Insect and Disease Assessment of the Demonstration of Ecosystem Management Options Site: Diamond Lake Ranger District Umpqua National Forest

Southwest Oregon Forest Insect and Disease Technical Center
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by

Ellen Michaels Goheen Plant Pathologist
Donald Goheen Plant Pathologist/Entomologist
Katy Marshall Forester/Plant Pathologist
Southwest Oregon Forest Insect and Disease Technical Center
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During the weeks of July 11 and 18, 1994, we surveyed 6 32-acre units and 1 12-acre control unit in the Demonstration of Ecosystem Management Options (DEMO) study area on the Diamond Lake Ranger District, Umpqua National Forest. The purpose of the survey was to identify areas in the units where root disease-causing fungi occur and to provide an assessment of root disease impacts. Incidence of other common forest insects and diseases was also noted.

Methods

Prior to this survey, unit boundaries had been delineated with flagging, and a 40 X 40 meter grid was established. Grid points were marked with flagging and PVC pipe and labelled according to axis coordinates. This grid was the reference for mapping root diseased areas.

Each unit 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 *the fungus Armillaria 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).* The interiors of white fir 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.

At each grid point, root disease severity was assessed for a .02 hectare (1/20th acre) circular area according to the following scale:

Root Disease Severity Ratings	
Rating	**Description**
0	No evidence of root disease visible within 50 feet of the plot.
1	Root disease present within 50 feet of the plot but no evidence of root disease on plot.
2	Minor evidence of root disease on plot, such as a suppressed understory tree killed by root disease or a minor part of the overstory showing signs of infection. Little or no detectable reduction in canopy closure or volume.
3	Canopy reduction evident, up to 20%, usually as a result of the death of 1 codominant tree on an otherwise fully stocked site. In the absence of mortality, numerous trees showing symptoms of root disease.
4	Canopy reduction 20% to 30% as a result of root disease. Snags and downed trees removed from canopy by disease as well as live trees showing symptoms of disease contribute to impact.
5	Canopy reduction 30-50% as a result of root disease. At least half of the ground area of plot considered infested. Plots representing mature stands with half their volume in root disease-tolerant species usually do not go much above a severity rating of 5 due to the ameliorating effect of the root disease-tolerant species.
6	50-75% canopy reduction as a result of root disease with most of the ground area considered infested.
7	At least 75% canopy reduction. Plots which reach this severity level usually are occupied by only the most susceptible species. There are very few of the original overstory trees remaining although infested ground is often densely stocked with regeneration of susceptible species.
8	The entire plot falls within a definite root disease pocket with only 1 or very few overstory trees of susceptible species present.
9	The entire plot fails within a definite root disease pocket with no overstory trees of the susceptible species present.

Results

Armillaria root disease is present on all units surveyed. Area affected, based on mapped mortality and infected stumps, is substantial for each unit (Table 1).

Unit Number	Area Affected by Armillaria Root Disease
1	50%
2	58%
3	31%
4	33%
5	42%
6	33%
Control	62%

Table 1. Area affected by Armillaria Root Disease.

Manifestations of disease range from large pockets of mortality with few remaining overstory trees, to scattered mortality of understory trees (See indivdual Unit Maps, Figures l-7). In most units, a number of plots had Root Disease Severity Ratings of 5 or greater, indicating that root disease is significantly affecting crown cIosure at the present time (Table 2).

Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Control
24%	33%	14%	19%	0%	6%	25%

Table 2. Percentage of plots by unit with Root Disease Severity ratings of 5 or greater.

White fir is the species most susceptible to Armillaria root disease on the DEMO units. Most mortality occurs in this species. In the portions of the units where mortality is scattered in overstory trees or where regeneration is affected, white fir is preferentially attacked. Other species, including Douglas-fir, Shasta red fir, Pacific silver fir, western hemlock, western white pine, lodgepole pine, and ponderosa pine are less frequently killed. These other species are dying mostly in areas where there are large disease pockets.

One small pocket of laminated root rot, representing approximately one percent of the area, was found in Unit 4. The disease was causing mortality in white fir and Douglas-fir.

One small black stain root disease center was found along an older skid road in Unit 2. Sapling Douglas-fir were being killed.

Numerous white fir stumps in Units 1 and 4 were colonized by *H. annosum,* cause of annosus root disease. The fungus did not appear to be causing direct mortality of firs adjacent to infected stumps. However, Amillaria root disease and annosus root disease are often found in association in other localities. To be certain of the role that *H. annosum* plays in the mortality of trees associated with infected stumps, isolations would have to be made. This was not done in this survey.

Bark beetles were closely associated with root disease mortality across ail units. The fir engraver beetle (Scolytus *ventralis)* was found infesting diseased true firs. Mountain pine beetle (Dendroctonus *ponderosae)* galleries were identified on ponderosa, lodgepole and western white pines. An abundance of older snags and down western white pines with characteristic bark beetle galleries suggests that mountain pine beetle had been very active in most units in years past. Western pine beetle (D. *brevicomis)* was found infesting large, older ponderosa pines.

Extensive topkill, branch flagging, and whole tree mortality in small (usually 1 meter tall or less) white fir was caused by the canker fungus *GrovesieIla abieticola*. White pine blister rust *(Cronartium ribicola)* was actively killing branches, tops, and whole trees in western white pine regeneration. Scattered topkill and branch flagging of overstory western white pines was also noted.

