

# **PROCEEDINGS OF THE 21<sup>st</sup> ANNUAL WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE**

**Estes Park, Colorado  
September 1973**



# **Proceedings of the 21st Annual Western International Forest Disease Work Conference**

**Estes Park, Colorado  
September 1973**

This scan has not been edited or customized. The quality of the reproduction is based on the condition of the original source.

TABLE OF CONTENTS

Page

- 1 Forward  
2 Chairman's Opening Remarks . Ed F. Wicker

PANEL I - AIR POLLUTANTS AND DAMAGE TO VEGETATION IN THE SOUTHWEST

- 5 Major Air Pollutants and Sources In The South West Roger L. Caldwell  
16 New Mexico and Arizona Air Pollution Survey Robert C. Loomis  
21 Air Pollution Activities in the Intermountain Region A. C. Tegethoff

PANEL II - THE FORESTS OF COLORADO, A RESOURCE UNDER PRESSURE - WHERE  
DOES FOREST PATHOLOGY FIT IN?

- 24 The Forest Resource of Colorado Tom Borden  
28 Pathology of Aspen - Wild and Tamed Thomas E. Hinds  
32 The Pathology of Colorado Conifers John M. Staley  
37 Forest Pathologists in Residential Forestry John G. Laut  
40 Summation - Perspective of Forest Pathology In Colorado In The Future Don Brown

PANEL III - FOREST DISEASE RECREATION HAZARDS

- 43 Forest Disease Recreation Hazards Peter Gaidula  
46 The Legal Implications of Hazards From Tree Disease and Related Factors in Recreational  
Areas Curtis Menefee  
55 Training Needs for Field Personnel in Detection, Evaluation, and Control of Tree  
Hazards in Forested Recreation Areas Peter Gaidula  
71 Hazard Tree Programs In the National Park Service James M. Dempsey  
78 Tree Hazard Program At Rocky Mountain National Park David B. Butts  
82 Fomes annosus in Forest Recreation Sites: Management Implications Neil J. MacGregor  
85 Aerial Photographs Used To Detect Infestation of Jack Pine Forests By Dwarf Mistletoe  
John A. Muir  
90 The Nature and Distribution of Armillaria mellea Infected Root Material in a Young  
Pine Forest Charles G. Shaw III  
96 Comparison Between the Use of Pesticides for the Protection of Forests and Forest  
Products From the Point of View of Environmental Pollution A. J. Cserjesi  
100 Responses of Lodgepole Pine and White Spruce To Bark Beetle Associated Fungi  
D. M. Shrimpton and H. S. Whitney  
102 Colonization of Freshly Cut Wood By Poria weirii Basidiospores E. E. Nelson

- 105 Damage to Conifers From Highway Deicing Salts in the Lake Tahoe Basin of California  
and Nevada Robert F. Scharpf and Michael D. Srago
- 109 Making Spot News Releases For Television Kenelm W. Russell

COMMITTEE REPORTS AND WIFDWC BUSINESS

- 113 Active Projects - Old, New and Terminated
- 137 Forest Disease Recreation Hazard Committee Reports
- 140 Dwarf Mistletoe Committee Reports
- 147 Publications
- 155 Business Meeting Minutes and Financial Statement

## FOREWORD

The Twenty-First Annual Western International Forest Disease Work Conference was held October 1-5, 1973 in Estes Park, Colorado, at the Holiday Inn. Sixty-eight members, students and guests registered for the Conference. Fifty-eight attended the Banquet.

The Conference was called to order on Tuesday, October 2 by Chairman Ed Wicker. Roger Contor, Superintendent, Rocky Mountain National Park, welcomed conference participants to Estes Park.

Local arrangements were made by John Laut. A pre-conference Dwarf Mistletoe Field Trip was organized by Don Brown and Frank Hawksworth. On Thursday, a Field Trip to Rocky Mountain National Park and an evening Wild West Chuckwagon Supper more than filled the day.

The officers for the twenty-first Western International Forest Disease Work Conference were:

Chairman - Ed F. Wicker

Secretary-Treasurer - Robert C. Loomis

Program Chairman - Robert L. Gilbertson

Local Arrangements - John G. Laut

## CHAIRMAN'S OPENING REMARKS

Ladies and gentlemen, conference members, honored guests - I wish to welcome you to the Twenty-First Western International Forest Disease Work Conference.

For purpose of orientation - and casting no reflections upon past experiences, premonition tells me that most of us need this, some perhaps more so than others - we are at the Holiday Inn, Estes Park, Colorado, high in the northern Rocky Mountains.

One year ago, we met in Victoria, B.C. commemorating a score of years since the birth of this conference. At that time, we reviewed our conference's history and even sneaked a peak at its future. Some of us even became cognizant of its presence. I believe that most of you who attended our Twentieth Conference or who read the Proceedings of that Conference will agree with me when I say - we have come a long ways since those inception days in 1953. Professionally, we have witnessed a variety of complex organizational and program changes. We have responded to these changes without serious loss of conviction and commitment to our objectives. Interest in W.I.F.D.W.C. remains high, indicating a sustained belief in our purpose. We have provided the incentive for the formation of similar conferences in the mid-western and eastern portions of our continent. Many honored guests repeatedly return to participate in this international communion of brotherhood; they are proven missionaries of W.I.F.D.W.C. We are no longer a fledgling - struggling to prove ourselves. Our accomplishments are many; we are a success.

While not measured by the same standards, perhaps to some of us, our progress in social achievement is as impressive as that for professional achievement. However, I suspect the list of social achievement award winners in the 20th Proceedings appears formidable to many of our newer members. Several members have expressed a concern for recent slippage in sippage in social achievement. This presents a challenge to past award winners; a challenge which I can assure you will be answered, pronto. Therefore, I say to the newer members we are here to learn and experience is the best teacher; and it bloody well should be because it is the most expensive.

As we enter a second score of years, I am highly optimistic of the future for W.I.F.D.W.C. New and greater opportunities will be ours and I sincerely believe that given opportunities, people can create their own destiny.

In closing, it is very gratifying to me, as I stand before this group, to see so many of our founding fathers present at this conference. Surely, in some way, this fact alone attests to the measure of success this organization has achieved.

Ed F. Wicker  
Chairman  
21st. W.I.F.D.W.C.

# MAJOR AIR POLLUTANTS AND SOURCES IN THE SOUTHWEST.

Roger L. Caldwell <sup>2</sup>

## INTRODUCTION

Because of variation in climate and geography in the Southwestern United States, it is not simple to assess existing or potential effects of air pollution on vegetation. Two approaches can be taken to simplify this task: 1) to summarize information from other geographical areas that relates to the vegetative types found in the Southwest, as an aid to determining the most susceptible plants, and 2) to develop information on air pollution sources in the Southwest, as aid to determining geographical areas of greatest probability of damage. In actual practice both of the approaches should be used. I would like to direct my remarks to the second approach. To do this, I will define what I mean by Southwest; discuss sources of information for air pollution emissions; review natural Vs. man caused air pollution; review air pollutant types, effects, and fate; review specific sources; and comment on possible future events and research needs relating to vegetation and air pollution in the Southwest.

## DEFINITION OF SOUTHWEST

The states or portions of states that comprise the southwestern United States vary depending on the purpose of comparison and the person providing the definition. For this paper, I will define it as follows: all of New Mexico and Arizona, southwestern Colorado, southern Idaho, southeastern Nevada, and southern California. This area covers the lower elevation, arid lands as well as the "four corners" area that has recently become a major source of air pollution.

When comparing sources of air pollution with possible effects, it is desirable to designate geographical areas defined by meteorological and climatic conditions rather than using existing political subdivisions. For this reason, the United States has been divided into Air Quality Control Regions (AQCR). These regions may be intrastate or interstate and may take all or a portion of existing counties.

The Southwest has been divided into a series of AQCR's; some states contain many AQCR's, some contain a few; some AQCR's are relatively large, some are small. For the Southwest as I have defined it, there are 13 AQCR's (Figure 1).

---

<sup>2</sup> Department of Plant Pathology, University of Arizona, Tucson, Arizona.

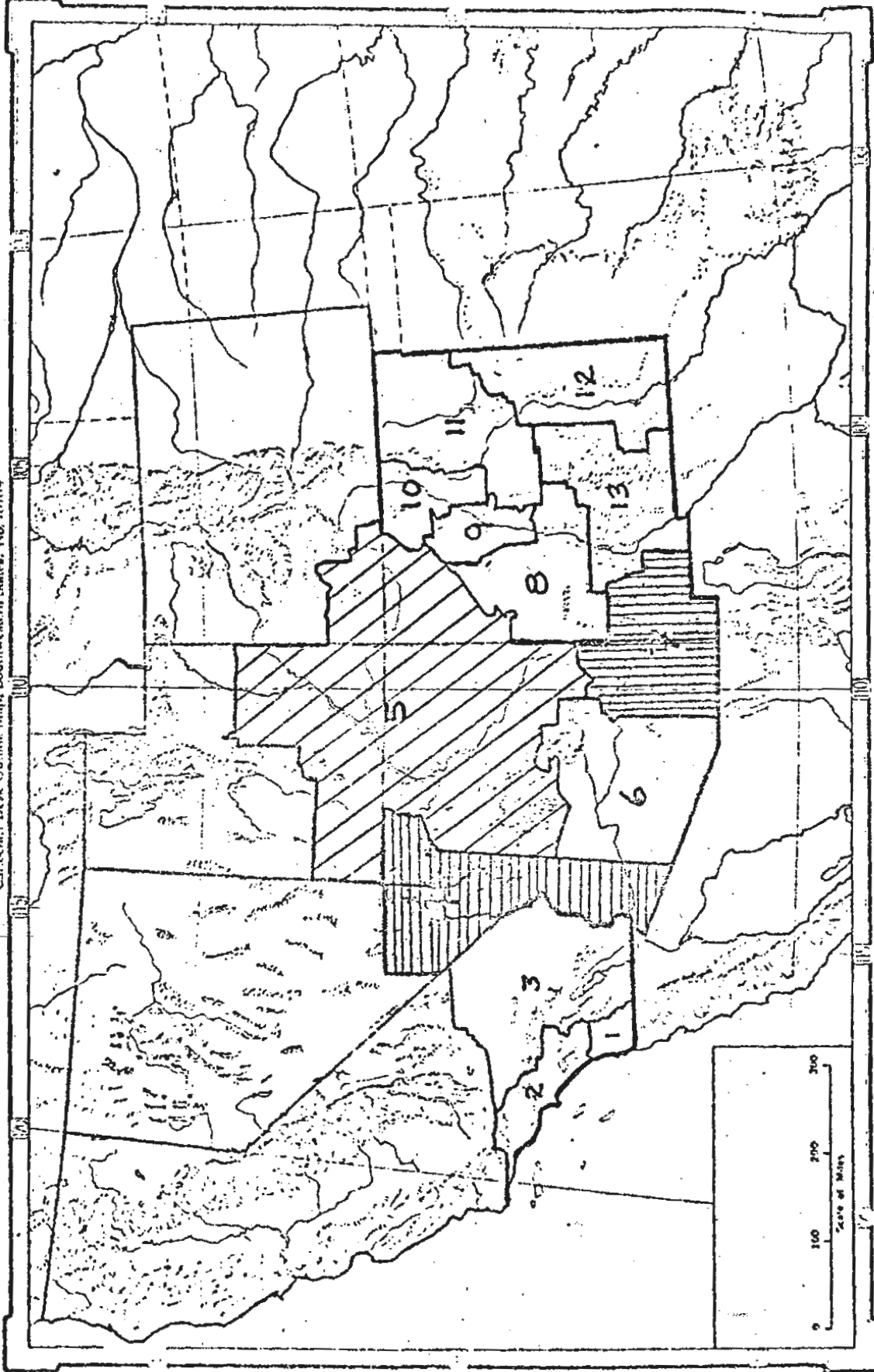


Figure 1. Southwest Air Quality Control Regions.

Numbers refer to Air Quality Control Region designations (Appendix A).

## INFORMATION SOURCES

Because of the multistate area included in the southwestern United States, air pollution sources must be evaluated by the respective state authorities, as well as by the U.S. Environmental Protection Agency. For this paper, I requested<sup>3</sup> and received an emissions inventory from each state in the Southwest. Because of variations in these reports, it is difficult to make comparisons.

The emissions inventory format of information on air pollution sources requires some qualification prior to use. The data are estimates of the amounts of specific pollutants emitted into the air within a specific geographical area (normally a county). The emissions inventory does not differentiate the relative importance of the individual pollutants, it does not consider atmospheric interactions that may alter the form of emitted pollutants, and it does not include small sources or sources for which it is difficult to estimate emissions.

Not all states use the same categories of polluters, they do not necessarily use the same emission factors for estimating emissions, emission factors are not available for some pollutants from major sources<sup>4</sup>, and as new techniques are developed, emission factors change (10). In addition, emission estimates made in different years are difficult to compare because of varying emission factors, addition of new sources, and controls on old sources.

Emission inventories cannot provide accurate predictions of ambient air quality. But, given proper consideration of their limitations, and by use of previously tested models of atmospheric behavior, emission inventories can provide insight into probable effects of air pollution in a given geographical area.

### NATURAL Vs MAN CAUSED AIR POLLUTION

There has been considerable argument on the relative quantities of air pollution caused by man and caused by nature. While much of the argument is meaningless because of improper consideration of emissions densities and pollutant residence times, some valuable information has been developed. Worldwide, nature produces more hydrocarbons, nitrogen oxides, carbon dioxide, and hydrogen sulfide than man; man produces a little more sulfur dioxide<sup>5</sup> (increasing so in recent years), and more carbon monoxide(7). In specific locations, natural pollution may have a

---

<sup>3</sup> A request to the U.S. Environmental Protection Agency was not completed because of computer programs being rewritten to provide this information (by county); these were not available in time for this report.

<sup>4</sup> For example, copper smelters are not listed as nitrogen oxide sources because there is no emission factor for that pollutant from that source.

<sup>5</sup> Hydrogen sulfide from natural sources is converted into sulfur dioxide prior to conversion to sulfate salts; if this is counted as sulfur dioxide then nature produces larger quantities.

significant impact. For example, sulfur dioxide from burning coal seams, hydrocarbons from vegetation, or biological or fertilizer nitrogen products may be important when added to mans contribution or when occurring in combination with other pollutants. This area is extremely important but the limited available data often lead to speculation rather than providing realistic information.

#### AIR POLLUTANT TYPES AND EFFECTS

Not all common air pollutants affect plants. It is important to understand which pollutants are of major concern when analyzing an emissions inventory as a guide to potential effects on vegetation (5). There is essentially no effect of carbon monoxide or particulate matter on plants. The major concerns are 1) oxidant (either ozone or peroxyacetyl nitrate formed from sunlight, hydrocarbons, and nitrogen oxides) and 2) sulfur dioxide. Minor concerns include pesticides (primarily herbicides), selected hydrocarbons (primarily ethylene), and chemical processing losses (1).

There is increasing concern over possible synergistic effects between various pollutants or between pollutants and insects, plant pathogens, and nutritional factors. Variations of climate, genotypic response, and problems of symptom recognition further complicate studies of air pollution effects on vegetation.

Additional information on the probability of pollution damage can be developed when considering the emission density of sources and the residence times of those pollutants that affect vegetation. In the Southwest, sulfur dioxide is primarily from point sources and oxidants are primarily from diffuse transportation related sources. Nitrogen Oxides are from both sources. The atmospheric residence time of sulfur dioxide is 1-7 days because of oxidation to sulfate, absorption on particulate matter, or removal by rain. This results in a maximum range of 30-40 miles from source to sulfur dioxide damage.

The residence time of oxidant is one day because of its reactive nature and need for sunlight for formation. Because of the diffuse nature of its formation, however, the damage can be widespread within a polluted area.

While there have been few observations of actual air pollution effects on plants in the southwest (most have been near industrial sulfur dioxide sources)<sup>6</sup>, it has been suggested that damage may occur. The Stanford Research Institute(SRI) in 1971 reported a nationwide estimate of economic effects of air pollution on crops, forests, and ornamentals. The total damage for the United States was estimated at \$132 million. The major damage was due to oxidant(8).

---

<sup>6</sup> Additional observations are reported at this workshop for Arizona, Colorado, New Mexico and Utah.

In a procedure involving plant sensitivity, plant value, and pollution potential, SRI estimated losses for the Mountain States at \$4.5 million (Montana, Wyoming, Colorado, New Mexico, Arizona, Nevada, Utah and Idaho). The major damage was due to oxidant, with crops accounting for 82% of the dollar loss. The remaining \$794,000 was allocated to forests and ornamentals.

#### SPECIFIC SOURCES

In Arizona, the major source of hydrocarbons and nitrogen oxides is transportation, with additional quantities from power generation. The major source of sulfur dioxide is copper smelting, with additional quantities from power generation.

In southern California, the major source of nitrogen oxides is transportation, with additional quantities from power generation; the major source of hydrocarbons is transportation; and the major source of sulfur dioxide is general industries.

In southwestern Colorado, the major source of hydrocarbons and nitrogen oxides is transportation; there are no sources of sulfur dioxide.

In New Mexico, the major sources of hydrocarbons are transportation and industry; the major sources of nitrogen oxides are transportation, power plants, and industry; the major sources of sulfur dioxide are copper smelting and power generation, with additional quantities from industry.

In southeastern Nevada, the major sources of hydrocarbons are transportation and industry; the major source of nitrogen oxides is transportation; and the major source of sulfur dioxide is power generation.

In southern Utah, the major sources of hydrocarbons and nitrogen oxides are transportation; the major source of sulfur dioxide is transportation, with additional quantities from solid waste and space heating.

While transportation sources are almost exclusively in large metropolitan areas, there can be potentially significant effects when concentrated in rural areas; for example, sulfur dioxide, nitrogen oxides, and hydrocarbons from trains. Industrial or power generation sources can most often be identified as the main sources in rural areas. Since sulfur dioxide elicits its effects within a 30-40 mile radius, this then defines the area of probable effects from that pollutant.

#### FUTURE

It is exceedingly difficult to predict the future air pollution potential of the Southwest. There are large deposits of minerals (such as oil shale, coal and copper) whose processing causes air pollution(6). There are planned increases in electric power production and coal gasification (9,11). There is consideration of population redistribution from large

urban areas to less populated areas; for example- metropolitan Arizona, El Paso- Ciudad Juarez, Colorado, Piedmont, and Salt Lake Valley (2,3).

It is apparent that the major energy related raw materials of the Southwest (and within the Rocky Mountain States) will be increasingly sought after and developed. It is also apparent that population, with its related energy, transportation, and recreational needs will continue to increase. It is not clear, however, at what rate these increases will occur. Because of the rapidly changing economic, energy and environmental considerations, it is unwise at this time to attempt anything more than a generalization in this area.

On the other hand, existing and planned air pollution sources will increasingly be provided with emission controls. Because of the rapidly changing technology of emission control devices, the rate of required implementation of inadequately tested devices, the unknown side effects of control strategies (particularly automobile), and the controversy surrounding the political, international, economic, legal and environmental consequences of air pollution sources and their control, it is not at all clear what degree of actual emission control will be achieved in the near future.

The most important future developments in the Southwest involve coal fired power plants (Appendix B). Because current plans are subject to many changes and because control technology is not fully in effect, it is difficult to predict accurately the effect of these plants. It seems clear, however, that there will be large increases of sulfur dioxide in the Four Corners Air Quality Control Region (9). The plants currently in operation are Cholla (AZ), Four Corners (NM), and San Juan (NM). By the end of 1974, Navajo (AZ) and Huntington Canyon (UT) are planned to be in operation. Additional plants under consideration for the Kaiparowits Plateau, Northwest Colorado Area, Southern Nevada Area, and Energy County, Utah (11). When completed, the largest (estimated) source of sulfur dioxide will be the Kaiparowits Plateau Area.

Potential effects of federal regulations such as "Maintenance of natural ambient air quality standards" (38FR 15834) and, "Prevention of significant air quality deterioration" (37FR 18986), or pending land use planning provisions will have tremendous, but unknown, influence on air pollution sources and their effects in the Southwest.

In regard to the effects on vegetation, a great many research needs exist (4). It is impossible to evaluate accurately the economic impact of air pollution on vegetation, particularly in the Southwest on non-crop plants. Often the potential effects of new air pollution sources on plants is unknown because of insufficient evaluation of the susceptibility of native species, crops, or ornamentals.

Much information is to be gained relative to effects of air pollution on enzymatic behavior, nutritional quality, disease or insect susceptibility, flowering, plant nutrition, or growth suppression, but field observations are also needed. We need more knowledge on natural indicator plants, more observation plots for base line studies, greater evaluation of field Vs laboratory

exposure conditions, and more educational materials and programs to develop a corps of trained observers to recognize air pollution effects.

#### SUMMARY

In summary, I have attempted to discuss broadly the major air pollutants and their sources in the Southwest. Because of limited data on existing and future sources, an evaluation of pollution emissions is often a simplistic approach to a complex problem. In discussing the data limitations, general sources and effects, and future possibilities, it is clear we can make general estimates of future activities; but I hope I have left you with the impression that times are changing, conditions are changing, and we therefore must allow for these factors in our research and investigation plans.

#### REFERENCES

1. ABELES, Fred B. and Howard E. HEGGESTAD. 1973. Ethylene: An Urban Air Pollutant. J. Air Pollution Control Association 23 (6): 517-521.
2. Advisory Commission on Intergovernmental Relations. 1968. Urban and Rural America: Policies for Future Growth. 186 p. U.S. Government Printing Office, Washington, D.C.
3. Commission on Population Growth and Americas Future. 1972. Population Growth and Americas Future, U.S. Government Printing Office, Washington, D.C.
4. HECK, W.W., O.C. Taylor, and H.E. Heggestad. 1973. Air Pollution Research Needs: Herbaceous and Ornamental Plants and Agriculturally Generated Pollutants. J. Air Pollution Control Association 23(4): 257-266.
5. JACOBSON, Jay S. and A. Clyde Hill. 1970. Recognition of Air Pollution Injury to Vegetation: A Pictorial Atlas. Air Pollution Control Association, Pittsburgh, Pa.
6. National Materials Commission. 1973. Material Needs and the Environment Today and Tomorrow. (Final Report). U.S. Government Printing Office, Washington, D.C.
7. Stanford. Research Institute. 1968. Sources, Abundance, and Fate of Gaseous Atmospheric Pollutants (Supplement). 77 p. Menlo Park, Ca.
8. Stanford Research Institute. 1971. Economic Impact of Air Pollution on Plants in the United States. 83 p. Menlo Park, Ca. (NTIS number PB-209-265).

9. U.S. Department of Interior. 1972. Southwest Energy Study. U.S. Government Printing Office.
10. U.S. Environmental Protection Agency. 1973. Compilation of Air Pollutant Emission Factors. 2nd Ed. AP-42. Research Triangle Park, N.C.
11. WALTHER, Eric. 1973. Personal Communication, Museum of Northern Arizona, Flagstaff.

