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**Northern
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Forestry**

Forest Pest Management

Evaluation of Conifer Regeneration Mortality from RootDiseases on the Cabinet Ranger District Kootenai National Forest, Montana

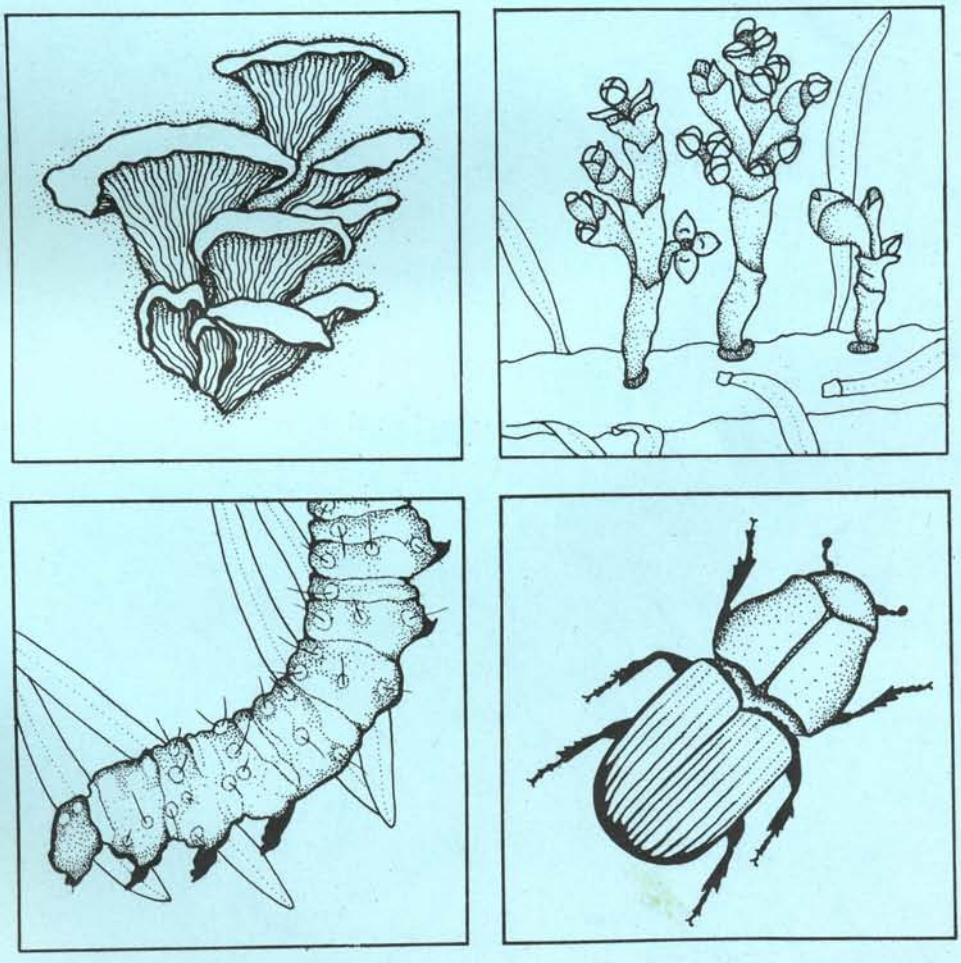
Report No. 82-29

December, 1982

Establishment Report

by

R.L. James and C.A. Stewart



EVALUATION OF CONIFER REGENERATION MORTALITY FROM ROOT DISEASES ON THE CABINET RANGER DISTRICT, KOOTENAI NATIONAL FOREST, MONTANA ESTABLISHMENT REPORT

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R. L. James, Plant Pathologist
and
C. A. Stewart, Biological Technician

USDA Forest Service
Cooperative Forestry and Pest Management
Missoula, Montana

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ABSTRACT

Three permanent plots were established within a 15-year-old conifer plantation on the Cabinet Ranger District, Kootenai National Forest, to monitor mortality associated with root diseases. Information on disease spread and host symptom development over time will be obtained. Plots were located surrounding groups of ponderosa pine recently killed by Armillaria mellea; an infected stump served as the plot center. Trees over 0.6 m (2 ft.) in height adjacent to plot centers were mapped and evaluated for root disease infection. Plots will be rechecked periodically for new root disease mortality.

INTRODUCTION

Root diseases cause serious losses in many commercial forest stands in the Northern Region. These diseases are most common and cause greatest impact in northern Idaho and northwestern Montana (Byler 1982). We estimate that from 0.2 to 0.3 m^3 of wood per hectare are lost annually to root diseases in the Region. This amounts to more than 2.3 MM m^3/yr. or about 40 percent of the average annual timber harvest (James et al. 1982).