Discussion

Root diseases, particularly Armillaria root disease, are **major** influences on vegetation in the Diamond Lake DEMO units. 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.

Most of the root diseases that occur in the DEMO units are diseases of the site; they are able to maintain themselves for decades in stumps and woody root material. Annual mortality rates are generally low and spread within stands is a slow process compared to other disturbance agents, but impacts over the long term are great, especially in the most susceptible stand types. Currently, root diseases in the DEMO units are affecting crown closure in 2 different ways. Root diseases are causing mortality of scattered individuals, preferring certain species or size classes, or they are creating substantial openings in stands that are devoid of mature susceptible hosts. Both of these kinds of effects occur in most units on the DEMO site. The larger openings created by root disease in these units are most frequently occupied by susceptible conifer regeneration and less frequently by

hardwood shrub species. These openings are sources of within-stand diversity and may be preferred by some wildlife species.

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 across a variety of vigor classes whose roots come in contact with inoculum, or it can be a saprophyte, colonizing weakened or dead trees. Spread is slow, usually l-2 feet per year. New infections occur when susceptible hosts contact infected root material or fimgal rbizomorphs in the ground. Those living trees that have been able to resist fimgal 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.

Host susceptibility to Armillaria root disease varies from site to site in the Pacific Northwest. In the Diamond Lake DEMO units, white fir is highly susceptible; it is readily infected and killed. No clear hierarchy of susceptibility exists for the other DEMO species. In some units, western white pine and ponderosa pine are damaged. In others, Douglas-fir and Shasta red fir seem more 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 DEMO units and no below ground investigations of hardwoods were done.

Some Arrnillaria root disease caused-mortality on the units was found in association with large ponderosa pine stumps and western white pine snags and stumps. Annillaria root disease's prevalence on such sites may be partially the result of white pine blister rust infection, mountain pine beetle infestation and associated salvage activities in the past. In addition, several years of drought and overstocking in some portions of the units has weakened individual trees, making them less capable of resisting invasion and therefore more susceptible to infection.

In general, the expectations for developing stands with major components of large overstory white fir are not high where Armillaria root disease is as active as it is in the DEMO units. White fir will continue to be infected and killed by *A.* ***ostoyae.*** Harvesting activities that create large stumps, or further stress residual trees by compacting soils or wounding stems will also contribute to increased disease activity.

Laminated root rot's influence in this area is limited to one pocket in Unit 4. It is expected that this infection center 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 DEMO units, Shasta red fir, 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 "S''-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 transfemed. 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 Units 1 and 4 is not clear. Many 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 these units. Further investigations are required and will be undertaken.

Black stain root disease in Douglas-fir is occuring at very low levels in one of the stands. It is not yet having significant impacts. Spread of the causal fungus *L.wageneri* 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. Monitoring for increased disease incidence and impact may be important with future harvest activities.

Bark beetles are active in all the DEMO units. Fii engraver beetle attack is closely associated with tree stress caused by root disease. Mountain pine beetle and western pine beetle attack root diseased-trees but they are also often attracted to trees that are stressed by overstocked conditions. Basal areas greater than 150 square feet per acre are considered high risk for pine bark beetles on moderate sites. Bark beetles will remain active on these sites wherever root disease occurs and stocking levels are high.

White pine blister rust infections in young western white pine significantly decrease the likelihood that these trees will succeed in maturing. Blister rust has been active in the DEMO stands for several decades; the large numbers of western white pine stumps scattered through most of the units are likely the result of salvage activities associated with damage caused by the disease in the past. Unless resistant western white pine stock is deployed, the future white pine components of these stands will be minimal.

