Insect and Disease Assessment of the Long Term Ecosystem Productivity Plots Diamond Lake Ranger District Umpqua National Forest

Southwest Oregon Forest Insect and Disease Technical Center
December 1994

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During the week of July 18, 1994, we surveyed 30 l-acre plots in the Long Term Ecosystem Productivity (LTEP) study located in Units 1, 3, 4, 5, and 12 of the Watchdog Timber Sale, Diamond Lake Ranger District, Umpqua National Forest (Figure 1). The purpose of the survey was to assess current insect and disease activity in the plots and to provide baseline information on those agents that may influence vegetaion in the future.

Methods:

Prior to this survey, plot boundaries had been delineated with flagging and 16 points on a 20 X 20 meter grid were established. Grid points were marked with orange-tipped wooden lathe. This grid was the reference for mapping root diseased areas.

Each plot was examined systematically. All dead trees and stumps in the vicinity of dead trees were examined carefully for evidence of root disease. Wood was exposed at the root collar and along roots to identify the white mycelial fans typical of Armillaria root disease (caused by *ArmiIIaria ostoyae),* the delaminated, pitted decay and setal hyphae associated with laminated root rot (caused by *Phellinus weirii),* or the violet to black streaking in the xylem associated with black stain root disease (caused by *Leptographium wageneri* var. *pseudotsuga).* The interiors of true fir and hemlock stumps were also examined for fungal fruiting bodies of *Heterobasidion annosum,* cause of annosus root disease. Location of trees with identified root disease (dead trees and stumps only) and those with crown symptoms typical of root disease, such as chlorotic foliage, thinning crowns, and stress cone crops, were mapped according to unit grids.

In addition, bark was removed from dead tree boles to uncover galleries of bark beetles. Other insects and diseases were identified based on characteristic symptoms and signs.

Results:

Armillaria root disease is present in 24 of the 30 plots surveyed (Table 1). Laminated root rot is present in 3 of the plots, black stain root disease in 1 plot, and annosus root disease in 5 of the 30 plots surveyed. Bark beetles, particularly fir engraver beetle (Scolytus *ventralis),* and Douglas-fir beetle *(Dendroctonuspseudotsugae)* are associated with root disease at most locations.

Impacts from root disease range from mortality of single scattered individuals to large pockets occupying most of the plot area (See individual plot maps, Figures 2-6). Relatively large pockets of laminated root rot occur in Plots 20, 22, and 23. Armillaria root disease affects a substantial portion of Plots 10 and 22. In Plots 3-9 Armillaria root disease is scattered across entire plots. Black stain root disease is affecting a single overstory Douglas-fir along a skid road in Plot 11. H. *annosum* conks are present in western hemlock stumps in Plots 6, 16, 17, and 18, and in white fir stumps in Plot 16; mortality attributable to annosus root disease in trees surrounding infected stumps was not observed.

Douglas-fir dwarf mistletoe *(Arceuthobium douglasii)* was present in Plots 22 and 25, and in the overstory of the surrounding stands. Hemlock dwarf mistletoe *(A. tsugense* subsp. *tsugense)* was found in Plots 1, 14, 16 and 27 and in the vicinity of plot boundaries.

Stem decays were present throughout several units. Red ring rot, caused by *PhelIinus pini,* and brown cubical butt rot, caused by *Phaeolus schweinitzii,* were often found associated with large, older Douglas-fir. *P. pini* var *cancrijormans* was found on white fir. Rust red stringy rot, caused by *Echinodontium tinctorium,* was occasionally found on large white fir.

White pine blister rust, caused by the introduced fungus *Cronartium ribicola,* was killing western white pine in the understories of Plots 14,22, and 24. It was responsible for topkill and branch flagging in overstory western white pines in surrounding stands.

Table 1. Diseases and insects observed by plot.

