A

PROJECT PROPOSAL

FOR

DISEASE AND INSECT PROBLEMS OF WILDERNESS-AREA FOREST TREES

by

David L. Hobbins

for

The Wilderness Research Center

and

Taylor Ranch Field Station

College of Forestry, Wildlife and Range Sciences

Submitted________________________

Advisor's approval G. D. Pailing

INTRODUCTION

Little work has been done, except for one study (Publication attached), to survey the destructive forest agents in the Idaho Primitive Area. Consequently, no information exists on present or potential damage in the forested areas of this region; and we have no idea if a build-up of insects or disease is occurring or has occurred. This knowledge could be vital both for protecting the area and as a base for comparing wilderness problems with those of other areas. Also, we currently do not have tested survey methods for wilderness areas. Thus, this project, which fits the objectives of the MacIntire-Stennis Project MS-23, will supply needed and important damage information and will help us to evolve survey systems which can be applied to the rest of the State.

OBJECTIVES

Objectives of this forest survey are twofold. First, we will define the causes of damage and the extent of damage by cause. This will enable us to map centers of loss and to project the potential for damage or outbreak by each agent. Secondly, we will develop survey methods suitable for wilderness areas, particularly those with patchy forests as in the Idaho Primitive Area.

METHODS

Initially, we will employ a sampling system of selective randomization to survey the Idaho Primitive Area. Although plots will be established on a random mileage basis and we will record site condition and the potential for tree establishment and survival at all selected points, our major efforts will be directed at the scattered patches of forest in the area. All forest