APPENDIX A

AIR QUALITY CONTROL REGIONS  
(SOUTHWEST)

<u>KEY</u>	<u>DESCRIPTION OF AQCR</u>	<u>COUNTY (STATE)*</u>
1	San Diego Air Basin	San Diego (CA)*
2	South Coast Air Basin	Santa Barbara (CA)* Ventura (CA) Los Angeles (CA)* San Bernardino (CA)* Orange (CA) Riverside (CA)*
3	Southeast Desert Air Basin	Kern (CA)* Los Angeles (CA)* Imperial (CA) San Bernardino (CA)* San Diego (CA)*
4	Clark-Mohave-Yuma	Mohave (AZ) Yuma (AZ) Clark (NE)
5	Four Corners	Apache (AZ) Navajo (AZ) Coconino (AZ) Yavapai (AZ) San Juan (NM) Rio Arriba (NM) Sandoval (NM) McKinley (NM) Valencia (NM) Archuleta (CO) Dolores (CO) La Plata (CO) Montezuma (CO) San Juan (CO) Grand (UT) Emery (UT) San Juan (UT) Wayne (UT) Garfield (UT) Iron (UT) Kane (UT) Washington (UT)

---

\*Designates portion of county. California has 9 additional; Nevada has one additional, Utah has two additional, and Colorado has 7 additional AQCR than described above.

KEYDESCRIPTION OF AQCRCOUNTY (STATE)\*

6	Phoenix-Tucson	Maricopa (AZ) Gila (AZ) Pinal (AZ) Pima (AZ) Santa Cruz (AZ)
7	Southern Borders	Graham (AZ) Greenlee (AZ) Cochise (AZ) Hidalgo (NM) Luna (NM) Grant (NM)
8	Southwestern Mountains- Augustine Plains	Catron (NM) Socorro (NM) Valencia (NM)* McKinley (NM)*
9	Albuquerque-Mid Rio Grande	Sandoval (NM)* Bernalillo (NM) Valencia (NM)*
10	Upper Rio Grande Valley	Santa Fe (NM) Rio Arriba (NM)* Taos (NM) Sandoval (NM)*
11	North Eastern Plains	Colfax (NM) Union (NM) Mora (NM) Harding (NM) San Miguel (NM) Guadalupe (NM) Torrance (NM)
12	Pecos-Permian Basic	Quay (NM) Curry (NM) De Baca (NM) Roosevelt (NM) Chaves (NM) Lea (NM) Eddy (NM)
13	El Paso-Las Cruces- Alamogordo	Lincoln (NM) Otero (NM) Sierra (NM) Dona Ana (NM)



# NEW MEXICO AND ARIZONA AIR POLLUTION SURVEY

Robert C. Loomis <sup>8</sup>

During this presentation I will discuss an air pollution detection survey conducted in Arizona and New Mexico by U.S. Forest Service plant pathologists. The survey, begun in July 1970, was intended to obtain information about the following:

1. What is the effect of sulfur dioxide (SO<sub>2</sub>) from existing major sources to southwestern forests?
2. What is the existing foliage condition of trees and associated plants growing in areas where major sources of air pollution are expected in the near future?

Symptoms of acute SO<sub>2</sub> injury were found on three National Forests in Arizona. In addition, symptoms which resembled SO<sub>2</sub> injury, but need further evaluation, were noted on a National Forest in New Mexico. No areas were found where trees were being killed by SO<sub>2</sub> fumigation.

I will discuss these results in more detail later, but first I would like to emphasize the circumstances and procedures which went into developing the survey. This basic plan of action may be helpful to those individuals faced, as we were, with determining if air pollution is affecting the forest resource of a given area.

Let me briefly explain how forest pathologists may get involved with air pollution. As concerns U.S. Forest Service, Forest Pest Management (FPM) pathologists, the Forest Pest Control Act of 1947, makes provision for the detection, evaluation and suppression of forest insects and diseases. Thus, evaluation of air pollution effects, a noninfectious disease, falls within the normal detection and evaluation responsibility of FPM Units. On Federal land, this detection and evaluation is done directly by FPM personnel. On State and Private land, it is done cooperatively with State Forestry personnel. Other Forest Service pathologists are involved through research or consulting activities.

In our case, the National Park Service requested information about the possible effects that a coal-fired electrical generating station might have on vegetation in the Glen Canyon National Recreation Area. This area is located on the Arizona-Utah border. While investigating this request, it soon became evident that (A), There wasn't much information available concerning the effects of air pollution on Southwestern forest vegetation, and (B), The possible effects of air pollution had been largely ignored in our normal detection and evaluation activities. Thus, the initial air pollution investigation was expanded to a region-wide detection survey. This program

---

<sup>8</sup> U.S. Forest Service, Southeastern Area, State & Private Forestry, Atlanta, Ga., formerly, U.S. Forest Service, Div. Timber Mgmt., Albuquerque, N.Mex.

was undertaken to better answer questions raised by the public, Environmental Organizations, and Government Agencies, concerning the effects of air pollution on Southwestern forest vegetation.

Other ways in which forest pathologists may become involved in evaluating the effects of air pollution are in cooperation with Federal or State Air Pollution Control Organizations. Presently, most Air Pollution Control Agencies are involved with health aspects of air pollution, and therefore, are monitoring air quality in urban areas. Little monitoring is being done in rural areas. Many of these organizations look to State and Federal Forestry Organizations, Universities, and Agricultural Extension Organizations to help evaluate possible air pollution effects to vegetation. Evaluation of air pollution injury to vegetation in both urban and rural areas is helpful in; (A) Obtaining necessary information to set standards and regulations, (B) Determining where air pollution problems exist now, and where they may develop in the future, (C) Learning how effective the various regulations have been. Thus, Air Pollution control, State Forestry and State Extension Organizations, are faced with evaluating the effects of air pollution to vegetation. Perhaps we will be asked to contribute to this effort.

I have discussed some ways in which forest pathologists may get involved with air pollution. Let us turn our attention to the New Mexico and Arizona survey.

A detection procedure was needed which would give an indication of the severity of forest plant injury near existing sources of air pollution, and also, would serve as a basis for background evaluation in areas where sources were expected in the near future. To meet this need, a survey of forest areas was conducted during the period of July 1970 to September 1972.

The survey can be broken down into six phases. These are:

1. Conduct an emissions inventory to determine the number, size, location and pollutants emitted by major sources of air pollution.
2. Collect available information on pollutant distribution patterns for each area.
3. Locate forest areas which fall within the normal pollutant distribution pattern and within a specified radius where the possibility of injury is thought to occur.
4. Select sensitive observation areas and, if required, install appropriate air quality monitoring equipment.
5. Examine vegetation on the observation areas.
6. Report results.

I would like to share with you some of our experiences as we attempted to complete each phase of the survey procedure.

1. EMISSIONS INVENTORY.

The inventory phase of the survey was straightforward in that the sources were well known and relatively few in number. We considered twelve major sources of air pollution which are located in, or adjacent to, the Southwestern Region. In addition, four other sources are planned for the near future. All of these major sources are either copper smelters or electrical generating stations. Sulfur dioxide (SO<sub>2</sub>) is the major pollutant of concern from the copper smelters, SO<sub>2</sub> and nitrogen oxides (NO<sub>x</sub>) are of concern from the electrical power generating stations.

2. POLLUTANT DISTRIBUTION PATTERNS.

For most sources, information on pollutant distribution was sketchy at best, especially in rural areas. The main factors which affected pollutant distribution were local meteorology and topography.

3. LOCATE FOREST AREAS WHERE INJURY MAY OCCUR.

In the case of the New Mexico/Arizona survey, we chose a 30-mile radius limit from each source. This limit was based upon distances from the source of reported field crop injury in the Southwest.

4. SELECT SENSITIVE OBSERVATION AREAS, AND WHEN APPROPRIATE, INSTALL AIR QUALITY MONITORING EQUIPMENT.

Because SO<sub>2</sub> was of major concern, sulfation plates were established in the observation areas. The observation areas were variable in size, ranging from several chains of roadside ditch to approximate 30 acres. Consideration for establishing these areas included:

- A. A variety of trees and associated plants growing in the area. One phase in evaluating possible air pollution injury to plants is to determine if similar injury has occurred to a variety of plant species.
- B. Adequate soil moisture and high humidity. Plants growing in areas with adequate soil moisture and high humidity are more susceptible to SO<sub>2</sub> injury than plants growing under moisture stress. For this reason, much of the field evaluation was done in the relatively wet months of June, July and August.

Sensitive observation areas were selected so that some conclusions about the effect of SO<sub>2</sub> on plants throughout a particular area could be made, based on the effect of air pollution on plants in these observation areas. For example, if no injury occurred in the sensitive areas, then one would not expect to find injury in adjacent, less sensitive areas. We

found that sulfation plates appeared to be reliable enough to provide an economical way of determining general information about average monthly dispersion of sulfur compounds in an area. Where information is needed concerning specific SO<sub>2</sub> concentration and fumigation duration, more sophisticated equipment is needed.

Sulfation plate reliability was determined on the basis of duplicate sulfation plates exposed in eight locations in New Mexico and Arizona.

5. EXAMINE VEGETATION ON THE OBSERVATION AREAS.

The foliage of broad-leaved trees and plants are examined for interveinal bleaching or browning. The foliage of conifers was examined for tip-burn or banding. These symptoms are typical of acute SO<sub>2</sub> injury. In addition, leaf and needle abnormalities which resembled acute SO<sub>2</sub> injury were noted for future reference. Neither chronic injury nor the so-called "invisible" injury were evaluated in this survey.

6. REPORT RESULTS.

As with survey reports on any forest disease, the final report should give the reader an idea of how severe the injury appeared to be at the time of observation. We attempted to do this by making two estimates of injury for each plant species found in each observation area. The first was an estimate of the proportion of leaves with SO<sub>2</sub> symptoms on injured plants. The second was an estimate of the proportion of plants which were injured. Both estimates were based on the following injury classes: 0 = None; 1 = 1-33%; 2 = 34-66%; 3 = 67-100% injury.

As mentioned before, symptoms of acute SO<sub>2</sub> injury were found on the Tonto National Forest near Miami, Arizona; on the Coronado National Forest near San Manuel, Arizona; and on the Apache National Forest near Morenci, Arizona. In addition, symptoms which resembled SO<sub>2</sub> injury, but need further evaluation, were noted near Hurley, New Mexico. No areas were found where trees were being killed by SO<sub>2</sub> fumigation. Interpreting the significance of foliage injury is difficult. We do not know the immediate and long-term effects of foliage injury on forest plant condition.

An important addition to the report are the use of color photographs. These photographs help document the symptomatology of observed air pollution injury. We used a Polaroid CU-5 close-up land camera with Polacolor 108 film. This camera system has the advantage of producing color prints in the field, thereby insuring the investigator that the desired picture was obtained. Several drawbacks to the use of this equipment were encountered. These include bulkiness and weight of the camera and sensitivity of the film to excessive heat.

We found that for an extensive survey of this type, plants themselves proved to be the best monitors of air pollution trends. Static monitors such as sulfation plates give general dispersion data; however, they are not sensitive. Sophisticated monitoring equipment, while yielding a wealth of air quality data, are expensive, difficult to maintain and operate, and require a power source. In addition, they must be protected

from vandalism. Native plant species can usually be found which are particularly useful as indicators of air pollution injury. If desired, other plant species can be grown which are known to be sensitive to air pollutants. In the Southwest, brickellbush appeared to be the most sensitive to SO<sub>2</sub>. Other plants which appeared sensitive to SO<sub>2</sub> were: skunkbush, cottonwood and willow saplings, and velvetweed.

In summary, I have pointed out why forest pathologists have an important contribution to make in the evaluation of air pollution effects, not only in relation to forestry oriented organizations, but also in relation to air pollution regulatory organizations. I have also discussed some aspects of a survey which was recently completed by Forest Service plant pathologists in New Mexico and Arizona.

# AIR POLLUTION ACTIVITIES IN THE INTERMOUNTAIN REGION

A.C. Tegethoff

## RESEARCH AT UNIVERSITY OF UTAH

1. Field evaluations of methods used to measure levels of SO<sub>2</sub> and NO<sub>x</sub>. Known concentrations of the pollutant to be measured and chemicals that might interfere with measurement are generated and measured. This work is done in the field at the Four Corners and Huntington Canyon Plants.
2. Total environmental analysis including mapping vegetation, noting insects and diseases present -- at Huntington Canyon Plant.
3. Field surveillance for air pollution damage around the Four Corners, San Juan, Kemmerer and Castlegate Generating Plants. Results to date -- no damage found.
4. Studies of the oxidation of SO<sub>2</sub> and NO<sub>x</sub> to sulfate and nitrate. Visual analysis of air samples with SEM. Results -- at Four Corners Plant airborne dust more common than fly ash.
5. Synergistic studies of SO<sub>2</sub> and NO<sub>x</sub> in combination with O<sub>3</sub>, PAN + F in fumigation chambers and greenhouse.
6. Miss Connie Lamb, Graduate Student, has done greenhouse and field fumigations with SO<sub>2</sub> on vegetation of southern Utah.
7. Mr. Bill Edwards is doing air quality studies at the Mojave Plant. This includes dust sampling, SO<sub>2</sub> and O<sub>3</sub> background, and particle size and identity studies.
8. SO<sub>2</sub> damage studies around Magna, Utah, smelter. Results -- damage in an approximate 5 mile area around smelter.

## RESEARCH AT BRIGHAM YOUNG UNIVERSITY

1. Basic ecological studies and quantitative particulate measurements and analysis for trace elements. Trace element analysis of soil, water, plants and selected animal tissues. Basic pathology of rabbits and deer. Around Navajo Plant, Page, Arizona.

---

<sup>7</sup> U.S. Forest Service, Division of Timber Management, Ogden, Utah

2. Limnological studies at the Huntington Canyon Plant.

#### STATE OF UTAH

1. Twenty-four hour particulate sampling. Installing static effects sampling and electronic SO<sub>2</sub> and NO<sub>x</sub> sampling. Sampling for S with sulfation plates. Sampling for O<sub>3</sub> with rubber strips and for H<sub>2</sub>S with Ag. plates. A weather station is located at Wahweap. These activities are in the Lake Powell area around the Navajo Plant.
2. At Huntington Canyon SO<sub>2</sub>, NO<sub>x</sub> and particulate sampling devices are being installed. Wind data is being taken.

#### UNIVERSITY OF NEVADA

1. Air quality studies being conducted by both University and county. SO<sub>2</sub>, NO<sub>x</sub>, O<sub>3</sub> and particulates are being studied by Dr. Fritz Went. Plant damage studies revealed automobile exhaust damage only. These studies are being conducted around the Mojave Plant.
2. Vegetation damage studies around the McGill Smelter, Kennecott Copper Corporation.

#### U.S. FOREST SERVICE

1. A sulfation plate network was established and readings on plates conducted for one year to get background S levels in the air around the Navajo Plant. No S picked up by this method. A modified West-Gaeke apparatus picked up 0.002 ppm which is in the range of natural background.
2. Macrophotography of representative vegetation on NPS and BLM lands around the Navajo Plant.

## THE FOREST RESOURCE OF COLORADO

Tom Borden<sup>2</sup>

Before talking about Colorado and the forest resources of the state, perhaps we should take just a few minutes to talk about where you are and some of the pertinent facts relating to the Estes Park area. For example, we are at an altitude of 7500 feet. I have never been particularly impressed with that fact until last summer when I drove into the north-west part of the nation visiting LaGrande, Oregon, Lewiston, Idaho, and Missoula, Montana. Some of the high passes were approximately 5000 feet which is still 150 feet below the elevation of Fort Collins where I live. The highest temperature ever recorded in the Estes Park area was 98° and the lowest a minus 40. Generally, the mean temperature of this area is 43°. A little over 17 inches of precipitation falls each year; approximately, one-half in the form of snow. Estes Park receives 100 inches of snow each year. The growth period is 86 days. While this may be considered somewhat restrictive, let's think about the little town of Fraser not very far from here where their growing season is 4 days each year.

In our state, we have 54 mountain peaks in excess of 14,000 feet in elevation. It is no wonder that Colorado is oftentimes called "the top of the Nation". Incidentally, we have people who "collect" mountain peaks. These folks belong to a special club, having climbed every mountain peak above 14,000 feet. I recall around seven or eight years ago, an 84 year old friend of mine by the name of Roy Murchison belonged to this elite group. It was discovered, however, that a peak formerly listed as being 13,986, the Mount of the Holy Cross, was actually 14,003 ft. Much to his distress, he realized he no longer belonged to the 54 Peak Club and had to take a week and climb Holy Cross.

I see a great similarity between the 54 Peaks people and the movement now to further the establishment of wilderness areas in Colorado. Where once an area was unvisited and virtually a true wilderness area, we now find that the designation of particular geographic areas as "wilderness" draws people to those named areas in large numbers. In other words, the collectors are at work in overrunning the wilderness areas in our state.

Colorado has had as colorful a history as most other states. Approximately 200 years ago, plus or minus a decade or two, the French and the Spanish alternated in claiming parts of Colorado, primarily eastern Colorado, for their governments. Coronado and Rivera were two of the Spaniards and, of course, the famous LaSalle from the French government was very intimately involved in laying claim to our state. It wasn't until 1803 that the Louisiana purchase provided for eastern Colorado to become part of the United States. With this in mind, a few years later, Captain Zebulon Pike came to the state and among other things discovered Pike's Peak. While

---

<sup>2</sup> State Forester, Colorado State Forest Service, Ft. Collins, Colorado.

he tried to climb that peak, he failed and it wasn't until 1820 when Major Stephen Long came to the state and discovered Long's Peak that a member of his party actually did climb Pike's Peak. One hundred fifty years ago the mountain men arrived to lay claim to the beaver and to trade with the Indians. Eight years later, in 1833, Bent's Fort was established in southeastern Colorado to protect the Santa Fe Trail and then in 1836, of all things, the huge state of Texas laid claim to parts of Colorado; in fact, Estes Park was at one time a part of the state of Texas. Several years later, in 1848, Mexico ceded western Colorado to the United States and fortunately, the United States government found enough money to pay off Texas; the geographic boundaries of the territory of Colorado as we know them today were established.

We have all heard stories of the great Gold Rush which occurred between 1858 and 1868 and if you are a railroad enthusiast, the next century produced most of the railroads in our state, including an extensive network of narrow gauge railroads. Finally, in 1876, Colorado joined the Union.

The exploitation of the Colorado resources began with the Gold Rush in the late 1850's. Early settlers used the timber at the lower elevations, particularly in the Black Forest area north and east of Colorado Springs. Further, the accessible areas along the Front Range east of the Continental Divide and at the lower elevations provided tremendous quantities of Ponderosa pine, Douglas-fir and to a certain extent Englemann spruce and lodgepole pine for construction of shelters, business places and housing for industrial expansion.

Let's take a look at the most common product talked about when forest resources of any particular geographic area are discussed: timber. Colorado is the eighth largest state and has a total of over 66 million acres of land. Of these acres, 22,500,000 are forested. This is approximately 34%. The commercial forest, however, only amounts to 11,500,000 acres. Twenty-seven percent of this state's commercial forest land is privately owned. Over all, approximately 1/3 of the total forest of the state is owned by private landowners. The forests of Colorado now support 12 billion cubic feet of growing stock which includes 46 billion board feet of sawtimber. The recent yields in board feet have centered on approximately 350 million board feet harvested each year. Recently, I visited the Mount Hood National Forest in western Oregon. The Mount Hood annually produces close to 600,000,000 board feet on its own, so you can see that 350,000,000 board feet for the state of Colorado is somewhat insignificant compared to other better timber-producing states. We have no pulp mills in the state which has created problems in restoring a healthy forest. In other words, it is impossible to fully utilize immature, stagnant stands of trees to restore a more healthy, vigorous forest. The state's 155 lumber and wood products firms employ close to 3,000 people with an annual payroll of \$16,000,000.

One interesting point to mention is that while we have 11,500,000 acres of trees, I am being generous when I state we are removing 30% of the allowable annual cut each year. In other words, if each of these commercial acres is growing a very conservative average of 100 board feet per acre, the allowable annual cut would be 1,150,000,000 board feet. Since we are only harvesting 350,000,000 feet, then only 30 percent of the allowable cut is being removed.

But, this is enough discussion on our timber resources. In comparison with the other forest resources, timber is only a part. Starting with the turn of the century, magnified in the 1920s and further enhanced in the 1960s and 70s, the recreational potential of Colorado is highly significant. We have become the recreation state. Our scenery is superb and people from all over the nation flock to our high mountains if for no other reason than to just sightsee. Camping, fishing, hiking and hunting also claim a large share of the tourist market. Summer homes are flourishing, many of which become permanent homes as the mountains are made more accessible to urban communities.

Land subdivision is rampant. A simple statistic will illustrate this fact. At this time, enough land has been subdivided into building sites to house a population of 17 million people. Our present population is 2½ million people. More subdivisions are being organized and developed each year. In fact, we anticipate close to 800 new subdivision proposals during this fiscal year. In some respects, it is very fortunate that the Federal Government owns so much of the forest land. It means that these lands will not be subdivided. Federal lands, however, are very directly affected by the broadly defined recreational-tourist industry. Where the Federal lands are adjacent or near private land, the private landowners become quite concerned over the lack of ability by the Federal Government to control mountain pine beetle, spruce budworm, mistletoe and other pests. Freedom of operation in land use on federal land is directly related to what citizens will allow. In other words, where a decision might be made to clear-cut a stand of trees, the public outcry from such a practice oftentimes results in abandoning the proposal. Where water diversions and ski areas are anticipated, be assured there are people who will fight to their "last breath" to prevent the Federal Government from utilizing the forest area for those purposes. And, the use of chemicals such as DDT or other suspect pesticides is looked upon with disdain.

Moving to another forest product, water, we should recognize that five major rivers originate in Colorado. The North and South Platte, Arkansas, Rio Grande, and the Colorado River all produce tremendous quantities of water for 1/3 to 1/2 of our nation's total land. As an example, the Colorado River produces pretty close to ten million acre feet per year. This is equivalent to a column of water one acre in basal area, 2,000 miles high. Within the state, one of our major problems is the physical location of that water. For example, western Colorado has 37% of the land and 69% of the water yield. On the other hand, 80% of the population is on the other side of the Continental Divide. Consequently, the historic diversion of water from the Western Slope to the more heavily populated area has been a bone of contention for many decades.

Other products of the forest such as the livestock industry, hunting and fishing, won't be discussed due to lack of time; but, in passing, I will acknowledge that they are significant parts of the forest economy of our state.

With all the uses of our forest lands, basically the forest is in very poor health. Various forest pests should be mentioned. With the control or at least the attempt to control forest fires and in the absence of replicating Mother Nature's way of reducing the forest cover through clearcutting, the unhealthy condition has led to epidemics by various pests. One of these is the Englemann spruce beetle which in the '40s and '50s destroyed approximately 5 billion board feet of wood on the Western Slope, primarily on the White River-Uncompahgre National Forest. Even today, the mountain pine beetle is in the epidemic stage primarily affecting ponderosa and lodgepole pine. Further, severe localized epidemics of spruce budworm are beginning to be recognized, and further, the tussock moth is here in Colorado as it is in other western states. In this latter case, the urban forests are being affected and the tops of many specimen ornamental blue spruce are being completely defoliated.

Lastly, the Dutch Elm disease is having a severe impact on our urban forests.

In part as summary, and in part as further embellishment, I have a series of slides which may better illustrate the forest resource of our state.

(Slides)

The forest pathologist has a major role in protecting and managing our forest resources. Without a healthy, viable forest, management for many generations will remain at less than a maintenance level.

## PATHOLOGY OF ASPEN - WILD AND TAMED

Thomas E. Hinds <sup>3</sup>

Few people realize the large botanical range of aspen (*Populus tremuloides* Michx.) on the North American Continent. Fewer realize that although the commercial range of aspen does not include Arizona, Colorado, New Mexico, Utah, and Wyoming, these five Western States contain more sawtimber sized aspen than the three Lake States of Michigan, Minnesota, and Wisconsin. In Colorado alone there are about 2.5 million acres of commercial aspen type found at elevations of 7,000 to 10,500 feet. This type is the second largest in the State. Colorado's 3.5 billion board feet of aspen sawtimber, and 2.4 billion cubic feet in sound live trees, is more than is found in any other State (3).