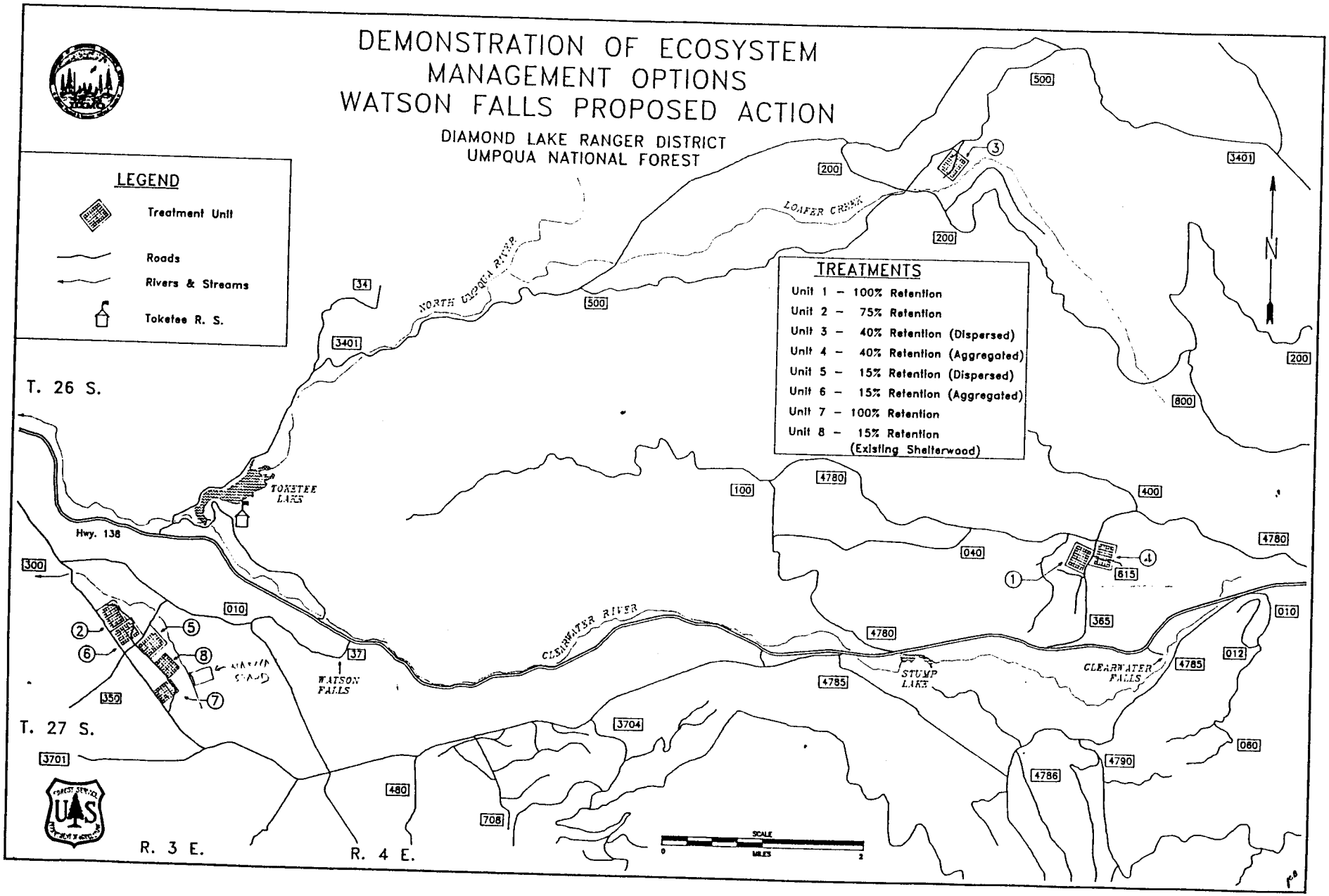
Grovesiella canker of white fir is currently causing rather widespread mortality, topkill, and branch dieback of regeneration. Canker fungi are typically secondary pathogens; they require weakened or stressed hosts. Root disease does not appear to be associated with cankered trees. Most likely, drought stress is the main predisposing factor. Incidence is high now; future activity will depend upon environmental conditions. The disease might also be favored if harvest activities result in significant amounts of wounding in white fir regeneration.