Plot Number	Diseases and Insects Present
1	Armillaria root disease affecting white fir and western hemlock, fir engraver beetle western hemlock dwarf mistletoe
2	Armillaria root disease affecting white fir, fir engraver beetle
3	Arrnillaria root disease affecting white fir and ponderosa pine, fir enmaver beetle
4	Armillaria root disease affecting white fir fir engraver beetle
5	Armillaria root disease affecting white fir, fir engraver beetle
6	Armillaria root disease affecting white fir and Douglas-fir, fir engraver beetle, Douglas-fir beetle, annosus root disease in western hemlock stumps
7	Armillaria root disease affecting white fir, Douglas-fir, and ponderosa pine, fir engraver beetle
8	Armillaria root disease affecting white fir, Pacific silver fir and western hemlock, fir engraver beetle
9	Armillaria root disease affecting white fir and Douglas-fir, fir engraver beetle, red ring rot *(var. cancriformans)* of white fir
10	Armillaria root disease affecting White fir, Douglas-fir, western hemlock, and ponderosa pine, fir engraver beetle
11	black stain root disease affecting Douglas-fir, red ring rot of Douglas-fir
12	Armillaria root disease affecting white fir and western hemlock, fir engraver beetle red ring rot of Douglas-fir
13	red ring rot and brown cubical butt rot of Douglas-fir
14	white pine blister rust, red ring rot and brown cubical butt rot of Douglas-fir
15	Armillaria root disease affecting Douglas-fir

Discussion:

Root diseases, particularly laminated root rot and Armillaria root disease, are major influences on vegetation in several of the Diamond Lake LTEP plots. Root diseases affect stand structure, species compostion, tree density, and crown closure. They injure trees by decaying and killing roots or by preventing proper root functioning. Damage is expressed by reduced growth rates, butt decay and stain, windthrow, death, and predisposition to bark beetle attack. Root diseases are influenced by many factors including stand species composition, rooting pattern individual tree vigor, and past management activities.

Critical to this study, most of the root diseases that occur in the LTEP plots are diseases of the site; they are able to maintain themselves for decades in stumps and woody root material. Unless this residual infected material is removed from the site, Armillaria root disease, laminated root rot, and possibly annosus root disease will continue to influence growth and cause mortality of planted vegetation for years to come. Effects of root disease may not be visible for several years after trees are planted. It generally takes 12-15 years for roots of new regeneration to grow into contact with old infected roots and become infected. Annual mortality rates due to root disease are generally low and spread within stands is a slow process relative to those associated with other disturbance agents, but impacts over the long term are great, especially in the most susceptible stand types. Currently, root diseases in the LTEP plots are affecting vegetation in 3 different ways. Armillaria and black stain root diseases are causing mortality of scattered individuals, preferring certain species or size classes. Laminated root rot and sometimes Armillaria root disease are creating substantial openings in stands. Pockets occur that are devoid of mature susceptible hosts; windthrown trees occur as well as standing dead trees. Annosus root disease occurs as a butt decay in stumps. It does not appear to be influencing trees adjacent to infected stumps at this time; however, susceptible species planted in the vicinity of these stumps have a high likelihood of becoming infected.

Armillaria root disease is the most prevalent disease found in the units. The causal pathogen, A. *ostoyae,* can be both an aggressive tree killer, killing trees whose roots come in contact with inoculum across a variety of vigor classes, or it can be a saprophyte, colonizing weakened or dead trees. Spread is slow, usually 1-2 feet per year. New infections occur when susceptible hosts contact infected root material or fungal rhizomorphs in the ground. Those living trees that have been able to resist fungal attack by blocking fungal invasion through a variety of host responses can be quickly colonized once they are dead or cut. Harvesting can have the effect of greatly increasing the available inoculum on a given site especially when stumps created are large. Activities that further stress residual trees by compacting soils will also likely contribute to increased disease activity.

Host susceptibility to Armillaria root disease varies from site to site in the Pacific Northwest. In the Diamond Lake LTEP plots, white fir is highly susceptible; it is readily infected and killed. No clear hierarchy of susceptibility exists for the other LTEP species. In some plots, Douglas-fir and ponderosa pine are damaged. In others, Pacific silver fir

and western hemlock seem readily killed. No conifer species completely escapes damage, but all others are more resistant to A. *ostoyae* than white fir. There is evidence that hardwoods can be infected by A. *ostoyae* and may play a role in inoculum carryover on sites. No above ground evidence for hardwood infection was observed in the LTEP plots and no below ground investigations of hardwoods were done.