With the exception of Colorado, the pathology of aspen in the Western States has not been studied to any great extent because the species is little utilized and in general is considered a weed species. The amount harvested is considered unimportant for the species is not included in the Forest Service yearly allowable cut. Utilization of aspen varies from 1 to 8 million board feet annually. Present stumpage prices begin at a dollar per thousand board feet, consequently research on the diseases of this tree cannot be justified.

Aspen is probably plagued by more diseases than any other forest tree. Leaf diseases do not seem to be of much importance because they usually appear in epidemic form only sporadically, and seldom cause sufficient defoliation to measurably affect the health, vigor, or rate of growth. However, their overall impact is at present unknown. The common leaf diseases include *Ciborinia whetzeli* (Seaver) Seaver, *Marssonina populi* (Lib.) Magn., and the rust *Melampsora medusae* Thuem. A leaf and twig blight caused by *Pollaccia radiosa* (Lib.) Bald and Cif. is also common on young aspen sprouts.

Decay of aspen has been studied rather extensively by sampling most of the commercial areas in Colorado. This information is readily available (1) so only a few highlights will be presented here. The amount of cubic foot decay in stands under 60 years is negligible on all site classes. In 100-year-old stands, decay averaged 4 percent on Site I (the best site), 8 percent on Site II, and 13 percent on Site III. It was correspondingly greater in each site class for stands above 100 years. A pathological rotation age of around 100 years is recommended.

---

<sup>3</sup> Forest Disease Research. Rocky Mountain Forest & Range Experiment Station, Fort Collins, Colorado.

The two major trunk rot organisms found in aspen are *Phellinus tremulae* (Bond.) Bond. et Boris (= *Fomes igniarius* var *populinus* (Neu.) Campb.) and *Peniophora polygonia* (Pers. ex Fr.) Bourd. et Galz. While *P. tremulae* causes a much greater volume loss, *P. polygonia* is more frequently encountered. Common butt and root rots are *Collybia velutipes* Curt. ex Fr., *Pholiota squarrosa* Fr., *Ganoderma applanatum* (Pers. ex Wallr.) Pat. (= *Fomes applanatus* (pers. ex Wallr.) Gill., and *Armillaria mellea* (Fr.) Quel. *Ganoderma applanatum* is by far the most important as it causes windthrow and loss of the entire tree.

Aspen is also plagued by a variety of canker diseases and the damage they cause by tree mortality and cull is probably exceeded only by losses from heart rots. A paper dealing with aspen cankers found in the West was presented at the Fifteenth Western International Forest Disease Work Conference at Santa Fe in 1967. One idea presented in the 1967 paper was that the diseases of aspen, and particularly the cankers, which have been tolerated in wild stands would soon have to be dealt with in the new high value recreational areas. It is in this context which I would like to discuss the aspen cankers.

Operation Outdoors was a Forest Service program launched in the early 1960's to expand and build new recreational areas; specifically picnic sites and campgrounds. Many sites selected were fenced in mixed and pure aspen stands. From my point of view whenever a fence is placed around a stand of trees and people introduced into the area, the stand then becomes a "tamed stand". The pathology of these tamed stands changes character. It is not the leaf diseases, the decay fungi, nor the occasional aspen girdled by a canker that plays an important role in the tree's health. It is simply people. I also prefer to classify the killing diseases of tamed aspen as social diseases for they are brought about by a society of thoughtless travelers. The travelers are intimately involved in the death of many trees in our recreational areas.

Disease of tamed aspen, in general, are the same as those in the wild. It is their intensity, however, that varies. Campground aspen are more vulnerable to canker diseases than those in the wild and campground degradation is the result of these losses. Consider Maroon Lake campground just out of Aspen, Colorado. It is probably the most popular and most frequently used campground in the state. The area consists of 51 overnight campsites and 11 picnic areas on 25 acres. The campground was constructed in the early 1960's at a cost of approximately \$60,000 to provide access to Maroon Lake and the adjoining Maroon Bells Snowmass Wilderness Area. In 1972, there were approximately 255,000 visitor days registered in the 100 day tourist season. This amounts to about 10,200 per acre. A monetary value of \$2.00 per visitor day has been established for the social benefits derived by a visitor from these public recreation areas. The social benefits in the case of Maroon Lake campground amounts to \$20,400 per acre for that year. This high acreage value should justify some research on campground degradation.

The year 1972 was also known as "the year of the big cut" at Maroon Lake campground. Over 1,600 aspen were cut on the 25 acres because they were either dead or potentially hazardous to the public. Although a heavy early snow was responsible for much of the damage, canker diseases have played havoc in this campground and other campgrounds in aspen over the past decade.

The etiology of the social diseases of aspen is rather simple. Campsites are usually constructed four to the acre. Society moves in with their autos, tents, trailers, and motorbikes with their desire to enjoy the many pleasures of the outdoors. This results in a certain amount of soil compaction, however, its effect upon the trees is unknown and has not been studied. Tree trunks become the familiar walls of home to be used as such. Knife throwing, carving, darts, hanging places, clotheslines, target practice, and numerous other uses are found for these tree trunks. The resulting trunk wounds are frequently so numerous that they actually cause a physical girdling and subsequent death of the tree. More frequently, however, the wounds become infected by canker fungi and it is not long before they are girdled and die. Any dead tree in a recreation area is considered a hazard and consequently cut down to be used for fire wood. In effect, society is causing miniature clearcuts around their aspen campsites.

Sooty-bark canker caused by *Cenangium singulare* (Rehm.) Davidson is the most aggressive canker organism of aspen in the West. It was found on 2.4 percent of the live trees and on 51 percent of the dead trees in a canker survey made in Colorado forests in 1963 (2). Its occurrence in tame stands appears to be more serious, however, the prompt removal of dead trees in recreational areas may conceal its true role in tree mortality. The canker is usually found on the larger trees and is capable of girdling in 5 or 6 years.

Ceratocystis canker (*Ceratocystis fimbriata* Ell. and Halst.) Davidson) is universal but does not usually appear in its typical form in campgrounds. Cankers established at individual wounds appear as typical target-shaped cankers after several years. When several wounds in the same vicinity become infected, the infections coalesce and trunk girdling occurs. *Ceratocystis* infection of wounds via insect vectors is probably the most common disease of tame aspen.

Hypoxylon canker (*Hypoxylon mammatum* (Wahl.) Miller) is not too common in wild nor in tame stands. The canker is usually localized in wild aspen stands and appears to be the same in campgrounds. That is, if the disease is present in the surrounding stands then it is also common in the campground. Cankers take several or more years to girdle a tree.

Another canker of aspen which we have recently become acquainted with is caused by *Cryptosphaeria populina* (Pers.) Sacc. Although the organism was collected from dead aspen in 1897 in Colorado and believed to be only mildly parasitic, it escaped further detection until very

recently. The apparent reason is that its appearance on a tree trunk closely resembles *Cytospora chrysosperma* Pers. ex Fr. infection. It has no doubt been misidentified for many years. The canker is usually associated with wounds and *Cytospora*. Infection proceeds up and down a tree trunk often becoming 10-20 feet in length before girdling. Our present knowledge of this canker is limited to only its identification.

*Cytospora* infection of tame trees is common, particularly on suppressed trees of poor vigor. It is also common on smaller trees in stands which have been opened up during construction or because of overstory mortality. Actual cankers are seldom found. Infection associated with other cankers, particularly when a tree is nearly girdled, is likewise common. Trees in their last stages of decline are inevitably infected with *Cytospora* from top to bottom. In this respect *Cytospora* should be regarded as a saprophyte.

Of the various decay fungi, it appears that only two play a significant role in campground degradation. *Phellinus tremulae* decay is common as evidence of its infection appears as conks on trees of all sizes. Whether or not it is more prevalent in tamed stands will probably never be known for infected trees are frequently felled as potentially hazardous trees. *Ganoderma applanatum*, on the other hand, only occasionally fruits at the base of living trees. Its importance is that it predisposes the tree to windthrow and tree loss.

The resulting differences between the pathology of wild and tame stands is that trees in wild stands may survive to be 250-300 years old in spite of their various endemic diseases while trees in tame stands, particularly within a short radius of a fire pit and table, will be lucky to celebrate their 20th anniversary of campground development. The preliminary results of a recent survey of camp-sites located in aspen stands reveals that tree loss in the immediate vicinity accelerates with time. Actual loss is not all due to disease but canker diseases play the major role. How these camp-sites fare in the future is open to question but if tree mortality continues as in the past, I'm afraid most will be closed by the end of this century.

#### LITERATURE CITED

1. Davidson, R.W., T.E. Hinds, and F.G. Hawksworth. 1959. Decay of aspen in Colorado. USDA For. Serv., Rocky Mt. For. & Range Exp. Sta., Stn. Pap. 45, 14 p.
2. Hinds, T.E. 1964. Distribution of aspen cankers in Colorado. Plant Dis. Repr. 48: 610-614.
3. Miller, R.L., and G.A. Choate. 1964. The forest resource of Colorado. USDA For. Serv. Res. Bull. INT-3, 54 p.

## THE PATHOLOGY OF COLORADO CONIFERS

John M. Staley<sup>5</sup>

Four of the twelve species of conifers listed in "The Forest Resource of Colorado" (8) are of sufficient importance to be mentioned in a brief presentation. Engelmann spruce contributes most to the total volume of Colorado's forests. Of the total 17.3 billion cu. ft. in Colorado's commercial forests, 6.2 are of this species. Another 2.4 billion cu. ft. are in true firs. Together, the spruce-fir type comprises almost half of Colorado's commercial forest volume. In spruce-fir there is three times the volume found in lodgepole pine and nine times the volume found in ponderosa pine.

Much of the spruce-fir type is in remote and rugged terrain. Despite this, there has been more spruce cut in Colorado than any other species for the last 20 years. Spruce-fir occupies much of the playground that is the basic resource of Colorado's important recreational industry, and the headwaters of rivers flowing to the Atlantic, the Pacific, and the Gulf of Mexico. The biggest pathological problem in this type is rot in standing overmature trees (7). Of an average volume of 10Mbd. ft./A. as much as 15-30% may be affected by rot. Fomes pini is the most important causal organism. Stereum sanguinolentum second. The most important decay indicators are the sporophores and punk knots of Fomes pini. The control is of course to harvest at an earlier age and to select indicated trees.

Decay in beetle killed spruce is another important facet of the same problem. The most common rots are the same as those in living trees (6). Windthrow is a most important factor in deterioration of standing timber. When it occurs, decay proceeds rapidly because of increased moisture content in the fallen tree. The volume of undecayed wood in beetle killed spruce remains a surprising 60% however after as long as 20 years.

There are numerous and individually fascinating disease problems affecting spruce and fir in Colorado: problems such as rusts, cankers, and foliage diseases. These are, from an economic standpoint, of minor importance. Root rot problems have remained largely unstudied.

One interesting problem at the other end of the age spectrum may be of interest to this audience. It has been termed spruce solarization injury (10). It affects seedlings planted in unshaded locations, commonly on clearcuts where slash was windrowed and burned. Affected seedlings, although they suffer no nutrient lack nor unusual moisture stress in affected parts, yellow and die. Shade is necessary and it has been shown that insolation causes the yellowing and a reduced capacity to photosynthesize. We know now to leave debris and brush as a protection for young spruce seedlings to allow them initial shelter until they grow large enough to shade themselves.

---

<sup>5</sup> Rocky Mountain Forest & Range Experiment Station, Fort Collins, Colorado.

Lodgepole pine is second in volume: 3.3 billion cu. ft. - 1/3 that of spruce-fir and 3 times as much as ponderosa pine. The most important pathological problem in this type is the dwarf mistletoe, Arceuthobium americanum (3). In stands suffering from long standing infestation losses can be as great as 80-100% of the normal volume. The control is by destruction of the infected host, either by clearcutting or by early thinning (before 30 years of age). Clearcut blocks of not over 40 acres are adequate for the control of A. americanum. Aesthetic values are often ignored in clearcuts of larger size, and such practices have drawn heavy criticism in recent years. The regeneration evident in recent clearcuts is beginning to hide the evidence of cutting. Pathologists should take note of past errors and promote mistletoe control by arguing for the preservation of scenic values along with disease control.

Myers, Hawksworth, and Stewart (9) have recently simulated the yields of mistletoe infested lodgepole pine stands. Field application of the method was the subject of a pre-workshop field trip. We saw stands being thinned in accordance with predictions specifying yields in relation to times of initial infections, stand entry dates, and residual stockings. The method promises to be of useful application in other regions and to other disease problems.

In lodgepole pine, decay is the second most important pathological problem, again causing up to 20 or 30% loss in old stands. F. pini, Polyporus circinatus, and Coniophora putanea account for 90% of the decay.

Lodgepole pine and ponderosa pine, the next species to be discussed, occupy sites that sometimes are developed for residential use. Therefore, disease problems must frequently be controlled to the satisfaction of residents. This aspect of practice is the subject of another paper. Certainly ponderosa pine is the type most frequently invaded by "civilization." Its major forest disease problems remain of concern in any case.

Of first importance is the dwarf mistletoe, Arceuthobium vaginatum (2). This mistletoe is the cause of much mortality and growth loss. In managed stands the control of choice is removal of the diseased host. In recreational sites pruning out of infections is frequently possible. A simulated yield program similar to that for lodgepole pine, is being developed for uneven-aged, mistletoe-infested, ponderosa pine. This will be an aid to land managers, and is serving as a model for similar programs in other regions.

Decay in standing trees is the second most important problem. The information on decay of ponderosa pine in Colorado is based on the apparent agreement of local observations with data obtained in the southwest (1) and the Black Hills (5). The most damaging fungus is Polyporus anceps, the cause of red rot. In the Black Hills Veluticeps berkeleyi and Polyporus schweinitzii are important causes of brown rots.

It is assumed that these organisms predominate in Colorado ponderosa pine stands. Fomes pini, the common cause of rots in spruce, fir, and lodgepole pine, is not recognized on ponderosa pine in Colorado.

Ever present as a background to forest pathology efforts in Colorado are the relatively low harvestable product values per acre, and the observable (frequently scenic) persistence of vegetative cover in the face of the most severe disease and environmental influences. The pathologist who must advise on problems ranging from treatment of a single high value tree on a recreational site to management of a disease in a relatively slow growing forest is forced to a perspective on the cost of recommendations versus the value of benefits realized. He is also made aware of two viewpoints, frequently held to be in opposition: One is negligent to ignore economic analysis, vs. to be guided solely by economic analysis is to forsake ideal forestry practice. These viewpoints need not oppose, and I believe most scientists favor assembled facts and careful analyses as a basis for their recommendations. I try to keep in mind some limiting values useful in evaluation of disease control recommendations. These are presented in Tables 1 and 2.

These values in Tables 1 and 2 only suggest a few limits by which recommended control measures might be judged. They do not evaluate such benefits as accrue from eradication of point sources of infection, and they ignore acceptable profit levels. They do, however, aid in the development of a rough perspective that can be refined by further discussion. I believe that the effective practice of forest disease control demands at least elementary analysis of economic (and other) implications so we can prevent and respond to misuses of disease control advice.

Such analyses are and certainly will in the future be insufficient. Therefore we can end on an optimistic note by pointing to an economic analysis now in preparation for dwarf mistletoe control in the Southwest (4). This analysis will provide data that can be incorporated into simulated yield programs, thus providing land managers with additional estimates on which to base their actions.

Table 1. Present Value of Future Returns

Value to be saved	Allowable break even expense for given period and discount rate			
	<u>Forest stand</u>	<u>130 years</u>	<u>100 years</u>	<u>50 years</u>
\$100/Acre (8% discount)		< 1¢/A	< 5¢/A	\$2.13/A
\$100/Acre (2.5% discount)		\$4.05/A	\$8.46/A	\$29.09/A
<u>Christmas tree planting</u>		<u>10 years</u>	<u>3 years</u>	
\$2000/Acre (8% discount)		\$886/A	\$1588/A	
<u>Individual privately-owned tree</u>				
Discount rate and period are of no concern. The replacement cost and desire are the only limiting factors.				

Table 2. Minimum Costs/Acre of Treatments

Aerial Survey	\$2/A +
Bulldozer-chopper	\$15-30/A +
Chemical Spray	
Aerial application	\$6-12/A +
Surface application	\$4-5/A +
Hand Labor	\$2.50/Hr. +

## Literature Cited

1. Andrews, Stuart R. 1954. Red rot of ponderosa pine in the southwest. USDA For. Ser. Sta. Pap. RM-15, 11 p.
2. Hawksworth, Frank G. 1961. Dwarfmistletoes of ponderosa pine in the southwest. USDA Tech. Bul. 1246, 112 p.
3. Hawksworth, Frank G. 1964. Diseases of lodgepole pine. Proc., Soc. Am. For. Denver, Colo.
4. Hawksworth, Frank G., et al. 1973. An economic evaluation of ponderosa pine dwarf mistletoe control in the Southwest (in progress).
5. Hinds, Thomas E. 1971. Decay of ponderosa pine sawtimber in the Black Hills. USDA For. Serv. Res. Pap. RM-65, 11 p.
6. Hinds, Thomas E., Frank G. Hawksworth, and Ross W. Davidson. 1965. Beetle killed Engelmann spruce, its deterioration in Colorado. J. For. 63:536-542.
7. Hinds, Thomas E., and Frank G. Hawksworth. 1966. Indicators and associated decay of Engelmann spruce in Colorado. USDA For. Serv. Res. Note RM-25, 15 p.
8. Miller, Robert L., and Grover A. Choate. 1964. The forest resource of Colorado. USDA For. Serv. Resource Bul. INT-3, 54 p.
9. Myers, Clifford A., Frank G. Hawksworth, and James L. Stewart. 1971. Simulating yields of managed, dwarf mistletoe-infested lodgepole pine stands. USDA For. Serv. Res. Pap. RM-72, 15 p.
10. Ronco, Frank. 1972. Solarization--a high elevation problem. West. Reforestation Coord. Comm. Ann. Meet. 1972:115-115.

John G. Laut<sup>4</sup>

Land managers and those advising them are becoming increasingly involved with problems of vegetation under heavy urban, recreational and residential pressures. Forest pathology has much background expertise that can be useful in managing people-stressed vegetation. However, compared to traditional forest management and forest pathology this concern with heavy people pressures presents some new dimensions in focus, problems and their potential solutions.

For purposes of definition residential forests are those areas on which trees are maintained primarily for their effects on people. (Richards and Leonard, 1973). This definition requires attention to trees on city streets, yards and parks -- urban trees in the time sense -- as well as to trees in the forest where people have chosen or are choosing to live. As Tom Borden mentioned earlier this morning the forest resource of Colorado is, or soon will be, under heavy people-pressure as a result of a developing tree-awareness in the mountains as well as on the city streets.

Let me first up-date you on our Dutch elm disease program as a lead-in to urban problems. The recurrence of DED in Colorado was first noticed in 1968 with 5 trees at Fort Morgan. In 1970 the Colorado State Forest Service was assigned, and funded, by the State Legislature to determine what should be done about the disease. In the interim a total of about 60 cases had been diagnosed. Since that time our program has evolved to its present status. We carry out, state-wide, detection surveys, primarily in municipalities but also in rural areas, designed: (1) to locate suspect trees; (2) to obtain samples from suspect trees; (3) carry out diagnostic laboratory cultures on all samples; (4) to notify the proper authority of the results of each culture. What does this mean in terms of work load? In the 4 seasons (3 years) since we began we have looked at 1,182,000 elms, of which 134,000 are American elms, cultured from 8800 samples and diagnosed 3800 positive cases of Dutch elm disease. The map gives some idea where the disease is in Colorado.

I have purposely left out the most important, and most difficult, phase of our program - control. The actual control of DED is the responsibility of local authorities - municipal or county. The State has a law requiring that diseased elms and/or elm wood suitable for breeding of the principle vector, *Scolytus multistriatus*, be promptly and suitably disposed of. Enforcement and funding is presently left to local levels of government. Here is where we enter the field of Urban Forestry. We must sell the need of sanitation for DED control to the towns and counties that have a threatened resource. Where this selling job is successful, and we do have some successes which I will not go into here, invariably the larger result is an overall awareness of their "forest resource" on the part of the local citizens and

---

<sup>4</sup> Colorado State Forest Service, Fort Collins, Colorado

their elected officials. What to plant, how to care for what they have and how to improve it suddenly become pressing problems. In essence a pathological problem, brought to their attention, has developed a tree awareness.

This new awareness includes, to be specific, awareness of "sick" trees and not only elms but all species - trees with individual values infinitely higher than trees in the forest. Who will service this demand? Anyone with foresight and guts! Can forest pathologists be tree pathologists? I think we can and I think we should.

Let's now return to the forest quickly before we are overwhelmed and become psychotic about our problems of the city. The cool, green forest, away from the noise, the pollution, the maddening throng. The mind-healing solitude of Mother Nature - isn't that why we are Forest Pathologists? I said quickly - and we had better hurry - that maddening throng is right on our heels. This is happening in Colorado, California, Oregon had better hurry and get their fence built, Montana, Alberta, British Columbia - you name it! 'Wherever Mother Nature has been especially generous the affluent society is there, or will be shortly.

The human foot is trampling the forest floor and worse - construction damage, drainage changes, chemical additions to soil, water and air rapidly create sick trees both in their own right and by enhancing the syndromes of existing but hitherto latent pathogenic situations. An example of this is dwarf mistletoe. Trees with non-lethal infections or at least not immediately in danger of dying are evidently particularly susceptible to additional stress. As soon as someone builds a house under or near such a tree it very soon will die. Trees on extremely poor sites, as many of our Colorado East Slope ponderosa sites are, suffer from any additional stresses put on them.

Where does this lead us? Just as the discovery of Dutch elm disease can lead to a tree awareness in the city dweller the fading of a pine tree shading his new expensive forest home awakens the forest resident to some new facts of life. You may be tempted to say that we have always had people living in the forests and trees have always died so what is new? What is new is the type of resident. The older resident was there most likely through necessity --his livelihood came from the forest, one way or another. The new resident very often is there by choice. The trees are part of his investment and even can be the reason behind his choice. Each tree is important. Couple this personal awareness with the overall concern for the environment that has developed in the last decade. The result is concern for trees.

One result of this concern is a change of values that are at stake. Under these new values if a treatment or control method is biologically feasible it is very likely to be economically feasible. Under the more stringent economics of commercial forestry how many forest diseases have been controlled? The opportunity to effect control in residential forestry, on single trees or small stands that now have extremely high values, are essentially unlimited. Tom Hinds described aspen cankers - in commercial forestry the prospect, or perhaps even the need, for direct control methods is very low. Our customers in residential forests cry for a way to "save our tree." No method should be discarded because of so-called

economic unfeasibility based on previous forestry practices.

To repeat - can forest pathology serve these newly emphasized needs in tree pathology? We can and we should! Shade tree problems are now becoming almost synonymous with forest tree problems. Species are the same - only the values are different. Cures and preventive measures that may have occurred to us as we have worked on our particular problems but have been discarded because of forest economics are now needed. The criterion in residential forestry is biological feasibility. Tree owners, as opposed to forest owners, talk different economics.

Let us not be accused of not seeing the TREES for the FORESTS.

SUMMATION - PERSPECTIVE OF FOREST PATHOLOGY  
IN COLORADO IN THE FUTURE.

Don Brown <sup>6</sup>

In summation, I would like to touch briefly on each topic covered by the other panel members.