We suspect that losses from root diseases may increase during the next and subsequent rotations because of buildup and persistence of pathogens on susceptible host trees and within infected stumps (Roth et al. 1980; Shaw and Roth 1976). Stumps serve as food bases for pathogens which may spread to and infect surrounding trees through root system contacts and sometimes a short distance through soil (Filip 1977; Huntley et al. 1961; Roth et al. 1980). Inoculum may remain viable in stumps for several decades, resulting in a hazard to new crops of trees (Johnson 1976).

Root disease losses in young regeneration may not necessarily be serious if adequate stocking levels are maintained. Many more trees often regenerate a site than can become crop trees; root diseases may selectively remove the less vigorous individuals and actually thin the stand (Johnson and Hawksworth 1977). However, root disease mortality is often grouped and results in understocked areas (Filip 1979).

To determine root disease effects on stocking and monitor persistence and buildup of root disease in young plantations, plots were established within a representative plantation where small groups of tree mortality around stumps were common.

METHODS

The selected plantation (No. 4.6-05) was located adjacent to the south fork of the Bull River in the SW 1/4 Section 13, T28N, R33W (Principle Meridian) (fig. 1). The site was clearcut in 1966, broadcast burned, and planted with 2-0 ponderosa pine (Pinus ponderosa Laws.) seedlings in 1967. The plantation was precommercially thinned in 1979. Natural regeneration of many other species, including western white pine (Pinus monticola Dougl.), western redcedar (Thuja plicata Donn), grand fir (Abies grandis (Dougl.) Lindl.), Douglas-fir (Pseudotsuga menziesii Franco), lodgepole pine (Pinus contorta Dougl.), western hemlock (Tsuga heterophylla (Rafn.) Sarg.)), and western larch (Larix occidentalis Nutt.) gradually occupied the site.

Three permanent 0.04 ha (0.1 acre) fixed-radius plots were established during 1981-82. Plots were placed around active root disease infection centers with an infected stump designated as the plot center (fig. 2). Sufficient green, healthy trees were included in each plot to allow for monitoring of disease spread. All trees greater than 0.6 m (2 ft.) in height and all stumps from the previous stand were located by azimuth and distance from the plot center. Each tree and stump was identified with a permanent numbered metal tag and the following information collected: species, height, d.b.h. (if applicable) or stump diameter, and foliar condition. 1/ Yellow, red, or black trees and stumps from the previous stand were examined for signs or symptoms of root disease including resinosis, mycelial fans, and fungal sporophores.

All plots will be monitored at least once every 2 years for root disease spread as indicated by new tree mortality and foliage color changes. Suspected infections will be confirmed by examination for signs of pathogens.

RESULTS TO DATE

Approximately 27 percent of the ponderosa pine within the three evaluation plots showed symptoms of root disease infection (table 1). Grand fir was the only other species infected; only about 5 percent of these trees were root diseased. Approximately 15 percent of the western white pine within plots displayed symptoms of blister rust (Cronartium ribicola Fisch.) infection.

1/ General foliage color throughout most of the crown: G = green (healthy); Y = yellow (chlorotic foliage); R = red (tree died within the past year); B = black (tree was dead for at least 2 years).