Laminated root rot is present in several plots. It is expected that these infection centers will continue to increase in area as long as susceptible host trees are available. Infection will take place when the roots of susceptible species come into contact with viable inoculum. Individual tree vigor does not play a role in susceptibility to infection. All conifers are susceptible to some degree. Douglas-fir and white fir are highly susceptible; they are readily infected and readily killed. Of other species on the LTEP plots, Pacific silver fir, and western hemlock are considered intermediately susceptible; they are readily infected but usually not killed. These species often develop butt decay when infected. Lodgepole pine and western white pine are tolerant of laminated root rot. They are infrequently infected unless growing in close association with the most susceptible species, and they are rarely killed. Ponderosa pine is considered to be resistant to laminated root rot. It is very rarely infected and almost never killed by the pathogen. All conifers will play some role in maintaining fungal inoculum on the site. Hardwoods are immune. P. *weirii* can survive for very long periods of time (50 years or more) in large stumps. Spread rate of the pathogen is slow, usually 1-2 feet per year.

Annosus root disease caused by the 'Y-type of *H. annosum* affects true firs and hemlocks throughout their ranges. On the west side of the Cascades, annosus root disease generally causes butt decay. It is sometimes found killing low vigor trees associated with large infected stumps. Windborne spores from fruiting bodies of the fungus colonize recently cut stumps or fresh wounds. The fungus then grows down through the stump or tree into the root system. When roots of susceptible species come in contact with infected root systems, the disease is transferrred. Stands where true firs and hemlocks have been harvested have significantly higher levels of disease than unentered stands. This is especially true when several entries have been made to harvest susceptible hosts.

The role of annosus root disease in the Diamond Lake area is not clear. Inoculum sources are available yet mortality that can be ascribed to *H. annosum* alone appears to be absent. It is possible that annosus root disease is working in association with Armillaria root disease to cause some of the fir mortality observed in the LTEP plots.

Black stain root disease in Douglas-fir is present on a single overstory tree in one plot. It is not currently having significant impacts. Spread of the causal fungus *L.wageneri* var. *pseudotsuga* is rapid and occurs via both insect vectors and root to root contact of Douglas-fir. The disease is most often associated with roadsides, skid trails, and soils compacted by tractor logging. The fungus only affects Douglas-fir. It will not be carried over into the next stand in stumps or woody material; however it's presence in surrounding stands is a factor that increases the risk for disease occurrence with Douglas-fir planted on these plots. The site-altering activities proposed for these plots will also

greatly increase this risk. Monitoring for increased disease incidence and impact may be important in the future.

Bark beetles are active in many of the LTEP plots. Fir engraver beetle attack is closely associated with tree stress caused by root disease. Douglas-fir beetle populations are maintained at endemic levels in root disease pockets. Heavy dwarf mistletoe infections and other tree stresses will also increase beetle activity. Bark beetles will remain active in surrounding stands. They have the potential to influnce trees planted on the LTEP plots in the distant future.

Dwarf mistletoes are host specific parasitic plnts whose impacts include growth loss, distortion, topkill, tree mortality, and predisposition to bark beetles. Douglas-fir dwarf mistletoe causes the greatest impacts of any of the dwarf mistletoe species. In the LTEP stands, it infects only Douglas-fir. The impact of hemlock dwarf is relatively minor unless trees are severely infected. In the LTEP stands, hemlock dwarf mistletoe will infect western hemlock and Pacific silver fir. The dwarfmistletoes will be eliminated with their hosts in the clearcut harvest planned for the LTEP plots. Risk of reinfection in the plots will be great where overstory border trees are infected and susceptible host is managed in the plots.

White pine blister rust, has been active in the LTEP stands for several decades. Larger trees have branch flags or are topkilled. Regeneration is dead or severely cankered. The area has characteristics that make it relatively high risk for this disease. If western white pine is planned as a species of choice for planting in plots, resistant stock should be deployed to minimize losses from blister rust.

Stem decays, including red ring rot, brown cubical butt rot, and rust red stringy rot are present in several plots. They will be eliminated with the removal of infected trees. If suppressed understory white fir are left on plots, there is a high probability that these trees have already been infected by *E. tinctorium* if they have been growing under infected overstories.