1. Forest Resources of Colorado

As Tom Borden described earlier, Colorado has a highly varied forest resource including commercial and noncommercial forests ranging from low elevational pinyon-juniper to high elevational spruce-fir type. These types are subjected to various economic-social pressures or demands from the population for such products and services as housing, recreation, timber, water and grazing. These demands place additional stress on a resource that includes diseases which can be aggravated or minimized depending on opportunities and administrative decisions made by land managers at all levels of Government. A major element here is land use planning which is vital for best utilization of the forest resource. This will necessarily involve some tradeoffs between strict environmental safeguards and meeting peoples needs. Forest pathologists must become involved and provide input in land use planning to help minimize existing and potential forest disease problems.

2. Pathology of Aspen

If Tommy Hinds' detailed description of the disease of aspen gave you the impression that aspen is a fragile species, you're right. I call these mostly social diseases because they are directly related to people pressures, especially in recreation sites. Our recommendation on proposed recreation sites is to avoid using aspen type wherever possible. For existing sites, we suggest a rest and rotation system and underplanting or understory release of more durable species such as spruce, Douglas-fir or lodgepole pine.

Increasing commercial utilization of aspen is producing some real interest in aspen management and is stretching our knowledge and expertise in this area. Research is needed to provide some practical techniques for the land manager to use in minimizing the impact of diseases. The San Juan Forest has programmed a cut of 5-6 million board feet of aspen this fiscal year. The raw material is being utilized in such things as match sticks, paneling, pallets, pulpwood and excelsior. The market is expected to continue and even increase in the near future. One mistake we want to avoid is the wholesale adoption of Lake States management techniques for Colorado aspen.

3. Pathology of Conifers

Management opportunities are available now to minimize disease impacts in our conifer types. Enlightened management can correct past mistakes and avoid future repetition of the same. One past practice that has gotten us into trouble in Colorado and other parts of the country is high grading or single product utilization which takes the best and leaves the rest. This

---

<sup>6</sup> U.S. Forest Service, Division of Timber Mgmt., Denver, Colo.

practice in the lodgepole pine type has promoted the spread and intensification of dwarf mistletoe. In our Forest Pest Control program in Region 2, we have been "bailing out" the Districts by financing the removal of infected residual trees in the older (over 10 years) commercial clearcuts. In the more recent and current commercial sales the overstory is removed in the post sale area improvement work. Clearcutting in lodgepole pine is now restricted to a maximum of 40 acres.

The recent development of simulated yield programs for dwarf mistletoe infected lodgepole pine and ponderosa pine has given the land manager an important management tool to weigh alternatives and set priorities. We need more of these tools to get away from a crisis style of management. Many of our diseases can be suppressed through management. However, we can anticipate the possibility of some new or unexpected problems, particularly in the more intensively management monocultures if some of the examples in the South and Northwest hold true. Another practice largely related to economics and fiber production is shorter rotations, which will help reduce losses to stem decay.

#### 4. Residential and Urban Area Pathology.

The high values of individual trees in residential areas offer more opportunity for intensive care. Good expertise in residential tree culture is needed to minimize disease problems; otherwise the homeowner can be in for an expensive adventure. The invasion of housing subdivisions into marginal forest land puts increased pressure on trees already under stress. In existing subdivisions the continued protection of the more healthy trees and gradual replacement with more durable species will help. In proposed subdivisions some developers that John Laut has worked with are willing to improve the condition of the trees before improvements and construction begin. Land use planning again is the key to avoid unnecessary problems. Professional foresters and pathologists are providing a valuable assistance here.

The loud and clear message at the recent Society of American Foresters convention in Portland was for the forester to be aggressive and get involved in land use planning.

I think the outlook for tree pathology in the city or the forest is optimistic. We can provide a valuable service through technical assistance, both in research and administration that is now in demand.

PANEL - FOREST DISEASE RECREATION HAZARDS

Peter Gaidula,<sup>1/</sup> Panel Chairman

OPENING REMARKS

This morning we will be discussing the subject of hazards posed by trees in recreation areas.

Webster's dictionary defines hazard as follows: 1. An early game of chance played with dice from which craps is derived. 2. Chance. 3. Risk, peril, danger, jeopardy.

In his publication entitled "Administrative Goals and Safety Standards for Hazard Control on Forested Recreation Sites", Dr. Lee A. Paine has defined hazard as: "The probability of mechanical failure or uprooting of a tree with consequent injury or property loss".

Yesterday we had several fine papers that had a strong relationship to our subject concerning forest disease recreation hazards. Tom Hinds, in his talk, related the problems with aspen in forested recreation sites in Colorado. John Laut spoke on residential or urban area forest pathology in Colorado, and the tree problems that followed building of homes in subdivisions, or new urban areas, within forest lands. The tree problems John Laut spoke about are not greatly different from those that we find in recreation sites. If we stop to think for a moment, we can see that new home developments in forested areas and our campground developments have strong basic similarities, in that they both bring people and constructed facilities into conflict, so to speak, with the forest environment. It isn't the trees that cause the problem; it's the people among the trees!!. One of the basic principles of tree hazard is that in order for a hazard to exist it takes a tree, together with people and/or property. Take away the people and the property and there will be no hazard.

LOSSES AND COSTS

Data gathered by Dr. Lee A. Paine, Forest Pathologist at the Pacific Southwest Forest and Range Experiment Station, indicate that in 11 continental western states personal injuries, including fatalities, resulted in losses estimated to be nearly a million dollars for the period 1968-1973. This is thought to be a conservative figure because the data are incomplete. Many tree failure accidents are not reported to Lee Paine, because many public agencies at the county level, plus private campground operators, are not participating in the tree failure reporting which is the basis of Lee Paine's data.

Let us look at costs of control. Here again data are incomplete, but Lee Paine has estimated that annual losses from tree failure accidents plus control costs for developed recreation sites are approximately 2 million dollars on State and Federal lands in California alone. Within the California State Park System I do know that we are spending over \$60,000 annually for tree hazard control.

---

<sup>1/</sup>Resource Protection Specialist, Resource Management and Protection Division, California Department of Parks and Recreation, Sacramento, California

## Losses within the California State Park System

The losses in 1972-73 fiscal year from damage and injury resulting from tree failure within the California State Park System with over 200 park units was approximately \$25,000. Without a statewide coordinated tree hazard control program, we have no doubt these damage losses would be several times this figure.

At first glance the subject of tree hazards would appear to be a rather narrow one, confining itself to simply finding the hazard and removing it. However, the problem is not that cut and dried, and furthermore, it involves far more than just public safety. A good tree hazard control program must, of course, meet the goal of public safety, but it must also take into account several other highly important considerations. These are:

- (1) Legal implications of actions recommended, taken, or not taken
- (2) Protection of the environment
- (3) Public relations
- (4) Costs of control

Mr. Menefee, our next speaker, will be discussing legal implications in some detail; therefore, I need not say any more on this aspect now.

Let us next consider environmental consideration. The environment within which a camp or picnic unit is situated plays a very important part in contributing to the appeal that site will have for the recreationist. In removing or reducing the hazards the environment must be fully recognized for the basic resource that it is, and measures must be taken to protect this environment from undue damage. This protection should begin with the hazard inspection, at which time the decision to remove a tree must be weighed against the multiple effects that could follow such removal. These include:

- (1) Reduction in shade
- (2) Diminution of attractiveness of the site
- (3) Increase in wind action and possible wind damage to remaining trees

During the actual control phases, whether the tree felling or the removal of limbs or tops is to be done by one's own personnel, or whether it is to be done by contract, appropriate steps need to be taken to prevent unnecessary damage to the environment. Whoever does the actual control work needs clearly written guidelines and standards. This in turn should be supplemented by adequate and competent supervision of the control program.

### PUBLIC RELATIONS

As for public relations aspects, public agencies or even private campground operators strive constantly for a good image; therefore, it is quite obvious that deaths and injuries and property damage suffered by recreationists are highly damaging to that image. While public relations is an important topic, it is not within the scope of our discussions here today.

Costs of control, which I have previously discussed, is an important one especially in this day of tight budgets. One of the factors, among several, that influences costs is the standard of control to be achieved. Without

well-defined control program goals and clear standards to achieve these goals, hazard control costs can be higher than necessary. Standards for hazard control will be discussed by several of our speakers this morning.

And now let me introduce our first panel member.

THE LEGAL IMPLICATIONS OF HAZARDS FROM TREE DISEASE  
AND RELATED FACTORS IN RECREATIONAL AREAS

Curtis Menefee <sup>2</sup>

When Mr. Gaidula called me several months ago and asked if I would prepare and deliver a speech on the subject matter, I must admit I was at first somewhat skeptical whether there really was a hazard to people or property in the public parks and recreational areas in this country from diseased or defective trees. The reason for my skepticism was that in the two and one-half years in which I have been concerned with claims against the United States for personal injuries and damages, we had not had a claim resulting from falling trees or tree limbs in the ten-State Region over which this office is responsible. However, my attitude changed as soon as I began looking into the claims handled by the Solicitor's Office, both in court and administratively before the Department, which resulted from falling tree limbs or falling trees in National Parks and other Recreation Areas under the jurisdiction and supervision of the Interior Department. In fact, within a week after talking with Mr. Gaidula, I received a claim from a camper in Glacier National Park in the amount of \$1,100.00.

The question arises: How can the United States find itself liable for damages caused by the results of what is basically a process of nature and usually unassisted by any human efforts; namely, the fall of a tree or tree limb as the result of disease.

Prior to August 2, 1946, the United States was immune from suit from injuries or damages resulting from any cause. This included automobile accidents as well as damages and injuries caused by the failure and resulting falls of tree limbs and trees. If some injured party wanted to be compensated, they had to apply to Congress for relief. The relief granted was in the form of a Private Relief Bill. Meanwhile, the doctrine of sovereign immunity reigned supreme.

However, this situation changed on August 2, 1946 when President Truman signed into Law the Federal Tort Claim Act (28 U.S.C. Secs. 2671-2680). This Act waived the doctrine of sovereign immunity by providing that the United States would be liable in the same manner as a private party would be liable for the negligent acts or omissions of its employees. Of course, the negligent acts or omissions had to have been committed while the employee was acting within the scope of his employment. The Act also provides a number of exceptions where the doctrine of sovereign immunity of the United States has not been relaxed.

The Federal Tort Claims Act has made the Government liable to the same extent a private person would be liable in accordance with the law of the place where the accident occurs. In other words, State Law will be used in determining liability.

---

<sup>2</sup> Attorney-Advisor, U.S. Dept. of Interior, Office of the Solicitor, Denver Region, Denver, Colorado

In the field of premises liability in which the problem of all hazards of visitors to public facilities falls, the trend to Tort Law in recent years has been away from the traditional view of classifying people who enter lands not owned by them as trespassers, licensees or invitees. The modern trend is to make the owner or the occupant of the land responsible to exercise reasonable care under the circumstances to prevent harm to the person who might come on his land.

In determining liability, the first question to be decided in all cases is: Has the owner or occupant been negligent in the use or management of his property? Negligence has been defined by Black's Law Dictionary to be:

The omission to do something which a Reasonable man, guided by those ordinary considerations which ordinarily regulate human affairs, would do, or the doing of something which a reasonable and prudent man would not do . . . (Emphasis added.)

The second question to be decided, assuming that a negligent act was committed, is: What duty does a landowner in the use and management of his real property owe to persons who enter his lands? An act of negligence alone does not automatically result in liability. The person guilty of negligence, failing to act as that reasonable man, must have owed some duty to the person who was damaged or injured by the act of negligence. If no duty is owed, there can be no liability.

Under the Old Common Law rules, whether or not one's Act or omission which occurred on his own property was negligent was first determined by resorting to the status of the injured person upon the land and the correlative duty the landowner owed to a person in that status. The landowner owed the trespasser the least duty of care.

A trespasser has been defined to be one who enters the property of another without the consent of the possessor of the property. Under the traditional rules of negligence, the landowner was under no duty to keep his premises in a safe condition for the use of trespassers and as a result the courts have not held a landowner responsible for an injury sustained by a trespasser resulting from a condition existing on the land. The only duty a possessor owed was to refrain from setting traps that would ensnare a trespasser. In this context, you might recall the case that arose in Iowa several years ago and achieved National publicity where a couple that owned an unoccupied farm house set a spring gun that seriously injured a trespasser. The trespasser sued the owners and recovered a sizeable award of damages as a result of the injuries he sustained when he set off the spring gun in the house.

A greater duty of care was owed by a landowner to licensees who are persons who are invited or permitted by the owner or occupier of real property to enter for their own convenience, pleasure or benefit or for some other purpose unconnected with any interest of the owner or occupier.

Social guests in the home and visitors to Federal Lands other than office buildings, Campgrounds, Parks, Monuments and Wildlife Refuges fall into this category. Generally speaking, although there are differences from State to State, the occupier or owner of real property is under no duty of care to inspect the premises or to prepare them so that they will be in a safe condition for the use of a licensee. However, the owner, if he knows of a dangerous condition and can reasonably anticipate that the licensee will neither discover nor realize the danger, may be held liable for the bodily harm caused by some condition if he fails either to give warning of the existence of the condition and of the risk involved or to eliminate the condition. Of course, a landowner owes no duty to warn a licensee, or for that matter, anyone else, of a hazard that is open and obvious especially if it is reasonable to expect that the licensee will observe the hazard and realize the risk involved.

The final status and the one in which a landowner owes the greatest amount of duty of care is the status of an invitee. The courts have defined invitees in various manners which are oftentimes conflicting. The best definition is one that simply defines an invitee as one who was directly or impliedly invited by the landowner to enter the land for some purpose or advantage to the owner. The landowner owes a duty of care to the invitee not only not to injure him by some unreasonably dangerous conduct but also to act with reasonable care to discover any unreasonably dangerous conditions of the premises and either to put the premises in a reasonably safe condition for the use of the invitee and in a manner consistent with the invitation or to warn the invitee of the danger and the risk involved.

As some of you may no doubt think at this point, the duty owed to a licensee and an invitee is very similar and there is little distinction between the two statuses. This is correct and it has caused no small amount of difficulty to the courts in distinguishing between the two classes when attempting to assign persons to one class or another.

Under what status do most people who enter Federal lands fall? The answer depends upon whether they have entered a National Park, National Wildlife Refuge, a National Monument, or a National Forest campground or some other National Recreation area. The person who enters one of these above described areas is universally classed as an invitee to whom the Federal Government owes the highest degree of duty. With respect to the remaining public lands or federal property, a visitor is only a licensee to whom the lesser duty is owed.

Under the traditional rules of premises liability, a great deal of inequity, in addition to the confusion and the difficulty encountered by the courts, has occurred by the use of technical status classifications. As a result many state Supreme Courts have eliminated the technical distinctions in the status classifications. Instead, the courts are beginning to use a single prudent-man test of a duty of reasonable care owed to all who enter upon the property of another. Colorado has followed this trend with the case entitled Mile High Fence Company v. Radovich, 489 P. 2D 308 (1971). California had previously adopted this rule. More recently the District of Columbia and even the Supreme Court of Massachusetts which had been firmly committed to the old rule has followed this trend.

Under this modern rule, the courts have held that the proper test to be applied in determining the liability of a possessor of land is to determine whether in the management of his property he acted as a reasonably prudent man in view of the probability of injuries to others. The status of a person on the lands of another is still to be considered in determining whether the landowner had acted as a reasonably prudent man but that this status is not to be controlling as it had been before.

I want to emphasize that throughout the previous discussion I have used two key phrases. They are; "the reasonable or prudent man" and the "duty of care". Whether a person has been free of negligence will be determined by measuring his conduct against the objective standard of what a reasonably prudent man would have done under like circumstances. If it is determined that this conduct falls short of the reasonable or prudent man's conduct, his liability will be determined by considering whether he breached some duty of care owed to the injured or damaged person.

I also want to emphasize that no landowner is the insurer of the safety of the property or person of those who might enter his land either under the traditional status classifications or under the modern rule. Neither the courts nor the legislatures have made a landowner absolutely liable for any injury suffered by another person on the property except where some ultrahazardous activity is being conducted such as the use of high explosives.

I have been discussing the liability of private landowners and the Federal Government up to this point, but one further matter of State Law should be mentioned and that is: What the liability of the States may be for injuries sustained on lands owned by or supervised by various agencies of the States and used for recreational purposes. Of course, in States where the doctrine of sovereign immunity, sometimes stated as "The King can do no wrong," prevails, there, of course, will be no recovery and no liability. However, little by little this rule is being relaxed either by Judicial fiat or by Legislative action. It has been relaxed in Colorado. With respect to the liability of counties or municipalities, this question has always been decided on the basis of whether the Agency of Government was functioning in a Governmental capacity, in which case immunity was the rule, or whether it was acting in a proprietary capacity in managing the Park or Recreation area. In the latter case, it could be held liable for the injury or damage resulting from an act of negligence.

One further statute deserves mention before discussing a few of the experiences of the Interior Department in the area of diseased trees. This statute has been enacted by 42 of the 50 States in various forms. It basically provides for the limitation of liability for landowners who open their privately held lands for recreational purposes. It does so by providing that a landowner who opens his lands but does not charge for the use of his lands does not make any assurance that the premises are safe for any purpose or confer the status of invitee or licensee upon those who enter. I doubt that it has much application to Federal lands. First because most of the campgrounds, National Recreation Areas, Wildlife Refuges, Parks and Monuments are areas which require the so-called Golden Eagle or Golden Age Passport for entry; and I doubt that any court would

have much trouble finding that these permits were not fees for entry. Secondly, as I said before, most visitors to Federally owned and maintained campgrounds, parks and recreation areas have already achieved the status of an invitee which was clearly recognized by the various courts long prior to the enactment of these statutes.

Therefore, in summary, the Federal Government and State and Local Governments where the doctrine of sovereign immunity has been abolished, or at least relaxed, owe those persons who enter their recreation areas and campgrounds the highest degree of care; namely, to make the premises reasonably safe, or at least to warn of existing hazards including diseased or defective trees which pose an unreasonable risk of harm, and that might not be observed by an ordinarily reasonable and prudent person.

TORT CLAIMS EXPERIENCE OF THE FEDERAL GOVERNMENT IN PARKS AND  
RECREATIONAL AREAS AS A RESULT OF CLAIMS ARISING FROM  
DAMAGED OR DEFECTIVE TREES OR LIMBS.

Fortunately, the United States has had very few cases considered by the Courts. In fact, I found only two cases which were decided and these were decisions at the Federal District Court level. There were no U.S. Court of Appeals or U.S. Supreme Court cases. One of these cases arose from a tree limb falling in a National Forest campground in California and the other arose from a tree which fell in Yellowstone National Park. In fact, although my research into the cases was not extensive, I found only two other court cases which involved a Governmental entity on any level. One arose in Illinois which at the time of the decision adhered firmly to the doctrine of sovereign immunity and, therefore, no liability. The other case arose in California in which the State Legislature had enacted a statute making a county liable for certain acts. It appears that most of the cases involving the fall of defective or hazardous trees have occurred in the area of trees falling onto highways from either the right-of-way or the land immediately adjacent to the highway right-of-way rather than in Parks or Recreational areas. I made no study of this aspect of the subject and so it is not included here.

In order to discover how extensive the Interior Department's experience in claims was, I briefly consulted the Field Solicitor's Offices in San Francisco and Santa Fe. As a result, I have concluded that our problem area from the standpoint of high frequency of accidents from trees or tree limbs is in California, particularly in Kings Canyon-Sequoia National Park and Yosemite National Park. With two exceptions, the accidents in recent years have not resulted in fatalities but only minor personal injuries and property damages, mostly the latter. Of the two accidents that resulted in fatalities, only one reached the Federal District Court and that was in Wyoming.

In the case of Middaugh v. United States, 293 F. Supp. 977 (D. Wyo. 1968), the Administrator of the Estate of Stephen Athan sued the United States to recover for the death of Mr. Athan. He was struck by a tree which Judge Kerr found was 300 years old, had a "cat face" at the base of the tree, which extended into what would have normally been heartwood but was apparently rotted away, and had a rust canker above the cat face

extending some 50 inches up the tree on the same side as the direction the tree fell. The weather at the time the tree fell was normal with a moderate wind blowing but from the opposite direction in which the tree fell. At the time the tree fell across Mr. Athan's tent, he was 39 years old, happily married, the father of three minor children and an electrical engineer with North American Rockwell Company in Los Angeles. The court awarded \$43,750 for his death.

The other case involving a fatality was handled at an Administrative level resulting in an award of only \$1,681.38. This was a rather unusually small amount for a fatality, but can be explained by the fact that the woman killed was 60 years of age and had no known relatives or survivors who could legally assert a claim. The award amounted only to her funeral expenses and some other expenses incurred by the attorney who handled her estate. In this case, Mrs. St. John was having breakfast with some friends in a campground in Sequoia National Park when one of the giant trees cracked and began to fall. It hit another tree knocking it down where it struck the decedent as she tried to outrun it. The evidence obtained by a forester who examined the tree after it fell was inconclusive to establish what caused the tree to fall. However there was evidence of rot in some of the burn scars and carpenter ant activity. As stated earlier, \$1,681.38 was awarded to the Administrator of the Estate after a conclusion of negligence was found by the Field Solicitor.

The one other reported case involving a fatality due to the fall of a diseased tree arose in a Park owned by San Mateo County, California. In the case of Smith v. San Mateo County, 144 P.2D 33(1944), the plaintiff's son was killed when a large coastal redwood fell on the cabin in which the boy was sleeping. The tree was admittedly dangerous as all the heart had been "burned" out of it. The tree leaned in the direction it fell, and it had had a "spike" top for at least 40 years. An examination of the tree revealed that there were only three live spots, the largest being 15 inches in diameter which connected the roots to the base of the tree which was 7 to 10 feet in diameter. Liability was based upon a State Statute imposing liability upon Counties for injuries resulting from dangerous or defective conditions but failed to remedy them within a reasonable time. In this case, there was testimony from two employees of the County about the County's program to remove dangerous trees. Prior to the accident the program had been curtailed because of complaints that too many trees were being removed.

Before discussing the Administrative handling of claims by the Department, I should explain what is meant by the term "Administrative Claim". Section 2675 of 28 United States Code provides that a claim must be filed with the Administrative Agency involved in the claim. That Agency then has six months in which to either allow or deny the claim. During this six-month period a claimant may not institute suit unless a final determination has been made. Under regulations of the Department of Interior, all claims filed against Interior Agencies such as the Bureau of Land Management and the National Park Service must be referred to the Solicitor's Office which makes the determination whether to allow or deny a claim. This is what I mean when I use the term "Administrative Claim."

So far as the Administrative Claims filed with the Department are concerned, most have involved property damage generally not in excess of \$1,500 although there was a claim for \$35,000 for personal injury that was denied. These Administrative Claims have been allowed when the tree or the tree limb that caused the damage was dead or the evidence of disease or rot was readily observable by competent personnel. In some cases the trees had been rated as high risks and were slated for removal when they fell and caused injury or damage.

Claims have been denied when the trees appeared to be sound with no outward signs of disease or decay. Especially where the only means of determining whether disease was present was to dig around the base of the tree to expose the roots so that root fungus could be detected. Claims have also been denied when the cause of the fall of the tree was attributed to an Act of God such as a sudden extreme gust of wind.

The location of the accident has also played a significant consideration. If the accident occurred outside a developed area or a campground, the claims have been denied generally because it would be unreasonable to require every tree in an undeveloped or infrequently used area be examined for potential defects. The visitor must assume some risk. By the same token, where the accident occurred in a campground or other developed area, claims have been allowed when the offending tree was obviously defective.