PLOTNU________ RCORDR___ MEASUR___ T____ R____ S___ ELEVTN_____M/ ASPECT___/

DUFFDE_____cm/ SOILDE_____cm/ SOILTY______________/ SLOPPE___/ POSLOP___/

TREESP____

PLANTS____

____

REPROD____

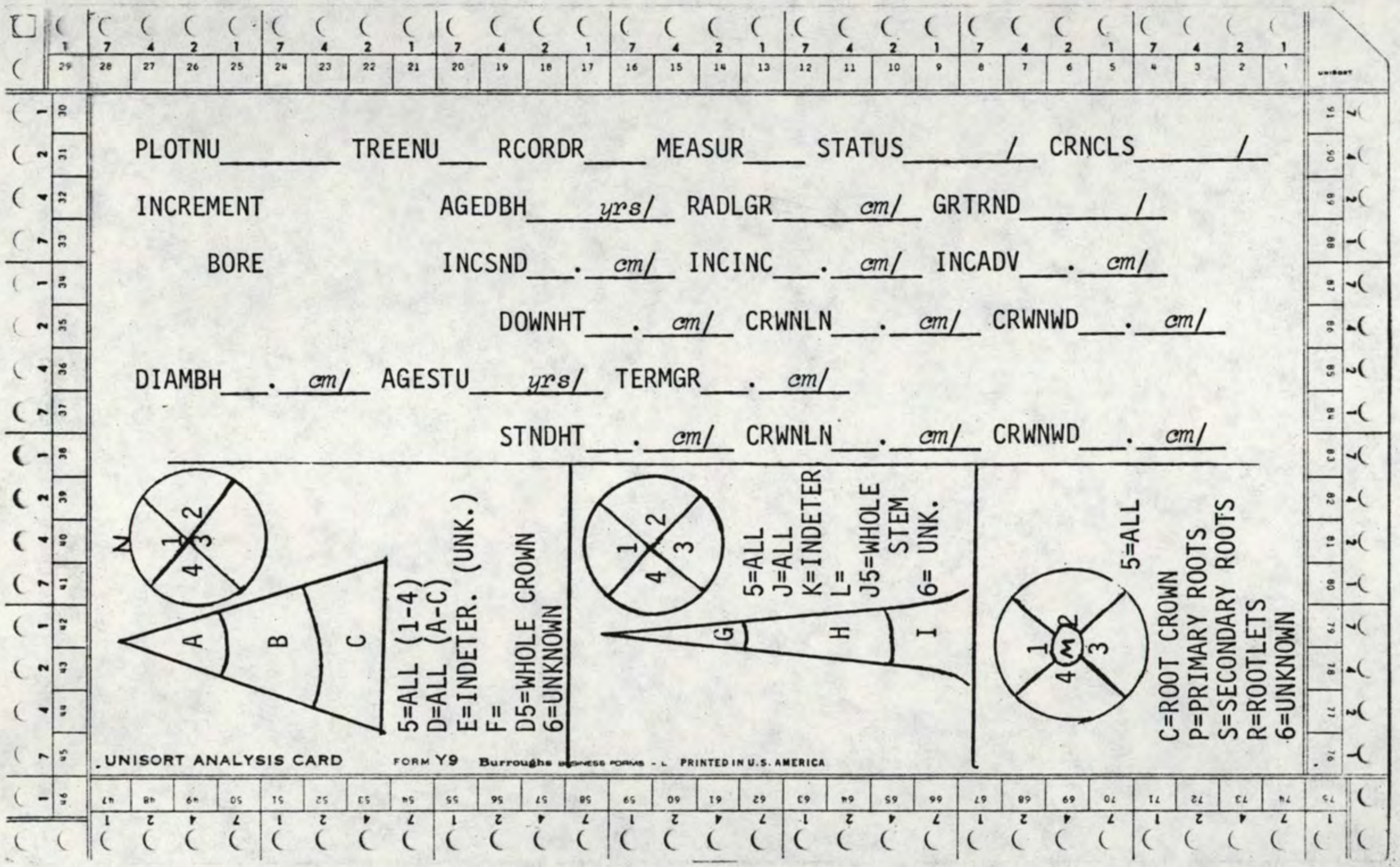
STNDCO____

____

____

UNISORT ANALYSIS CARD FORM Y9 Burroughs BUSINESS FORMS - L PRINTED IN U.S. AMERICA

Figure 1. Plot Cards.



PLOTNU________ TREENU___ RCORDR____ MEASUR____ STATUS______/ CRNCLS______/

INCREMENT AGEDBH_____yrs/ RADLGR_____cm/ GRTRND______/

BORE INCSND___.___cm/ INCINC___.___cm/ INCADV___.___cm/

DOWNHT___.___cm/ CRWNLN___.___cm/ CRWNWD___.___cm/

DIAMBH___.___cm/ AGESTU_____yrs/ TERMGR___.___cm/

STNDHT___.___cm/ CRWNLN___.___cm/ CRWNWD___.___cm/

Figure 2. Tree Cards.

lands will be delineated from maps and aerial photos; and then plots will be randomly selected within these stands. However, we anticipate modifying both the plot selection method and data collection system to fit wilderness conditions.

After the plots are located, randomly-entered standardized data (such as aspect, slope, vegetation, etc.) will be taken and recorded on plot data cards (Fig. 1). All data will be recorded in metric units. On each plot, trees will be selected at random, completely dissected, and data on the crowns, stems, and roots will be recorded on tree cards (Fig. 2). In addition, general stand and plot information concerning damage will be recorded from ground and aerial observations while passing through or over a given area. This will provide information from outside the randomly selected plots, and will enable us to estimate the reliability of plot information in describing forest situations. Finally, for those insects and diseases which are not identified in the field, samples will be taken and brought back to the ranch or University where cultures and proper identification can be made.

Output of field data will involve a list of the major problems in the Primitive Area, an estimate of their actual damage, an estimate of their potential damage, and maps of problem areas. All data will be analyzed according to cause, interacting causes, location, elevation, and using the "on-line" DISACC (Disease and Insect Access) program developed by personnel working on the MS-23 project. This program allows rapid computer analyses and will assure immediate output of our information.

SUMMARY

Because the Idaho Primitive Area has not been surveyed for destructive forest agents, this project will provide an inventory of agents that are

present and estimates of potentials for future damage. Output of the data will be especially enhanced by processing through a computerized assembly and analysis program (DISACC) which allows comparisons, associations, locations, volumes of all data, both physical and biological. Additionally, mapping of the problem areas will be included. Development of a survey system for this area and application of this system and the acquired information to other parts of the state make this project valuable not only for the Idaho Primitive Area, but for forested areas throughout Idaho.

PERSONNEL

David L. Hobbins, a senior in Forest Sciences in the College of Forestry, Wildlife and Range Sciences, will be the principal investigator.

He has had training in mycology, forest pathology, and entomology which qualify him for this work; and intends to pursue a course of graduate study in forest pathology.

Dr. Arthur D. Partridge, Professor, Forestry, Pathology, College of Forestry, Wildlife and Range Sciences will act at supervisor and advisor.

TIME SCHEDULE

I will be available for work in the Primitive Area from 1 June 1981 to 21 August 1981. Surveying work will be conducted during this period as well as a week of work at the Taylor Ranch. Analysis of data and preparation of final results will be conducted back at the University during the fall semester.

