Forest Health Protection
Pacific Southwest Region

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To: District Ranger, Feather River Ranger District, Plumas National Forest

Subject: Insect and Disease Evaluation of the Silvicultural Certification Stand at Lexington Hill (FHP Report NE06-15)

At the request of Sara Ashkannejhad, Forester, Feather River Ranger District, Danny Cluck, Forest Health Protection (FHP) Entomologist, and Bill Woodruff, FHP Plant Pathologist, conducted a field evaluation of her silvicultural certification stand at Lexington Hill on July 17, 2006. The objective of our visit was to evaluate the current forest health conditions within the stand, discuss what influence these conditions would have on stand management objectives and provide recommendations as appropriate.

Background

The Lexington Hill area is located on the Plumas National Forest, near the community of La Porte, CA (T21N, R9E, Section 20), at an elevation of 5000-5500 feet. Precipitation for the site averages greater than 80 inches per year. This certification stand is a white fir mixed conifer type with white fir (*Abies concolor*) being the dominant species, making up approximately 90% of the stand. Sugar pine (*Pinus lambertiana*), red fir (*Abies magnifica*), ponderosa pine (*Pinus ponderosa*), incense cedar (*Libocedrus decurrens*) and Douglas-fir (*Pseudotsuga menziesii*) are all present in low numbers within the stand (listed by order of abundance). These species are found mostly in the mid and overstory layers as regeneration is limited by dense canopy cover (canopy cover is approximately 58 %). The current average basal area is 286 sq.ft./acre with a stand density index (SDI) of 503. The stand was logged over during the mid to late 1800's and again in the early 1900's removing most of the old growth pine and incense cedar. This harvest activity combined with fire suppression has resulted in the currently overstocked and true fir dominated stand conditions. The management objective for this stand is to create a defensible fuel profile zone (DFPZ) by removing ladder fuels and increasing overstory tree spacing.

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Observations

White pine blister rust (*Cronartium ribicola*) has infected nearly all large diameter sugar pine within the stand. These infections are currently causing top-kill and branch dieback in the upper portions of the crowns. These same sugar pines also appear to be losing crown volume from below as competing true fir shade out lower branches. Some trees that have lost a significant amount of crown volume are currently being attacked and killed by mountain pine beetle (*Dendroctonus ponderosae*).

True fir dwarf mistletoe (*Arceuthobium abietinum*) appears to be present at very low levels within the stand. However, the entire stand was not surveyed and many of the tree crowns were too high to make an accurate assessment without the aid of binoculars. Closer examination of the upper crowns would need to be accomplished in order to establish a more accurate level of infection. Branch flagging caused by cytospora canker (*Cytospora abietes*) was observed in a few red fir located outside of the stand and across the county road. Some true fir within the stand have been attacked and killed by the fir engraver beetle (*Scolytus ventralis*).

Although no specific signs of annosus root disease (*Heterobasidion annosum*) were found within the stand, it is likely that a low level of infection is present and may be playing a role, possibly in conjunction dwarf mistletoe infections, in the observed true fir mortality.

Regeneration of pine species is lacking within the understory mostly due to shading and competition from true fir.

Discussion and Recommendations

Insect and disease caused tree mortality is occurring at a low level within the Lexington Hill area, except in the case of a few large diameter sugar pine, despite overstocked stand conditions. This low level of mortality is mostly attributed to the above normal precipitation received over much of northern California during the past two winters. During extended dry periods, these overstocked stands would be highly susceptible to bark beetle attacks and subsequent tree mortality.

Two thinning alternatives are being considered for this certification stand, both meeting the requirements of a defensive fuel profile zone. The first will result in a post treatment canopy cover of 40%, a basal area of 198 sq.ft./acre and an SDI of 255 (36% of the maximum SDI for the stand). The second will result in a post treatment canopy cover of 50%, a basal area of 276 sq.ft./acre and an SDI of 327 (46% of the maximum SDI for the stand). Small group selections (0.5 to 2 acres) will occur in 10% of the stand. Both of these treatment alternatives are consistent with recent direction from the Regional Forester that suggests designing thinnings to "ensure that density does not exceed an upper limit (for example: 90% of normal basal area, or 60% of maximum stand density index)" and to "design thinnings to ensure that this level will not be reached again for at least 20 years after thinning." (Regional Forester letter, "Conifer Forest Density Management for Multiple Objectives", July 14, 2004). Both thinning alternatives should effectively reduce tree competition for limited water and nutrients and reduce the risk of insect and disease caused mortality. The current low level infections of dwarf mistletoe, the potential low level presence of annosus root disease and the limited bark beetle activity should be considered when developing the silvicultural prescription and marking guidelines but they should not affect overall DFPZ management objectives.