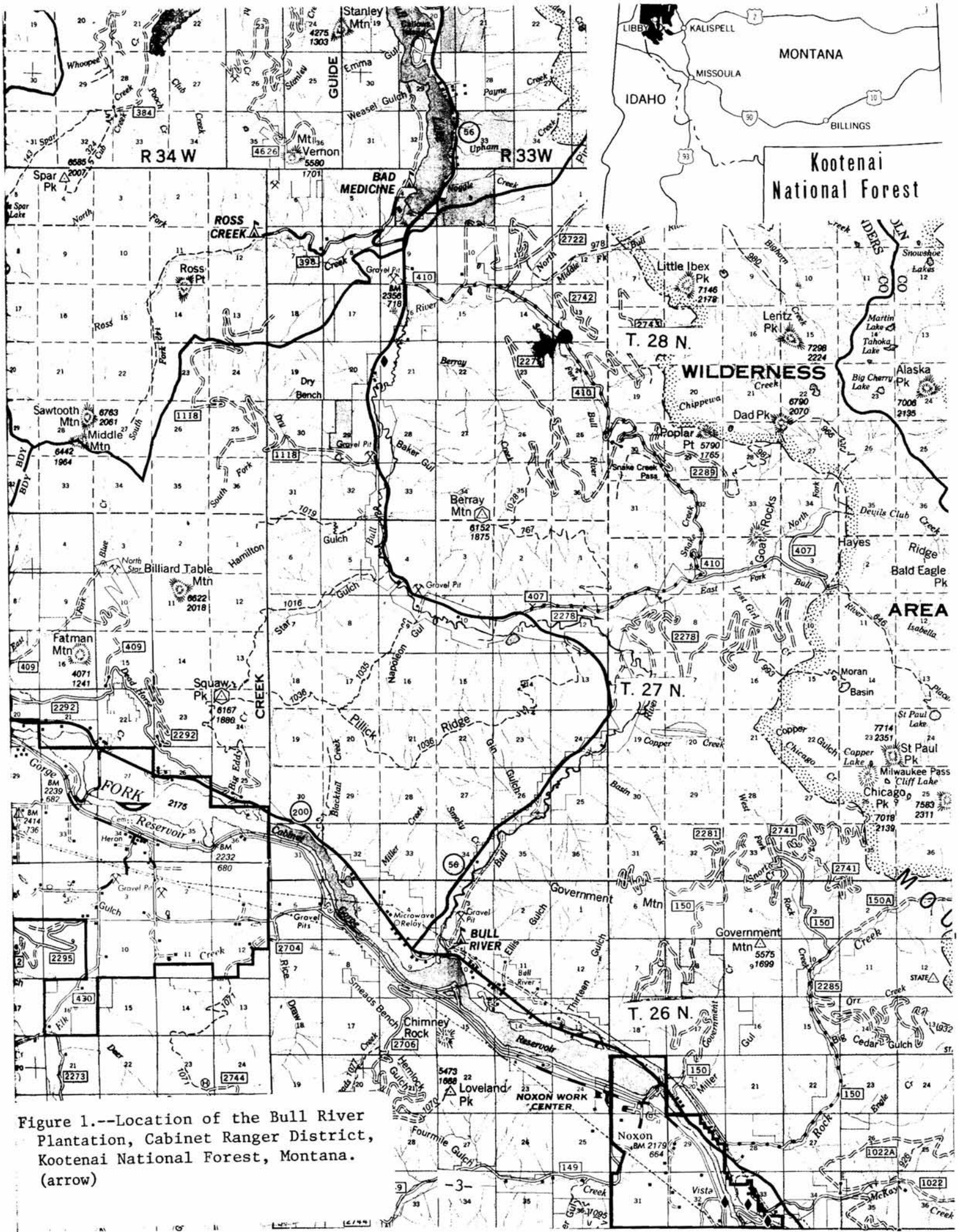


Figure 1.--Location of the Bull River Plantation, Cabinet Ranger District, Kootenai National Forest, Montana. (arrow)

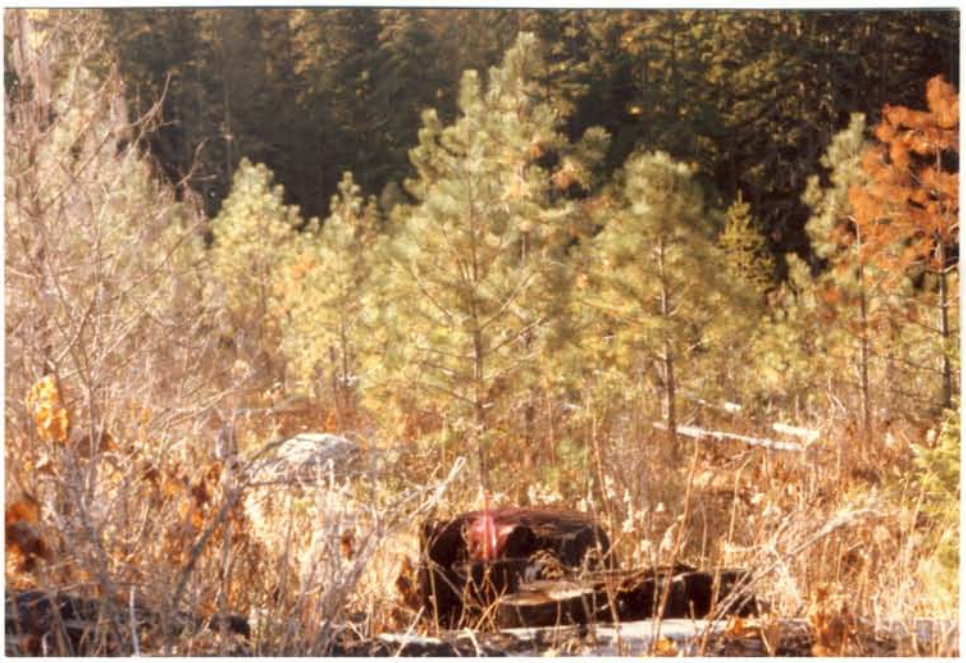


Figure 2.--Ponderosa pine mortality within a plot established to monitor root disease development on the Cabinet Ranger District, Kootenai National Forest. Note the stump in the plot center and adjacent tree mortality. A recently killed tree with a red-brown crown is on the right. An older killed (black) tree is on the left.