EQUIPMENT AND MATERIALS

Below is a list of equipment needed for the survey, sampling, an culturing. All items currently are available at no cost.

Survey Equipment

Bow Saw (4 ft) (with tapered replaceable blades)	Compass
Single bit axe (2.5 lbs.)	Maps and photos
Wedges	Increment borer (12 in)
Hatchet/pruning shears	Diamter tape
File, stone, oil, solvent and rags	Metric ruler (15 cm)
Plot cards (Fig. 1)	Alcohol (70%)
Tree cards (Fig. 2)	Collecting vials
Camera (35 mm)	Collecting bags
Close-up lense	Shovel

Culture Equipment

Alcohol	Alcohol lamp (matches)
Tweezers	Knife
Flame board	Forceps

Identification Manuals

Boyce, J. S. 1961. Forest pathology. 3rd ed. McGraw-Hill. New York. 572 pp.

Furniss, R. L. and V. M. Carolin. 1977. Western forest insects. U. S. Dept. Agr., Misc. Pub. No. 1339. 654 pp.

Partridge, A. D., E. R. Canfield, and D. L. Kulhavy. 1978. Keys to major disease, insect, and related problems of forests in northern Idaho. Forest, Wildlife, and Range Experiment Station. Moscow. 100 pp.

Partridge, A. D. and D. L. Miller. 1974. Major wood decays in the Inland Northwest. Idaho Research Foundation. Moscow. 125 pp.

Camping/Hiking Equipment

Tent

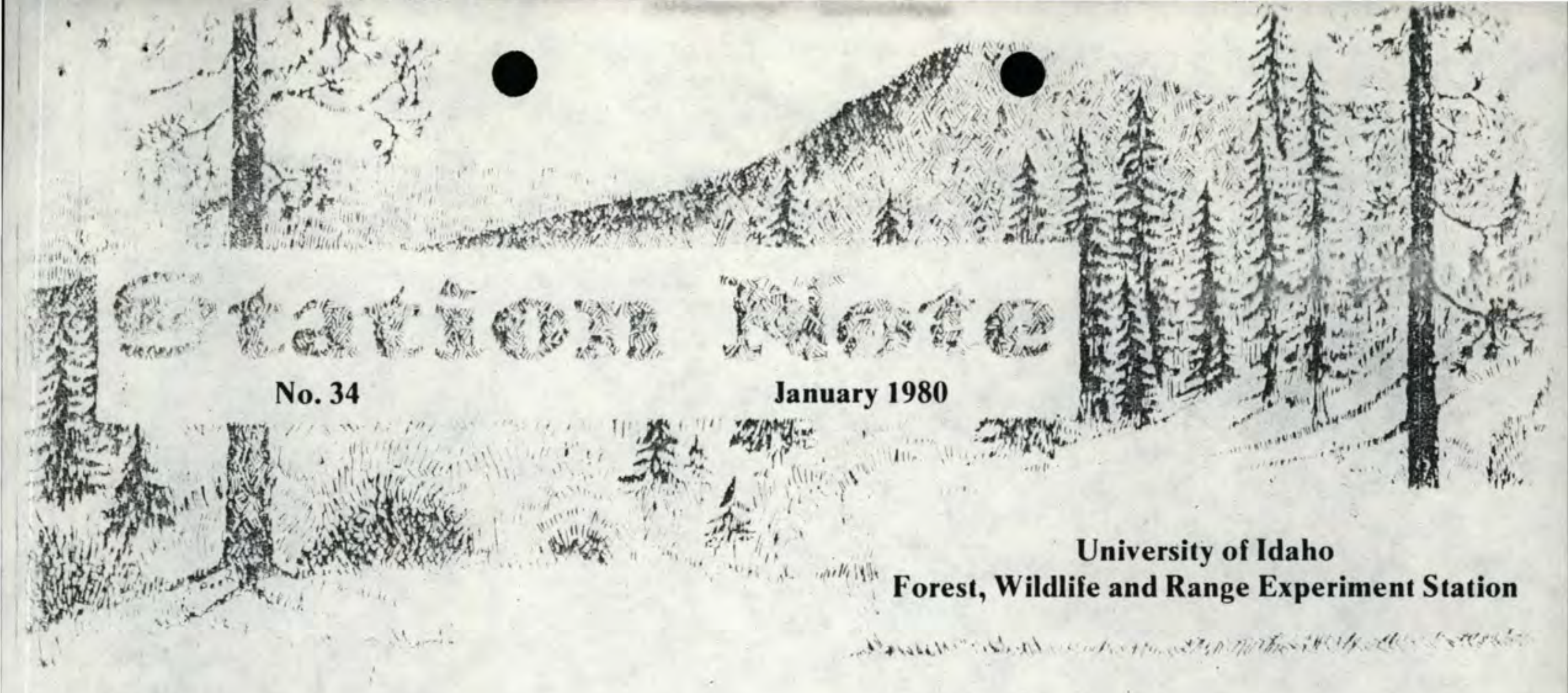
Stove

Fuel

Pack board

Line (rope)