One other instance when claims have been allowed should be mentioned. This is the case where lightning has struck a tree and the strike was reported to Park officials who failed to take any action. Subsequently the tree causes damage and the resulting claims have been allowed. I cannot overstress the importance of taking some action in cases where a visitor or other person reports the possibility of damage to a tree from an Act of God. At least investigate. Even if you determine a high hazard exists, you will more than likely be given a reasonable amount of time to take some action to either remove the tree or the persons or the property that could be injured or damaged from the area of the risk. Of course, the greater the probability of the tree falling, the less the amount of time will be allowed in which to take action. Under these circumstances, if you take no action whatsoever, I think such inaction can only be negligent.

Overall, I think the Department of the Interior has been fortunate in the amount of money awarded for claims. With two exceptions, the Claims have been for relatively small amounts since most accidents involving trees have caused only property damage such as to campers or camping equipment. In only one instance has a large award been made and that was for the breadwinner of a family. However, I must caution you that awards for death and personal injury are increasing in amounts with awards in excess of \$1 million occurring frequently, especially against Governmental entities. Greater effort to eliminate not only hazardous trees but other hazards will have to be made if such awards are to be avoided.

#### HAZARD RATING SYSTEMS

When Mr. Gaidula asked me to speak to you he suggested that you might be interested in a lawyer's reaction to a hazard rating system such as that outlined by Mr. Lee A. Paine in his Research Paper PSW 68-1971 published by the Department of Agriculture. There are two ways of approaching such a

system so far as a lawyer is concerned. One way is from the plaintiff lawyer's viewpoint and the other is from the defense lawyer's viewpoint. A plaintiff's lawyer would approach such a system by showing that it obviously does not work and the fact of injury or damage to his client is evidence to support his conclusion. He would argue that reliance on such a hazard rating system should not be a basis for relieving a landowner from liability. Whereas the defense lawyer will claim that the use of such a system by his client is reasonable under the circumstances and the fact that one tree which caused damage or injury was not detected or that its potential hazard was underrated should not result in liability for his client on the basis of negligence.

Personally I think such systems are a useful management tool to be used by an Administrator. But, as Mr. Paine acknowledges, they are not foolproof and it must be accepted that there will be those embarrassing moments when injury or damage will occur despite the use of such a system. In such circumstances liability is not going to be determined on the basis of whether such a system was or was not used. Rather liability is going to be determined on whether that particular tree or tree limb was or was not defected; and, if so, was the defect so obvious that the administrator knew or should have known that it existed and posed a potential hazard to some person who would be using the area for its intended purpose. Under such circumstances, a hazard rating system, especially if the tree that had caused damage had been one of the trees rated, could either be an asset or a liability to the defense lawyer depending upon whether the tree was rated as a high potential hazard or a low hazard. But if you do not have such a system whereby periodically the trees in a recreation area are surveyed and inspected and rated, it might be very easy for a plaintiff's attorney to make a public agency appear indifferent and insensitive to the matter of the safety of visitors to Public recreational areas which is not a desirable position for any Agency of Government, whatever the level.

#### SUMMARY

The liability of a Public Agency for the injuries or damages caused by falling trees or tree limbs is going to be determined first of all by whether the doctrine of sovereign immunity will apply to bar a claim. In the case of the Federal Government, this doctrine was partially waived by the Federal Tort Claims Act of 1948. Some States have also found that the doctrine is an anachronism of the past and should be abolished; or, where it is still alive and well, the Courts have sometimes found local Government entities were engaged in proprietary functions, therefore, the doctrine did not apply.

Once sovereign immunity no longer applies, liability as in the case of the Federal Government is determined on the basis of whether the Agency managed its property as a reasonably prudent person would have done considering the duty owed to that person in accordance with the rules of law in effect at the place where the accident occurred.

Though there are only a few number of reported cases dealing with death, injuries, or damages resulting from falling trees in Federal Recreation Areas, the Courts seem to universally find that the United States is liable for damages to injured persons. On the other hand, the Solicitor's Office has generally weighed the factual circumstances surrounding the accident and found or denied liability on the basis of its findings.

Hazard rating systems are used by the National Park Service particularly in the California National Parks where the incidence of damage appears the greatest. They are a useful management tool but they, like most systems, are not foolproof. However, a failure to use such a system might be used as a basis for finding of negligence at best or used to create the appearance of indifference toward the safety of the public at worst.

In view of the possibility and the fact that awards in the hundreds of thousands of dollars for personal injury or death are becoming more commonplace, it behooves all employees of Agencies at any level of Government-- Federal, State or Local -- to do more to protect the safety of those who use Recreation Areas if the funds collected from the taxpayers are to be used for the purposes intended rather than to pay damage awards.

# TRAINING NEEDS FOR FIELD PERSONNEL IN DETECTION, EVALUATION, AND CONTROL OF TREE HAZARDS IN FORESTED RECREATION AREAS

Peter Gaidula<sup>3</sup>

## INTRODUCTION

It is my plan here to set forth some ideas on training of personnel in detection, evaluation and control of tree hazards in forested recreation sites. In doing this I will not set forth a detailed outline of a training program. Rather, it is my hope that what I say - much of it based on first-hand experience in setting up a state-wide control program within the California State Park System - can be of some help to you in not only setting up training programs on the subject of tree hazard, but also in carrying out such hazard control programs. Going back to detailed training outlines for a moment, I believe these can be very helpful, and, for your information, our Forest Disease Recreation Hazard Committee has been working on such an outline for training personnel on this subject. We have assigned this task to several of our committee members and the project is pretty well on its way.

Some of us may be already involved in tree hazard programs involving one or several facets of such a program such as formulation of policy, technical guidance of field personnel, or even the actual carrying out of detailed field inspections for detection of tree hazard. We are from various Federal and State Organizations, each of which has its own resource management objectives. These objectives may be based on multiple use of the resources for production of timber, water, recreation, minerals, livestock and wildlife, as is the case with the U.S. Forest Service and the Bureau of Land Management. Or, the objective may be basically single purposes - that is, aimed at providing recreation, as is the case with the National Park Service and also with the California State Park System. Or, speaking again of single-purpose, it may be mainly power production, as with the Bureau of Reclamation at its dams, where recreation is allowed as a secondary benefit.

With the differing objectives of various organizations some may well ask how can I stand up here and even think of contributing anything of substantial use in training programs for tree hazard detection and evaluation and control. My answer is that I believe I can do just this. Why do I say this? Because despite varying overall resource management objectives from one organization to another, the overall objectives of an effective tree hazard control program on recreation sites should be substantially the same for all. These objectives are:

- (1) To achieve an acceptable level of safety from tree hazards by a control program aimed at reducing the potential for damage and injury to persons and property.
- (2) To avoid or keep to a minimum the damage to the environment resulting from removal of the hazards.

---

<sup>3</sup> California Dept. of Parks and Recreation, P.O. Box 2390, Sacramento, California

- (3) To keep costs reasonable and consistent with the level of safety prescribed by the top Administrators of the organization.

### IS TRAINING NECESSARY?

There are some who would question the need for a program of training in tree hazard control. I've had some Park personnel say to me, "I know a hazard when I see one. If the tree has a lean to it, I just order the tree taken down. I don't need a forester to tell me when a tree is hazardous." Well, there is one way not to have tree hazards - just remove the tree. But it is quite frequently neither the best way nor the right way. As professionals in forestry and plant pathology we cannot and should not accept this kind of approach. If we do, we are not living up to our professional calling. If this is the kind of thinking that prevails in your organization, it is up to you to do what you can to set it on the right track by proposing a policy or a program, if the need is apparent.

### SOME CONSEQUENCES OF TRAINING LACK.

When personnel managing recreation sites lack training and awareness of what tree hazard control involves, they may allow hazards to remain which should be controlled. Consequently this endangers people and property unnecessarily, and the legal consequences alone can be very serious. On the other hand, many untrained personnel have a tendency to overstate the seriousness of the hazard problem, and they may unnecessarily order trees removed or heavily pruned. This can lead to serious site degradation, physically and aesthetically, as well as result in needless expenditure of funds to do unnecessary work. Still another serious consequence of lack of training could be the failure to properly record and preserve the evidence at the scene of an injury or property damage. In later litigation, such omissions could seriously hamper the defense efforts of the Agency operating the Recreation site.

### TRAINING SHOULD BE BROAD SCOPE AND INCLUDE ENVIRONMENTAL CONCEPTS

A good training program on the subject of tree hazard must go beyond the mere teaching of recognition of a hazard. It should instill an awareness in the trainee that we are dealing not only with single trees or groups of trees containing hazards to campers and picnickers, but that we are also dealing with the environment of which the trees containing hazards are only a part. Whatever is done to these trees to remove or reduce the hazard will affect not only the tree trimmed or felled, it will also affect the other nearby trees and the general environment in the vicinity. How the hazard is controlled can have wide ranging effects on the environment within public use and administrative areas. A carelessly felled tree, for example, can wreck havoc within a campground environment. In addition to possible damage to buildings and other man-made improvements we have to consider potential damage to other trees and lesser vegetation. The value of trees damaged or destroyed during hazard control should be pointed out during training. What is the value of a tree in a campground for landscape and shade purposes? The basic value established by the International Shade Tree Conference is now \$10.00 per square inch of cross section at breast height. This means that a 10-inch coast redwood in our campgrounds is worth \$785 before adjustments downward for condition, location, and several other factors. A 20-inch tree is valued at \$3,140 for shade and aesthetics, while its stumpage

value based on 500 board feet of lumber at \$100 per thousand Bf, is \$50. As we can see, the landscape values are high dollar values.

Willis S. Wagner, formerly Forest Pathologist at the Pacific Southwest Forest and Range Experiment Station, fully recognized the need for looking beyond the individual defective tree and considering the multiple effects. In his publication, "Judging Hazard From Native Trees in California Recreation Areas" he wrote:

"This guide is intended chiefly for professional foresters charged with making safety inspections of trees in recreational areas. We assume that such men have a general background and understanding of the more common tree defects that may affect safety and of the causes of defects. We further assume that they realize that any decision made regarding hazard removal is likely to have multiple effects. Some of these effects may be undesirable when measured against the intended function of the area."

Dr. Wagner further stated:

"The removal of a defective tree, for example, may create an opening that allows greater wind action with the increased possibility of wind damage to the remaining trees. Excessive tree removal may reduce the attractiveness of a campground to the public, thereby impairing its usefulness. It is important, therefore, that a person conducting a hazard examination should be aware of all consequences of any contemplated action. His judgment on individual trees should be based on as broad and complete a background as possible."

#### THE TRAINING PLAN IN BROAD OUTLINE

The training should last not less than two days, but preferably longer, I believe at least three days or more are needed. The first day should be taken up in the classroom. The following two days should be spent mostly in the field to allow trainees to practice what was covered in the classroom.

Prior to the beginning of the course, certain background reading materials should be sent to each trainee. These could include manual sections of policy, procedures, publications on judging hazard, and on hazard evaluation and rating.

In the classroom slides and films showing various pathological indicators, and mechanical and structural conditions which contribute to tree failures are good teaching aids. Preserved specimens of conks and other indicators should be used to familiarize trainees with the indicators they will be most likely to encounter in their assigned areas.

A number of recreation sites in different forest types and situations should be examined and tree hazards in each type evaluated. As an example, a training plan for our personnel would include a visit to a site in a redwood forest; to one in a coast live oak forest; to one in a valley oak forest; to one in a landscape area of a historic park having mostly exotic species.

The field sessions as well as classroom sessions should consider not only control of hazard by working on the tree itself, but also, there should be constant discussion and consideration of alternatives not involving tree removal or heavy trimming.

#### THE VALUE OF HANDBOOKS GIVING POLICY, PROCEDURES, GUIDELINES AND STANDARDS FOR TREE HAZARD CONTROL

As in any worthwhile endeavor, organization of materials and resources are helpful in getting a job done, and this is also the case in carrying out training in tree hazard control. It is ideal if policies, procedures, guidelines and standards have been previously gathered together in a handbook on the subject of tree hazard control. This will be a useful training tool as well as a ready reference for the man in the field. To show you that I try to practice what I preach, for the past several months in our Department we have been in the process of doing just this. Our materials are now being brought together as a tree hazard control handbook which will contain the following:

- (1) Our booklet entitled, "Tree Hazard Control - Policy and Administration in the California State Park System."
- (2) Guidelines and Standards for Detection, Evaluation and Control of Tree Hazards.
- (3) Procedures for Tree Hazard Inspection, Including Use of Forms and Procedures of Information.
- (4) Hazard Rating.
- (5) Specifications for Tree Trimming, Felling and Bracing.
- (6) Reporting of Tree Failures on Appropriate forms - Part of the Cooperative Study with the Pacific Southwest Forest and Range Experiment Station.
- (7) Actions required following property damage and/or injury from failure of a tree or portion thereof. This is aimed at ensuring proper reporting, photographing and investigation of technical causes of failure and for preserving the scene and evidence, including portions of the tree or limb which failed.

## JOB SPECIFICATIONS AND TREE HAZARD CONTROL TASKS

Public safety from tree hazards in forested recreation sites is an important part of resource management and the tasks required in carrying out a tree hazard control program merit inclusion in job descriptions. Within a Ranger District or within a Park District having a number of park units or within a single large park, such as Sequoia National Park, it is desirable to have the same individual or individuals carry out the inspections and supervise the control work year after year. This important task should not be handed out to a different individual each year, perhaps, mainly because his workload happens to be light at the right time. The benefits of continuity of personnel are several: (1) Increased experience in detection and evaluation; (2) Better familiarity with the hazard problems of the recreation sites; (3) Improvement of quality and reliability of hazard detection and evaluation; (4) More successful application of environmental and arboricultural considerations during control work.

In the California State Park System the tree hazard control program is included within the job description of our District Park Foresters for each of our six Districts. Each district averages over thirty park units, all of which have tree hazard control problems. These range from those in massive redwoods and other species associated with the coast redwoods to ponderosa pine and associated species in mixed conifer types of the Sierra Nevada and from the Riparian Woodlands of large California or white oak and Fremont cottonwoods to many landscaped areas with both exotic and native tree species present.

Once again, the main point that I wish to emphasize is this: Tree hazard control is a very important task which deserves its rightful place as an established task within job descriptions.

### TRAINEES

It would be ideal if trainees would have a good forestry background in pathology, log scaling, relative strength of various woods, and arboriculture. We find, however, that more than likely personnel with forestry backgrounds who are to be trained in tree hazard detection, evaluation, and control will be deficient in one or several of these subjects. Assuming a trainee has a good background in all of these subjects, there still remains the job of fitting his particular background to the particular goals of the tree hazard control program. The emphasis in the application of forest pathology to a forest stand for production of a timber crop is somewhat different than it is in a forest stand devoted to recreation use. In addition to this, many foresters need to be trained in the fundamentals of arboriculture in order to supervise the control phases properly, particularly if contact work is involved.

The point that I wish to emphasize here is that in setting up the training program we must proceed on the basis that all trainees need to acquire particular background and orientation that is especially applicable to the tree hazard control program. We should not assume that they already have the special knowledge that this program needs.

## THE INSTRUCTORS

It is advisable that the instructors be selected from among those having experience and background in one or more facets of a tree hazard control program. Several different people can handle the classroom portions. For example:

- (1) Organization, policy and administration can be handled by administrative personnel of a district or a region.
- (2) Inspection procedures and tools and also reporting procedures and forms can be covered by District Foresters who have received previous instruction and have used the system.
- (3) Recognition of hazard can be handled by several people. For example, a forest pathologist can carry on the discussion of recognition of indicators, while the District Forester might discuss relative susceptibility of different species to the various defects and the relative wood strengths of various species.

In regard to keeping environmental damage to a minimum and in discussing specifications for tree work and ways to prevent environmental damage, environmental specialists within the organization such as landscape architects or tree foremen could be called on for participation. As a matter of fact, these may be the people to call on to write specifications for tree work if the organization does not already have such specifications.

## SUBJECT MATTER

The subject matter of a training program on tree hazard control can be grouped into categories as follows:

- (1) Organization policies, goals and administration as these pertain to the tree hazard program.
- ✓ (2) Inspection procedures and tools.
- (3) Reporting procedures and use of forms.
- ✓ (4) Recognition of hazard - through indicators and defects; susceptibility of species; relative strength of woods of different species.
- ✓ (5) Evaluation of hazard - discussion of the main elements of hazard and the use of a rating system.
- (6) Methods for reducing the hazard.
- (7) Specifications for tree work - their use as standards to guide the control work whether done by one's own personnel or by private contract.

## ORGANIZATION POLICIES AND ADMINISTRATIVE PROCEDURES

Training should cover the following points:

- (1) What is organization safety policy?
- (2) What is the inspection cycle desired, whether annual, semi-annual, or other?
- (3) Who has responsibility for the administrative and technical phase of the program - does Park Maintenance or Resource Management handle this? Does Timber Management or Recreation Management handle it?
- (4) What are the time objectives to be met for completion of hazard reduction or control work beginning from the date of detection of the hazard?
- (5) What portions of public facilities will be inspected? Will this include all roads and trails; are power lines included; are lease areas and concessions included?

## INSPECTION PROCEDURES, TOOLS

From experience there has developed a basic set of procedures and tools for making the field inspections. Let me mention a few of these:

- (1) Team Approach. At least two men should work as a team and, if possible, both should have completed training in control of tree hazards.
- (2) Basic Tools. Effective use of certain basic tools should be discussed. These include the hatchet, diameter tape, binoculars, clipboard, hand compass, and safety helmet.
- (3) Systematic Approach. The desirability of establishing a system of inspecting the trees within a camp unit or other facility should be stressed, so that the possibility of overlooking a tree or a condition in a tree is reduced. For example, in approaching a camp unit it might always be approached and inspected by beginning at the parking spur, then proceeding toward the center of the facility. Then systematically inspecting each tree by moving clockwise; likewise for each individual tree a suggested system is to begin at the ground level and proceed to the butt portion, then up the bole into the crown.

- (4) Marking of Trees. A numbering system is advisable to identify the trees in the notes and at the site. Whatever system is adopted, the trainees should be informed of this fact. A system that has worked well with our Department consists of a 1-1/2" x 1-1/2" square cut from roofing felt, on which a number is placed with lumber crayon. This is tacked to the tree with a roofing nail and left there until control work has been completed.
- (5) Location of the Trees. This will involve explanation of the use of a hand compass to obtain a reasonably correct bearing from the tree to a fixed object such as a campsite or a building corner. The distance can be obtained by pacing. It is well to have each trainee calculate the length of his pace during one of the first outdoor training sessions.

#### REPORTING PROCEDURES AND USE OF FORMS.

Proper recording of inspection notes and the later retention in the files of the notes is important to the agency administering a recreation site in case of litigation. Legal advisers from the California State Attorney General's Office have advised our Department that an agency that makes a systematic and conscientious effort to recognize and to remove tree hazards from areas of visitor concentration can be defended successfully in lawsuits. They further have advised that an agency must keep written records of work undertaken, in order to be free of liability.

The importance of good notes on inspection and work completion needs to be stressed during training. To do this the agency should provide a form or forms on which to record such notes. Such forms should preferably be Region-wide or State-wide forms so that each local unit or district need not design its own. Experience indicates the necessity for two separate forms to serve as follows:

- (1) Annual or periodic inspection form - for recording the complete inspection of an area or site.
- (2) Interim Hazard report - for reporting individual hazards found by local personnel during the period between annual or major periodic inspections.

The field inspection form should not only record the hazard detected with all the necessary descriptions of the hazard and the recommendations for its control. It should also provide a space for recording action taken to control each tree hazard listed.

A second form is necessary to take care of interim hazards; that is, hazards that appear in the interim between the major annual or periodic inspections. This form is initiated by anyone at the field level who finds a tree hazard. It is in essence a request for inspection and evaluation of this specific hazard by those assigned to do the tree hazard inspections.



8. Additional Remarks: (Continued)

INSTRUCTIONS

Only inspections for tree hazards made by District Park Foresters and other qualified Resource Management personnel are to be recorded on this form.

Print clearly with a No. 2½ pencil, or a pen with black, waterproof ink. Clear, dark, unsmudged notes are required for obtaining good clear copies.

Column 1 – Each tree on the report should be numbered consecutively, and tags with corresponding numbers should be placed on each tree and left there until hazard control work on that tree has been completed.

Column 2 – Enter diameter at breast height (4½ feet) to the nearest whole inch.

Column 3 – Use list of abbreviations given below for various species.

Column 4 – A numerical rating, based on a uniform system approved for departmental use, should be assigned each tree.

Column 5 – Locations of trees should be described by use of camp or picnic unit numbers, or building name or number, and by giving compass bearing (approximate) and distance, (accurately estimated or paced) of the tree from a fixed object such as a table, stove, cupboard, etc.

Column 6 – Indicate with an X the defects or conditions found. In describing location of defect, use of the following terms is recommended: root; butt (lowest six feet of trunk); bole (trunk portion above butt); crown; limbs; tops (conifers mainly).

Dead trees should be differentiated from snags on the following basis:

Dead tree – A standing tree of somewhat recent mortality. Its limbs, branches and bole are still essentially intact.

Snag – A standing remnant of a tree. It is devoid of most of its limbs and branches, and sometimes of a portion of its bole.

If further space is necessary, use space under Item 8, "Additional Remarks".

Column 7 – Typical tree hazard control actions that may be applicable include: site relocation; safety prune; crown reduction; fine prune; thin; fell; cable(s). Where felling is recommended, indicate if tree is to be limbed before felling; also, if tree is to be felled in sections. Where cables are to be installed, indicate wire diameters, and diameters of lag eyes and/or bolts. Indicate disposition of bole under Item 8.

Agency to accomplish work may include departmental Tree Crew (TC); Park Unit (P); Conservation Camp (CCS); or Contractor (Cont). Use abbreviations shown in parenthesis.

Item 8 – This space is provided for overflow notes from other columns, but especially for Columns 6 and 7.

Item 9 – All work must have the approval of the District Superintendent. When inspections are carried out by Resource Management and Protection Division personnel, approval of the Tree Hazard Program Supervisor will be required. All cabling, rodding, and cavity treatments must have approval of the Resource Management and Protection Division.

Column 10 – This is a very important part of this form. Unit personnel should record hazard control actions by dating and signing opposite the tree on which work was completed.

Distribution – Where District makes the inspection, District inspector sends two copies to Area. Sacramento Headquarters personnel making inspections will send two copies to District and two copies to Area.

After Work Completion – Area fills in Column 10, sends copy having original signatures to District Headquarters, and retains a copy for Area file.

