundary. Proof of these leases is shown when applying for a permit. In essence, the permittee's personal land and leased grazing rights comprise the privately held portion of the allotment. The federal permit accomplishes two things. First, it waives the private lands to the federal agency. In other words, it adds these lands and their grazing capacity (AUMs) to the allotment. Second, it enables the permittee's livestock to enter federal land without trespass.

The signed agreement between the federal agency and the permittee is the Exchange of Use Grazing Agreement (BLM) or Term Private Land Grazing Permit (USFS). The state does not sign the federal permit, having transferred grazing use of its land to the permittee through a lease. In spite of provisions that require the permittee to comply with various laws, regulations, and conditions on all lands in the allotment, there is no clear obligation for a federal agency to administer the allotment or enforce the terms of the permit on the non-federal lands.

If the state stopped leasing its land to the permittee, this action would effectively cancel the waiver (i.e. exchange of use arrangement). The use of state land might continue under the open range law, although it might be with a smaller herd.

Term Private Land Grazing Permit (USFS) — This document is the master permit for Forest Service grazing allotments that include state or privately owned land. It waives private lands identified in the permittee's application to the United States for grazing use and gives the U.S. exclusive and continuous possession of the waived lands for livestock grazing during the term of the permit.

The permit may be suspended or canceled “for conviction for failure to comply with federal laws or regulations or state and local laws relating to livestock control and to protection of air, water, soil and vegetation, fish and wildlife, and other environmental values.” Supplemental provisions may be attached in the form of an allotment management plan (AMP).

Annual adjustments to the permit can be made in accordance with forage conditions. Forest Service officials may order livestock to be removed from Forest Service-administered lands before the designated grazing season expires if further grazing would damage the resource. Fundamental changes in the allotment, such as the number of livestock or the period of use, require a one-year notice.

Exchange of Use Grazing Agreement (BLM) — The Exchange of Use Grazing Agreement allows the Secretary of Interior to exercise the same regulations and controls on both private (i.e. owned and leased) and BLM lands under the permit. In exchange, the permittee is allowed to graze livestock on BLM lands that are intermingled and adjacent to the owned and leased lands.

BLM uses two additional documents: (1) the BLM grazing lease allows grazing on BLM land; (2) the annual grazing license specifies the number of livestock and AUMs on both BLM and all other lands.

The BLM documents are considerably shorter than the Forest Service versions, and do not refer to any specific conditions or allotment management plans. The Taylor Grazing Act, Federal Land Policy and Management Act, and the Public Rangelands Improvement Act are specifically mentioned.

Current Situation — Grazing Leases

The next several pages provide information on all Klamath-Lake District grazing leases and federal grazing allotments that enclose state lands. The information is organized under the East Block and Southwest Block. Under each block, the information is summarized by allotment, with information about ownership provided under each allotment.

The following acronyms are used in the grazing lease summaries:

AUM	Animal Unit Month	DSL	Division of State Lands
BLM	Bureau of Land Management	ODF	Oregon Department of Forestry
BOF	Board of Forestry	USFS	U.S. Forest Service
CSFL	Common School Forest Lands		

East Block

Yainax Butte Allotment Agency: USFS Size: 118,000 acres

State Leases and/or Land Associated with Allotment

- 3,044 acres of CSFL lands (120 AUMs) under lease to James Rodgers.
- 876 acres of BOF land (21 AUMs) under lease to James Rodgers.

Management Status

Of the allotment total, 82,000 acres are USFS lands and 9,000 acres are the permittee's lands. State lands are listed above. The Yainax Butte Coordinated Resource Management Plan (CRMP) is recognized as the allotment's management plan. Participants include Weyerhaeuser Company, DSL, ODF, ODFW, OSU Extension Service, USFS, SCS (Soil Conservation Service), BLM, and the permittee. The Forest Service is currently updating the plan in order to meet NEPA requirements. According to the CRMP, cattle are wintered in California, spend a short time on the headquarters ranch, then rotate between pastures on the allotment. The plan has a four-year schedule for 1,000 cows and bulls, requiring 6,500 AUMs.