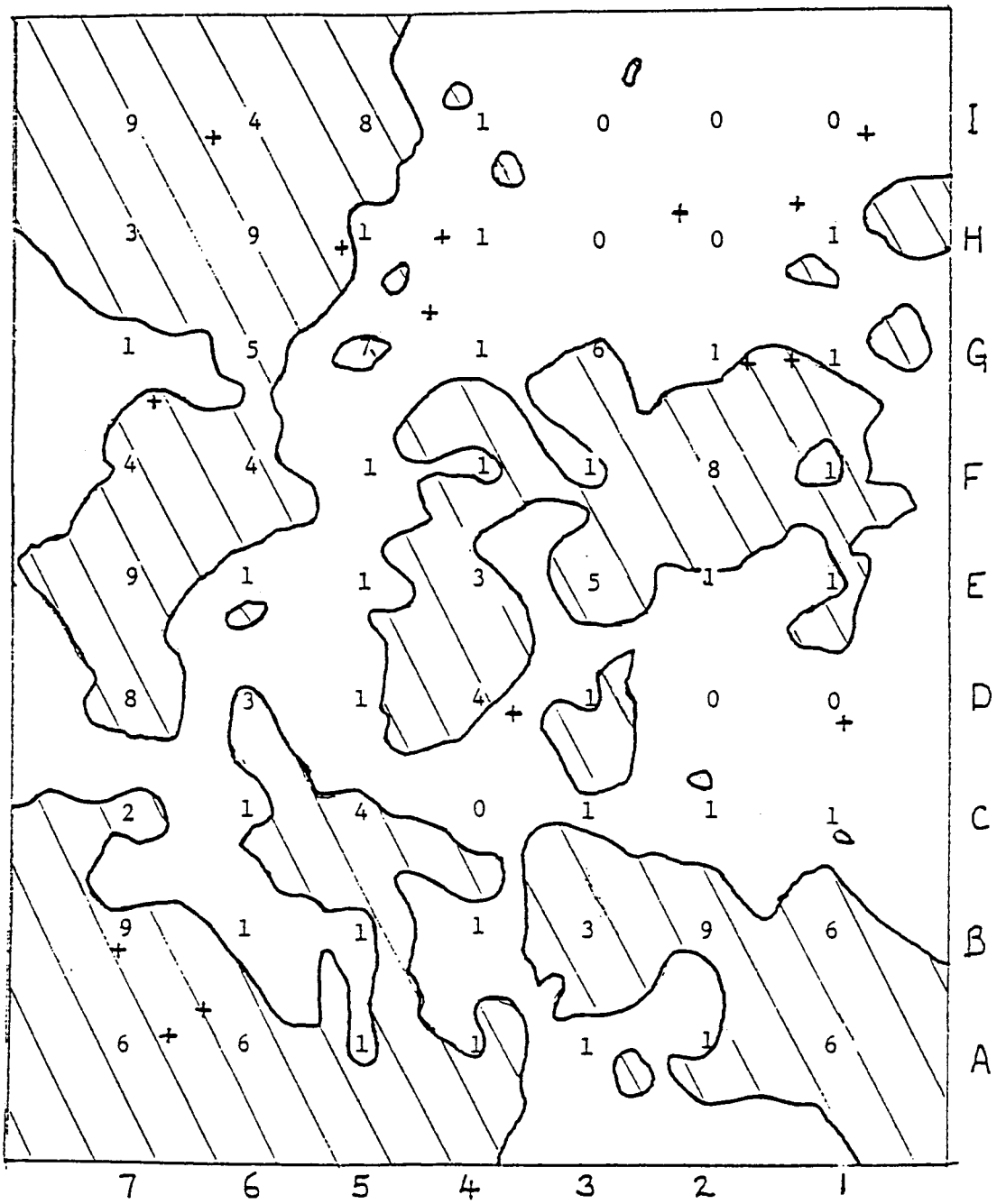
Conclusion

The impact of root disease is very significant in the Diamond Lake DEMO units. The effects of Armillaria root disease on white fir are paramount; this disease will have an overriding influence on all management outcomes. Although often overloked, situations such as this are very common in the Pacific Northwest. The area offers an important opportunity to monitor root disease spread and mortality. Data gathered will provide insights on the relationships of management practices and disease incidence and severity. Root disease effects on stand structure and diversity will also be related to wildlife habitat characteristics. This information will be useful for validating and calibrating the Western Root Disease Model extension to the West Cascades variant of the Forest Vegetation Simulator.

The insect and disease survey conducted by the staff of the Southwest Oregon Forest Insect and Disease Technical Center was an area-wide assessment based on visible impacts. No attempts were made to collect samples from nonsymptomatic trees. Information regarding impacts by species or size classes will come from vegetation data. It will be essential to merge both databases when analyzing stand structure, species composition, and stocking, now and after proposed harvest activities.

The staff of the Southwest Oregon Forest Insect and Disease Center looks forward to continued cooperation on the DEMO project, Umpqua National Forest. Please feel free to direct questions relating to this survey to us at any time.


DEMONSTRATION OF ECOSYSTEM MANAGEMENT OPTIONS
WATSON FALLS PROPOSED ACTION
DIAMOND LAKE RANGER DISTRICT
UMPQUA NATIONAL FOREST
LEGEND
Treatment Unit
Roads
Rivers & Streams
Toketee R. S.
TREATMENTS
Unit 1 – 100% Retention
Unit 2 – 75% Retention
Unit 3 – 40% Retention (Dispersed)
Unit 4 – 40% Retention (Aggregated)
Unit 5 – 15% Retention (Dispersed)
Unit 6 – 15% Retention (Aggregated)
Unit 7 – 100% Retention
Unit 8 – 15% Retention (Existing Shelterwood)
N
T. 26 S.
T. 27 S.
R. 3 E.
R. 4 E.
NORTH UMPQUA RIVER
LOAFER CREEK
CLEARWATER RIVER
TOKETEE LAKES
WATSON FALLS
STUMP LAKE
CLEARWATER FALLS
Hwy. 138
SCALE
MILES
0
2