ABBREVIATIONS FOR TREE SPECIES

CONIFEROUS

<i>Abies concolor</i> – white fir	WF
<i>Abies magnifica</i> – California red fir	RF
<i>Abies grandis</i> – grand fir	GF
<i>Cedrus deodara</i> – Deodar cedar	DC
<i>Cedrus atlantica</i> – Atlas cedar	CA
<i>Chamaecyparis lawsoniana</i> – Port-Orford-cedar	PC
<i>Cupressus guadalupensis</i> – Tecate (Forbes) cypress	TC
<i>Cupressus macrocarpa</i> – Monterey cypress	MC
<i>Libocedrus decurrens</i> – incense-cedar	IC
<i>Picea sitchensis</i> – Sitka spruce	SS
<i>Pinus contorta</i> var. <i>murrayana</i> – lodgepole pine	LP
<i>Pinus coulteri</i> – Coulter pine	CP
<i>Pinus halepensis</i> – Aleppo pine	AP
<i>Pinus lambertiana</i> – sugar pine	SP
<i>Pinus monticola</i> – western white pine	WWP
<i>Pinus muricata</i> – Bishop pine	BP
<i>Pinus ponderosa</i> Laws – ponderosa pine	PP
<i>Pinus jeffreyi</i> – Jeffrey pine	JP
<i>Pinus radiata</i> – Monterey pine	MP
<i>Pinus sebiniana</i> – Digger pine	DP
<i>Pinus torreyana</i> – Torrey pine	TP
<i>Pseudotsuga macrocarpa</i> – Bigcone Douglas-fir	BDF
<i>Pseudotsuga menziesii</i> – Douglas-fir	DF
<i>Sequoia sempervirens</i> – coast redwood	RW
<i>Sequoiadendron giganteum</i> – Sierra redwood	SR
<i>Thuja plicata</i> – western red cedar	WRC
<i>Tsuga heterophylla</i> – western hemlock	WH

BROADLEAF

<i>Acer dasycarpum</i> – silver maple	SM
<i>Acer macrophyllum</i> – big-leaf maple	BM
<i>Acer negundo</i> var. <i>californicum</i> – box elder	BE
<i>Aesculus californica</i> – buckeye	BU
<i>Alnus rhombifolia</i> – white alder	WA
<i>Alnus rubra</i> – red alder	RA
<i>Arbutus menziesii</i> – madrone	MAD
<i>Castanopsis chrysophylla</i> – giant chinquapin	CHI
<i>Eucalyptus</i> (various)	EUC
<i>Fraxinus oregona</i> – Oregon ash	OA
<i>Fraxinus velutina</i> var. <i>glabra</i> – Modesto ash	MA
<i>Lithocarpus densiflorus</i> – tanoak	TO
<i>Platanus racemosa</i> – California sycamore	SYC
<i>Populus</i> (Cottonwoods and Poplars) – various	COT
<i>Populus tremuloides</i> – Aspen	AS
<i>Quercus agrifolia</i> – coast live oak	CoLO
<i>Quercus chrysolepis</i> – canyon live	CLO
<i>Quercus douglasii</i> – blue oak	BLO
<i>Quercus kelloggii</i> – California black	KO
<i>Quercus lobata</i> – valley oak	VO
<i>Quercus wislizenii</i> – interior live	ILO
<i>Quercus garryana</i> – Oregon oak	OO
<i>Salix</i> Various willows	WIL
<i>Umbellularia californica</i> – California laurel	Laur

State of California – The Resources Agency  
**DEPARTMENT OF PARKS AND RECREATION**  
**TREE REMOVAL AND HAZARD CONTROL REQUEST**

PARK UNIT _____ DATE _____ 19__															
SUBMITTED BY _____, AREA MANAGER <i>(Signature)</i>															
Tree No.	Species	Diameter(s)	Height(s)	Dead tree	Leeper	Uprooting	Undermined	Root rot	Butt rot	Cracks	Weak crotch	Defective limb	Hangers	Other (explain)	DESCRIPTION OF TREE LOCATION (Give campsite numbers, distances, & directions from fixed objects)
<i>(Place X where applicable)</i>											<i>(Sketch tree location on reverse)</i>				
REMARKS: _____															
DISPOSITION OF WOOD: _____															
<i>(Continue on Reverse)</i>															
DISTRICT FINDINGS AND RECOMMENDATIONS:															
Hazard Ratings: NO. 1 _____ NO. 2 _____ NO. 3 _____ NO. 4 _____															
<i>(Continue on Reverse)</i>															
Work to Be By _____ Park _____ Inmates _____ Tree Crew _____ Highways _____ Contract _____															
Inspected By: _____ Date _____ 19__ <i>(Signature)</i>															
DISTRICT SUPERINTENDENT APPROVAL:															
_____ <i>(Signature)</i> Date _____ 19__															
ACTION TAKEN:															
Work on the above trees was completed on : NO. 1 _____ NO. 2 _____															
NO. 3 _____ NO. 4 _____															
_____ <i>(Signature)</i> Area Manager Date _____ 19__															

STATE OF CALIFORNIA RESOURCES AGENCY

DEPARTMENT OF PARKS AND RECREATION



It may appear that I am dwelling too much on training personnel on how to take notes. Gentlemen, we are dealing here with information which sooner or later could end up in a courtroom for critical examination. Therefore, the importance of clear, complete notes needs to be highly stressed. Let me give you a concrete example of the consequences of incomplete notes in our own Department. One summer in one of our campgrounds a dead limb fell during a wind and caused a concussion on a park visitor. A claim of \$18,000 was filed against the State of California. The question was raised by the investigators: When was the last date of inspection and of completion of consequent hazard control actions? A search of our records showed that this particular park was thoroughly inspected about a year prior to the accident. The park contains about five separate campgrounds, but the inspection sheet identified specifically only those campgrounds in which tree hazards were found. Where a campground was found to have no tree hazards, it was not mentioned at all in the notes. The result was that we found it difficult to prove we ever inspected this campground that year. Such omissions can be costly to an Agency, but they need not occur if trainees or even more experienced inspectors are required to state on the form "No tree hazards were detected in \_\_\_\_\_ Campground".

Each Agency will design these forms to fit into its own organization and personnel structure. I have passed around examples here of forms used at Sequoia and Kings Canyon National Parks and also of forms used throughout our California State Park System.

#### RECOGNITION OF HAZARD

Before they can properly evaluate a hazard, trainees must be taught to recognize what constitutes a hazard, a basic principle being that (1) There must be a potential for tree failure; (2) There must be a target in range, either persons or property. The recognition of the potential for tree failure requires a knowledge of what the casual factors in tree failure are. These may be grouped into two categories as follows:

(A) PRIMARY - That is predisposing conditions

- (1) Biological agents - Insects and diseases
- (2) Mechanical wounds; fire wounds
- (3) Structural conditions - weak crotches, strong lean
- (4) Environmental factors - winds

(B) SECONDARY - Contributing factors

- (1) Environmental

For our purposes here today it should suffice to say that each of the above mentioned topics should be covered adequately both in the class work and in the field practice sessions.

Now the second part of the principle: That there must be a target within range- Trainees should be made aware of the fact that it is necessary for the inspector to become familiar with recreationist use - patterns for each site - that is, when the use occurs, and where within

each camp or picnic unit. This information can usually be supplied by the recreation site manager.

## EVALUATION OF HAZARD

Having taught the trainee what a hazard is, we then must provide him with ways to size up the seriousness of the hazard. Dr. Lee Paine, who has studied the tree hazard problem in detail more than any other person I know, recently stated that tree hazard is really an art rather than a science. And, as you know, art can be approached in a number of ways. So it is also with evaluation of tree hazard.

One method that has been in use over the years and still is favored by many foresters is to examine the tree for defects and faults, think for a few minutes, or maybe longer, and decide that it is or isn't a potential hazard. Presumably, this deliberation includes all the necessary considerations of species susceptibility to failure, length of occupancy of site, class of failure, potential damage based on whether a limb or bole or butt failure is involved, and the value of the target.

The other method involves a somewhat more systematic, logical step-by-step consideration of the main factors involved in tree accident hazard. This method has the built-in advantage of enabling the examiner to rate the hazard on a numerical scale. Several systems using this method are now in use. Sequoia and Kings Canyon National Parks and also Yosemite have a numerical rating system based on evaluating two elements of hazard; namely, (1) Probability of failure based on condition of the tree and its defects, (2) The probability of impact combined with the value of the target. Each element is rated on a scale of values of 1 to 3. The two values arrived at for each element of hazard rated are added to give the hazard rating. A tree in very bad condition might sometimes be rated at 4. A maximum rating of 7 is possible using this system. George Briggs, Resources Management Specialist, has informed me that this system has worked very successfully at these Parks. Similar systems may be in use in other National Parks and elsewhere.

A more recently developed system has been published by the Pacific Southwest Forest and Ranger Experiment Station based on research work by Lee Paine. This takes four main factors in hazard, namely:

- (1) Probability of failure.
- (2) Probability of target impact - which is a joint probability that (a) the falling tree will strike a specific area, (b) that the area will be occupied.
- (3) Damage potential - based on failure classes. Limb failures have lowest potential; bole and butt failures have higher potential. Dr. Paine has published tables giving relative values for each failure class.
- (4) Target value - which is defined as the maximum possible loss if the target is involved in an accident.

In brief, this system involves multiplication of four values to arrive at a numerical probability or hazard rating. I have successfully used this system for hazard evaluation and have come to realize that it can be one of the most valuable training tools we have in preparing personnel to examine

and evaluate hazards in recreation sites. I'm sure that the system in use at Sequoia-Kings Canyon and Yosemite National Parks has similar advantages. Other advantages also accrue from the use of these methodical evaluation methods. First, they assure that the major factors in hazard are considered. Second, they help achieve a somewhat uniform approach to hazard evaluation throughout a Region or State. Third, it enables the Administrator to rank the hazards in order of priority and this can be helpful in planning expenditures for greatest return.

#### HOW TO CONTROL THE HAZARD - THE MOMENT OF DECISION

We have now brought the trainee to the moment of decision. His evaluation of the hazard under whatever system he has used appears high enough to warrant action aimed at control of the hazard. What recommendation will be entered under "Action Recommended" on his tree hazard report form? His training should have informed him that he has several ways to reduce or control the hazard. These are:

- (1) Tree work - That is, removal of the tree, or a portion of it, or the strengthening of the defects by bracing with rods, cables, or other types of supports.
- (2) Removal of the target - There are several ways to accomplish this including (a) Physical removal of campsite or picnic site, furniture, or other fixed property; (b) Relocation of the facilities outside the range of the potential tree hazard; (c) By some method of closure such as signs, fences, and barriers to keep the public out of the area; (d) Seasonal closure during storm periods.

Probably one of the most important things to stress in discussing ways to reduce hazard is that removal of live trees from recreation sites is the last resort and should be considered only after removal of the target has first been thoroughly considered. In other words, tree removal should not become too automatic a decision.

It is at this point also where environmental considerations come into play. If the tree is removed what will be its effect on the remaining forest stand. Will the opening increase wind velocities through the site and cause windthrow? Assuming tree removal is finally decided upon, it then behooves the examiner to recommend how it shall be accomplished so that minimum damage and destruction to the site occurs. He should have been made aware during his training that there are certain accepted techniques for minimizing damage during felling operations. Some of these include (1) limbing before felling; (2) removal section by section; (3) use of ropes to lower limbs and tops.

Let us suppose that the hazard can be controlled by tree pruning. Here is where he needs to have a background on tree pruning standards and specifications. Assume he checks the item "safety prune" under the recommendations column (Column 7). He needs to know what safety pruning includes. If the work goes out for bids to contractors, certainly they will want to know. This then leads me to one of my favorite subjects - specifications for tree work.

## SPECIFICATIONS AND STANDARD FOR TREE WORK - A VALUABLE TRAINING TOOL.

Written specifications for tree work can be an invaluable tool for an organization in its tree hazard control program. Why do I think so:

- (1) Specifications serve as minimum standards of work to guide not only an organization's employees but also any work done by contractors.
- (2) They assist an organization to achieve an acceptable and reasonably uniform level of tree hazard control and tree maintenance.
- (3) Well-written specifications for tree work are invaluable training aids for training inspectors of tree hazards.
- (4) They can result in monetary savings when properly used. For example, the inspector who is familiar with the various classes of pruning usually outlined in the specifications will also know that fine pruning is much more intensive pruning and therefore is more costly.
- (5) Savings may be realized during the bidding process, especially as tree surgery contractors become familiar with the specifications after repeated use.
- (6) Written specifications, when part of an overall program of tree hazard control and visitor safety, may be good evidence, in part, in case of lawsuits that an agency has a systematic approach to hazard reduction in public use areas.

# HAZARD TREE PROGRAMS IN THE NATIONAL PARK SERVICE

James M. Dempsey <sup>4</sup>

The program states that I will discuss the hazard tree programs within the Midwest Region of the National Park Service. Since the hazard tree problem exists within all areas of the National Park Service, I would like to discuss how some of the other Regions, including the Midwest Region, are handling this complex problem.

To begin with, the National Park Service has had hazard tree problems since Yellowstone National Park was first established back in 1872. In all probability during the early days of the Park Service the hazard tree situation didn't receive too much attention. I can envision an early day ranger removing a tree if it posed a threat to his particular ranger station or other buildings located within his area of operations. I don't feel that much emphasis was placed on trying to make the early day campgrounds safe from hazard trees.

Down through the years many changes have occurred throughout the National Park Service as well as with other federal agencies involved in recreation activities. One of the biggest events that occurred was the passage of the Federal Tort Claims Act of 1946. Here for the first time the parks could be held liable for a civil wrong. Needless to say, there were changes made in the way managers were to administer their areas. The torts covered by the act are almost necessarily those based on negligence and this word alone can encompass a wide range of situations.

I do not know precisely when the Park Service began to actively engage in hazard tree programs. I feel that more emphasis has been placed on this subject during the last 20 years than what had been done prior to 1946.

Since we have the hazard tree problem and will continue to have it, how do we administer it? At present, we do not have any written policy concerning this subject. It is generally assumed that we must deal with this situation until no more foreseeable hazards exist. Past legal decisions and monetary awards to visitors who have been injured and/or killed make it important that hazard tree work receive a high priority in the overall management picture. Under our present accounting system, we do have a category for this particular type of work. Money is requested by the field areas for hazard tree removal, but it seems that when cuts have to be made this is one category that gets "the axe" early in the budget cycle.

To assist the smaller field areas that couldn't justify a full time forestry crew, the Park Service established two tree crews in the early 60's, a Western and an Eastern crew. These crews, consisting of 3 to 4

---

<sup>4</sup>Assistant Regional Safety Officer, Rocky Mountain National Park, Estes Park, Colorado.

men in each crew, were provided with the necessary equipment and training to perform tree work. A schedule was established whereby these crews would move into an area and do the necessary tree work in such developments as campgrounds, picnic areas, housing and maintenance areas and around visitor centers --- places receiving high use from people. In order to obtain the maximum benefit from these crews it was determined that no clean-up work would be done by them, this would be the responsibility of the area personnel. Occasionally this policy creates some problems in areas that only have one or two maintenance people for cleanup purposes.

Today, only one tree crew, the Western crew, is still functioning. In the late 1960's the Eastern crew was abolished.

The larger parks in the system, mainly West of the Mississippi, are able to justify maintaining full time forestry crews. Some of the larger Eastern parks do have tree workers on their staff. In fact, when the Eastern Tree Crew was abolished, personnel were moved into different areas within the East. These people, because of the skills developed while on the tree crew, were able to conduct hazard tree surveys within their areas.

The people who handle the hazard tree problems within the Park Service usually are the rangers who have a forest management or recreation degree. However, there are people on forestry crews, who, because of the field experience gained throughout the years, are quite capable of and do perform hazard tree surveys. If there would be any question about a particular tree then they would consult with the Resource Management Specialist.

Publications produced by the Forest Experiment Station on hazard trees are obtained and used as a guide. Dr. Paine's guide was used by personnel in a number of our Regions and from that, modifications were made. I can recall when I was stationed in Sequoia and Kings Canyon National Parks, 10 years ago as park forester, that I used a hazard tree publication from the Pacific Southwest Station entitled, "Judging hazard from native trees in California recreational areas ... a guide for professional foresters" by W.W. Wagener.

Southeast Region personnel do use Dr. Paine's publication. One of the big problems in that Region is trying to keep up with removal of the large limbs on the deciduous trees that become hazardous.

Presently the areas that are without tree workers have to contract with commercial tree outfits to perform the hazard tree work. Lately, this cost of contracting is increasing to the point where small areas cannot afford this service. I do not know how we are going to solve this problem other than keep asking for increases through the budget processes. The present Southeast Regional Safety Officer feels that areas within that Region are getting way behind in their hazard trees program because of this lack of funds.

The hazard tree program within the Midwest Region varies from area to area. The areas have Dr. Paine's publication and use this as a guide. Yellowstone National Park personnel know from past experience that lodgepole pine presents one of the most serious hazards within that park. The problem arises from the high wind conditions which cause the "blow downs." Through knowledge gained over the years, the Park has concentrated on the lodgepole pine when hazard tree work is done. A hazard tree survey is carried out on an annual basis by the employees assigned to the Resource Management Specialist. Yellowstone does have a policy indicating immediate removal of obvious serious hazard trees.

The most comprehensive plan for a hazard tree program is used in Yosemite National Park, and Sequoia and Kings Canyon National Parks. These three parks have an active program, restricted only by priorities of funding.

I wish to quote a memorandum that George S. Briggs, Resource Management Specialist of Sequoia and Kings Canyon National Parks prepared on the rating system:

"The hazardous tree rating system used in these parks comprises two basic elements. One relates to the tree itself, i.e., the relative degree of chance of imminent failure. There are three degrees, numbered 1-3, with 3 representing the highest chance for imminent failure. Assessment of a value depends upon many factors, such as the effects of the various pathogens on the structural soundness of trees, including roots, base, bole and limbs. Other considerations may be mechanical structural defects such as damage from lightning, heavy equipment, etc.

In some cases an additional value point may be added if a tree exhibits an unusually severe lean. As an example, a tree affected by a pathogen causing extensive rot of the main bole and which also leaned heavily, would be given a value of 3 for the structural defect and 1 for the lean, with a final value of 4. This value would indicate the chance of imminent failure was of the highest category.

Element #2 relates to the type or extensiveness of damage and/or injury which would probably occur if the tree failed. The values for this element are similarly rated 1-3, with 3 being the highest, i.e., a tree rated 3 under this element could be expected to do extensive damage or cause injury or death upon failure. As an example, a large tree leaning over a cabin or a number of campsites would be rated as a 3. One on the periphery of a campground leaning away from campsites would be rated as a 1. If it failed, its chance of causing extensive damage and/or injury would be low.

The value of both elements is combined for each tree, and it results in a combined value which is equivalent to the priority for removal. The highest priority is a 7, and a 7 indicates a highly defective leaning tree which will cause extensive damage and/or injury upon failure. The lowest priority which could be assessed is a 2.

Outstanding features of the system used are:

- (1) When the system is applied by knowledgeable technicians, experience over the years has shown that priority values arrived at for given trees are normally the same, but in any event seldom differ by more than one point. Assessment of priority can be considered reliable.
- (2) By assigning priorities to individual hazards, funds which may be available may be expended most efficiently. Trees whose failure is most imminent and in falling will cause the most extensive damage and/or injury may be removed first."

Along with this rating system, forms have been developed (copy enclosed) that provide an accurate record of hazard tree location and work performed or action taken. Besides the form used by the Forestry Technicians, there is a local form that can be used by employees or residents to report a possible hazard tree.

By using the above system it is evident that the established trails within Park Service areas receive a lower priority in regards to a hazard tree reduction program. This is one category which can generate quite a bit of discussion between management and members of the Solicitors Office. The discussion would pertain to the legal aspects of hazard trees along established trails. The question, "To what extent do we go in removing these trees?" The Superintendents know that they have an obligation to make their area as safe as possible and would not hesitate to perform work on trails if funds were available. Lately the majority of our efforts have been expended within developed areas because this is where visitors are concentrated.

Throughout the years tort claims have been submitted by park visitors damages and/or injuries incurred from falling trees or limbs. Not all claims have been awarded in favor of the claimant because the Park Service was able to show in some instances that a reasonable and prudent effort was made to reduce the hazards within the area where the accident happened.

In my present position as a Safety Officer I have the opportunity to visit 26 of the 52 areas within this Region. When I visit a small area, I do look over the hazard tree situation and if necessary, make recommendations to the Superintendent. The Superintendent in turn will arrange to have the Western Tree Crew visit the area to do the necessary work. Because of the availability of the Western Tree Crew I do not have to initiate any hazard tree programs within this Region.

In concluding, because of the management practices and philosophy of the National Park Service, our hazard tree problems are not going to diminish. When a development is established within a mature to over-mature forest, a continuing problem results. Trees will inevitably die from one cause or another and necessitate removal. In the future we must minimize the number of new developments within the park boundaries. At present we will work with existing circumstances and keep in mind the safety of the visitor and employees as well as the aesthetic values of the park.



RETURN TO RESOURCES MANAGEMENT  
SEQUOIA AND KINGS CANYON NATIONAL PARKS  
Individual Hazardous Tree Report

Do Not Use This Block

Report No. \_\_\_\_\_  
Unit \_\_\_\_\_  
Date Received \_\_\_\_\_  
Received By \_\_\_\_\_  
(Reverse Side for Disposition)

Date \_\_\_\_\_

Complete Location \_\_\_\_\_

Nature of Hazard

Rot, dead limb, etc.

Sketch location of trees; show in reference to buildings, roads, trails, etc.

Species \_\_\_\_\_

Diameter (4.5 ft. above ground) \_\_\_\_\_

NPS      Concessioner      Other

Remarks \_\_\_\_\_

Signed \_\_\_\_\_

Title \_\_\_\_\_

|  
N  
|

Location Map - Orient top of card with north

1. Initial Inspection Assigned to: \_\_\_\_\_ Date \_\_\_\_\_  
Action Recommended:

Signature \_\_\_\_\_ Date \_\_\_\_\_

2. Follow-up Inspection Assigned to: \_\_\_\_\_ Date \_\_\_\_\_  
(If necessary)  
Action Recommended:

Signature \_\_\_\_\_ Date \_\_\_\_\_

3. Disposition: Foreman Assigned To: \_\_\_\_\_ Date \_\_\_\_\_  
Hazard Removed \_\_\_\_\_ Date \_\_\_\_\_  
Foreman (Signature)

Adjudged Non-Hazard or Low Hazard \_\_\_\_\_ Date \_\_\_\_\_  
Resources Management (Signature)

## TREE HAZARD PROGRAM AT ROCKY MOUNTAIN NATIONAL PARK

David B. Butts <sup>5</sup>

In contrast with the West Coast parks -- those with the giant sequoias, redwoods, coastal Douglas-fir -- the magnitude of the hazard problem in this park is relatively simple. The majority of our trees are under 50 feet tall and under 24 inches in diameter, so the matter of assessing hazards is simplified. Also, within our developed areas we have essentially only four species of trees that give us any significant problems. These are the ponderosa pine on the lower portions of this side of the park, with lodgepole pine, subalpine fir and the Engelmann spruce at higher elevations. Of these species, only the ponderosa pine has a significant amount of hazard limb problems. Most of the rest of the species have relatively small limbs, particularly those in the growing developed areas, so it's mainly a problem of assessing bole and root hazards.

### PROGRAM ADMINISTRATION

The National Park Service has yet to adequately define responsibility of a field area to carry out a hazard tree program other than the fact that the Superintendent is responsible for all park operations. This does not put an individual park in a good position for establishing and maintaining a sound hazard tree program, and Rocky Mountain, I think, is a typical example. While it is one of the larger parks in this region and has a full time Resource Management Specialist on its staff, there are no firm guidelines on how a hazard program should be assessed, and so the results have been sporadic over the years.

Previously various titles have been used, including the Park Forester. The name "Resource Management Specialist" does not necessarily imply a professional forester. It may be a professional wildlife or fisheries management specialist or virtually any of the associated fields. So this sets the stage for highly variable degrees of forest management and hazard control programs in the parks.

### TREE FAILURES

Typical of tree failures in the park are those associated with some mechanical injury at the site of failure. Most failures occur during the wintertime, particularly on the east slope where trees are subjected to high velocity winter winds. In ponderosa pine, the systematic analysis of hazards is very important, as in the case of mid-bole failure. One such case was a 20 inch dbh pine that failed 20 feet up the bole. It had

---

<sup>5</sup> Resource Management Specialist, Rocky Mountain National Park, Estes Park, Colorado.

previously been hit by Mountain Pine Beetle only on one side. Blue stain fungus had spread up and down the bole, and the bark had sloughed off a strip about a foot wide and ten feet up the tree.

