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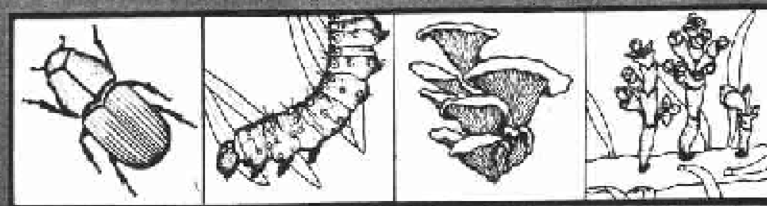

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WHITE PINE LEAVE TREE GUIDELINES

compiled by

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BACKGROUND

Dead and dying white pine are common throughout the range of western white pine. The major cause of this mortality is white pine blister rust, although mountain pine beetle and root diseases may also play a lesser role in some areas. Since much of the mortality is in trees of commercial size, Districts are anxious to capture this mortality using salvage sales. This concern has resulted in requests for guidelines to assist in managing white pine forests.

White pine blister rust is an exotic disease introduced to North America early in this century. White pine populations have been devastated by this disease, altering the functioning of mesic forest ecosystems throughout the Northern Rocky Mountains. Until a few decades ago, white pine was the most common forest type in Idaho north of the Clearwater River. Stands of white pine are now uncommon, and the amount of white pine has been reduced by 80-90 percent.

Fortunately, white pine populations had some natural resistance to blister rust and the Inland Empire Tree Improvement Cooperative has used this to enhance the resistance of white pine seedlings available for reforestation (Mahalovich and Eramian 1995. A long term goal in north Idaho forests is to restore western white pine as an important forest type. The major focus of this restoration is planting genetically improved white pine seedlings. However, a tree-breeding program is logistically constrained in the number of genotypes it can include. Maintaining a naturally regenerating white pine component is essential to the long-term adaptation of the species to blister rust.

As a result of a request from the Idaho Panhandle National Forests, a scoping meeting was held in Coeur d'Alene to develop marking guidelines to assist in selecting reserve white pine under a variety of stand conditions and silvicultural treatments. The meeting was attended by following Forest Service personnel: Art Zack, Donna Dekker-Robertson, Russ Graham, Joyce Stock, John Schwandt, Jim Byler, Bob James, Darrell Frogness, and Risa DeVore.

The following is a summary of this meeting plus comments from others. It includes a brief summary of guidelines and recommendations, followed by additional background information from silviculture, pathology, entomology, and genetic perspectives. Foresters are encouraged to seek additional help from specialists for unusual cases which may not fit these guidelines.

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GOALS/OBJECTIVES

These marking guides aim to contribute to the long-term goal of restoring white pine as a functioning ecosystem component while providing for timely salvage of dead and dying white pine. As a minimum basic principle, silvicultural treatments should meet the criteria of "DO NO HARM" to the ecosystem. We help meet this criteria if we leave some potentially blister-rust-resistant white pine to contribute genes through natural regeneration. Our deliberations were guided by the following objectives:

a. protect genetic resources which may contribute to long-term white pine restoration,

b maintain a large (diameter) white pine component where feasible to provide a source for natural regeneration,

c. leave economic options for the future.

PRIORITIES FOR SELECTING WHITE PINE LEAVE TREES

The objective of these priorities is to select white pine leave trees with the greatest probability of having some genetic resistance to blister rust. Although potential impact from blister rust may vary from site to site, all white pine should be evaluated using the following criteria to determine their priority for being left in a stand. These are based in part, on the publication by Hoff and McDonald (1977) *Selecting Western White Pine Leave Trees*. Classes are listed in descending order of priority.

Class 1. Trees with no evidence of rust cankers, and dense green **or rapidly growing crowns** with large live crown ratios (it's important to note that needle cast diseases in the spring and normal fall needle shed may temporarily make crowns look sparse; see pathology background).

Class 2. Same as above, (no bole cankers and a dense, dark green crown), but with a few (less than five) branch flags. The fewer flags and the higher up and farther out from the bole, the better.

Class 3. A dense, vigorous, green crown with large crown ratio, but with one bole canker or multiple branch flags (more than five). The lower the percentage of bole girdled, the better. No dead top, crown thinning or discoloration (see pathology background information regarding slow canker growth).

Class 4. Trees with dead tops, but with otherwise good looking crowns. (A tree needs at least 30 percent live crown ratio to be a viable leave tree. Priority declining with declining vigor and higher proportion of dead top). The denser the crown, the higher the percentage of live crown, and the fewer branch cankers, the better the leave-tree candidate.

Although Class 1 trees have the highest probability of resistance, Classes 2, 3, and 4, may also carry genes for resistance mechanisms which serve important functions and therefore should not be ignored (see genetic background).

GUIDELINES & RECOMMENDATIONS FOR SILVICULTURAL TREATMENTS

Our best strategy for restoring white pine is to use a combination of planting genetically improved white pine in conjunction with retaining 5-10 trees per acre of the best white pine for natural regeneration.