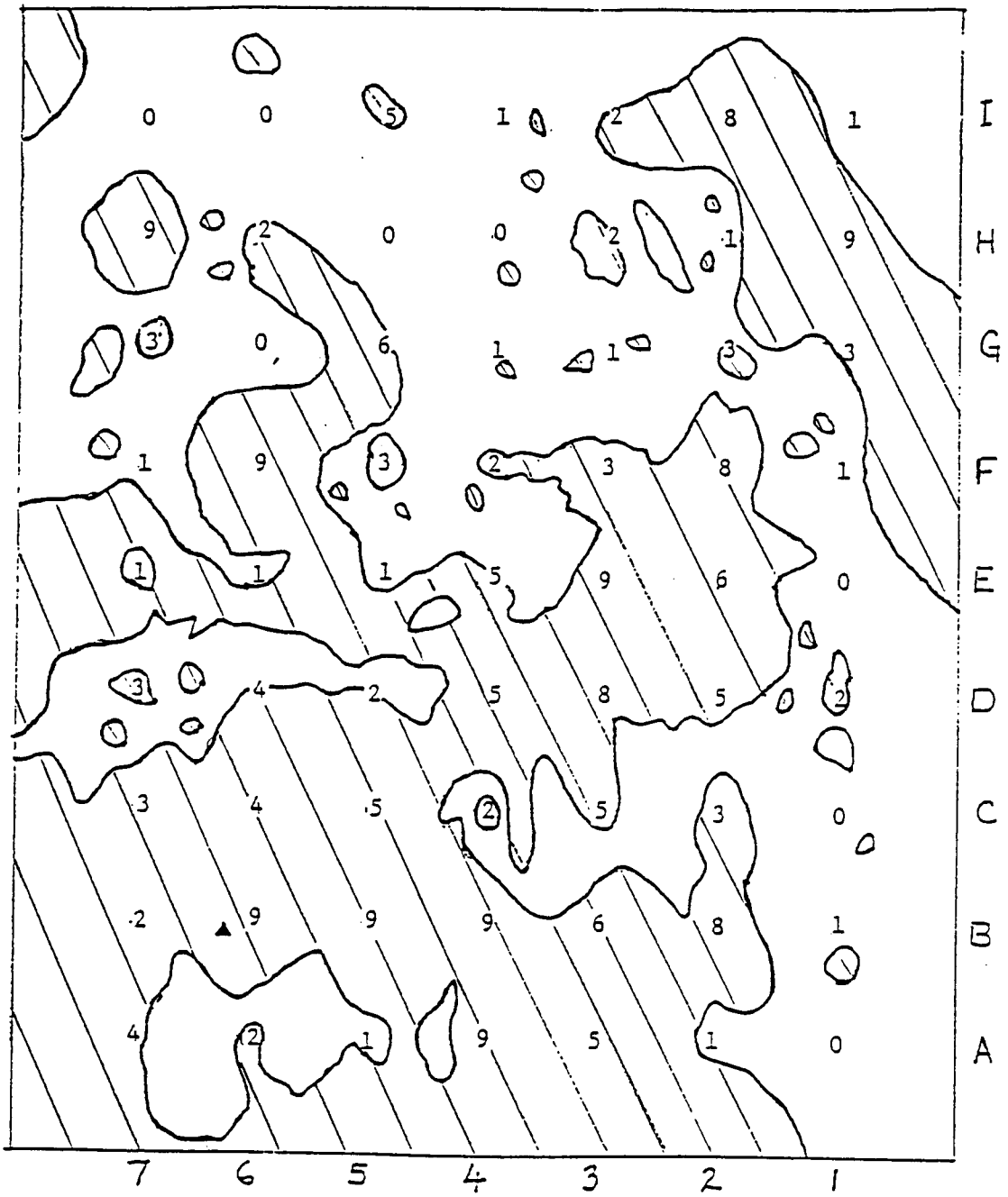
Legend

Plot Center with Root Disease Severity Rating 6

Armillaria Root Disease Center

Annosus Root Disease in Stump +

Figure 1. Root Disease Distribution in Diamond Lake DEMO Unit 1.



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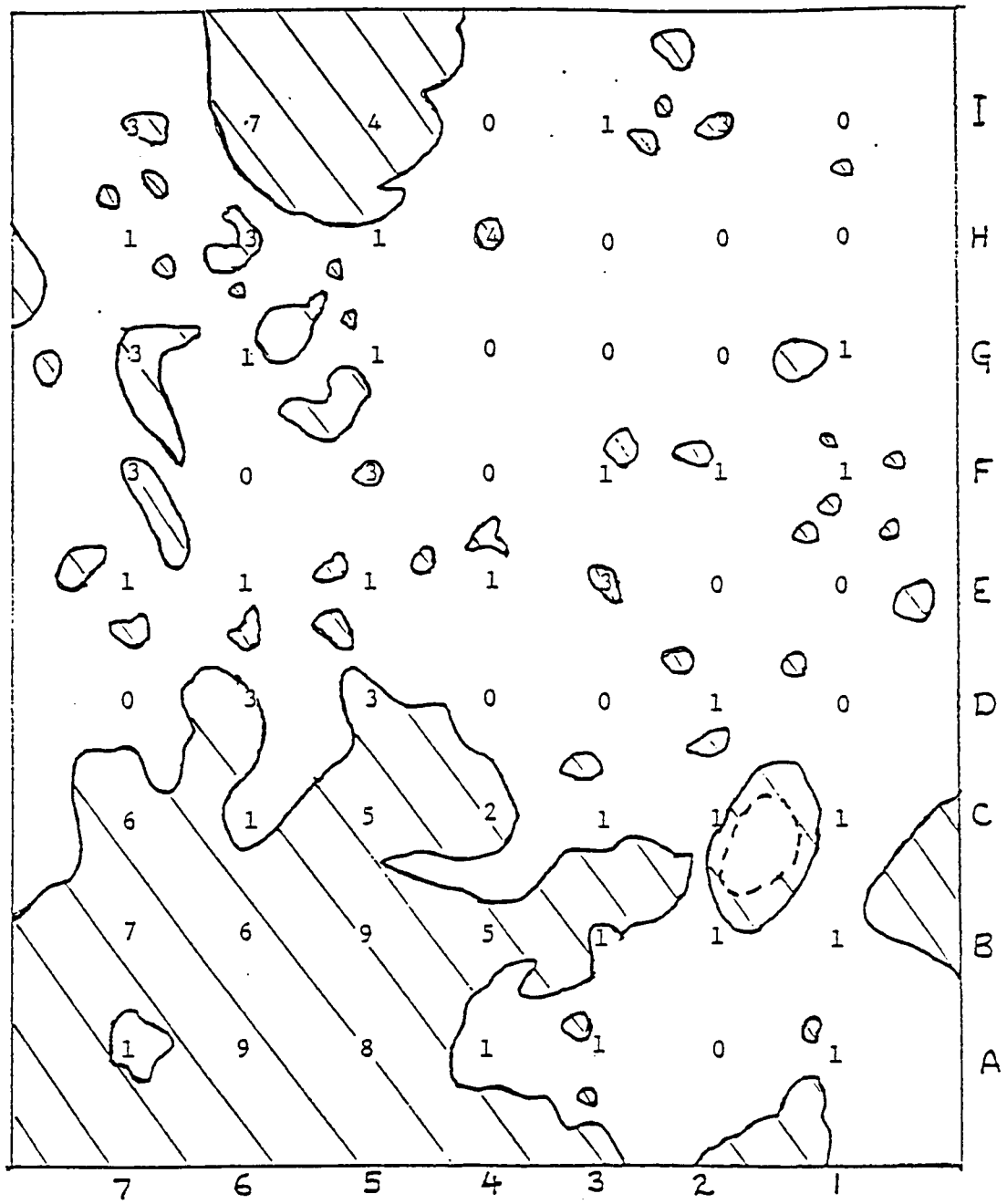
Plot Center with Root Disease Severity Rating 5