Although the site was planted with ponderosa pine, this species currently makes up only 19 percent of the trees more than 0.6 m tall within the plots (table 2). Most of these trees had diameters from 6.0-7.9 cm (2.3-3.1 in.) (fig. 3) and heights from 3.9-4.4 m (9.8-14.4 ft.) (fig. 4). Western redcedar was the most prevalent species within the plots; many of the trees were very small and growing beneath the crowns of other species. The previous stand was composed primarily of grand fir, western redcedar, and Douglas-fir, based on information collected from stumps (table 3). Average stump diameter was 30 cm (11.8 in.).

Stem maps were prepared for the three plots (figs. 5-7). These maps show location and current condition of each plot tree. Maps will be updated periodically with transparent overlays to indicate changes in tree condition and include new plot trees (ingrowth).

The only root pathogen found on symptomatic trees was Armillaria mellea Vahl. ex Fr. Infected trees had extensive basal resinosis, often overlying large mycelial fans within the cambium.

Table 1.--Disease incidence on plots established to monitor mortality dynamics on the Cabinet Ranger District, Kootenai National Forest. 1/

Plot number	Ponderosa pine			Grand fir			Western white pine 2/		
	Yellow 3/	Red 4/	Black 5/	Yellow 3/	Red 4/	Black 5/	Yellow 3/	Red 4/	Black 5/
1	0	1	2	0	0	0	0	0	0
2	0	0	10	1	0	0	0	3	0
3	1	1	5	1	0	0	4	0	1
All plots	1 (1.3)	2 (2.7)	17 (23.0)	2 (4.9)	0 (0)	0 (0)	4 (7.7)	3 (5.8)	1 (1.9)
All infected		20 (27.0)			2 (4.9)			8 (15.4)	

1/ Figures in table are number of trees over 0.6 m (2 ft.) tall. Percentages are in parentheses.

2/ All western white pine referred to in the table were infected with white pine blister rust (Cronartium ribicola). Ponderosa pine and grand fir were infected with Armillaria mellea.

3/ Yellow trees were alive with chlorotic foliage.

4/ Red trees were recently killed (within last year).

5/ Black trees died more than 1 year ago.

Table 2.--Species composition of plots established to monitor root disease mortality in young regeneration on the Cabinet Ranger District, Kootenai National Forest. 1/

Tree species	Plot 1		Plot 2		Plot 3		All plots	
	No. trees	Percent	No. trees	Percent	No. trees	Percent	No. trees	Percent
Ponderosa pine	22	53.7	36	26.1	16	7.7	74	19.1
Western white pine	7	17.1	13	9.4	32	15.3	52	13.4
Western redcedar	5	12.2	27	19.6	70	33.5	102	26.3
Grand fir	4	9.7	18	13.0	19	9.1	41	10.6
Douglas-fir	3	7.3	17	12.3	26	12.4	46	11.8
Lodgepole pine	0	0	7	5.1	14	6.7	21	5.4
Western hemlock	0	0	16	11.6	27	12.9	43	11.1
Western larch	0	0	4	2.9	5	2.4	9	2.3
Totals	41	100.0	138	100.0	209	100.0	388	100.0

1/ Number of trees in plots are those over 0.6 m (2 feet) tall.