Salvage Harvest

All stand entries should have a silvicultural prescription that addresses management objectives, stand trajectory, and desired future conditions. If a stand is being considered for salvage, care should be taken to ensure that the post-salvage trees form a manageable stand that is on a trajectory to meet long-term management objectives (Moss and Wellner 1953). If this is not the case, the stand should be regenerated. Avoid salvage that precludes future economic options to get the stand on a desired prescription trajectory.

Even in the most severely infected stands, there will be some Class 1 and 2 trees, and the higher the rust pressure, the greater the probability that these trees carry some genetic resistance. Therefore, be sure to properly classify all white pine. This is not an easy task, especially in mature trees and multi-storied or dense stands. (Binoculars are highly recommended.) Remember, mature trees with only flags (Class 2) are NOT in imminent danger of dying, and some Class 3 trees with small bole cankers may live a long time (see pathology background).

Regeneration Harvests

Under ideal circumstances, five healthy resistant white pine per acre could regenerate a stand (Haig 1941). But because conditions are rarely ideal and resistance of leave trees is untested, we should also plant genetically improved white pine. We recommend that a minimum of 5-10 Class 1 trees per acre be left to maintain a broad gene pool (see genetics background). If not enough Class 1 trees can be found, select enough Class 2 or 3 trees to bring the total to ten. In areas of very high rust levels (>75 percent trees infected), efforts should be made to save additional Class 1 trees.

If there are more than 10 Class 1 trees per acre, more may be left if needed to meet other objectives, but 10 white pine per acre should be sufficient from the genetic viewpoint.

Where broadcast burning is planned, it may be difficult to adequately protect leave trees. However, it may be possible to find suitable trees along stand borders, or do some creative manipulating of borders to try to encompass Class 1 trees. If site preparation-induced mortality is expected, allow for this by initially selecting more leave trees. Leave tree spacing does not have to be even across large areas; leaving clumps of white pine is desirable if it allows selection of better quality leave trees.

There is no biological reason to reduce leave tree density on large areas, or to change the guides for plantations of unknown parentage. White pine seed zones are extremely broad, so Class 1 trees in a plantation are valuable regardless of origin. Mountain pine beetle may cause some additional mortality, although impacts in these stands are unknown (see entomology background).

Commercial Thin (white pine a minor component)

For potential commercial thins in stands with less than 50 percent white pine, keep all Class 1 trees. Keep as many Class 2 trees as possible within the constraints of the prescription. If there aren't sufficient trees in Class 1 or Class 2, leave Class 3 trees to reach a minimum of 10 white pine per acre if available (see silvicultural background).

Commercial Thin (white pine a major component)

For potential commercial thins in stands where white pine is the dominant component, a decision should be based on an assessment of whether white pine can continue to carry the stand and whether thinning is the appropriate course of action (Foiles 1955, 1972, Graham 1983). Regional pathologists should be consulted to assist in projecting rust effects.

If white pine is expected to be the dominant species after thinning, it is important to know how many white pine per acre will be desired at the next entry. This will depend on how long the stand is expected to be held, and how high the infection levels are. These factors make it very difficult to make specific recommendations, but a rough rule of thumb can be applied as follows:

1. Calculate a "TARGET NUMBER" by estimating the number of white pine desired at the next entry and adding 10 percent per decade until the next entry (to account for anticipated mortality from all causes).

2. Determine the current number of Class 1 and Class 2 trees per acre and compare it to the desired "target number." (NOTE: if the stand will be held more than 20 years, only Class 1 trees should be used to reach the target number.)

If the current number of white pine is greater than the "target number," it is likely that the stand can be carried until the next entry. If the curent number of white pine is less than the target number,a regeneration harvest is recommended.

Precommercial Thin

Wait as long as possible to allow blister rust to do the selection (Deitschman and Pfister 1973). The waiting period depends on the number of desired white pine, infection levels and if pruning might be applied as a way to reduce infection and extend the life of the stand (Hagle and Grasham 1988). If natural white pines are a major portion of the white pine, pruning may greatly reduce mortality (Schwandt et al. 1994). However, additional mortality can still be expected after pruning, so increasing the density of white pine may be desirable (up to twice the normal number depending on the infection levels expected on the site).

ADDITIONAL BACKGROUND INFORMATION FOR RECOMMENDATIONS AND GUIDELINES

Silvicultural Background

Past effects of blister rust, harvesting patterns, and suppression of wildfires have greatly reduced the amount of western white pine and other long-lived seral species (Flint 1925, Haig 1941). As a result, old-growth white pine and larch have largely disappeared from the landscape and have been replaced by an excess of grand fir and western hemlock stands. Therefore, we encourage regeneration harvests in grand fir and hemlock followed by planting with rust-resistant white pine and larch wherever possible.