Armillaria Root Disease Center

Black Stain Root Disease Center

Figure 2. Root Disease Distribution in Diamond Lake DEMO Unit 2.



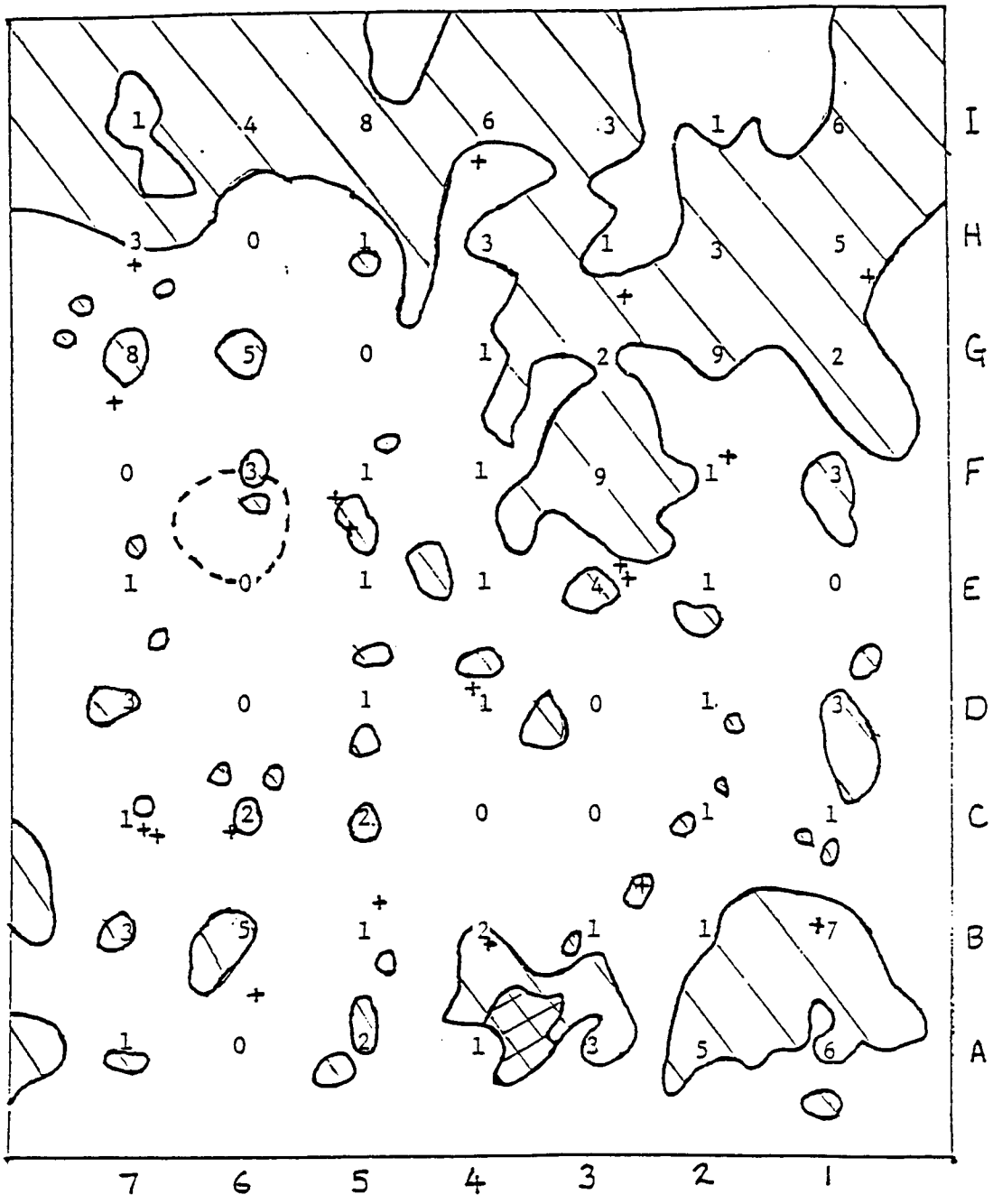
Legend

Plot Center with Root Disease Severity Rating 6

Armillaria Root Disease Center

Old Landing

Figure 3. Root Disease Distribution in Diamond Lake DEMO Unit 3.