Flash light



No. 34 January 1980

University of Idaho
Forest, Wildlife and Range Experiment Station

Frequency and Damage by Forest-Tree Pests in Southern Idaho

A.D. Partridge and E.R. Canfield

ABSTRACT

Frequencies and volume-loss data derived from ten years of forest insect and disease survey work cover ten important forest-tree species native to the northern Rocky Mountains. All important disease and insect causal agents found during the surveys are listed. The amount of volume lost from each tree species to each damaging agent is given. Budworm, needle diseases, aphids and dwarf mistletoes caused the most frequently found damage. However, carpenter ants, heart rots, and root diseases caused the greatest loss of volume. Spectacular or conspicuous agents such as needle casts and insects account for much less volume loss than do the far less noticeable agents such as heart rots and root diseases.

INTRODUCTION

Of the few comprehensive studies of forest-tree problems published, only one (1) compares impacts by various causes. None is available for the State of Idaho. The relative damage done by each agent remains ill-defined even though inventories are an essential part of management planning. Recognizing that it is impossible to assign harvesting priorities correctly without estimates of real or potential loss for an area, the University of Idaho assigned forest entomologists and forest pathologists to initiate surveys and studies of survey methods in 1968. Since then, tree data have been gathered each year throughout the state. Additional financial aid from the U.S. Department of Agriculture - Forest Service in 1978 permitted us to gather sufficient information to report occurrences in the central part of Idaho. All lands, regardless of ownership, were included in our studies. The study area encompassed all roaded portions of the Payette, Salmon, Boise, and Challis National Forests and the Northern Division of the Sawtooth National Forest along with included and adjacent lands owned by other agencies and individuals.

METHODS

During the 10 years of study we compared several systems of survey including studies from low-flying aircraft, random and nonrandom map spotting and modified random selections from stratified roadside locations. Repetition of each system and comparisons of data indicated that aerial surveys located the fewest problems and overlooked some of the most damaging ones. Nonrandom selections heavily favored spectacular problems while again overlooking major damage. Modified random selections from maps or from

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roadside provided essentially the same results as modified random selections in nonroaded areas except in sparsely wooded areas or exceptionally steep or rocky terrain. Therefore, the data reported here were gathered from randomly-located sample trees not more than 800 meters and not less than 40 meters from a road. Roads along which trees were to be sampled were selected by aerial examination of sample areas. We preferentially selected roads which traversed cover types representing the sampled area. Roads located on or near stream beds, nonforested desert or nonforested alpine sites generally were eliminated or used sparingly. However, we did not exclude recreational areas, grazing lands with sparse tree populations or watersheds. Judgment and experience rather than strict adherence to a statistical design were necessary parts of this survey system. As we drove into each forested area, we selected a number from a container of tags numbered separately from 1 to 10. These numbers then were considered selected mileages at which we would stop to establish plots. This procedure stratified the preselected road network in a practical and unbiased manner. When each plot was finished, we again selected a number for the same road or on a continuing side road. We emphasized unbiased selections and representative sampling rather than precision of location throughout the selection processes. A toss of a coin at each stop decided whether the plot would be uphill or downhill, or to the left or right of the road. We then chose a series of five markers from a container with numbers 1-25. The first of the 5 numbers was used to locate a plot center from which stand measurements were made. A simple count of trees beginning at least 40 meters from the road edge or beyond obvious road disturbance was used to find the plot-center tree. The other four chosen numbers were used to select four sample trees, one upslope, one downslope, and two along slope in two directions. The four trees were completely measured and described in their standing conditions, then felled, measured, dissected and carefully searched for any and all problems. Any tree, alive or dead, having any remaining foliage and a measurable diameter at breast height (1.37 m) was eligible for selection as a sample tree. The restriction of foliar presence prevented sampling badly decayed, nonrecoverable specimens.