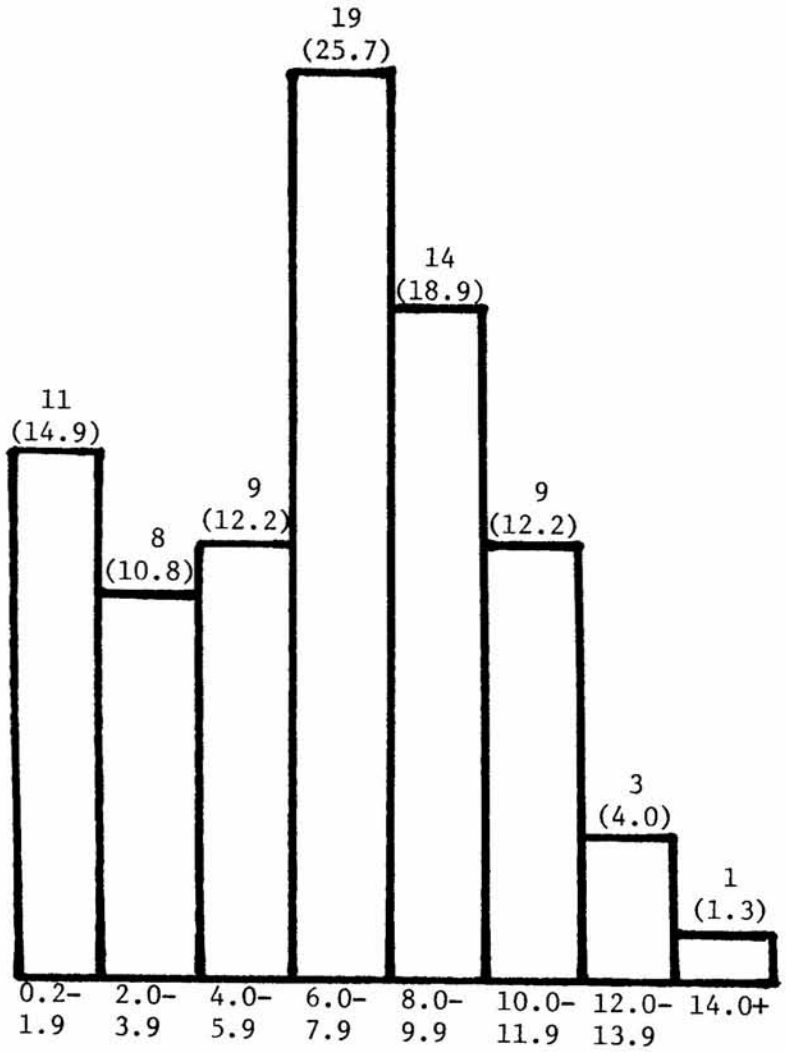


Figure 3.--Diameter class distribution of ponderosa pine regeneration within root disease evaluation plots on the Bull Creek Plantation, Cabinet Ranger District, Kootenai National Forest. Numbers of trees for each class are shown above each bar. Percentages are in parentheses.

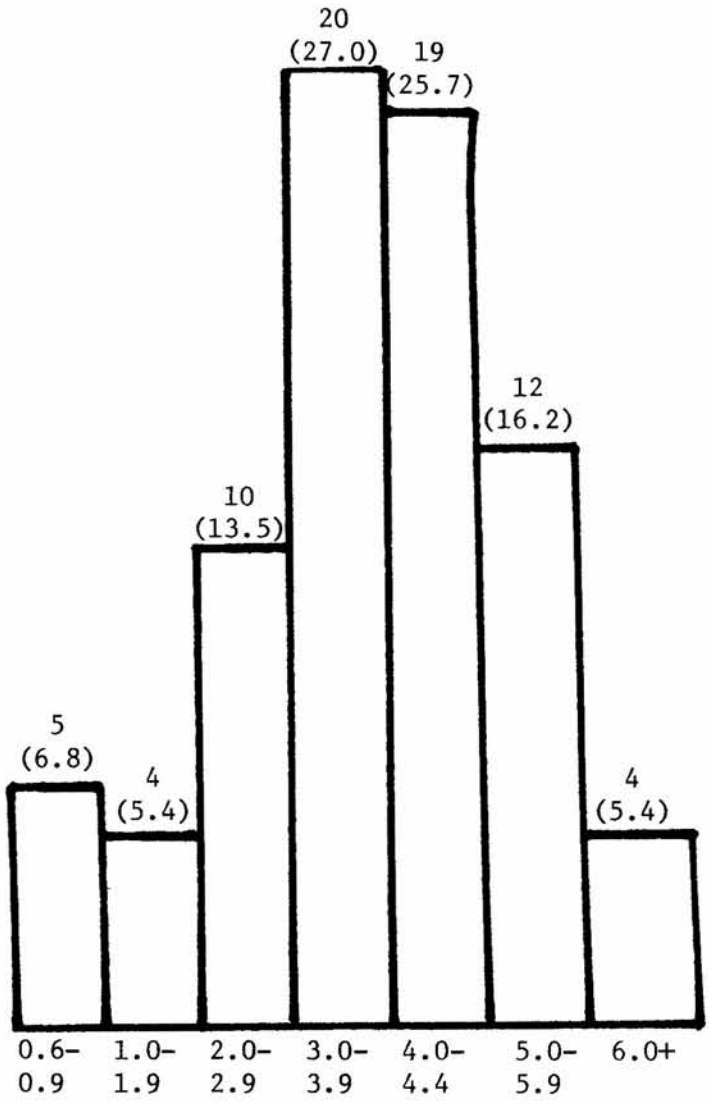
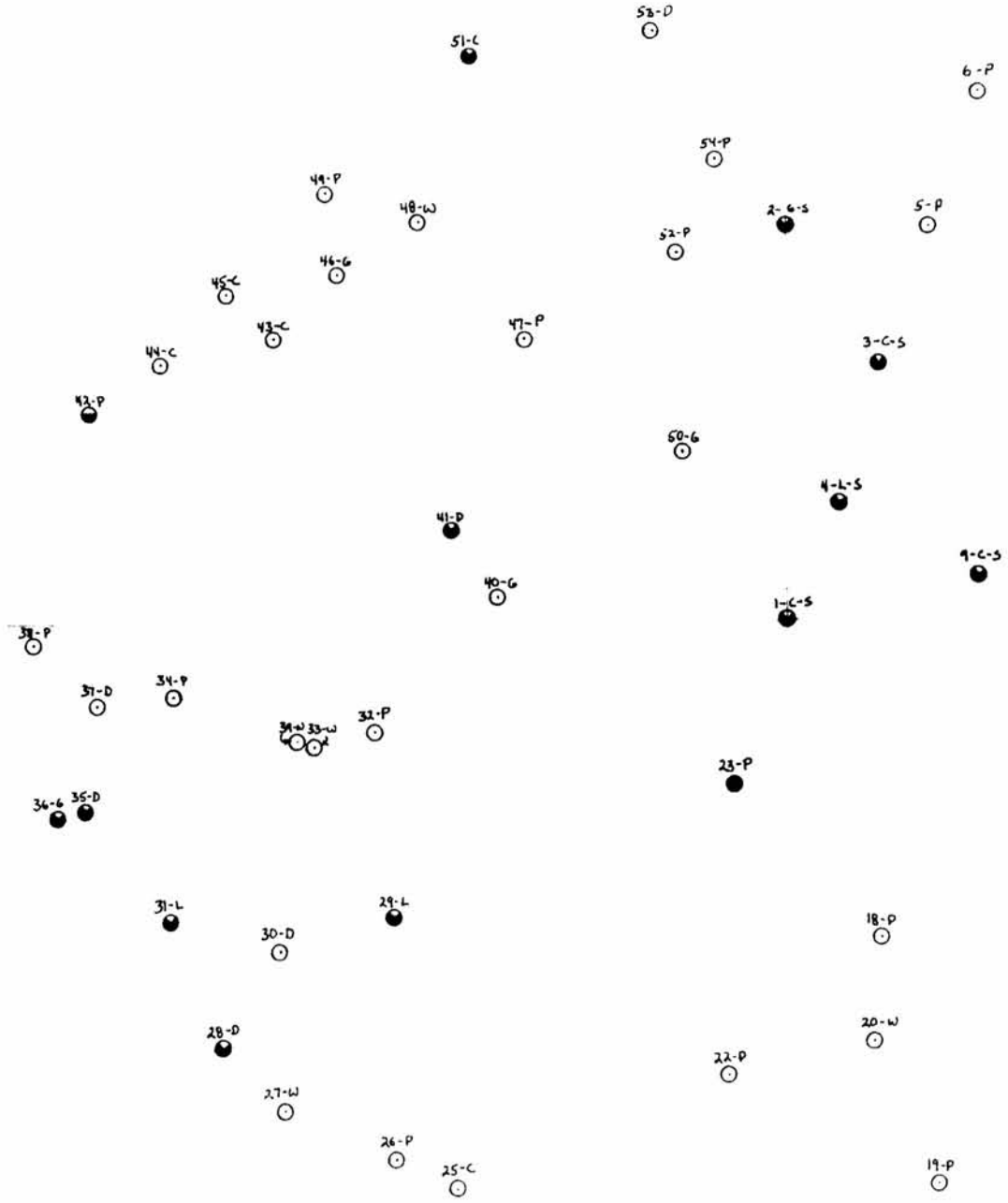


