Prescribing Control in Mixed Conifer Stands Affected by Annosus Root Disease[1]

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Abstract: Tree mortality caused by root diseases € constitutes a major drain on Forest productivity € of mixed-conifer stands. Factors such as changes € in species composition, selective harvesting, € unfavorable economic climate, and optimizing of € short-term benefits have contributed to current € stand conditions. Computer simulation models, € such as the "RRMOD Computerized Root Disease € Simulation Model", are currently available to € managers to evaluate the effects of stand € management under different silvicultural € prescriptions. Several management strategies are € available to managers to reduce losses caused by € Annosus root disease. €

Tree mortality caused by root diseases € constitutes a major drain on forest productivity € of "east side" mixed-conifer forests in the € western United States. Mixed-conifer stands tend € to be most seriously affected. Documented losses € averaging as high as 45 percent for 98 randomly € selected stands have been noted (Schmitt and € others 1984). Numerous individual stand surveys € show that mortality of 10 percent-80 percent of € the trees with 10 percent-60 percent basal area € reduction is common (Goheen and Hagle 1988). In € one specific survey of a 2,500-acre (1012 € hectare) mixed-conifer stand on the Sisters € Ranger District, Deschutes National Forest, 19.0 € percent of all trees over 5 inches (12.8 € centimeters) diameter breast height (DBH) € representing 21.8 percent of the merchantable € board foot volume were found to have been killed € by root disease during the previous 20 years € (Filip 1980). €

On east side forests, three fungal pathogens € generally are responsible for most losses due to € root diseases. These pathogens are Armillaria€ ostoyae, Phellinus weirii, and Heterobasidion€ annosum. €

In recent years, more attention has been € focused on the role and effect of root disease in € tree stands. Increased public use of national € forests along with increased awareness of € forest managers have resulted in a perception of € declining forest tree health. €

The root disease problems now being faced € are probably a direct consequence of past € management or utilization activities. €

First, a general change in species € composition has occurred in east side € mixed-conifer forests in the last 75 years. € Sites that were once park-like in appearance and € dominated by ponderosa pine or western larch are € now stocked with more shade-tolerant climax € species, primarily the true firs or Douglas-fir. € This change is largely due to fire exclusion in € these stands (Arno 1980; Gruell and others 1982). €

Second, many forest stands have been € subjected to past selection harvesting, often € with repeated entries over the same ground. € Frequently, only high-value, large trees, mainly € ponderosa pine or western larch, were removed € during these entries. Not only did selective € harvesting remove the more root disease-resistant € species of a stand, but partial-cutting harvest € techniques often left numerous infection sites in € the form of damaged residual trees and freshly € cut stumps. Stand compositions were altered in € ways that steadily increased the proportion of € highly susceptible tree species left in the € stand. €

Third, there has long been an unfavorable € economic climate for the harvest and € manufacturing use of some species. Many forest € operators simply found it uneconomical to remove € large volumes of white fir or grand fir € material. Consequently, large acreages of € highly susceptible species were left on site. €

Finally, the long-term consequences of € management activities often have not been well € thought-out or considered. Some forest managers € and public groups are too willing to optimize € short-term benefits while foregoing long-term € interests. Overriding concerns about short-term € benefits may prove detrimental by causing forest € managers to give too little weight to significant € long-term consequences. Failure to address root € rot problems in areas such as National Forest € full retention visual management allocations is a € good case in point. €

MANAGEMENT CONSIDERATION - SILVICULTURAL € OPPORTUNITIES €

Root disease management is basically an €

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ecological and social issue. Direct control € measures are not effective in the management of € forest tree root diseases because the long-term € problem is not resolved. However, resolution of € the root disease problems can be achieved € silviculturally. Silvicultural control of root € disease requires some degree of knowledge of root € disease organisms, how diseases respond to € management activities, long- and short-term € consequences of decisions, and silvicultural € techniques. Silvicultural control of root € disease requires reversing past management € patterns, primarily by manipulating tree species € composition to develop stands less favorable for € root pathogens (Goheen and Hagle 1988). €

Knowledge of Root Diseases€

Many forest managers are grossly unprepared € to deal with root disease problems. Some € foresters working in the field today graduated € from accredited schools without any formal class € work in forest pathology. Fortunately, people € can gain skills on the job. Leaflets, brochures, € studies, proceedings, papers, and numerous other € reference materials are available. Most state, € private, or federal forest managers have access € to trained forest pathologists to assist with € disease problems. Recent technological advances € have provided access to computers and programs, € including development of simulation models. €

The RRMOD Computerized Root Disease Simulation € Model €

One such model available in Region Six is € the root disease model known as "RRMOD". The root € disease model is linked to several versions of € the prognosis stand model and is designed to€ work with existing forest inventories. While the € model was developed primarily for the pathogenic € fungal species of Armillaria and Phellinus, € managers are able to generate reasonable "stand € responses" to H. annosum by manipulating some of € the model's component interactions. €