When planning thinning treatments, it should be recognized that the target stand density is an average to be applied across the landscape and some variability may be desired. Individual high value trees, such as mature pines, should benefit by having the stocking around them reduced to lower levels. In addition, when selecting trees for removal, preference should be given to trees infected with dwarf mistletoe, root disease, and trees infested with bark beetles. Group selections should be utilized to remove root disease pockets and clumps of trees with heavy dwarf mistletoe infections. Drought tolerant species such as ponderosa and sugar pine should be retained over white fir to help increase their numbers within the stand and increase overall species diversity.

It is recommended that a registered borate compound be applied to all freshly cut pine and true fir stumps >14" dbh. Since it appears that presence of annosus root disease is limited within the stand, treating fir stumps is recommended in order to reduce the chance of new infection centers being created through harvest activity.

Special consideration needs to be given to sugar pine in the Lexington Hill area. White pine blister rust, a non-native pathogen, has continued to weaken and kill this species over most of its range since its introduction into the Pacific Northwest in 1910. Identification and protection of local rust resistant trees for seed collection, if not already occurring, will aid in the future planting of rust resistant seedlings. Planting openings created by the group selection harvest with rust resistant stock would help insure this species persists in the area.

<u>Conclusion</u>

Forest Health Protection may be able to assist with funding for thinning and removing green material from overstocked areas within the Lexington Hill area on a competitive basis. If you are interested in this funding please contact any of the Forest Health Protection staff for assistance in developing and submitting a proposal.

If you have any questions regarding this report and/or need additional information please contact Danny Cluck at 530-252-6431 or Bill Woodruff at 530-252-6680.

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Insect and Disease Information

Mountain pine beetle

The mountain pine beetle, *Dendroctonus ponderosae,* attacks the bole of ponderosa, lodgepole, sugar and western white pines larger than about 8 inches dbh. Extensive infestations have occurred in mature lodgepole pine forests. Group killing often occurs in mature forests and young overstocked stands of ponderosa, sugar and western white pines.

Evidence of Attack

The first sign of beetle-caused mortality is generally discolored foliage. The mountain pine beetle begins attacking most pine species on the lower 15 feet of the bole. Examination of infested trees usually reveals the presence of pitch tubes. Pitch tubes on successfully infested trees are pink to dark red masses of resin mixed with boring dust. Creamy, white pitch tubes indicate that the tree was able to "pitch out" the beetle and the attack was not successful. In addition to pitch tubes, successfully infested trees will have dry boring dust in the bark crevices and around the base of the tree. Attacking beetles carry the spores of blue-staining fungi which develop and spread throughout the sapwood interrupting the flow of water to the crown. The fungi also reduces the flow of pitch in the tree, thus aiding the beetles in overcoming the tree. The combined action of both beetles and fungi causes the needles to discolor and the tree to die.

Life Stages and Development

The beetle develops through four stages: egg, larva, pupa and adult. The life cycle of the mountain pine beetle varies considerably over its range. One generation per year is typical, with attacks occurring from late June through August. Two generations per year may develop in low elevation sugar pine. Females making their first attacks release aggregating pheromones. These pheromones attract males and other females until a mass attack overcomes the tree. The adults bore long, vertical, egg galleries and lay eggs in niches along the sides of the gallery. The larvae feed in mines perpendicular to the main gallery and construct small pupal cells at the end of these mines where they pupate and transform into adults.

Conditions Affecting Outbreaks

The food supply regulates populations of the beetle. In lodgepole pine, it appears that the beetles select larger trees with thick phloem, however the relationship between beetle populations and phloem thickness in other hosts has not been established. A copious pitch flow from the pines can prevent successful attack. The number of beetles, the characteristics of the tree, and the weather affect the tree's ability to produce enough resin to resist attack. Other factors affecting the abundance of the mountain pine beetle include nematodes, woodpeckers, and predaceous and parasitic insects. As stand susceptibility to the beetle increases because of age, overstocking, diseases or drought, the effectiveness of natural control decreases and pine mortality increases.