We compared the results of our roadside sampling with results of a similar sampling in nonroaded areas. These tests were located at seven widely separated areas of the Payette and Boise National forests (Table 1), and each included a similar roaded and nonroaded area. In nonroaded

Table 1. Locations of nonroaded and roaded comparison-plot areas on the Payette and Boise national forests.

Comparison no.	Nonroaded area	No. of plots/trees	Roaded area	No. of plots/trees
I.	Trapper-Creek area, Boise N.F. (T17N R8 and 9E)	8/32	Yellowpine-Landmark road (T17N 8E and 16N 7E)	6/24
II.	Scott-Mt. area, Boise N.F. (T15N R5 and 6E)	3/12	Big-Pine-Creek road and Scott-Mt. road (T9 and 10N R6E)	4/16
III.	Sheep-Creek area, Boise, N.F. (T4N R7 and 8E)	6/24	Middle-Fork-Boise River road and Lost-Man-Creek road (T4 and 5N R7 and 8E)	6/24
IV.	Big-Creek, Taylor-Ranch area, Payette N.F. (T20 and 21N R13E)	4/16	Big-Creek and Crooked-Creek roads (T21N R10 and 11E)	4/16
V.	Monumental-Creek trail area, Payette N.F. (T18 and 19N R11E)	2/8	Monumental-Creek road (T18N R10E)	1/4
VI.	French-Creek area, Payette N.F. (T21 - 24N R3E)	5/20	French-Creek-Burgdorf road (T23 and 24N R4E)	7/28
VII.	East-Fork-Weiser River area, Payette N.F. (T16 and 17N R1 and 2E)	2/8	Unnamed roads N and E of nonroaded area (T16 and 17N R1 and 2E)	3/12
VIII.	Kennally-Creek area (T17N R5E)	4/16	Paddy-Flat-Kennally Creek roads (T17N R5E)	4/16
		34 plots/ 136 trees		35 plots/ 140 trees

Table 2. Listing of causal organisms and common names of causes of problems each incites.

Acleris gloverana (Walsingham)
western blackheaded budworm

Adelges cooleyi (Gillette)
cooley spruce gall aphid

Arceuthobium spp.
dwarf mistletoe

Armillariella mellea (Vahl ex Fr.) Karst.
(*Armillaria mellea* (Vahl ex Fr.))
shoestring root rot
spongy root and butt rot

Camponotus spp.
carpenter ants

Chionaspis (Phenacaspis) *pinifoliae* (Fitch)
pine needle scale

Choristoneura occidentalis (Freeman)
western spruce budworm

Chrysomyxa sp. *Melampsora* spp. and *Uredinopsis* spp.
needle rust – in general

Collybia radicata (Fr.) Quel.

Coriolellus squalens (Karst.) Bond. et Sing.
(*Dichomitus squalens* (P. Karst.) Reid)
(*Polyporus anceps* Pk.)
red ray rot

Cronartium coleosporioides Arth. f. *coleosporioides*
(*Peridermium stalactiforme* Arth. et Kern.)
stalactiform rust

Cryptoporus volvatus (Pk.) Shear
(*Polyporus volvatus* Pk.)
grey-brown saprot

Dendroctonus ponderosae Hopkins
(= *monticolae* Hopkins)
mountain pine beetle

Dendroctonus pseudotsugae Hopkins
Douglas-fir beetle

Dendroctonus valens LeConte
red turpentine beetle

Echinodontium tinctorium (Ell. et Everh.) Ell. et Everh.
fibrous yellow heartrot

Elytroderma deformans (Weir) Darker
pine needle cast

Endocronartium harknessii (J.P. Moore) Y. Hirat.
(*Peridermium harknessii* J.P. Moore)
western gall rust

Eucosma sp.
pine shoot borer

Fomitopsis annosa (Fr.) Karst.
(*Fomes annosus* (Fr.) Karst.)
(*Heterobasidion annosum* (Fr.) Bref.)
Fomes root rot
white spongy rot

Fomitopsis pinicola (Swartz. ex Fr.) Karst.
(*Fomes pinicola* (Swartz. ex Fr.) Cooke)
crumbly brown cubical rot

Fomitopsis rosea (Alb. et Schw. ex Fr.) Karst.
(*Fomes roseus* (Alb. et Schw. ex Fr.) Cooke
light brown cubical rot

Ganoderma applanatum (Pers. ex Wallr.) Pat.
(*Fomes applanatus* (Pers. ex Wallr.) Gill.)
white mottled rot

Haematostereum sanguinolentum (Alb. et Schw. ex Fr.) Pouz.
(*Stereum sanguinolentum* (Alb. et Schw. ex Fr.) Fr.)
red heartrot