Conclusions:

Root diseases, particularly laminated root rot and Armillaria root disease are influencing vegetative structure, composition, and stocking on the plots where they occur. They will continue to be an important influence after the plots have been harvested and planted. The impact of Armillaria root disease, in particular, will likely increase with applied stresses such as soil compaction and the disease may manifest itself in plots where it was previously undetected. Black stain root disease also has the potential to have much greater effects in future stands where soils are compacted. The role of annosus root disease is not known and should be monitored.

This study provides an important opportunity to monitor the relationships of site disturbance and root disease incidence and severity. The staff of the Southwest Oregon Forest Insect and Disease Technical Center looks forward to continued cooperation on this project. Please feel free to direct questions relating to this survey to us at any time.

WATCHDOG T. S.

UNIT 1

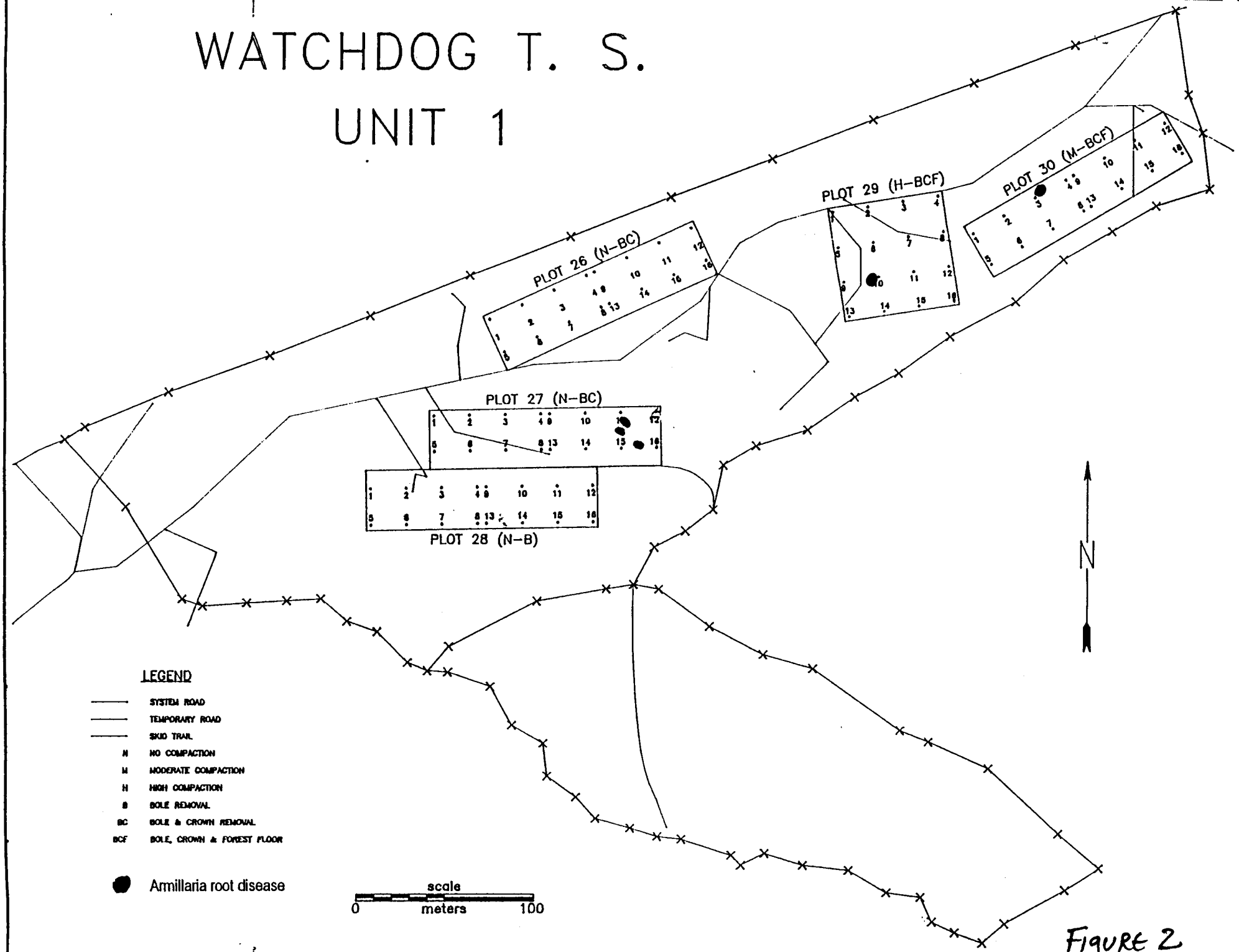

FIGURE 2

WATCHDOG T. S.