Figure 4.--Height class distribution of ponderosa pine regeneration within root disease evaluation plots on the Bull Creek Plantation, Cabinet Ranger District, Kootenai National Forest, Montana. Numbers of trees for each class are shown above each bar. Percentages are in parentheses.

Table 3.--Stump characteristics of plots established to monitor root disease mortality in young regeneration on the Cabinet Ranger District, Kootenai National Forest.

Tree species	Number of stumps			
	Plot 1	Plot 2	Plot 3	All plots
Grand fir	2	14	27	43
Western redcedar	4	14	1	19
Douglas-fir	4	5	6	15
Lodgepole pine	3	0	1	4
Western white pine	0	5	0	5
Western larch	0	2	0	2
Western hemlock	0	0	3	3
Totals	13	40	38	91
Average stump diameter (cm)	44.3	22.9	33.0	30.0
Diameter range (cm)	15.2-68.6	10.2-73.7	10.2-91.4	10.2-91.4



LEGEND

- ⊙ Green
- ◓ Yellow
- ◒ Red
- ● Blue
- ◓ Stump

P = Ponderosa Pine
C = Western Redcedar
L = Lodgepole Pine
G = Grand Fir
W = Western White Pine
D = Douglas-fir
S = Stump
*1-53

Figure 5.--Stem map of regeneration plot 1, Bull River Plantation, Cabinet Ranger District, Kootenai National Forest.