The CRMP also includes: (a) objectives by participant and for the group as a whole; (b) major problems and concerns; (c) management plans for livestock grazing, irrigated cropland, forestry, wildlife, fisheries, T&E species, recreation, cultural resources, and watershed; (d) information about forage management, livestock control, special improvements, and livestock management. Grazing schedules are reviewed annually to adjust for range condition and any concerns that the participants might have.

In addition to the CRMP, DSL keeps a Rangeland Inventory of the CSFL lands in the Yainax Allotment. The inventory contains information about the range, improvements, water features, wetlands, threatened and endangered species, cultural resources, and recreation. Vegetative inspection reports are cited.

Horsefly Allotment

Agency: USFS

Size: Over 100,000 acres

State Leases and/or Land Associated with Allotment

- 120 acres of CSFL land (12 AUMs) under lease to Newman Enterprises; this lease also includes 93 acres of non-forest trust lands managed by DSL, for a total of 213 acres (21 AUMs).
- 160 acres of BOF land that is not under lease — grazing could be occurring on these 3 parcels due to open range.

Management Status

An allotment management plan was written in 1984.

Traphouse, Horseglades, and Reservoir Creek Allotments

Agency: USFS

State Leases and/or Land Associated with Allotment

- 364 acres of BOF land leased to Rocking AC Ranch; this lease also includes 35 acres of BOF land in an isolated parcel that is not inside a Forest Service allotment, for a total of 399 acres (40 AUMs).

Management Status

Horseglades is roughly 12,000 acres. Traphouse and Reservoir Creek are each less than 800 acres. Management standards and guidelines are set by the Fremont National Forest Land and Resource Management Plan.

Southwest Block

Chicken Hills Allotment

Agency: BLM

State Leases and/or Land Associated with Allotment

1,126 acres of BOF land (60 AUMs) leased to Lee Harrington.

Management Status

BLM currently lists the allotment as having 114 cattle (20 BLM and 94 exchange of use). In terms of forage, the allotment totals 465 AUMs (82 BLM and 383 exchange of use). The base property is 1,800 acres, which the permittee leases from Bart Hadwick. The AUMs are a reasonable estimate based on the number of cattle that were granted to the exchange of use. The 383 AUMs includes BOF lands (1,126 acres and 60 AUMs) and Boise Cascade (37 AUMs). The remaining 286 AUMs presumably account for the Hadwick pasture. Weyerhaeuser Company has canceled its exchange of use.

Chase Mountain Allotment

Management Status

The Bear Valley tract has previously been leased in connection with the BLM's Chase Mountain allotment. Both the lease and the BLM allotment are currently inactive. Weyerhaeuser Company, which owns the base property, has canceled its exchange of use. On the books, the allotment has 8,823 acres (195 AUMs) of BLM land and 19,680 acres (895 AUMs) of state and private land. The Klamath-Lake District's Bear Valley tract (approximately 2,000 acres BOF land) is inside the allotment.

North Block

The North Block's satellite parcels near Chemult are not within a Forest Service allotment and are not under lease (personal communication, Willis Albin, 1994). The parcels near Crescent are within vacant sheep allotments. However, these allotments are considered infeasible due to scarce water (personal communication, Helen McGranahan, 1994). Sun Pass State Forest is not within any Forest Service allotment. All Chiloquin Ranger District allotments are east of Highway 97 (personal communication, Ken Woodman, 1994).

Resource Management Information

Range

General management — Grazing needs to be conducted on a planned schedule of graze and rest treatments that substantially meets the requirements of vegetation, soil, and animals that are affected by such grazing. Numerous aspects of grazing can be beneficial to these elements if conducted properly. The diverse levels of forage off-take and conditioning aspect of forage plants can be quite important to fire management (Majors 1994).

Information and data — DSL has basic information on numbers of livestock, season of use, and AUMs of use on issued leases. Additional information that would be desired would be better records of fence locations, water resources, possible opportunities to develop better water, who is grazing land that is not under lease, and better inventory of key areas such as meadows and riparian areas (Majors 1994).

Yainax Butte — The Yainax Coordinated Resource Management Plan cites a number of concerns including pasture size, fences, water sources, and noxious weeds. A four-year grazing system has been charted in the plan, starting from September 1993. Past forage inventories include: (a) an SCS ecological site survey for the original CRMP in 1974; (b) Forest Service stand exams; (c) Forest Service range analysis in the early 1980s; (d) Forest Service utilization survey in 1985-1986.