Haplopilus alboluteus (Ell. et Everh.) Bond. et Sing.
(*Polyporus alboluteus* Ell. et Everh.)
subalpine brown rot

Inonotus tomentosus (Fr.) Gilbertson
(*Polyporus tomentosus* Fr.)
(*Polyporus circinatus* Fr.)
(*Polystictus tomentosus* Fr. ex Fr.)
red-brown root and butt rot
honeycomb root rot

Ips spp.
pine engravers

Laurilia sulcata (Burt.) Pouz.
(*Stereum sulcatum* Burt.)
slimy rot

Lentinus lepideus Fr.
brown cubical rot of conifers

Lophodermium sp.
pine needle cast

Neodiprion spp.
sawflies

Perenniporia subacida (Pk.) Donk
(*Poria subacida* (Pk.) Sacc.)
stringy root and butt rot
feather rot

Phaeolus schweinitzii (Fr.) Pat.
(*Polyporus schweinitzii* Fr.)
red-brown root and butt rot

Phellinus pini (Thore ex Fr.) Pil.
(*Fomes pini* (Thore ex Pers.) Lloyd)
(*Trametes pini* Thore ex Fr.)
red ring rot

Phellinus weirii (Murr.) Gilbertson
(*Poria weirii* Murr.)
(*Inonotus weirii* (Murr.) Kotl. et Pouz.)
yellow laminated root and butt rot

Pholiota adiposa (Fr.) Kumm.
brown-mottled white rot

Pucciniastrum spp.
fir rust

Tyromyces leucospongia (Cooke et Harkn.) Bond. et Sing.
(*Polyporous leucospongia* Cooke et Harkn.)
subalpine brown saprot

Verticicladiella spp.
root-stain diseases

areas we traveled trails using preselected mileages and a pedometer. When we arrived at the preselected mileages, we moved at right angles to the trail, employing the selection process outlined previously and found four trees for examination. Data were recorded as for roadside selections.

During all parts of this survey we took unknown insects, problems, fungi, stains, or decay to our laboratory facilities for culturing, rearing, and identification.

After 10 years we have accumulated sufficient sample trees to calculate the frequencies at which problems occur and actual or potential volume losses for many problems. Although gaps in information regarding growth loss are evident, we feel that our volume-loss calculations are the best available data for the area of southern Idaho bounded on the north by the Salmon River and on the south by the Snake River. We will update and modify methods to enable sophistication of our data as the project continues.

RESULTS AND DISCUSSION

Although we recognize the interactions and associations of fungi, insects, higher plants, and other agents in causing mortality, growth loss, or decay, we have included only the more obvious ones in this report. This permits simplifying this first presentation and comparing activities or prinicipal causal agents. The primary cause ascertained by each involved scientist is reported as the destructive force. Our roadside sample included 545 trees of 10 species and our off-road comparison-sample included 136 trees of 10 species in eight locations. A list of the scientific and common names of causal organisms and associated problems (Table 2) in the study area provides the names used in our summaries. Common names have been employed whenever practical, but scientific names and their synonyms are included. The first scientific name listed is considered the preferred modern name; others are synonyms.

The distribution of tree species (Table 3) conforms to expected frequencies for this area but includes insufficient information about larch, whitebark pine, or poplars to permit drawing conclusions. We combined data covering grand fir and its hybrid in this area because of problem similarities and because few field foresters can identify differences between these trees.

Data are presented in several forms (Tables 4 and 5) to permit flexible comparisons and interpretations. All volumes are given in cubic meters which can be roughly converted to board feet by multiplying by 200.[1] Unusable or potentially unusable volume is reported as "loss" or "potential loss." Loss includes volumes that are now

Table 3. Percentage of each tree species in the sampled forest population of 545 trees.

Species	Percent of the total trees sampled
Abies grandis (Dougl.) Lindl.	7.7
Abies lasiocarpa (Hook) Nutt.	9.9
Abies grandis hybrid	0.3
Larix occidentalis Nutt.	0.7
Picea engelmannii Parry	8.1
Pinus albicaulis Engelm.	1.1
Pinus contorta Dougl.	26.6
Pinus ponderosa Laws.	17.6
Populus spp.	0.5
Pseudotsuga menziesii Franco	27.3

unusable such as decayed wood. Potential loss includes both unusable wood and recoverable wood which is dead or dying. This is the loss that will be realized unless recovery occurs. Ordinarily it will be the same as real loss unless extensive salvage is performed. We used the term "recoverable" in the broad sense to include all material that could be utilized if it were accessible and marketable.