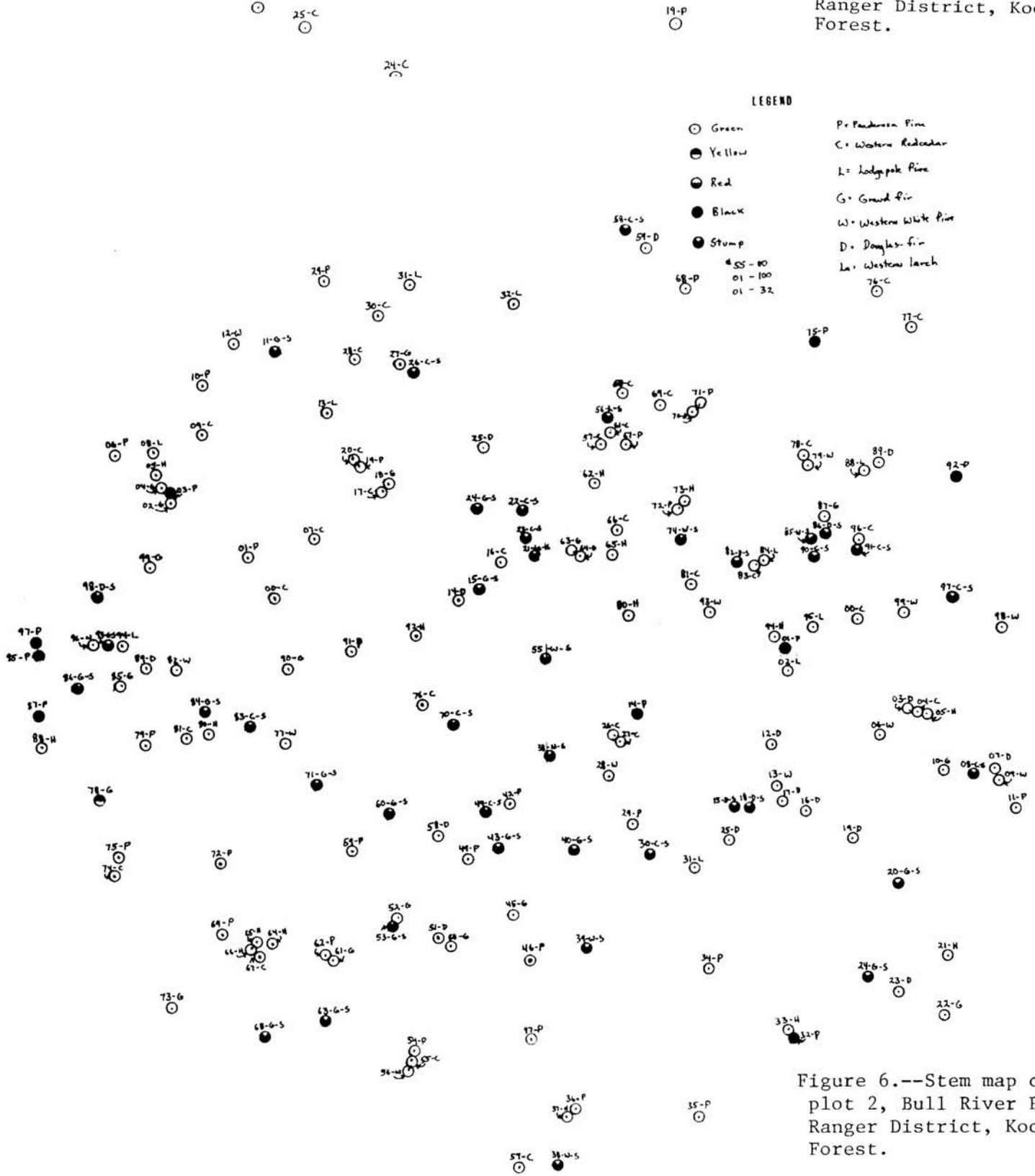


Figure 6.--Stem map of regeneration plot 2, Bull River Plantation, Cabinet Ranger District, Kootenai National Forest.