Timber

Livestock have damaged the Department of Forestry's forest plantations at Yainax Butte. Recently, it was necessary to protect seedlings with vexar tubing. The damage is in the vicinity of a heavily used livestock pond (personal communication, Craig Leech, 1994).

A properly applied grazing program may have silvicultural benefits. Weyerhaeuser Company has permitted livestock to graze forest plantations in the past to control competing vegetation. More recently, the program has been cut back because the stands have grown older and there are concerns about riparian impacts (personal communication, John Monfore, 1994).

Watershed

Stream water quality is impacted primarily when livestock intrude into riparian areas. Upland impacts, such as an increased risk of soil erosion, are considered minimal on most eastern Oregon soils (personal communication, Keith Mills, 1994).

Damage to stream side vegetation can be minimized by excluding livestock during certain months and by managing the concentration of animals. Fencing is the best solution for sensitive riparian areas. However, it is not certain which types of streams need to be protected. The Forest Practices Act's stream classification system and water protection

rules do not address livestock grazing. There are no grazing practices rules or grazing BMPs analogous to the Forest Practices Act.

The Yainax Butte Coordinated Resource Management Plan (CRMP) acknowledges “damage to some water resources and adjacent riparian areas which affects water quality (sanitation), channel stability, and watershed condition.” (USDA Forest Service, et al., 1993c) The availability and distribution of water is a problem because cattle tend to linger around wet meadows and livestock ponds. On state land, the pond in Section 34, T37S, R12E holds water throughout the summer even during drought years. It is difficult to ascertain whether the intermittent stream’s riparian functions have been degraded by grazing, but the dam itself has interrupted stream flow and impacted the immediate site.

Tamarack Spring and Cold Spring are heavily used by livestock. Wet meadows and forested wetlands surround Tamarack Spring. The Department of Forestry classifies the 37-acre site as “Protective Conservancy — Critical Wildlife Habitat” for forestry uses. However, the Division of State Lands manages grazing on this site. Eight acres were fenced to protect the spring itself in a project sponsored by DSL, the Audubon Society, the Oregon Hunter’s Association and the Rocky Mountain Elk Foundation. A watering trough still attracts cattle to the wet meadow outside the fence. Cold Spring is not impacted as much because it is on a hillside, and a fence protects most of the immediate area. Water drainage in the meadows surrounding Tamarack and Cold Springs has been altered by various ditches and dikes.

With regard to the broader impacts of grazing, federal agencies are concerned about how the Yainax CRMP relates to their efforts to benefit the endangered shortnose sucker. But according to a BLM fish biologist (name not cited in the CRMP), the Gerber Reservoir population is believed to be stable, even under widely fluctuating pools. The Yainax Butte CRMP does not cite any evidence that land management is having adverse effects on the sucker or the quality of water reaching Gerber from the Dry Prairie area. Dry Prairie is a good buffer for potential water problems in the upper watershed. In order to improve riparian habitat that may impact the sucker, the CRMP prescribes certain protective measures with regard to Ben Hall Creek and Horse Canyon. (USDA Forest Service et al., 1993c)

A better understanding of watershed conditions will come out of current studies that will bring the Yainax CRMP up to NEPA requirements. The revised CRMP will include a biological opinion on the Forest Service grazing program in the entire Lost River watershed (personal communication, Julie Bolton, 1994).

Subsurface Resources

The economic value of minerals and natural gas produced in Oregon each year is high. The benefits of mineral exploration and development include lease receipts and royalties paid directly to the state, as well as high-paying jobs in the rural areas.

The Division of State Lands (DSL) leases oil, gas, and minerals on state-owned lands. They lease by auction for 40 acres or more, or through negotiation on less than 40 acres of land. DSL handles the leases on both Common School Forest lands and Board of Forestry lands, but must get the approval of the Department of Forestry on Board of Forestry lands. DSL also issues prospecting permits and permits for surface disturbance, such as seismic lines.

The Department of Geology and Mineral Industries (DOGAMI) regulates gas, oil, and mineral exploration, development, and reclamation/abandonment throughout Oregon. DOGAMI routes applications for drilling permits to all state natural resource agencies, which then have 21 days to respond. Additional statutes and regulations apply to exploration and development, and various permits and licenses are required. The various laws, regulations, and permits address issues such as air quality, water, threatened and endangered species, fish, explosives, and mine issues. They are enforced by various state and county agencies.