The model can be used to evaluate the € effects of stand management under different € silvicultural prescriptions with varying levels € of infection by fungal root pathogen (fig. 1). €

The model can also be used to track the € effects of stand management decisions for € long-term planning (fig. 2). €

The basic components of the model include € relative susceptibilities of trees to infection, € resistance of trees to death resulting from root € pathogen attack, disease-related growth € reduction, decay of infected root systems, and € the life span of root disease pathogens. Because € trees weakened by root disease are subject to € attack by bark beetles and windthrow, the model € also simulates the impact of those agents (Eav € and Marsden 1988). €

Silvicultural Techniques €

Many management alternatives are available € to land managers to minimize timber losses in € mixed-conifer stands growing on sites affected € with annosus root disease. Fortunately, a € treatment method that works for one particular € pathogen will often work for other pathogens as € well. €

Several management strategies to reduce € losses caused by annosus root disease are € available. All management strategies consider € the following recommendations: €

1. Manage stands in short rotations, generally € less than 120 years. €

2. Minimize wounding of trees during thinning or € harvest operations. €

3. Retain or favor more disease resistant € species such as ponderosa pine, lodgepole € pine, western larch, and western white pine. €

4. Ponderosa pine has not been seriously € affected by H. annosum in Oregon except in a € few locations. Special measures to prevent € damage are needed only in stands within one € mile of severely infected stands. Borax € treatment of pine stumps will prevent € infection (Hadfield and others 1986). €

5. True firs should not be regenerated on sites € infested with large amounts of well € distributed inoculum of H. annosum (Hadfield € and others 1986). €

Some case examples of silvicultural € prescriptions directed toward minimizing root € disease losses are: €

1. Clearcut Harvest System €
   a Clearcut harvesting eliminates highly € susceptible tree species on the site. €
   b. Regeneration of harvested sites with € seral species such as ponderosa pine, € lodgepole pine, or western larch. €
2. Shelterwood Harvest System €
   a. Discriminate against true firs with € special selection of low disease-risk € trees of more resistant species to serve € as leave trees. €
   b. Site preparation activities should € discriminate against true fir advanced € reproduction. €
   c. A major objective should be to € regenerate the site with seral species. €
3. Selection Harvest (Full Retention Visual € Objective) €
   a. Small patch clearcut around every € identified infected tree, using 50-ft. € (15.2 meters) radius from infected tree. €