UNIT 3

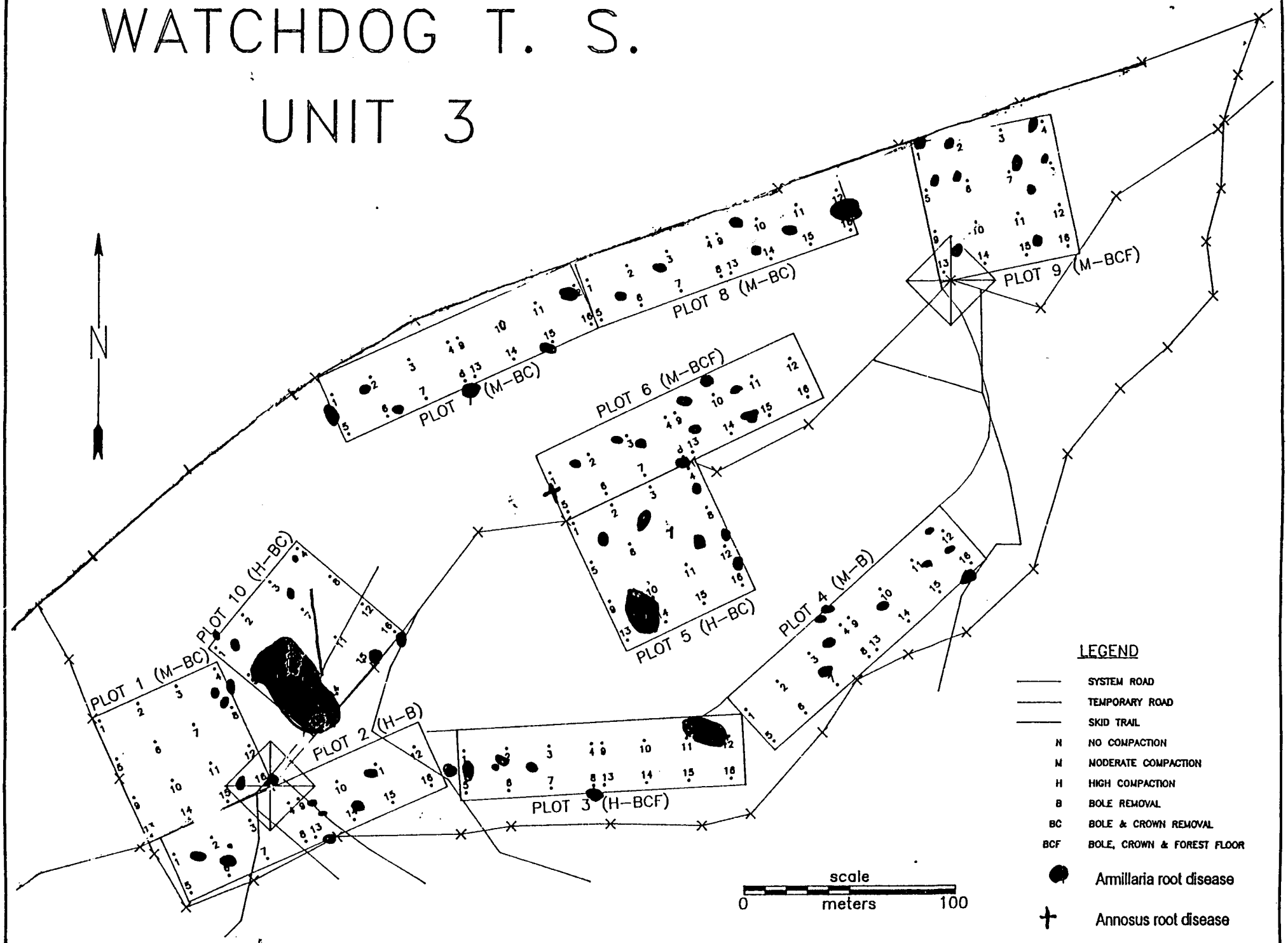

FIGURE 3

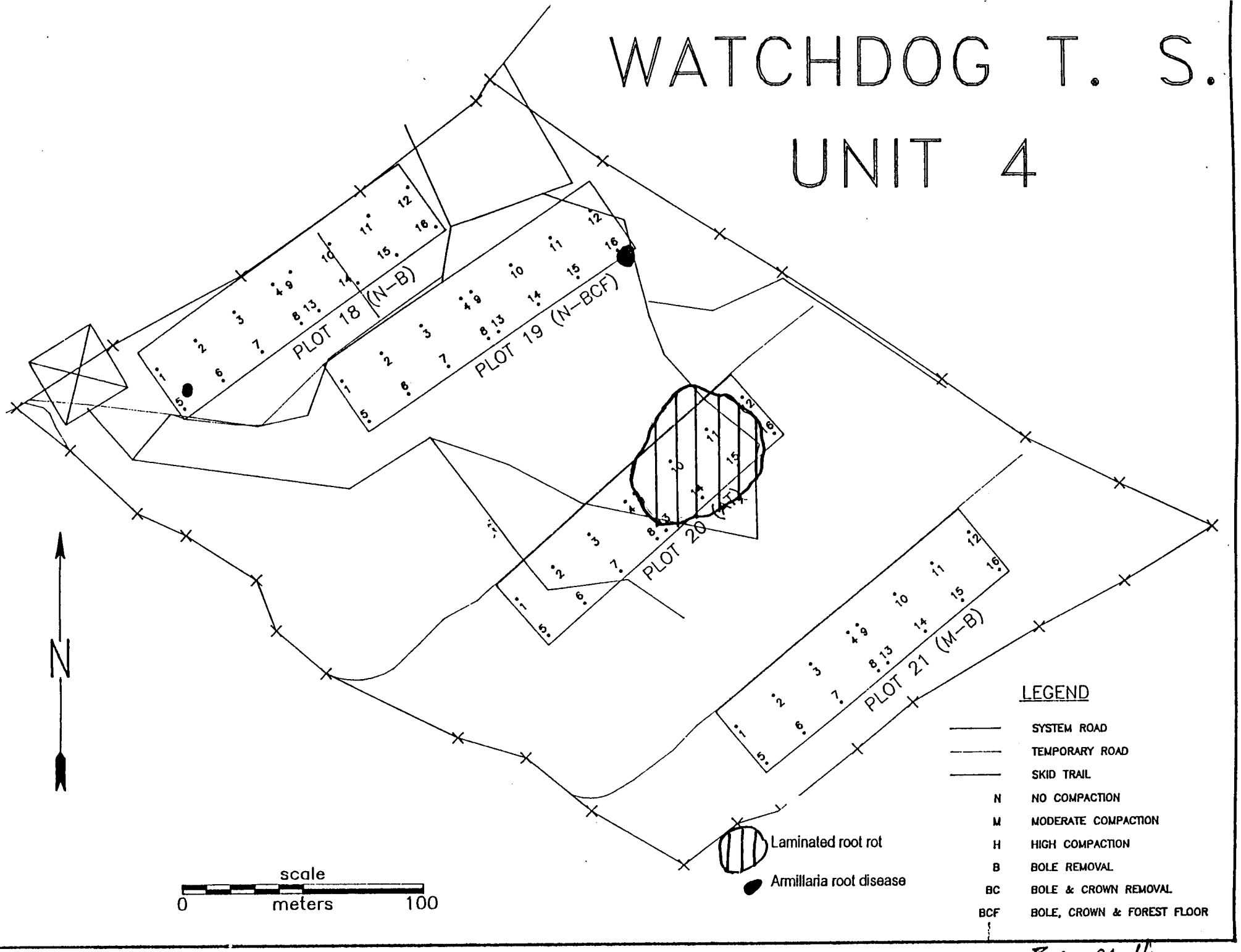
WATCHDOG T. S.
UNIT 4
PLOT 18 (N-B)
PLOT 19 (N-BCF)
PLOT 20 (M-F)
PLOT 21 (M-B)
N
scale
0
meters
100
Laminated root rot
Armillaria root disease
LEGEND
SYSTEM ROAD
TEMPORARY ROAD
SKID TRAIL
N NO COMPACTION
M MODERATE COMPACTION
H HIGH COMPACTION
B BOLE REMOVAL
BC BOLE & CROWN REMOVAL
BCF BOLE, CROWN & FOREST FLOOR

FIGURE 4

WATCHDOG T. S.