Energy & Mineral Potential of Klamath-Lake District State Forests

Few detailed geological studies have been conducted in the Klamath-Lake District state forests. Therefore, much of the information in this assessment is based on a review of literature in DOGAMI's Portland library and a search of that agency's mineral occurrence database. Prospecting permits were also examined; these were issued by DSL to California Energy Corporation for geothermal exploration in the Sun Pass area. Geologists familiar with the state lands were interviewed to provide information about the results of past exploration activities and the potential for future discoveries. No field investigations were conducted to confirm the validity of the information. This assessment was done by Jeff Kroft, of DSL. His full report is on file at the Salem headquarters, and is summarized here (Kroft 1994).

No significant mineral resources are known to occur on Klamath-Lake District state forest lands. There are indications of natural gas resources and diatomite deposits (see "Key Terms" box on the next page) on the Bear Valley and Yainax Butte tracts, and also of pumicite deposits on the Yainax Butte tract. However, it is unknown if these resources will ever be of commercial value. All of the major blocks of state forest land contain deposits of material suitable for road base and traction material. A number of these deposits have been occasionally mined. The mineral resources of the Klamath-Lake District lands are described in more detail on the following pages.

North Block

The underlying geology of the Sun Pass area consists mainly of interlayered Quaternary and Tertiary basalt and basaltic andesite flows and ejecta of varying thickness. These layers have been cut by numerous, often steeply sloped, faults. See “Geology, Topography, and Soils” earlier in this chapter for details on Sun Pass’s geology.

Several small quarries and pits exist in the vicinity of Sun Pass State Forest. There is one rock pit in Sun Pass State Forest. The Department of Transportation has a permanent easement for this pit (DeBlander 1994). The material removed from these operations is used primarily as road base and traction material.

No known metallic or industrial mineral occurrences have been identified on Sun Pass. There is no evidence to indicate that there have been any recent explorations for minerals on or adjacent to Sun Pass.

In the early 1980s, California Energy Company (through its subsidiary CE Exploration Company) obtained leases from DSL for much of Sun Pass State Forest, and from the federal government for nearby federal lands, in order to determine the area’s geothermal potential. Two holes were drilled. One hole was on the southeast corner of Mt. Scott, east of Crater Lake National Park and outside Sun Pass State Forest; it was 4500 feet deep. The other hole was drilled near Annie Creek, near the state forest; it was 1000 feet deep. Although both holes encountered some evidence of geothermal wallrock alteration and thermal water, the drilling results were not sufficiently encouraging to warrant further exploration.

Key Terms

For definitions of basalt, ejecta, Miocene, and Pliocene, see the Key Terms box under “Geology, Topography, and Soils” earlier in this chapter, or see Appendix A.

Andesite — A common volcanic rock; it occurs as lava flows, ash deposits, and accumulations of angular debris.

Cinnabar — A heavy, bright red mineral; it is the principal ore of mercury.

Dacite — A volcanic rock; it is a mixture of quartz and other minerals.

Diatomite — Diatomaceous earth; when dry, it forms a fine powder used as an abrasive, pottery glaze, etc. Diatoms are microscopic algae that are rich in silica; their fossils form diatomaceous earth.

Igneous — Formed by volcanic action or great heat.

Olivine — A silicate of magnesium and iron; found as green crystals in many rocks, and used as a semiprecious stone.

Perlite — A glassy volcanic rock with a pearly luster; it is a form of obsidian.

Pumice, pumicite — A lightweight, spongy, porous volcanic rock; pumice is used in solid or powdered form for removing stains, smoothing, and polishing.

During the time that CE Exploration Company held the leases, considerable controversy arose concerning the possible impacts that geothermal development could have on the clarity and quality of Crater Lake. This debate may have helped to discourage any additional geothermal exploration in the area.

East Block

The underlying geology of the East Block consists of Miocene-Pliocene olivine basalt flows. Information is not available about the extent of faulting in this area. No metallic or industrial mineral occurrences have been identified on the state forest lands in this block. However, diatomite, pumicite, perlite, and cinnabar have been found nearby.