Fir Engraver

The fir engraver attacks red and white fir in California. Fir engraver adults and developing broods kill true firs by mining the cambium, phloem, and outer sapwood of the bole, thereby girdling the tree. Trees greater that 4" in diameter are attacked and often killed in a single season. Many trees, weakened through successive attacks, die slowly over a period of years. Others may survive attack as evidenced by old spike-topped fir and trees with individual branch mortality. Although many other species of bark beetles cannot develop successful broods without killing the tree, the fir engraver beetle is able to attack and establish broods when only a portion of the cambium area has been killed.

Evidence of Attack

Fir engravers bore entrance holes along the main stem, usually in areas that are > 4" in diameter. Reddish-brown or white boring dust may be seen along the trunk in bark crevices and in spider webs. Some pitch streamers may be indicative of fir engraver attacks; however, true firs are known to stream pitch for various reasons and there is not clear evidence that pitch streamers indicate subsequent tree mortality or successful attack. Resin canals and pockets in the cortex of the bark are part of the trees defense mechanism. Beetle galleries that contact these structures almost always fail to produce larval galleries as the adults invariably abandon the attack. Pitch tubes, often formed when bark beetles attack pine, are not produced on firs.

Adults excavate horizontal galleries that engrave the sapwood; the larval galleries extend at right angles along the grain. Attacks in the crown may girdle branches resulting in individual branch mortality or "flagging". Numerous attacks over part or the entire bole may kill the upper portion of the crown or the entire tree. A healthy tree can recover if sufficient areas of cambium remain and top-killed trees can produce new leaders. The fir engraver is frequently associated with the roundheaded fir borer and the fir flatheaded borer.

Life Stages and Development

In the summer, adults emerge and attack new host trees. The female enters the tree first followed by the male. Eggs are laid in niches on either side of the gallery. Adult beetles carry the brown staining fungi, *Trichosporium symbioticum*, into the tree that causes a yellowish-brown discoloration around the gallery. The larvae mine straight up and down, perpendicular to the egg gallery. Winter is commonly spent in the larval stage, with pupation occurring in early spring. In most locations, the fir engraver completes its life cycle in 1 year, however at higher elevations 2 years may be required.

Conditions Affecting Outbreaks

Fir engravers bore into any member of the host species on which they land but establish successful galleries only in those that have little or no resistance to attack. Populations of less aggressive species like fir engraver are likely to wax and wane in direct relationship to the stresses of their hosts. Drought conditions often result in widespread fir mortality; however, attempting to determine when outbreaks will occur is difficult. Lowered resistance of trees appears to be a contributing factor. Overstocking and the increased presence of fir on sites that were once occupied by pine species may also contribute to higher than normal levels of fir mortality. Several insect predators, parasites and woodpeckers are commonly associated with the fir engraver and may help in control of populations at endemic levels.

Annosus Root Disease

Heterobasidion annosum is a fungus that attacks a wide variety of woody plants. All western conifer species are susceptible. Madrone (*Arbutus menziesii*), and a few brush species (*Arctostaphylos spp.* and *Artemisia tridentata*) are occasional hosts. Other hardwood species are apparently not infected. The disease has been reported on all National Forests in California, with incidence particularly high on true fir in northern California, in the eastside pine type forests, and in southern California recreation areas.

Annosus root disease is one of the most important conifer diseases in Region 5. Current estimates are that the disease infests about 2 million acres of commercial forestland in California, resulting in an annual volume loss of 19 million cubic feet. Other potential impacts of the disease include: increased susceptibility of infected trees to attack by bark beetles, mortality of infected trees presently on the site, the loss of the site for future production, and depletion of vegetative cover and increased probability of tree failure and hazard in recreation areas.

During periods favorable to the fungus, fruiting bodies (conks) form in decayed stumps, under the bark of dead trees, or under the duff at the root collar. New infection centers are initiated when airborne spores produced by the conks land and grow on freshly cut stump surfaces. Infection in true fir may also occur through fire and mechanical wounds, or occasionally, through roots of stumps in the absence of surface colonization. From the infected stump surface, the fungus grows down into the roots and then spreads via root-to-root contact to adjacent live trees, resulting in the formation of large disease centers. These infection centers may continue to enlarge until they reach barriers, such as openings in the stand or groups of resistant plants. In pines, the fungus grows through root cambial tissue to the root crown where it girdles and kills the tree. In true fir and other non-resinous species, the fungus sometimes kills trees, but more frequently is confined to the heartwood and inner sapwood of the larger roots. It then eventually extends into the heartwood of the lower trunk and causes chronic decay and growth loss.