UNIT 5

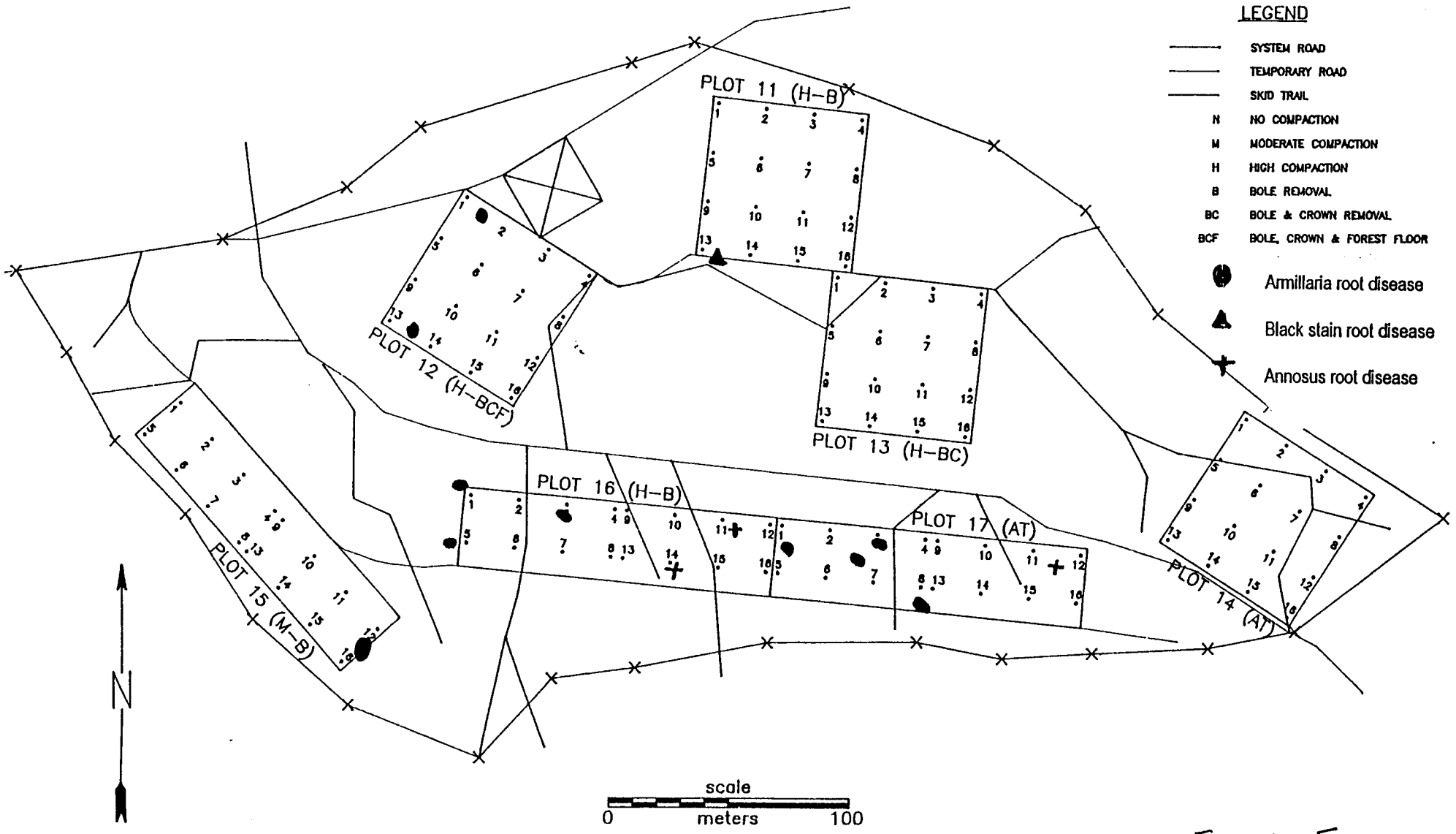

FIGURE 5

WATCHDOG T. S.