The exposed sapwood had cured and become brittle. This happened to be on the windward side, and when the high velocity winds occurred, the brittle wood cracked.

In 1972 we had quite a period of high velocity winds which broke numerous large, mature ponderosa pines in the Park Headquarters area particularly. These were 200- to 300-year-old trees over 24 inches dbh. At that time, an assessment was made through increment borings of the sound wood remaining in those trees which had failed. We came up with about five inches of sound wood around the tree; no trees had failed that had more than that thickness. The remainder of the ponderosa pine over 18 inches dbh were sampled with increment borer, and those in which rot was found within six inches of the bark were removed. One sampling problem did crop up; that occurred when we had just small pockets of rot on each side of the tree when the samples were taken. We were criticized somewhat for excessive removal of trees, which means, I guess, that we should have taken four increment borings to assure that the tree was in fact rotten clear through. Most of these larger diameter trees are in the age class of 200-300 years, and replacement is impossible within the life of the Headquarters area.

At the Hidden Valley Ski Area we have a prime example of the dilemma for a park superintendent, particularly under existing policy. We have a ski development in a known area of high velocity winds. The latest wind, which occurred in May of this year, caused 350 trees to fail and fall onto the slopes of Hidden Valley Ski Area, and almost half a square mile of trees were flattened in the general area. This was preceded in 1948 by a smaller blowdown, so we have at least two occurrences of high velocity winds, causing tree failure. Some of these trees fell onto the lifts, which could have caused severe injury to anyone riding the lifts at that time. Quite a few of them fell onto the slopes at various angles and would have created considerable hazard to skiers on the slopes at that time.

There was a bidirectional pattern to the falling of the trees, actually 90° to one another. Apparently two gusts of wind hit the area in a short time, with one layer of trees falling in one direction and the other falling at 90° to them, indicating some turbulence in the area. Sound trees were sheared, virtually with equal ease, along with trees with obvious butt rot and some forked trees that split in the vicinity of developments and damaged the tows.

We have here a large threat to public safety. At the same time, if we were to recommend closure of the Hidden Valley Ski Area on these grounds, I seriously doubt that politically this would suffice. We stand at this point, going into a ski season with a known extremely high hazard to the Park visitor. These two blowdowns have straddled our ski season. One occurred in November, generally before the ski season, and one occurred in May, generally after the ski season, with a very good probability that a third blowdown can and will occur during the operational period.

In addition to this type of failure we also have the typical mechanical injury to trees in and around developments, where rot is introduced to the tree at a relatively minor point, generally right at the base. This may be covered up in a short period of time with pine needles and not be obvious until stress is placed on the tree by wind or other action (snowload, etc.), at which time the tree fails. Sometimes an old lightning scar will provide this same injury for the introduction of rot.

There are advantages to building log cabins, one of which is that it can hold up trees that fall. A cabin in Hallowell Park did withstand about a 22-inch diameter ponderosa pine falling across it, with the exception of one limb which penetrated the bathroom ceiling. Fortunately this was an unoccupied cabin. However, this failure does point out the fact that hazards are predictable. Within 100 yards of this particular tree was an identical stump failure, where mechanical injury to the base of the tree had permitted the entrance of root rot. A colony of carpenter ants had moved in, further weakening the windward side of that tree. We could have predicted that this would occur, had we had opportunity to assess all the trees in the area.

One occurrence which is not purely pathogenic is the establishment of corrals within forested areas where, through the extreme nutrient enrichment from the manure, you end up with mortality of the trees and after mortality, then you have in fact standing hazard trees.

#### HAZARD CONTROL PROGRAMS

The problems in Rocky Mountain National Park are not unique. However, I think they are indicative of the fact that we have a long ways to go in the National Park Service in a systematic hazard tree program which assures visitors of all the parks that what is considered standard procedure for protecting them in one park is also a standard procedure for protecting them in another park. Jim Dempsey, as Assistant Regional Safety Officer, has no small job in trying to see to it that our safety program becomes a uniform procedure throughout even one region.

We have, in this park, a hazard tree report form through which we document those trees that are in need of attention. However, the prime weakness of the system is the lack of adequate criteria for field personnel to use in assessing the hazards. The first step is a matter of training personnel closest to the source of the problem. We hope that we will be able to improve our program.

The four-man resource management crew conducts control activities at the expense of "soil and moisture control." This account is currently referred to as maintenance of natural resources. It covers all our restoration and rehabilitation programs in our developed areas. Hazard

trees have been handled even though no fund increase was set aside for that purpose. There is barely enough to pay salaries three months a year, but we hope that we will be able to correct that. The Service's "Western Tree Crew" has assisted us on occasion, but they are intended to be used only for complex pruning of high value trees or complex felling jobs. The types of problems that exist in this area are generally handled by felling and removal. Some of these are sound trees at the top of cut slopes along roads where, through their physical location, they have been undermined and are known to be a hazard. The sloughing of the cut slopes is progressing, and we know the trees will come down the slope onto the roadway sometime.

We have not only pathogenic trees but also trees that are hazardous by their physical location. We have initiated a documented program at Rocky Mountain; however, limited funds have hampered the initiation of the truly systematic control of hazard trees that we now know how to administer.. Greater administrative attention is needed to this facet of park safety and appears to be materializing.

## FOMES ANNOSUS IN FOREST RECREATION SITES: MANAGEMENT IMPLICATIONS

Neil J. MacGregor <sup>6</sup>

Yosemite Valley, like many sites in the lower coniferous belt of California's Sierra Nevada, originally supported an oak forest containing scattered ponderosa pines, incense-cedars, white firs, and other trees. In the years since the National Park was established dense, young-growth stands, mainly pines, have replaced much of the open space. These pines now average 30 inches in diameter, ranging up to four feet. Most of the Valley's campgrounds and administrative sites are located in these stands. Visitor and resident use now is as great in Yosemite Valley as in any western forest.

Following the discovery of several trees infected by Fomes annosus (Fr.) Cke., the National Park Service asked the Forest Service to make a biological evaluation of the disease in Yosemite Valley. This evaluation is a cooperative project of the California Region of the Forest Service and the University of California, Berkeley.

All developed sites in the Valley were examined for evidence of F. annosus centers using several survey aids, principally aerial photographs, detailed stand maps dating from the 1930's, and systematic ground coverage. The survey revealed numerous active centers in many sites: more than 100 centers were found; these ranged in size from single stumps to half-acre openings; these centers totalled about six acres within which some 500 pines, 100 cedars, and 10 white firs had been killed, presumably by F. annosus in combination with other agents. The centers are thought to range in age from one to 35 years; a radial spread rate of three to five feet per year was deduced from measurements in the largest and oldest centers, for which early stand maps were available.

The results of the survey make possible several observations that bear on the future management of Yosemite Valley for visitor accommodations:

1. Although Fomes annosus has been known there since 1966, the extent and intensity of the infection was unsuspected until the survey was made.
2. In dense stands, annosus centers will continue to enlarge, killing virtually all pines and cedars as they do.
3. Infected pines tend to be killed by bark beetles before root decay is far advanced.

---

<sup>6</sup> Division of Timber Management, Forest Service, San Francisco, California.

4. Infected cedars tend to decline more slowly than pines as their roots are destroyed; as a result, cedars in or near annosus centers are potentially more hazardous than pines.
5. Oaks growing in the centers appear undamaged by Fomes annosus, despite long exposure.
6. With proper training, experienced technicians can easily identify annosus centers and can correctly diagnose most infected trees in them.

Even without consideration of possible control measures, there are a number of management implications for Yosemite Valley. The unrestricted spread of the disease -- both by center enlargement and through the formation of new centers -- will eliminate much of the pine forest in the choice, developed parts of the Valley. As yet, no evidence of center arrestment, except in the absence of suitable hosts, has been observed. Although this is not necessarily undesirable, many sites will suffer severe degradation. Revegetation will be needed in some, if they are to continue to be used for their present purpose; in others, the management goal will have to be reexamined. The removal of dead trees will be an increasingly demanding chore, and the identification and removal of hazardous trees, especially cedars, will require an increasingly greater effort.

Despite the importance of these considerations, the survey results may have an even more basic implication for the management of Yosemite Valley, and, by extension, for other recreation forests in California and the West.

When it has been shown, for a particular site, that an unsuspected condition of this importance can be detected with comparative ease, is there not an obligation to survey other sites? Fomes annosus is known to occur throughout California, and has been reported from a number of recreation sites. As a result of the Yosemite survey, the cooperative project with the University has been extended to deal more fully with detection problems. Low-level aerial photography is being studied as a means of rapid, inexpensive coverage; diagnostic guides for annosus-infected trees are being developed; other surveys are planned for other locations; and decision guides for the removal of hazardous, root-diseased trees are being developed.

Managers of infected forest recreation sites unavoidably face the need to integrate the effect of Fomes annosus into their management plans. Already, center-by-center decisions concerning control or the adjustment of use patterns are needed in Yosemite Valley. Present knowledge will permit little more than a listing of sites in which management alternatives should be developed. Some of the management alternatives to be considered are the following:

Prevention: The use of powdered borax to prevent colonization of newly-cut pine stumps. Stump treatment with borax has not been tested as an operational method in the West, although limited-scale studies suggest that it should be tested.

Fumigation: The removal of trees, stumps, and large roots, followed by soil treatment with fungicides. Efficacy has not been demonstrated and cost is extremely high; the method probably never will be used widely.

Containment. Replacement of susceptible species with non-susceptible plants. In principle, discrete annosus centers could be eliminated -- in time -- if an uninfected protective zone were treated along with the center. This method has not been attempted in the West.

Inter-planting: The introduction of less susceptible plants into a deteriorating annosus center. Not tested in the West, this method could be undertaken either as a short-range or long-range measure. As yet, the response of candidate plants (shrubs as well as trees) under field conditions has not been studied.

In the coming years University and Forest Service efforts, under the cooperative project, will be devoted increasingly to the development of management strategies for annosus-infested forest recreation sites.

AERIAL PHOTOGRAPHS USED TO DETECT INFESTATION OF  
JACK PINE FORESTS BY DWARF MISTLETOE

John A. Muir<sup>1</sup>

Today I would like to give a brief progress report on our work using aerial photographs to detect infestation of jack pine (*Pinus banksiana*) by dwarf mistletoe (*Arceuthobium americanum*).

As you may know, *A. americanum* occurs on jack pine from central Alberta to western Ontario - a geographical range of approximately 1200 miles. As a basis for determining impact of dwarf mistletoe, we need methods for extensive surveys of infestation. Remote sensing of forest diseases was reviewed in the 20th W.I.F.D.W.C. proceedings by John Wear. Aerial photographs were previously used by Anderson (1949) and Meyer and French (1966, 1967) to detect openings caused by eastern dwarf mistletoe (*A. pusillum*) in black spruce (*Picea mariana*) forests. Baranyay previously reported to this conference that large-scale, oblique photographs were useful for detecting *A. americanum* on lodgepole pine (*P. contorta* var. *latifolia*). Murtha (1972) reported that damage caused by dwarf mistletoe could be detected on aerial photographs.

In 1972 our laboratory undertook a low-level, aerial survey of dwarf mistletoe infestation in northeastern Alberta for the Alberta Forest Service. During the survey, J. Robins and J. Susut noticed on aerial photographs circular openings 50 - 300 ft. diameter in the canopy of a forest which was rated infested. Our ground and low-level aerial checks showed that openings were associated with infestation by dwarf mistletoe. Mistletoe-infested trees occurred at the periphery of, and extended 100 - 200 feet from openings. Dead and dying infested trees were present at the periphery of openings. Alberta Forest Service aerial photographs of a 1200 acre forest in 1952 and 1972 showed an increase in numbers and size of individual openings in the 20 year period. We reported (1973) these findings.

Subsequently we determined if infestation by dwarf mistletoe could be effectively surveyed by means of detecting openings. Two objectives of the work are: can openings caused by infestation be distinguished from other openings; and how often are openings associated with infestation? The approach we used was to compare photo interpretation of Alberta Forest Service photographs with the results of our previous low-level aerial survey.

---

<sup>1</sup>Northern Forest Research Centre, 5320 - 122 Street, Edmonton, Alberta, Canada

Procedures for the low-level aerial survey were described in a recent Forestry Report (1973), and more detailed reports of methods and apparatus are being prepared. For photo interpretation we randomly selected 40 of 160 photographs (scale 1:21,000) which were situated in the survey area (1800 square miles). Openings which were present in a 1 sq. mi. plot in the centre of each photograph were plotted on copies of Alberta Forest Service maps. We then superimposed the data of the low-level aerial survey on the maps. Areas of forest stands were determined using a dot grid, and data of tree heights and ages were taken from the maps.

Openings were determined by a student assistant who used a 2x pocket stereoscope. Openings previously determined to be infested were used as standards to judge infested openings.

Our results and a subsequent ground-check indicate that we could distinguish infested openings with a high level of confidence. Some of the distinguishing characteristics of infested openings include: circular boundaries, 50 - 300 ft. diameter; "ragged" margins of openings; association of several openings and "patchy" stands; and increase in size of openings in sequential (1952 and 1972) photographs. We were unable to distinguish between individual infested and non-infested trees.

Data showing the association of openings on photos and infestation determined by the aerial survey are shown in the table. Stands with one or more openings or with 0.1 in. or more of line indicating infestation were rated as infested. More total area was rated infested from aerial photos than was found from the aerial survey. Possibly the difference can be attributed to the greater precision of aerial photographs. For individual tree age and height classes there were several differences, but overall the results were very similar. A regression analysis of the infested area by each method (individual totals were weighed by the proportion of each age-height class to the total area) gave a high correlation ( $r = 0.97$ ).

Therefore we concluded that determination on conventional photographs of openings caused by infestation is very promising for surveys of dwarf mistletoe on jack pine.

In future work there are three questions to explore: 1) can aerial photographs be used for detection in other areas of infested jack pine; 2) are there other photographic methods of detecting infestation; and 3) what is the cause of mortality associated with infestation.

In using aerial photographs to detect dwarf mistletoe in other areas, a possible difficulty is where pine is intermixed with other species such as white spruce (*Picea glauca*). In a few instances found in Manitoba, spruce filled in the openings caused by infestation of jack pine. On conventional aerial photos spruce and pine are not easily distinguished. Thus, other methods of detecting infestation might be needed. Recently a project was initiated with the Canadian Centre of Remote Sensing to obtain colour and infrared colour photographs at scales 1:10,000; 1:40,000 and 1:120,000 of the infested jack pine examined in the present study. Photographs from the E.R.T.S. satellite also will be examined.

Mortality of infested jack pine was the major factor allowing detection of dwarf mistletoe infestation. Causes for the high mortality are presently unknown, and we need to determine the role of secondary factors such as insect attacks or root rots associated with infestation. In any event, mortality of infested trees is apparently a major effect of dwarf mistletoe infection of jack pine.

Table 1. Dwarf mistletoe infestation of jack pine as determined by low-level aerial survey and by aerial photographs.

FOREST TYPE		FOREST AREA				
AGE CLASS	HEIGHT CLASS	TOTAL	INFESTED			
years	ft.	ac.	SURVEY		PHOTOS	
			ac.	(% total)	ac.	(% total)
21-40	1-20	3026	164	(5.4)	77	(2.5)
	21-40	3276	575	(17.6)	680	(20.8)
41-60	21-40	8007	2011	(25.1)	2880	(36.0)
	41-60	2132	8	(0.4)	671	(31.5)
61-80	21-40	134	32	(23.9)	32	(23.9)
	41-60	8047	3080	(38.3)	3767	(46.8)
	61-80	2118	1278	(60.3)	1322	(62.4)
81-100	41-60	261	146	(55.9)	146	(55.9)
	61-80	61	32	(52.5)	0	(0.0)
101-120	61-80	2518	1379	(54.8)	2321	(92.2)
121-140	61-80	296	250	(84.5)	243	(82.1)
	81-100	304	291	(95.7)	291	(95.7)
TOTALS		30180	9246	(30.6)	12430	(41.2)

Literature cited.

Anderson, R. L. 1949. The black spruce dwarf mistletoe in Minnesota. Ms Thesis, Univ. of Minn., St. Paul.

Canadian Forestry Service. 1973. Forestry report: Forest insects and disease. Vol. 3 No. 2. Northern Forest Research Centre, Edmonton, Alberta, 8 p.

Meyer, M. P. and D. W. French. 1966. Forest disease spread. Photogrammetric Engineering 32:812-814.

Meyer, M. P. and D. W. French. 1967. Detection of diseased trees. Photogrammetric Engineering 33:1035-1040.

Muir, J. A. and J. K. Robins. 1973. Detection of dwarf mistletoe of jack pine on aerial photographs. Plant Dis. Repr. 57(11). In press.

Murtha, P. A. 1972. A guide to air photo interpretation of forest damage in Canada. Canadian Forestry Service Publ. no. 1292. 63 p.

# THE NATURE AND DISTRIBUTION OF *ARMILLARIA MELLEA* INFECTED ROOT MATERIAL IN A YOUNG PINE FOREST

Charles G. Shaw III<sup>1</sup>

## Introduction

It seems appropriate when talking on *Armillaria mellea* to refer to things that have been said about this problem in the past. Those of you that have done this know just how voluminous, confusing and oftentimes contradictory this literature can be. One statement that I ran across about 2-1/2 years ago, in of all places the 12th WIFDWC proceedings, is perhaps one of the most profound statements that has been given on the *Armillaria* situation as it exists in our forests today. "It seems unlikely that a satisfactory understanding of disease problems caused by A.M. will be found tucked away in some far-off library. It is more apt to emerge from the efforts of energetic plant pathologists investigating the physiology of host pathogen interactions."

Well, with this insight as backup and perhaps an even weaker mind than I was later to realize my back was, I decided to tackle the problem in the woods. In doing this, it didn't take long to realize that all of the action was underground and so I slowly became involved in subterranean epidemiology - more commonly known as root digging.

## The Area

This work is being carried out in an area known as the Klickitat working circle in Washington State. This is just outside of Glenwood, Washington, and in the foot hills on the southwest slopes of Mt. Adams.

Throughout much of this pine forest mortality of trees in all age classes is conspicuous in the form of off-color trees, dying and dead trees, and standing snags. So many trees have fallen that the ground is littered and unproductive. Openings too large to be acceptable to forest management, occur throughout much of the stand. The root rot fungus *Armillaria mellea* is consistently associated with dead trees. Damage is so severe that in some localities, often involving 200 acres or more, negative growth increments are inevitable. In larger areas where severity is moderate the foresters figure they are

---

<sup>1</sup>Department of Plant Pathology, Washington State University, Pullman, Washington

losing 1/2 their annual increment to A.M. Conservative estimates based on long-term annual disease cruises by St. Regis foresters place volume losses through A.M. mortality at 6.5 million board feet annually on the Klickitat working circle (614,500 acres). The problem is easily recognizable by visual appearance alone.

This pine area where my studies were conducted has a history of selective logging with cuttings in 1941, 1952, 1963, and 1965. This has left numerous 30" to 60" stumps in the ground. These stumps appear to be at the "root" of the problem as it now exists.

Of course the classic A.M. problem as reported in the literature is in a cut-over hardwood area that has been replanted to conifers. The hardwood stumps serve as a suitable long-term food base and soon the conifers (which are perhaps under some form of stress) start to die with typical A.M. symptoms. This is not the case at Glenwood. Here A.M. is apparently acting as an aggressive pathogen that has developed in the managed pine forest.

The A.M. pockets are most often associated with the old growth pine stumps that remain in the ground. This is in contrast to the situation in England where Redfern states, "A further significant feature of the life cycle of this fungus is that although it may kill both hardwood and coniferous trees and occupy the stumps of both species, only hardwood stumps appear to provide a suitable base from which the fungus can grow and infect young trees."

In talking with Redfern at the ICPP about his recent work and the situation as it exists in the pine forest I am familiar with, he slowly is beginning to recognize that coniferous stumps can definitely serve as a suitable A.M. food base. Apparently in the Glenwood area after initial establishment of the infection center around an old pine stump subsequent transfer is from young infected to young healthy pine.

In the fall of 1971 in conjunction with a 10 acre A.M. control experiment that Dr. Lewis Roth and I set up, some of these large old growth stumps representing all years of cutting were removed. Upon examination A.M. was found to be present on many of the stumps and pure cultures were obtained from the oldest stumps (1941) and the most recent (1965) stumps. This does not prove, but indicates that the 1941 stumps could have been serving as inoculum sources for 30 years.

In this same control experiment there were obvious progressive A.M. pockets. In this area all stumps, snags

and trees were mapped and recorded as to condition. The stumps and trees were then pulled individually from the ground and the root systems examined. Starting from what was considered to be the original source of infection and working out in 12' bands towards the healthy forest the following data was obtained:

Table 1. Occurrence of *Armillaria mellea* on the roots of small ponderosa pines, tabulated by 12' zones along a transect from a point of presumed origin of infection outward 168 ft. into a healthy stand.

Zone no. from point of origin	Total					Trees Infected	Basal Area Infected
	Trees	Dead Trees	Dead with Armillaria	Trees with Armillaria	Lesions		
	Number					Percent	
1	3	0	0	2	10	66	99
2	4	0	0	1	8	26	15
3	9	0	0	1	2	11	2
4	3	0	0	0	0	0	0
5	2	1	1	1	2	50	98
6	4	3	3	3	13	75	98
7	4	4	4	4	7	100	100
8	6	3	3	6	21	100	100
9	11	5	5	9	27	82	93
10	20	6	4	7	50	35	50
11	15	3	1	4	20	27	71
12	21	6	5	7	11	33	18
13	27	7	7	11	30	41	45
14	15	0	0	2	7	13	15

This information gave us an indication of what was happening

The data shows some of the things I had expected - a cyclic pattern with distance across the transect. *Armillaria* is still slightly active around the focus (zones 1 and 2). Then drops off in an area where all the larger older trees have died and decomposed; apparently the old roots have rotted away and young trees are coming in (zones 3 and 4). Now we move into the area where the fungus is present and very actively attacking and killing a high percentage of larger trees (zones 7, 8 and 9). This area might be called the "active margin" of the infection. We see a sudden drop as we move into an area of lesser activity (zones 10, 11, 12 and 13). This area might be termed the "advanced margin" of the infection. Zone 14 shows a sharp drop as we move into an area of supposedly "healthy" forest.

This general pattern was anticipated, however, the sharpness of the drop of infection as we move into the healthy stand was surprising. This led us to believe that we might be able to estimate the underground extent of infections in the healthy stand by going x number of feet beyond the area of obvious activity as seen by above ground symptoms. For all four of the transects examined the data for the first zones agree very well, but the healthy forest was never reached in three of the transects.

With the background learned from the stump examinations a trench approximately 13' wide x 150' long by 6' deep was dug by a D-7 cat at a right angle across an *Armillaria* pocket. The trench started with the expected focus (a 1941 stump) and continued through the active pocket into the healthy forest beyond. The south side of this trench was then excavated by hand with a devils trowel in an almost archeological type manner. The inside face of the trench was divided into 24 6' x 3' x 1' units. These blocks were then subdivided into individual cubic foot units. The roots were then clipped, bagged and dried by cubic foot units to give us a biomass of root material present across an *Armillaria* pocket. The entire face of the trench was excavated back 6' (6' x 3' x 144') and 1/4 of it was excavated back 10' from the face. Thus in all over 3,000 individual cubic foot units were excavated, data taken, roots clipped and weighed.