Heterobasidion annosum in western North America consists of two intersterility groups, or biological species, the 'S' group and the 'P' group. These two biological species of *H. annosum* have major differences in host specificity. All isolates of *H. annosum* from naturally infected ponderosa pine, Jeffrey pine, sugar pine, Coulter pine, incense cedar, western juniper, pinyon, and manzanita have, to date, been of the 'P' group. Isolates from true fir and giant sequoia have been of the "S" group. This host specificity is not apparent in isolates from stumps; with the 'S' group being recovered from both pine and true fir stumps. These data suggest that infection of host trees is specific, but saprophytic colonization of stumps is not. The fungus may survive in infected roots or stumps for many years. Young conifers established near these stumps often die shortly after their roots contact infected roots in the soil.

Dwarf Mistletoe

Dwarf mistletoes (Arceuthobium spp.) are parasitic, flowering plants that can only survive on living conifers in the Pinaceae. They obtain most of their nutrients and all of their water and minerals from their hosts.

Dwarf mistletoes spread by means of seed. In the fall the fruit ripen and fall from the aerial shoots. The seeds are forcibly discharged. The seed is covered with a sticky substance and adheres to whatever it contacts. When a seed lands in a host tree crown, it usually sticks to a needle or twig, where it remains throughout the winter. The following spring the seed germinates and penetrates the twig at the base of the needle. For the next 2-4 years, the parasite grows within the host tissues, developing a root-like system within the inner bark and outer sapwood, and causing the twig or branch to swell. Aerial shoots then develop and bear seed in another 2-4 years.

Dispersal of dwarf mistletoe seeds is limited to the distance the seeds travel after being discharged. From overstory to understory, this is usually 20 to 60 feet, but wind may carry them as far as 100 feet from the source. A rule of thumb is that the seeds can travel a horizontal distance equal to the height of the highest plant in an infected tree. There is some evidence that long distance spread of dwarf mistletoe is occassionaly vectored by birds and animals.

Vertical spread within tree crowns of most dwarf mistletoes is limited to less than one foot per year because of foliage density. Because of the thin crowns of gray pine, however, the vertical rate of spread has been measured as being greater than 2 feet per year. This rate of spread equalled or exceeded the rate of height growth of infected trees.

Dwarf mistletoes are easy to identify because they are generally exposed to view within a tree's crown. Signs of infection include the yellow-green to orange mistletoe plants, basal cups on a branch or stem where the plants were attached and detached plants on the ground beneath an infected tree. Symptoms include spindle-shaped branch swellings, witches' brooms in the lower crown, and bole swellings.

White pine blister rust

White pine blister rust is caused by Cronartium ribicola an obligate parasite that attacks 5-needled pines and several species of Ribes spp. The fungus needs the two alternate hosts to survive, spending part of its life on 5-needled pines and the other on Ribes spp. The disease occurs throughout the range of sugar pine to the southern Sierra Nevada, but has not been reported further south. Infection of pines results in cankers on branches and main stems, branch mortality, top kill, and tree mortality.

Spores (aeciospores) produced by the fungus in the spring on pine bole or branch cankers are wind-disseminated to Ribes spp. where they infect the leaves. Spores (urediospores) produced in orange pustules on the underside of the leaves reinfect other Ribes spp. throughout the summer, resulting in an intensification of the rust. A telial spore stage forms on Ribes spp. leaves in the fall. Teliospores germinate in place to produce spores (sporida) which are wind-disseminated to pines and infect current year needles. Following infection, the fungus grows from the needle into the branch and forms a canker. After 2 or 3 years, spores are produced on the cankers and are spread to Ribes spp. to continue the cycle. Although blister rust may spread hundreds of miles from pines to Ribes spp., its spread from Ribes spp. back to pines is usually limited to a few hundred feet.

Branch cankers continue to enlarge as the fungus invades additional tissues and moves toward the bole. Branch cankers within 24 inches of the bole will eventually form bole cankers. Bole cankers result in girdling and death of the tree above the canker. Cankers that have margins more than 24 inches from the main bole are unlikely to reach the bole and only branch flagging will result.