Openings at least 2 acres in size are recommended to successfully regenerate western white pine. Some white pine may survive on smaller openings, but early growth rates will be slow (Graham 1983). Smaller openings also have a relatively large proportion of their area in shaded margins where shade tolerant tree species will out compete white pine.

Pathology Background

These guidelines provide a basis for selecting white pine leave trees most likely to either have some blister rust resistance or to survive long enough to fulfill prescription objectives. Therefore, it is important to accurately diagnose blister rust in order to assign trees to the appropriate priority class.

Infections start in the needles, grow into branches and finally into the bole where cankers develop that girdle the tree. Young infections only cause small twig and branch death so diagnosis of infected trees can be very difficult, especially in dense stands where crowns are difficult to see clearly. In addition, foliage diseases, winter burning, and normal fall needle shed can cause considerable branch flagging and foliage discoloration that can be mistaken for blister rust or may mask rust infections (Hagle et al. 1987, Shaw and Leaphart 1960). Extreme caution should be used in classifying Class 1 and Class 2 trees if any of these conditions are present.

Total number of cankers on a tree can provide information about the overall hazard of a site, but it is usually the lowest (most "lethal") canker that kills the tree (Stillinger 1943). The rust fungus cannot survive on dead branches and canker growth is usually slow enough that cankers on branches that are more than 24 inches from the bole are not likely to reach the bole before the branch is shaded out or self pruned.

Blister rust cankers can usually be identified by profuse pitching from the infected area. However, white pine also wound easily and may even produce pitch at the base of branches as they are naturally pruned, so all pitch observed on the bole of white pine trees is not necessarily associated with blister rust infection (Nicholls and Anderson 1977). Sunscald may create elongate dead areas and bark flaking on the southwest sides of fast-growing or recently exposed trees, but there is usually little or no pitch associated with this damage.

The location of a canker is usually more important than the amount of girdle; bole cankers high in a tree will only result in top kill, while those on the lower bole are more likely to kill the entire tree. Although canker growth is extremely variable, we feel that the great majority of Class 1 and Class 2 trees will survive at least 10 more years and many Class 3 trees with small bole cankers will also survive many years.

Entomology Background

Mountain pine beetle has historically played a major role in recycling old growth white pine stands. We are now finding it causing mortality in younger second-growth stands once diameters reach 8-10 inches. Since this is not the normal behavior for this insect, we do not have a good understanding of the role it plays in these younger stands, but we have not seen major outbreaks in this size class yet.

This bark beetle is usually strongly influenced by stocking levels of host trees and stand density. In ponderosa pine and lodgepole pine stands, the normal recommendation is to reduce the basal area to minimize bark beetle risk (Cole 1978, Sartwell and Dolph 1976). However, this relationship does not apply to old-growth white pine; large isolated white pine have often been killed in stands of mixed species.

Genetic Background

The intent of selecting the best trees for rust resistance is based on the following principles (Manning and Howe 1983, Mahalovich and Eramian 1995):

1. If trees are in an area that has very high levels of mortality from blister rust, then older trees that are alive have a good chance of containing resistance genes.

2. Some resistance genes are recessive which means that they are carried by infected trees (Class 2, 3 or 4 trees), but pass these genes along to their offspring. If mated with another tree containing the same recessive gene, a portion of the offspring of this mating would then exhibit this resistance mechanism (because it would carry a double recessive).

3. Another resistance mechanism results in slow canker growth, but it is impossible to identify which cankered trees have this trait without monitoring canker growth over time. Therefore, it is important to leave some trees with bole cankers (Class 3) or we will miss the opportunity to select for this genetic characteristic.

4. The current resistance program is based on 3,000 trees which is a large number for a breeding program, but is a very small percentage of the millions of white pine trees in the population. Additional trees need to be selected because they may contain genetic resistance mechanisms that are not currently represented in the tree improvement program.

5. Western white pine does not tolerate inbreeding or mating among close relatives; it leads to reduced survival, poor growth and form, increased susceptibility to insects and disease, and inability to reproduce. This lends some validity to concerns about relatedness of offspring from only a few trees, especially if the parents were related (e.g., from a plantation). In an orchard or plantation environment, "pollen clouds" generally extend only 80 feet around any given tree, so it is important to leave as many trees per acre as possible.

6. Rust diseases are notorious for their ability to rapidly evolve and attack previously resistant plants. Therefore, maintaining a naturally reproducing population of white pine with a broad genetic base is an important part of our strategy to restore white pine.

The intent of these guidelines is to assist in selecting the healthiest white pine as leave trees. However, it is likely that some leave trees will have bole cankers we failed to see, or are "escapes" that will still become infected. As a result, some mortality in the leave trees can be expected either from blister rust or possibly mountain pine beetle or root disease. However, this mortality is more than balanced by the genetic contribution of the leave trees with some blister rust resistance that survive.

We hope that these guidelines will assist forest managers in making decisions regarding white pine in a way that will contribute to our long term goal of restoring white pine as a functioning component of the ecosystem.

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