UNIT 12

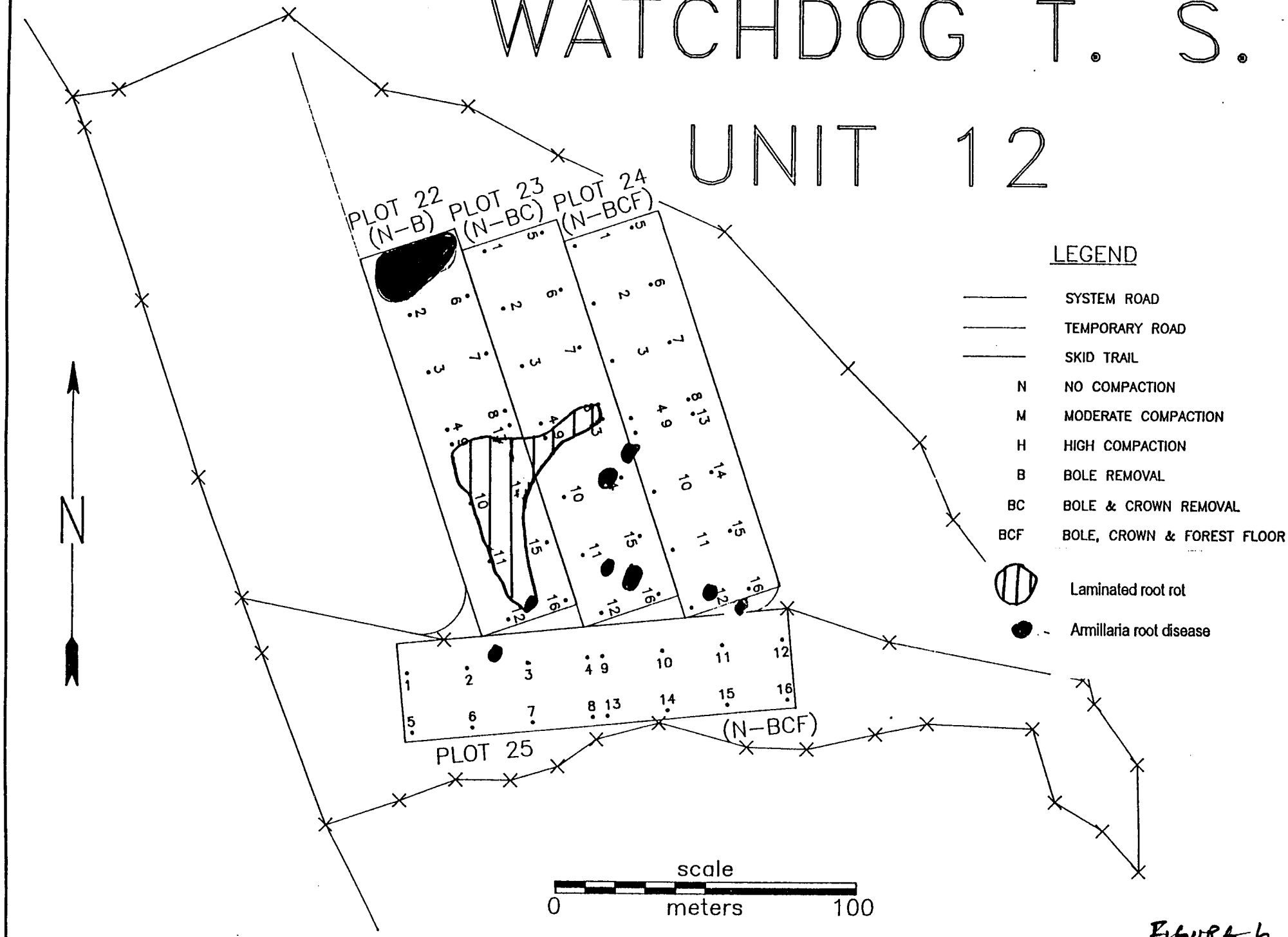

FIGURE 6