Legend

Plot Center with Root Disease Severity Rating 7

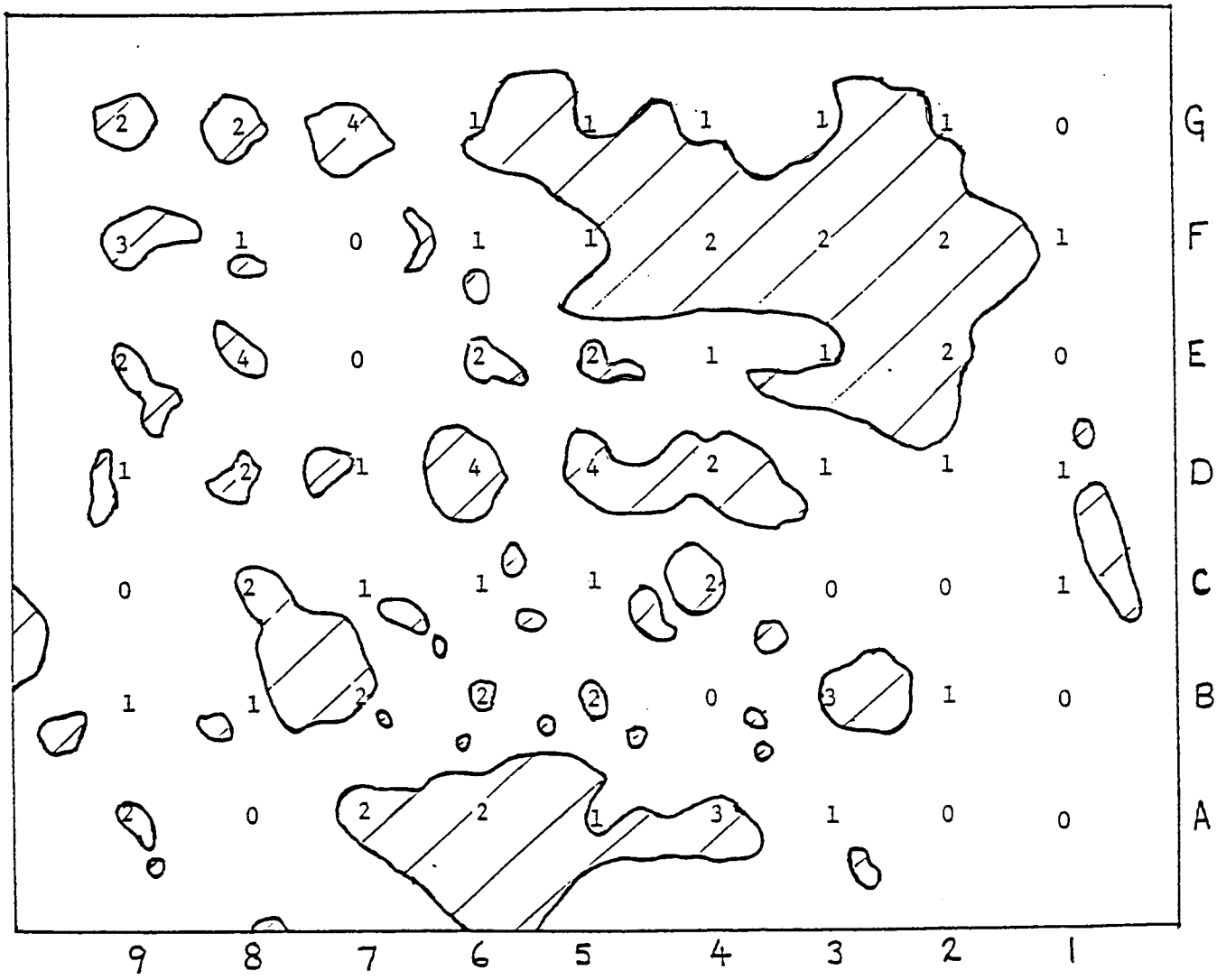
Armillaria Root Disease Center

Annosus Root Disease in Stump +

Old Landing

Laminated Root Rot Center

Figure 4. Root Disease Distribution in Diamond Lake DEMO Unit 4.