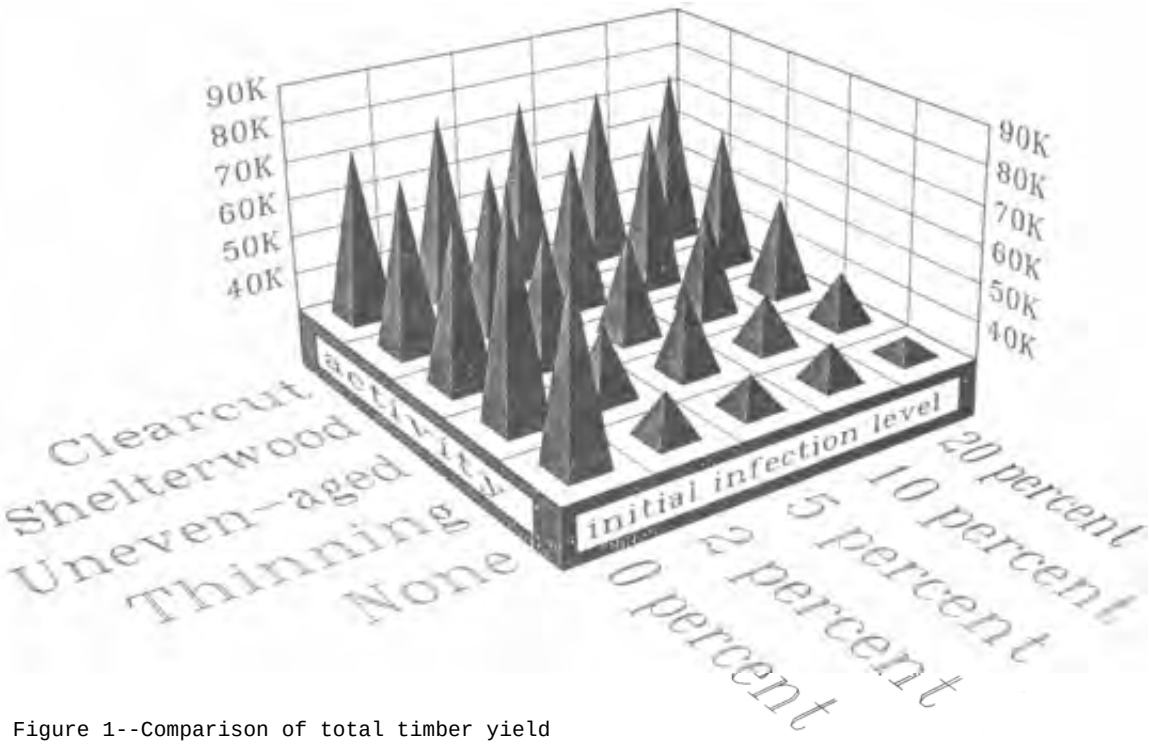

Figure 1--Comparison of total timber yield merchantable board feet) in Stand 216 over two rotation periods (240 years). Stand was modeled under€ 5 different silvicultural prescriptions, each€ exhibiting 5 different initial annosus infection levels.€

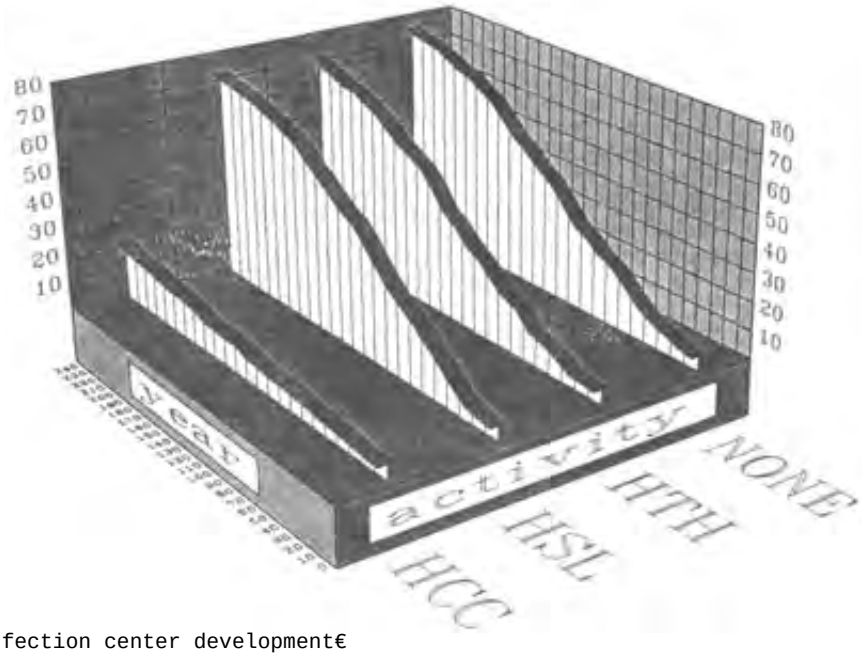

Figure 2--Annosus infection center development€ over time under different silvicultural prescriptions. Initial infection level is 5€ percent (scale 0-80 percent). HCC, HSL, HTH, and€ NONE represent prescriptions of clearcut, selection, thinning, and no treatment, respectively. €

b. Plant small clearcut with resistant tree € species such as ponderosa pine or € western larch. €

4. Selection Harvest, Mixed-Conifer Stands €

a. Selection harvest (such as commercial € thinning or uneven-aged management) of € stands with root diseases present is not € an attractive alternative. Infection € levels as low as 2 percent can cause € appreciable long-term yield losses. € Volume yield on one modeled stand with 5 € percent initial H. annosum was only 66 € percent of that obtained from the same € stand by using a clearcut harvest system € (table 1). €

CONCLUSIONS €

The mixed-conifer stands of the western € United States have been heavily impacted by root € diseases. Current levels of root disease are € related largely to fire exclusion, selective € cutting, uneconomical forest practices, and € optimizing short-term benefits. €

Silvicultural control of root disease can be € accomplished. Control must be considered both a € social and ecological issue. Managers must be € knowledgeable about root disease biology, and the € various publics must be willing to consider the € long-term consequences of decisions. €

Silvicultural techniques such as € clearcutting, shelterwoods, or selection harvest € are available to reduce root disease losses. € Major emphasis should be given to minimizing € wounding in stands, to reducing true fir € components within stands, and to regenerating € sites with resistant species such as ponderosa €

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Table 1--Total timber yield in Stand 216 (mixed-conifer € stand, Sisters Ranger District, Deschutes National Forest) € two rotations (240 years). €

Harvest Treatment	Total timber yield from stand exhibiting infection levels of:				
	0 pct	2 pct	5 pct	10 pct	20 pct
Clearcut	74,089	77,816	77,223	75,423	75,890
Uneven-aged	73,643	65,012	56,704	58,059	54,986
Thinning	88,425	48,109	50,643	43,171	43,009
Shelterwood	73,670	71,865	71,745	73,002	66,380
No Silv. Treatment	78,009	41,378	38,557	39,853	34,831