All species except Engelmann spruce and lodgepole pine had potential loss values near 50 percent of the standing volume (Table 5). This startling figure is moderated by figures for average recoverable volume. The latter imply that the principal form of volume loss is that which exists as dead or dying standing trees. The relatively high values for average recoverable volume per tree also indicate that this volume exists in large, often decadent, old trees. Keep in mind that a mature tree measuring 18 inches (45.72 cm) diameter breast high (4.5 feet = 1.37 m) and 70 feet (21.34 m) tall contains 1.16760 m^3 of wood.

Trees with completely sound wood were relatively small as indicated by the figures for sound tree volumes.

Throughout the samples ponderosa pine contained the largest volumes of sound or recoverable wood, indicating that this large, dry-site species is rarely decadent in the area surveyed. This is supported by the figures for average volumetric damage in this species (Table 4).

The frequencies of problems encountered (Table 4) do not correlate directly with the damage levels caused. The most frequent problems in order were budworm damage, needle diseases, spruce gall aphid, dwarf mistletoe, and decay by *Phellinus pini*. The greatest volume loss was caused by decays in general, followed by loss to carpenter ants which were associated with decays and particularly with decay by *P. pini*, followed by loss to root diseases.

[1] A cubic foot contains between 5 and 7 board feet of lumber which we can convert to between 176.5719 and 247.2007 board feet per cubic meter. Our figure of 200 board feet is a rough average of these estimates.

Table 4. Percent frequency and volumetric damage by individual problems in forest trees of southern Idaho.

Problem[a]	Forest tree: ABSGRN[b]	ABSLAS	PICENG	PINCON	PINPON	PSUDMN
Bark beetle damage by:						
D. ponderosae					2/ 6.38	
D. pseudotsugae						3/12.82[c]
D. valens					2/ 0.36	
Ips spp.					3/10.18[d]	
Brooming (branches)		2	2	1		1
Budworms	23	4	7			3
Canker (stem)						2
Canker (branch)		9				1
Carpenter ants			4/21.13[e]	2/13.24	2/ 6.80	1/ 7.36
Decay by:						
C. squalens					2/ 8.45	
C. volvatus				1	1	3
E. tinctorium	7/10.6	2/16.37				
F. annosa	2/ 0.17					
F. rosea				1/13.30		
G. applanatum	2/11.36					
H. sanguinolentum		2				
H. alboluteus		2				
I. tomentosus				1/ 0.20		
L. lepideus			2	1		1/ 0.79
L. sulcata		2				
P. subacida		2				
P. schweinitzii				1/ 1.93		
P. pini			14/41.75[e]	2/ 6.10		4/ 3.49
P. weirii		2				
P. adiposa		2				
T. leucospongia					1	
Dwarf mistletoe		4		12		10/ 0.0006
Gall rust (western)				10	2	
Needle cast	18	2	2	9	19	7
Rodent damage					2	
Root disease by:						
A. mellea			2		3/10.18[d]	1/ 5.18
C. radicata					1/13.30	
F. annosus					1	
I. tomentosus			2/ 0.40			
P. subacida					1/ 3.32	
P. schweinitzii		2/18.12				4/16.91[c]
Verticicladiella spp.			2		2/ 0.40	
Sawfly damage				7	2	1
Scale insects					2	
Shoot borers					1	
Spruce gall aphids			16			3
Stalactiform rust				2		
Wetwood	4			1	2	1
Winter (snow) damage		2				1

[a] Problems are listed by common name except where inappropriate because of possible error in interpreting a name. Frequency is expressed as a percentage of the sample population of each species and is stated as a whole number. The maximum potential volume loss, when available, is stated as a percentage of the total standing volume of the sampled species and is stated as a decimal number. A slash separates these two numbers when both are available. No number in a space implies no occurrence.

[b] Abbreviations: ABSGRN (*Abies grandis*), ABSLAS (*Abies lasiocarpa*), PICENG (*Picea engelmannii*), PINCON (*Pinus contorta*), PINPON (*Pinus ponderosa*), PSUDMN (*Pseudotsuga menziesii*).

[c] This insect always occurred with root disease, usually caused by *P. schweinitzii*, therefore these data and those for disease by *P. schweinitzii* should be combined.

[d] This insect and root disease by *A. mellea* occurred together.

[e] In this tree species carpenter ants and decay by *F. pini* were interrelated.