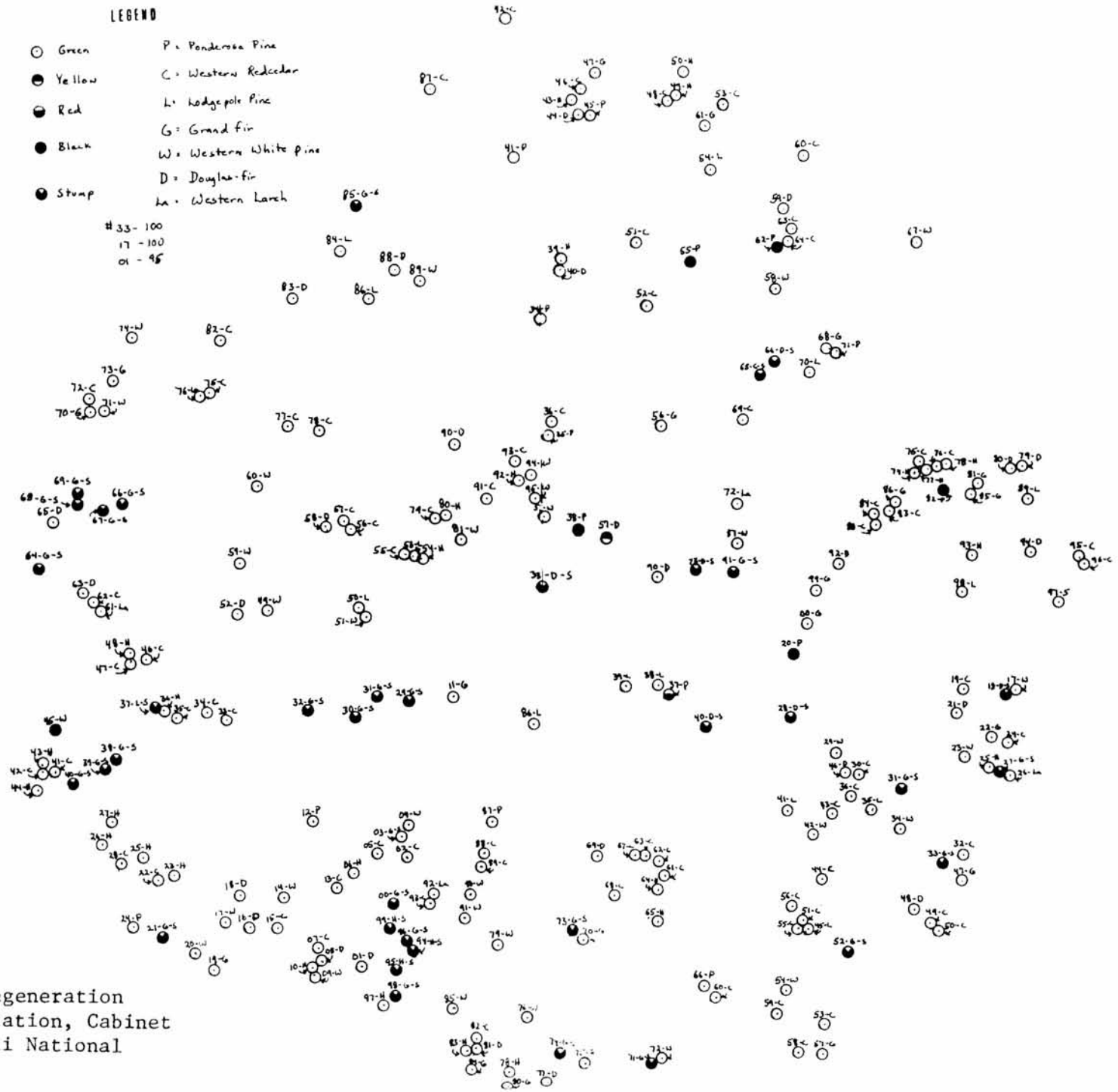


Figure 7.--Stem map of regeneration plot 3, Bull River Plantation, Cabinet Ranger District, Kootenai National Forest.

DISCUSSION

Root diseases are common in young stands regenerated on sites previously occupied by infected trees. Many of these previously infected trees may not have displayed external symptoms because only a limited amount of their root systems was infected. However, once infected trees are cut and all host resistance is eliminated, root fungi can readily colonize stumps and produce sufficient inoculum to attack and kill surrounding trees (Filip 1979). This inoculum within stumps may increase from one rotation to the next on susceptible host material (Roth et al. 1980). If this occurs, accelerated losses of susceptible trees might be expected on infected sites.

Most root pathogens spread from infected stumps to surrounding regeneration through root contact. However, A. mellea may also spread short distances through soil via rhizomorphs (Singh 1981). Subsequent spread from tree to tree results in groups of dead and dying trees; understocked stands may result from multiple disease centers (Filip 1979; Shaw et al. 1976).

Regeneration often becomes infected when it is young (5-10 years old) (Patton and Riker 1959; Weiss and Riffle 1971). However, this regeneration may become more resistant to infection with age (Huntley et al. 1961; Johnson and Hawksworth 1977; Rykowski 1981). Although severe losses may occur during the early life of a stand, percentage of losses after 10-15 years are often reduced. Apparently, trees may develop the ability to resist infection as they mature. Also, inoculum viability and intensity may decrease as the stand ages and thus infection hazard is reduced. General level of resistance in the stand may be increased because of elimination of the most susceptible genotypes early in the life of the stand.

We hope to obtain information about the influence of root diseases on stand structure and stocking levels and host susceptibility as related to tree age.

ACKNOWLEDGEMENTS

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