Diatomite has been identified in well cuttings approximately one mile to both the northwest and southeast of Yainax Mountain. Samples of a perlitic glassy dacite were taken north of Bly Mountain Pass, about six miles west of the state forests. Pumice and pumicite outcrops up to ten feet thick reportedly occur north and east of the state forests. Some pumice was removed from deposits twelve miles east of Yainax Butte in the 1940s and 1950s, but the commercial value of these deposits today is unknown.

An occurrence of rock containing cinnabar was located about six miles north-northeast of Yainax Butte. An assay of samples taken from this occurrence, called the Given Ranch prospect, indicated sixteen pounds of mercury per ton of host rock.

Some geothermal exploration has been conducted in the vicinity of Yainax Butte. At least two geothermal wells have been drilled several miles to the south of Yainax Butte. Reportedly, these were shallow wells and they did not encounter significant geothermal resources.

At least three oil wells were drilled in the 1920s to 1930s, approximately six miles west of the state forest lands. Two of the wells hit warm water, with temperatures of 200 degrees Fahrenheit reported for one and 85 degrees for the other. No commercial production was reported from any of the wells.

Some geologists believe that the Upper Cretaceous Hornbrook Formation underlies much of the southern end of the county, perhaps including the state forest lands in the East Block. This formation is suggested as being correlative with natural gas-producing formations in California's Sacramento Valley. Therefore, the possibility exists that natural gas resources could lie under the state forests.

Southwest Block

The underlying geology of the Southwest Block consists of interlayered Quaternary and Tertiary basalt and basaltic andesite flows, typical of the High Cascade igneous rock series. The area's topography is dominated by a series of northwest trending normal faults.

Several quarries and pits are located in the vicinity of the state forest lands. These operations are small and are used for road base and traction material.

Many wells have been drilled on or near the state forest lands in this block, with the majority of wells for water. Reportedly, several wells have been drilled in the vicinity in search of geothermal resources, but little information is available about these wells. Approximately one mile east of Chase Mountain, a water well drilled on state land for the U.S. Air Force first encountered basalt 26.5 feet below the surface. The basalt extended all the way to the bottom of the well, at 1305 feet.

No metallic or industrial mineral occurrences have been identified on these state lands, although some minerals have been reported in the general vicinity. Minor amounts of cinnabar are reported to occur in the Klamath Hills, about two miles east of the state forests. Diatomite has also been reported in outcrops and well cuttings within a mile to the northeast of the state forests.

No producing oil or gas wells are known to have been drilled in Klamath County. However, some geologists believe that the Upper Cretaceous Hornbrook Formation underlies much of the southern end of the county. This formation is suggested as being correlative with natural gas-producing formations in California's Sacramento Valley.

Social and Economic Resources

Although the Klamath-Lake District is closely identified with the Klamath Falls area, resource outputs from the district affect the economies and social structures of many communities and Oregon as a whole. This subsection reviews the current uses of forest resources and discusses the social and economic implications of resource management.

As Oregon's economy has matured, it has evolved from being quite dependent on the use of natural resources to a more diversified economy. Oregon's forests are still as important as ever to the state's economic health. But in addition to producing timber, they are now also expected to provide recreation, clean water, and healthy populations of fish and wildlife.

The Department of Forestry's stewardship responsibilities for state forests include generating revenue as well as conserving and protecting natural resources. The land's social and economic values are maintained over the long-term, even as current income is produced.

"Social and economic" describes the relationship between people and the forest. Economic resources include the ways that resource outputs contribute to schools, government entities, industry, and employment. Social resources include community stability and quality of life. The state forests contribute to quality of life in many ways, such as providing open space and recreational opportunities, contributing revenues to schools, and helping to provide secure employment. By making Klamath County a desirable place to live, the state forests may help attract other industries to the area.

Economic Trends

Although lumber and wood products employment has always been important to Klamath, Lake, and adjacent counties, changes have been occurring in the structure of local economies and in the lumber and wood products industry itself (Oregon Employment Department 1993; Oregon Employment Department 1994).