Table 5. Summarized percentages and volumes for each tree species encountered during the survey.

Summary	Tree species						
	All trees	ABSGRN[a]	ABSLAS	PICENG	PINCON	PINPON	PSUDMN
Number of trees sampled	545	44	45	44	145	96	149
Percent:							
Maximum potential volume loss	43	46	46	80	11	53	45
Average loss per tree	3	4	3	3	1	< 1	1
Live trees with loss	12	11	14	23	8	6	15
Live trees with partly sound (recoverable) wood	76	89	85	70	57	81	85
Recoverable or partly recoverable dead or dying trees	14	5	11	20	9	22	15
Entirely sound trees	52	36	63	39	50	52	57
Average volume[b] of wood:							
Lost in all trees	0.04269	0.21515	0.04499	0.08294	0.01017	0.00283	0.04007
Lost in trees with defect	0.36361	1.89332	0.30365	0.36492	0.13407	0.04537	0.25961
Recoverable in trees with defect	2.34533	2.94379	0.98510	2.17513	0.88608	3.07679	2.76533
Sound in sound trees	0.61117	0.57354	0.25744	0.56000	0.34192	1.00850	0.760169
Sound in all trees	0.51162	0.46962	0.21235	0.18787	0.57403	0.74004	0.64439

[a] For abbreviations see Table 4.

[b] Volumes are stated in cubic meters.

Table 6. Differences[1] found between records of problems on nonroaded (U) and roaded (R) areas of the Payette and Boise National Forests.

Comparison no.[2]	Problem(s) no.	Problem(s) name	Frequency[3] U/R	Max. pot. loss[4] U/R	Difference U/R[5]
I	1.	*C. squalens* in PINPON stems	2/1	9.80/ 8.25	+1.55
	2.	*E. tinctorium* in ABSGRN stems	10/8	13.36/14.70	-1.34
II	3.	*P. schweinitzii* in roots of PSUDMN	4/2	20.54/15.11	+5.43
III	4.	Pine butterfly on PINPON	2/0	–	–
	5.	Mountain pine beetle in PINCON	1/0	–	–
IV		No differences			
V	6.	*F. pini* in stems of PINCON	5/2	7.73/ 6.10	+1.63
	7.	*E. tinctorium* in stems of ABSGRN	0/1	0/ 6.30	-6.30
VI		No differences			
VII	8.	*E. tinctorium* in stems of ABSGRN	10/8	13.36/15.15	-1.71
VIII		No differences			

[1] Only those problems (Table 4) which differed in frequency or intensity between nonroaded and roaded areas are listed. Others can be assumed to be the same if they occurred in adjacent areas.

[2] See Table 1 for coordinates and names.

[3] "Frequency" is a percentage of the sample population and is stated as a whole number.

[4] "Maximum Potential Loss" is stated as a percentage of standing volume of the sampled species and is stated as a decimal number.

[5] + indicates more loss on the U area than on the R area; - indicates the opposite.

Great care must be exercised in measuring damage and assigning causes because interactions or close associations are common. This fact, obvious with carpenter ants and decays, often is overlooked when pine engravers work in ponderosa pine. The beetle may build up and attack healthy trees but more commonly attacks those with root disease. Western spruce budworm also is responsible for decay entry through dead tops which it creates.

Major causes of volume loss must be evaluated carefully because major loss does not equate with spectacular damage. For example, while mountain pine beetles cause localized, rapid, visible loss in lodgepole and ponderosa pines of this area, many other agents, including various root diseases, cause at least twice as much volume loss in an innocuous way.

When we compared problems on nonroaded and roaded areas (Table 6), few differences in the kinds or amounts of problems were discernible, indicating that our sampling procedure was adequate to describe conditions in the areas studied. Objections to roadside survey under such circumstances are invalid; however, we recognize that our data permit no comparisons between intensively-managed forests and extensively-managed forests.

Also, summaries are limited in the following areas. First, the data are not stratified by age or size classes, which may drastically influence the impacts of certain problems. The data (Table 5) imply that this is so for dead or dying trees caused by problems like root diseases. Second, we included only trees with a measurable diameter breast high, thus excluding seedling and some sapling problems. Third, we have not developed adequate growth-loss measures or estimates to include in loss estimates and are missing impacts by several agents. Nonetheless, major problems are well outlined by the data presented, and needs for management are implied. It also is obvious that the interrelation and interactions of fungi, insects, and predisposition must become part of the data used to develop management strategies.

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