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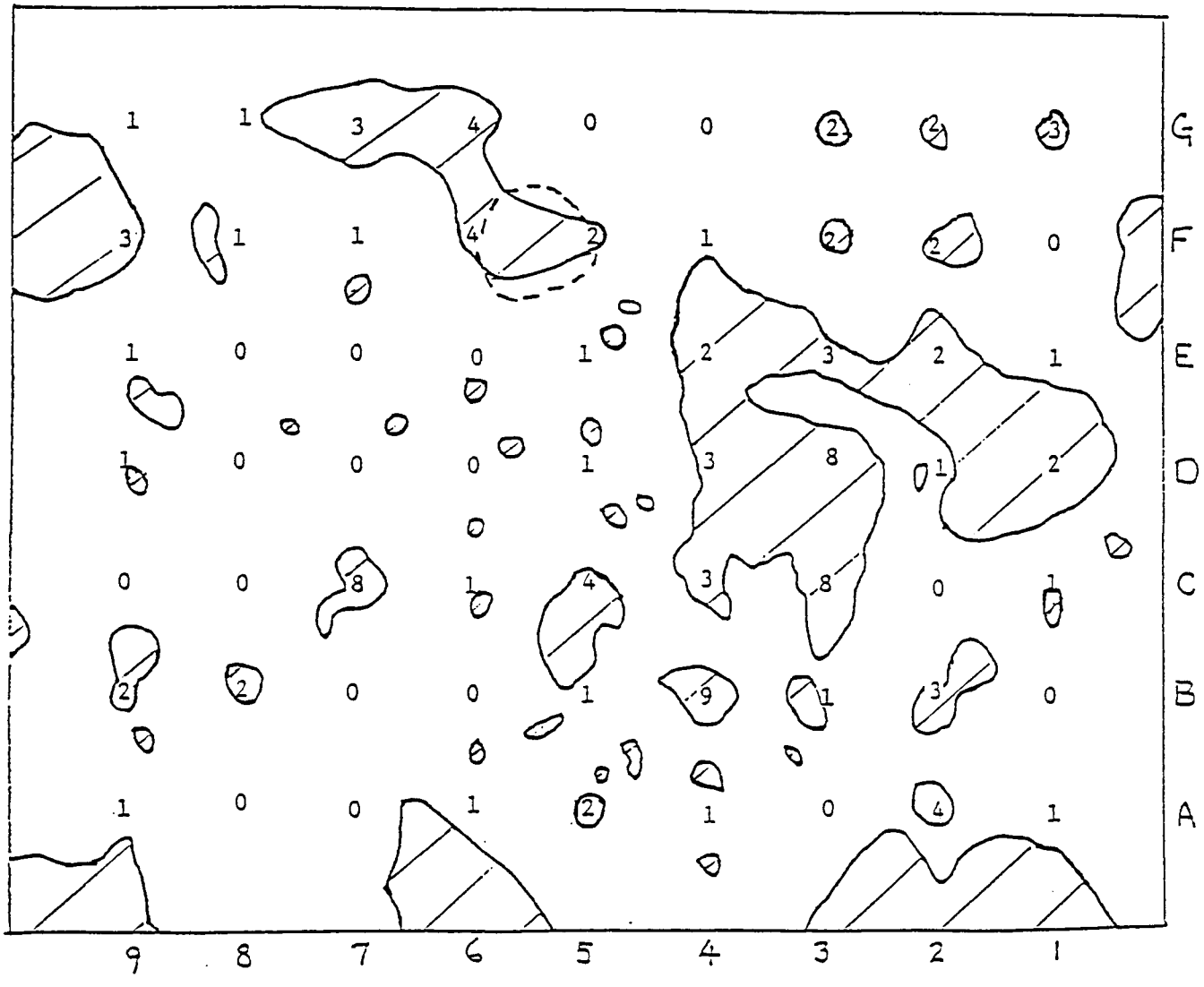
Plot Center with Root Disease Severity Rating 5

Armillaria Root Disease Center

Figure 5. Root Disease Distribution in Diamond Lake DEMO Unit 5.



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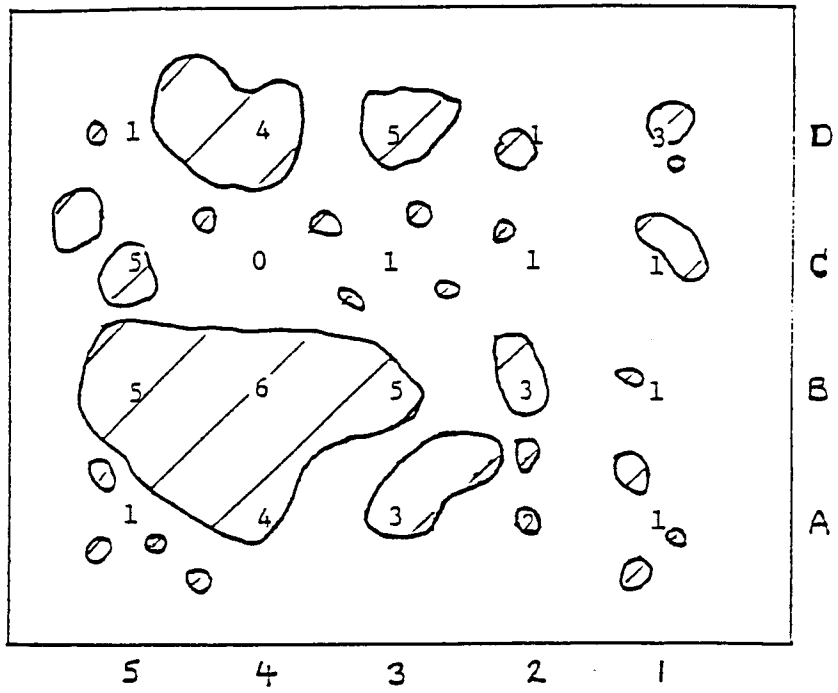
Plot Center with Root Disease Severity Rating 8

Armillaria Root Disease Center

Old Landing

Figure 6. Root Disease Distribution in Diamond Lake DEMO Unit 6 .



Legend

Plot Center with Root Disease Severity Rating 6

Armillaria Root Disease Center

Figure 7. Root Disease Distribution in Diamond Lake DEMO Control Unit .