Klamath County has 2.6 million acres of forest land, and 750,000 acres of farmland. Most of Lake County is grass-shrub rangeland, with about 15% (800,000 acres) forested. Lumber and wood products and agriculture (particularly livestock) are major sources of employment in both counties. Transportation (railroads) and recreation, e.g. Crater Lake National Park, are also important in Klamath County. Government is another source of income in the area, and is the largest source of payroll income in Lake County. Government employers include the U.S. Forest Service, the Bureau of Land Management, Oregon Institute of Technology, and others.

Klamath County is a major timber producer, usually ranking among the top three Oregon counties in volume of timber production. In the 1970s, the industry provided employment for almost 5,000 workers. By 1993, employment in lumber and wood products in the county had dropped to about 2,750. This decline was caused by lower timber harvests from federal land, a highly competitive market situation, and continuing automation. Although some mills dependent on old growth ponderosa pine have closed, capital investments in remanufacturing plants using wood products (chips or fiber) are leading to some recovery in this industry in both counties — and in Oregon as a whole. The net result of this trend is that a million board feet harvested today produces more jobs than in the 1980s, in spite of technological improvements and automation.

Future growth potential in the area depends on increasing economic diversification. Efforts to attract new industry have been successful, especially in attracting firms in electronics-related fields and manufacturing. Relatively low living costs and a pleasant environment provide prospects for attracting new manufacturing to a favorable location serving California and Asian markets. Local economic development strategy includes developing Kingsley Field into an international and industrial trade center.

In addition, retirees from out of state have been drawn by the area's low real estate costs and livability. Employment in trade, services, and government helps stabilize the local economy and offsets market fluctuations for lumber and wood products. However, lumber and wood products will continue to be a dominant element in Klamath and Lake Counties.

The economic trends described have resulted in the replacement of high-paying jobs in manufacturing, transportation, and utilities, held mostly by men, with low-paying jobs in trade and services, which employ a higher proportion of women and youths. Unemployment rates have tended to be higher than the state as a whole due to the seasonal nature of employment in forestry, logging, and agriculture. Unemployment peaked in Klamath County at 14% in 1982, during a recession that especially affected the timber industry. Unemployment is currently decreasing, with 1993 unemployment rates at 10.5% in Klamath County and 9.2% in Lake County.

Regional wage rates are low. Some of the factors affecting wage levels are the small size of most local firms, a labor surplus created by limited employment opportunities for women and young people, and mechanization of agriculture, with increasing numbers of Hispanic workers filling the available jobs.

Transfer payments have increased to become the largest source of personal income in Klamath County, accounting for 22% of the total, compared to the statewide average of 17%. Transfer payments include retirement, unemployment, and public assistance programs. The rapid rise has been primarily caused by gains in social security, Medicare, veterans' benefits, and government retirement, due to the influx of retirees. In Lake County, government, transfer payments, and investment income are the largest contributors to private income.

Funding of Schools and Local Government

Revenues produced from the Klamath-Lake District state forests directly benefit schools and local government. Income from Common School Forest Lands is added to the state's Common School Fund. Interest generated from this fund is used for schools statewide. Income from Board of Forestry lands is distributed to the county where the income was generated, although ultimately a portion of this income benefits all Oregon schools, as explained below. See "Location and Ownership of Eastern Region State Forests" in Section I and guiding principle 4 in Section II for more information about land ownership and legal mandates for state forests.

Over a 5-year period (1988/1989 through 1992/1993), the distribution from Board of Forestry lands to Klamath County averaged \$296,887 per year. This money is used for schools (grades K-12, community colleges, educational service districts) and non-school taxing entities (such as county government, rural fire districts, port authorities). About 70% of these funds usually go to schools and 30% to non-school uses (Bowling 1994).

Even though these funds are distributed to the county, the portion for schools has effectively become a state-wide resource. This happened as a result of voters' approval of Measure 5 (property tax limitation) in 1990 and subsequent changes to the State School Fund statutes by the Legislative Assembly in 1991. The statutes attempt to equalize funding among school districts and prevent local school funding from rising or falling when revenues from Board of Forestry lands fluctuate. Each school district is now entitled to a grant from the State School Fund, which is part of the state's General Fund. In computing this grant, income from Board of Forestry lands is counted as "local revenue" that offsets grant money. In essence, any fluctuations in local revenue will affect all schools in the state that receive payments through the State School Fund (Bruce 1994).

To put Board of Forestry lands in perspective, in the 1991-1993 biennium these lands generated \$37.6 million state-wide for distribution to counties. Of this, about \$26 million went to schools. This sum was 1% of the total schools' budget of \$2.6 billion (Bowling 1994).

Similarly, timber harvested from all Common School Forest Lands managed by the Department of Forestry has produced over \$230 million state-wide for the Common School Fund over the past twenty years (Oregon Department of Forestry 1993).

Review of Resource Outputs

Timber Sales

Timber harvested from the Klamath-Lake District supports employment in logging, millwork, and service industries in Klamath County and its neighbors.

Klamath and Lake Counties are among nine Oregon counties that were designated in 1992 by the Oregon Department of Economic Development as “severely affected” by declining timber harvests. These counties have a high unemployment rate in comparison with the rest of Oregon, have had declining timber industry employment, and are likely to show severe economic decline (Seidel 1993).

The amount of timber harvested from federal lands has declined, so Klamath-Lake District state forests are relatively more important to regional timber supply and employment. Not all of the jobs are filled by local residents. State timber sales are often purchased by mills outside of Klamath County.

Grazing

Klamath-Lake District state forests are a minor player in the livestock ranching industry. Only 5,561 acres of the district’s state forests were leased for grazing in 1994. The gross revenue generated by these leases in 1994 was about \$630. Most of the leased lands are associated with larger federal grazing allotments, and thus contribute to ranching employment and community stability.

Recreation, Scenery, and Wildlife

Klamath-Lake District state forests are used mostly by local residents for informal dispersed recreation. These residents enjoy activities such as camping, hunting, fishing, horseback riding, and snowmobiling in an undeveloped setting. The state forests have not attempted to provide developed forms of recreation, which are in ample supply on nearby state parks, federal lands, and private facilities. The forest’s aesthetic quality is maintained by uneven-aged management and other management considerations. Sun Pass State Forest is visible to tourists traveling to the south entrance of Crater Lake National Park.

Recreation does not directly contribute revenue to the Common School Fund or Klamath County, but the cost of providing dispersed recreation has been minimal. There are some opportunity costs associated with providing diverse habitat for game and non-game animals. However, this kind of forest management maintains the long-term value of the land and meets social and biological needs.

Water

Water from the state forests does not generate revenue directly, but it does have a number of other social and economic benefits. Sun Pass State Forest produces water for irrigation as well as aquatic habitat. The Yainax tract has several watering locations for livestock grazing. Riparian and wetland habitats in the forests are recognized as important resources. The greater emphasis being given to watershed planning is an indication of the

value of healthy watersheds. Water resources are a vital element in the livability and economy of the Upper Klamath Basin.

Subsurface Resources

The past development and potential future development of subsurface resources is very limited. There has been occasional mining of road base and traction material. No other significant mineral resources are known to occur. There are indications of natural gas resources, diatomite deposits, and pumicite deposits, but it is unknown whether these occurrences will ever be of commercial value. There has been exploration for geothermal energy, but it is doubtful whether there will be further exploration or development.

Cultural Resources

The Klamath-Lake District may have sites that have historical significance or social importance to the Klamath tribe. Forest management activities are planned and conducted with sensitivity to the inherent value of these resources and the need to protect them.

Air Quality

Smoke from prescribed burning or wildfire can affect visibility in Crater Lake National Park and wilderness areas. When added to woodstove pollution, smoke from forest lands can also affect human health in the Klamath Falls urban area. To protect air quality, the Klamath-Lake District manages fuels, follows smoke management procedures, and suppresses any wildfires that do occur.

Special Forest Products

Special forest products such as mushrooms have not produced revenue for the Common School Fund or Klamath County. Free harvesting permits have been issued for personal use, but no permits have been sold. The local community has voiced support for personal use harvesting. There are many social and economic concerns about the future development of a special forest products program. It is not certain that the benefits of a commercial program would outweigh those of personal use harvesting. A program would need to be analyzed in terms of returns to schools and government, local employment, environmental impacts, and administration.

Investments in Forest Management

Administration and maintenance of the state forests contributes to employment in Klamath County. The Department of Forestry employs people to manage state forests, and offers service contracts for labor-intensive activities such as precommercial thinning and tree planting. (Some workers on these contracts live outside Klamath County, so some contract money leaves the county.)