At this time the analysis of the data is not yet complete, but it has already yielded some items of interest. In the area that corresponds to zones 3 and 4 of the stump data very little root material (alive or dead) was present and no large pieces were found. The relationship of the amount of root material in the ground to the distance from the present active margin of A.M. has not yet been determined, however, I feel confident that some known relationship does exist.

#### Other Items

1. The old stump (1941 cut) hypothesized as the source of this particular pocket did contain *Armillaria*.

2. Insects were observed on several occasions in excavated root material. The possible relationship if any is not understood.

3. Numerous root channels (places where old roots have rotted away and left tunnels in the soil of various sizes) were found running throughout the profile. A.M. rhizomorphs were often observed in these root channels.

4. Excavations revealed a pattern of infected material

somewhat similar to that found in the stump data; except that an extremely sharp break was found upon re-entering the "healthy" forest. In less than 6 feet along the trench we went from areas where all cubic foot units contained at least some infected material to units entirely free of *Armillaria* infected material.

5. In the "healthy" forest only occasional isolated lesions were noted; many of which could not be positively identified as A.M. lesions.

6. In the areas where *Armillaria* was expected to be (at slightly behind the present active margin) it was everywhere; even in the minutest of pine roots ( $1/32$ " diameter). It appears that after the tree is killed the entire tree can become colonized by *Armillaria* (at least in the cambial region). How long the fungus can survive in the smaller material and if it even utilizes the woody part of this tissue is not known, at present.

From the examinations of some 300 individual root systems and subsequent root excavations some other observations as to the nature of A.M. infected trees have been made.

By far, the majority of the trees that have *Armillaria* lesions on lateral roots also have *Armillaria* present deep on the tap root whether or not the tree is dead or alive. Nearly all trees dead with *Armillaria* present had attacks high on the tap root and the majority had collar attacks and fans.

In the few young pine trees examined that did not have a definite tap root, but a more spreading root system, numerous lateral attacks were present and yet the trees were still alive. This corresponds well with the information that all pines examined which were dead from *Armillaria* had a definite tap attack (pitching reactions on the tap root itself). It appears to me that a spreading root system allows the pine to tolerate the A.M. for a longer period of time than the normal tap rooted trees.

In my opinion the A.M. attacks on the lateral roots and the tap root produces an identical reaction - namely a pitching lesion. The distal portion of the root is often dead and decayed while proximally the root is usually healthy. Thus I feel that the pitching reaction is a type of hypersensitive reaction of the tree to the pathogen; in this sense, the pine is fairly resistant to A.M. However, when the reaction occurs on the tap root the main root is girdled and the majority of the root system becomes effectively "cut off" from the tree. Death soon follows.

Having just discussed my opinions on the nature of infection of the individual root systems, let us now turn again to the distribution of infected material throughout the stand. With two pieces of evidence indicating a rather sharp break underground between infected and healthy material, we decided to see if this held up in general and to determine more precisely the actual distributions of infected and healthy root material across an A.M. pocket. To do this eight more trenches were dug across the pockets and excavated by hand. This time all root systems were left in place and distribution of healthy and infected root material was recorded and mapped and related to above-ground symptoms.

The fairly sharp line between infected and healthy as we move beyond the active margin was found to hold true as was the near total lack of root material from areas corresponding to the earlier zones 3 and 4. A fairly constant relationship exists from distance beyond the last infected tree to the end of infected material. As we progress into the "healthy" forest, through an *Armillaria* pocket, with trees varying from 3' to 16" DBH moving 14' from the last infected trees into the healthy takes in 95% of the infected material that exists underground. This can be seen in the following slides.

In conclusion then, three years ago I started mapping A.M. pockets from above-ground symptoms to try and delineate the borders of these infections. I found that I could not do this effectively with no knowledge of the distribution of infections underground. Through stump extractions and trench excavations I now know this underground distribution and can relate it back to above-ground symptoms. The question now is can this information be utilized to establish a feasible control program in the managed pine forests?

COMPARISON BETWEEN THE USE OF PESTICIDES FOR THE PROTECTION  
OF FORESTS AND FOREST PRODUCTS FROM THE POINT OF VIEW OF  
ENVIRONMENTAL POLLUTION

A. J. Cserjesi<sup>1</sup>

Pollution can be defined as the accumulation of synthetic or natural materials in the environment, or the accumulation of by-products caused by the slow degradation of these materials by physical, chemical or biological agents. Inert materials, in sufficient quantity, can cause problems (plastics are causing some concern in this respect). However, most pollutants do not belong to this group. Pollutants are substances which in larger or smaller quantities, do cause harm or death to some kinds of life forms. Most pesticides, intended to act against "harmful" organisms, may be toxic to others, also even at a relatively low concentration. Recently it was recognized that the harmful effects of certain chemicals can be detected only after a long period of exposure to a concentration below the generally accepted toxic limit.

Many years ago the earth's atmosphere contained virtually no oxygen but a high concentration of carbon dioxide. A gradual change occurred due to the appearance of living organisms and by the photolysis of water to hydrogen and oxygen. So life started in a virtually anaerobic atmosphere. These early organisms were capable of synthesizing organic compounds from carbon dioxide and water. The ability of organisms to utilize dead and living organic materials by oxidation developed subsequently when oxygen accumulated in the atmosphere and carbon dioxide was depleted. This biological oxidation of organic materials makes possible life on earth as it exists today.

Plants are capable of synthesizing very complicated organic compounds from CO<sub>2</sub> and water (e.g. large molecules of lignin, polysaccharides, proteins, DNA....; small molecules of alkaloids, sterols, phenolics...). Some of these are toxic, perhaps more toxic than any manufactured chemical. Most of the higher life forms (other than fungi and bacteria) have only a limited capability to degrade these compounds. Higher organisms have other means to cope with unusual and toxic chemicals. Animals, and to a certain extent plants, can dispose of them by excretion. Another way is to form derivatives of these chemicals by biological conjugation which are more or less toxic than the original compounds, e.g. the formulation of phenol glycoside in plants to detoxify phenol, or of a sulphate ester of pentachlorophenol in a shellfish,

---

<sup>1</sup>Forest Products Research Laboratory, 6620 N.W. Marine Drive, Vancouver 8, B.C., Canada

or of its glucuronide in rabbits to detoxify pentachlorophenol.

Although detoxification by conjugation is used by microorganisms (e.g. methylation of chlorinated phenols to the corresponding chlorinated anisoles) their capability of degradation of many different synthetic and natural compounds is much greater than that of other organisms (higher plants and animals). The degradation processes start usually by an addition of oxygen on to an organic compound. A similar but distinct oxidation process is used by all living organisms to produce energy.

It is well known that all animals, and many microorganisms, depend on green plants for their food supply. Some microorganisms and animals do not wait until the death of the organisms they feed on (parasites), and others utilize only dead organic materials (saprophytes). Some organisms from each group are pests which destroy materials beneficial to, or used by, humans.

As long as there was a plentiful supply of material required by humans no protection of goods was necessary, however, as soon as the supply of certain materials - at least locally - started to diminish the need for their protection arose. This protection began as the killing of crop or stock-destroying animals. Later, however, it was recognized that other agents were responsible for the destruction of certain goods. Probably the first protection of materials by chemicals was the preservation of wood against decay, using pitch in boats and the charring of the surface of wooden posts. The protective action of sulfur against molds was observed by the Greeks. Other inorganic compounds ( $\text{CuSO}_4$ ,  $\text{ZnO}_2$ , etc.) were also used subsequently.

Development of organic pesticides began in the middle of the 20th century. The discovery and success of dithiocarbamates as fungicides and of DDT as an insecticide caused the commitment of a great amount of effort and money to finding other--more potent and specific--organic pesticides.

The benefits from the use of pesticides are undeniable. Many pest problems were controlled and many lives were saved by using toxic chemicals. It was realized that the beneficial effects were, in some cases, accompanied by undesirable side effects on humans and animals. So the pollution hazard was recognized together with the necessity for the degradation of pesticides.

Before discussing the pollution hazard in the use of pesticides in forestry and in the forest products industries, four points should be discussed: (1) requirements for pesticides, (2) reason for their use, (3) application, and (4) degradation.

- (1) The main requirement for pesticides used in agriculture and forestry is that they do not damage the plants to be protected, however, the pesticide should be very toxic to the pest. In other words, it should have selective toxicity toward the pests. The original requirement for a pesticide to protect forest products was to be very toxic to pests which degrade wood, regardless of toxicity to other organisms. This attitude has been changed somewhat, and efforts are made to find wood preservatives with no or low toxicity, at least to humans.
- (2) The reasons for the application of pesticides are quite different in forestry and in the forest products industry. In forestry, a pesticide is applied as a cure for a problem insect attack or fungal disease on the trees. The intention is to kill the problem-causing organisms. As many cases showed, the cure might be only temporary and the treatment with the pesticide had to be repeated. In forest products protection, the treatment is remedial or precautionary and usually no second treatment is needed.
- (3) Pesticides in agriculture and forestry are applied often on a large area by aerial spraying and so close control on the spread of the chemicals is difficult. It is regularly carried out by trained personnel and the regulation to be followed in application, ensure large quantities of the pesticide relatively rarely get into waters and other areas not to be treated. The treatment of forest products is carried out mostly in an industrial plant in a relatively small area, and the treated materials subsequently used over large areas. Here it is relatively easy to take preventive measures against the loss of pesticides into the environment. It needs only some money and the willingness to do it.
- (4) In considering the pollution hazard of treatments with organic pesticides, their biodegradability also has to be considered. The degrading of pesticides is necessary for their safe use, when their protective actions are no longer required and before they poison other organisms than the pests against which they were used. Most pesticides are degraded mainly by (soil) microorganisms, and not by animals. The consumption of a toxic chemical by organisms, particularly predators, with their food may result in the accumulation of this chemical in their bodies without apparent harmful effect; however, the animal at the end of a food chain may be exposed to a concentration higher than its toxic limit (e.g. DDT).

From these discussions and from the point of view of pollution the most important differences between the use of pesticides in forestry and in the forest products industries seems to be the reason for their use and the application methods.

To use insecticides against insects attacking forest trees, as a cure for an already existing problem, a relatively high concentration of a chemical has to be used over a large area. Incomplete eradication of an insect population renders the treatment inadequate and it has to be repeated soon. From the pollution point of view this introduces into the environment large amounts of toxic chemicals over a wide area. This makes it possible for the pesticide to get into a food chain without degradation and, by destroying food for predators, resulting in a "silent" forest.

Unserviceable preservative treated wood may be burned, so with the wood, the fungicide is also destroyed. Or if the wood is discarded the degradation process, which started when the wood was still in service, will continue. Since the latter degradation, in connection with leaching, releases the fungicide slowly into the environment and the released chemicals are exposed mostly to soil microorganisms, the chance for their degradation is high. For this reason it can be assumed that the pollution hazard of a fungicide used for the protection of wood is low in comparison to the use of pesticides in the forests.

On the other hand, to use wood in conditions which favour its degradation, forest products have to be treated with toxic chemicals. If this type of treatment is not to be allowed in the future, the only alternative is to use other materials -- plastics, concrete or steel. In forestry, however, because of the expense, insecticides are used only in special cases, even today. For the protection of forests, other means of protection are being researched. These alternatives include the use of insect disease (viral, bacterial, fungal) parasites, predators and sex attractants, and as a final resort, intensive forest management may help. These alternatives are not available for wood protection.

RESPONSES OF LODGEPOLE PINE AND WHITE SPRUCE TO  
BARK BEETLE ASSOCIATED FUNGI

D. M. Shrimpton<sup>1</sup> and S. H. Whitney<sup>2</sup>

Mountain pine and spruce bark beetles (*Dendroctonus ponderosae* Hopk. and *D. rufipennis* Kirby) mine in the phloem of their respective hosts lodgepole pine (*Pinus contorta* Dougl. var. *latifolia* Engelm), and white spruce (*Picea glauca* [Moenck] Voss). Specific filamentous fungi; *Ceratocystis montia* Rumb. and *Europhium clavigerum* Robinson and Davidson associated with *D. ponderosae*, and *Verticicladiella* sp. associated with *D. rufipennis*, are carried into the trees by the attacking beetles. Once in the trees these fungi penetrate and kill ray and other living cells. Quantifying the response of lodgepole pine to attack by these organisms has potential for rating trees as to their susceptibility to bark beetle attack. Therefore, the response of spruce trees was examined and compared to that of lodgepole pine.

Lodgepole pine responds to the attack with an initial flow of liquid resin from resin ducts severed by the invading beetle. Within 24 hours of wounding, and in response to the onset of fungal growth, all living cells next to the wound start to produce additional liquid resin and other substances normally present only in the heartwood. A pliable, white "pitch tube" forms around the place where the beetle bored through the bark, and the phloem and sapwood next to the wound become impregnated with resinous substances. Cells die slowly as these compounds accumulate. These compounds are produced in an enlarging zone around the wound and the fungi soon die and the beetles leave or are drowned in resin. About 2 years after attack, the zone of impregnated sapwood extends towards the centre of the tree and is continuous with and indistinguishable from the heartwood. By this time the pitch tube is yellow, hardened and shrunken. In lodgepole pine, the cambium seldom rejoins over the wound and in time the trunk may assume a fluted appearance. Sometimes a pitch pocket is formed at the original wood surface as new tissues grow over the wounded area.

We studied the response of white spruce to inoculation with a fungus consistently carried by the spruce beetle and also examined young and old attacks of *D. rufipennis*. The response of spruce differed from that of pine. Firstly, the visible response was usually confined to the phloem, and secondly, resinous substances were produced relatively late in the process. A dry brown elliptical zone of apparently dead phloem developed within three weeks around each inoculation and only a small amount of resin flowed from the inoculation wound. Cambial growth ceased beneath the brown

---

<sup>1</sup>Pacific Forest Research Centre, Victoria, B. C.

<sup>2</sup>Pacific Forest Research Centre, Victoria, B. C.

phloem and bark adhered to the sapwood at the margins of the necrotic zone. Between three and six weeks after inoculation, the discoloured phloem was resin soaked. As the wood and phloem surrounding the response continued to grow, the dead phloem was lifted from the xylem surface, and resins flowed over the wood and soaked into the outer ring. New wood and bark tissues grew over the wound in about eight years. The cambium rejoined and brown resin soaked phloem was sloughed. Only a small area of discoloured resin soaked sapwood one or two rings deep and a small check where new tissues grew over the wound remained.

The fungus used to inoculate the spruce trees was consistently reisolated from the brown resin soaked phloem but was not reisolated from surrounding living phloem. The fungus was also recovered after 8-10 weeks from sapwood beneath most inoculations. Sapwood was frequently blue stained beneath old (3-10 years) healed-over bark beetle galleries and the blue stain fungus, *Verticidaiella* sp. was readily cultured from the margin of this tissue.

The slow forming diminutive resinosis and persistent growth of a blue stain fungus in spruce sapwood contrasts with the rapid extensive resinosis of sapwood and confinement and death of blue stain fungi that occurred in lodgepole pine.

COLONIZATION OF FRESHLY CUT WOOD BY  
PORIA WEIRII BASIDIOSPORES

E. E. Nelson<sup>1</sup>

Western forest pathologists are generally acquainted with the destructiveness of *Poria weirii* (Murr.) Murr. The damage caused in the expansion of root rot centers in an established stand and the reappearance of this fungus in a regenerated stand are familiar sights. Though our knowledge is incomplete a great deal is known about the vegetative habits of this fungus; the greatest gap in our knowledge of *P. weirii* is in the role of its basidiospore, especially as it relates to forest management practices.

In most years, *P. weirii* produces and releases large numbers of basidiospores during late summer and early autumn. These spores, though released near or in the forest floor, presumably function as propagules to initiate new root rot centers. At least one report presents evidence supporting infection of wounds by *P. weirii* basidiospores (Wright & Isaac, 1956). Is *P. weirii* sporulation a threat to forest management? What are its major infection courts? What conditions are necessary for infection?

Since 1967, we have attempted to inoculate stumps with *P. weirii* basidiospores annually. In 2 of the 4 years inoculations were made, we also inoculated trunk wounds by peeling bark and cutting into the sapwood about a foot above ground level. Basal wounds and stumps are products of the managed forest and their importance as entry courts for *P. weirii* infection must be determined.

During this study, spores have been sprayed in aqueous suspension on stumps and wounds or collected on cellophane, filter paper, or water agar film and inverted on the stump or wound surface. In a few cases, spores have been shed directly onto the stump surface from sporophores held over the stump by wire brackets. On similar stumps and wounds, we applied mycelium growing in pure culture on autoclaved alder chips. This vegetative inoculum was held in place with cheese cloth stapled tightly over the stump top or wound. Heavy kraft paper was used to retard moisture loss on half of the spore and mycelial inoculations. Temperature and relative humidity were recorded on the site continuously during and 2 weeks following inoculations.

---

<sup>1</sup>Forestry Sciences Laboratory, Pacific Northwest Forest and Range Experiment Station, 3200 Jefferson Way, Corvallis, Oregon.

The first year, we sampled stumps for colonization by *P. weirii* 6, 12, and 18 months after inoculation. In succeeding years, we sampled after about 10 months.

At the time of sampling, wounded, inoculated trees were felled. Their stumps, and stumps inoculated the previous autumn, were brought into the laboratory. Each was split and a board sawn radially, from the center of one split half. The remaining half was incubated at 45°C to observe fungus growth from the split surface. The board was split length wise in the sapwood (near the bark) and in the heartwood (near the pith) and sampled aseptically at 1 inch intervals from top to bottom (12 inches).

To date, none of the spore inoculation has produced infection. About half of the mycelial inoculations have been successful. Although vegetative mycelium is not likely to be a common source of natural infection, results have revealed that (1) *P. weirii* from mycelial inoculum is capable of penetrating 12 or more inches into the stump in 1 year (although averaging less), (2) growth rates in sapwood average about 1-1/2 times those in heartwood, and (3) size of tree or crown conditions before cutting do not seem to be closely related to susceptibility or rate of penetration.

We are continuing to inoculate stumps and wounds this season. Meanwhile, we hope to learn some of the requirements of the fungus for successful spore-initiated colonization of a natural substrate.

In autumn 1972, we subjected 1/2 inch disks of alder and Douglas-fir to *P. weirii* spores discharged from sporocarps. Disks were cut from fresh stem sections of about 3 inch diameter, debarked, and quick-frozen. Each was placed under a sporophore for 3 to 6 hours after first being immersed while still frozen in boiling water for 3 seconds. All disks were then incubated at 5°C for 45-60 days. Surfaces of all were covered with molds within a few days after exposure. After incubation, disks were broken and sample chips removed aseptically from the broken face from the innermost heartwood and the outermost sapwood.

Of 90 Douglas-fir sections sampled, 15 contained viable *P. weirii* in the heartwood and six in sapwood. Three of 90 alder sections also had *P. weirii* in the heartwood. Probably other sections were partially colonized but not at points sampled. We were unable to determine whether the cultures were dikaryotic or monokaryotic.

Wright, Ernest and Leo A. Isaac. 1956. Decay following logging injury to western hemlock, Sitka spruce, and true firs. USDA Tech. Bull. 1148: 34 pp.

DAMAGE TO CONIFERS FROM HIGHWAY DEICING SALTS  
IN THE LAKE TAHOE BASIN OF CALIFORNIA AND NEVADA

Robert F. Scharpf <sup>1</sup>

Michael D. Srago <sup>2</sup>

Salt has been used for deicing highways in Eastern United States and Europe for many years and the environmental problems associated with this practice are well known in these areas. Deicing salts have been used for a shorter period of time and less widely in Western United States. As a result, many of the detrimental effects associated with their use are not well recognized. This report summarizes the effects of highway deicing salts on conifers in the Lake Tahoe Basin, a heavily used winter recreational area in the Sierra Nevada Mountains of California and Nevada.

Observations by the U.S. Forest Service and other agencies suggested that conifers in the basin were suffering damage from road salt in the 1960's. Recently the problem has become of serious concern to not only various agencies but to the general public as well. As a result of this concern, a study was begun in the Winter of 1972-73 to determine the magnitude of damage to conifers from the use of highway deicing salts. The study undertaken consisted of 3 general components:

1. Background information.
2. Detection and incidence survey.
3. Evaluation--which includes field studies, greenhouse tests, and laboratory tissue analysis.

Background Information

The use of deicing salts in the basin began in the 1950's but no information is available on the amount of salt used and miles of highways treated during this early period. It is known that for California in general, the amount of salt used and the miles of highways treated has increased significantly over the past decade. For the Lake Tahoe Basin alone, nearly 3,000 tons of salt were used by several highway agencies to deice 450-500 single lane miles of highway during the 1972-73 winter season.

Detection and Incidence Survey

A survey made in spring 1973 of trees within 200 feet of the major highways in the basin showed the extent of the problem. Three hundred twenty one locations were noted on which salt damaged trees

---

<sup>1</sup> Forest Disease Research, Pacific Southwest Forest, Range Experiment Station, P.O. Box 245, Berkeley, California.

<sup>2</sup> Division of Timber Management, U.S. Forest Service, 630 Sansome St., San Francisco, Calif.

were recognized. These locations included one to many trees and estimates place the total number of damaged and dying trees at several thousand.

The conifer species affected were Jeffrey pine, sugar pine, lodgepole pine, incense cedar and white fir. Trees of all sizes and ages were damaged. Nearly all damaged trees were on down-hill slopes from the highway or on level areas on either side of the highway. Little damage was noted on up-hill slopes.

Symptoms of damage were particularly noticeable in the spring. Tipburn of the current years foliage was the most noticeable symptom. In pines and white fir tipburn symptoms are easily recognized. Incense cedar on the other hand has small scale-like leaves and tipburn is not as readily apparent. Depending on the pattern of salt uptake by the tree roots, foliage with tipburn may occur throughout the crown or only on scattered branches. Severe tipburn results in reduced tree vigor, defoliation, and often death.

### Evaluation

After careful examination of damage and symptoms in the field, a simple damage rating system was devised for the conifers in the Tahoe Basin. The description of the symptoms and damage used for each rating is listed below:

- |               |   |
|---------------|---|
| <u>None</u>   | No foliar tipburn or damage observed.   |
| <u>Light</u>  | 1/3 or less of the tree crown affected. Tipburn appears scattered and only light browning observed. Only the very tips of the foliage showing damage.             |
| <u>Medium</u> | About 1/3 to 2/3 of the crown with at least half the foliage showing tipburn. On pines and firs tipburn including up to half the length of the needle or foliage. |
| <u>Heavy</u>  | 2/3 or more of the crown with more than half of the foliage affected. On pines and firs needles dead more than half their length.                                 |

Tree damage was found to be directly related to proximity to deiced highways. The following list shows the mean distance from the edge of the pavement of deiced highways of trees with different rated levels of damage. (Only trees 0-100' from highways recorded)

Tree DamageMean Distance (in feet)

None	41
Light	21
Medium	20
Heavy	15

Levels of both sodium (Na) and Chloride (Cl) were also higher in the foliage of trees nearer highways than in trees at greater distances as is shown below:

<u>Distance from Pavement (in feet)</u>	<u>Na (% dry wt.)</u>	<u>Cl (% dry wt.)</u>
0-20	0.10	0.79
21-40	0.04	0.30
41-60	0.03	0.20
61 +	0.02	0.09

Thus both damage and abnormally high levels of Na and Cl are directly related to proximity to highways on which deicing salts are used.

The concentrations of Na and Cl in foliage tissue of different conifer species is also related to rated levels of tree damage:

Tree Species	Sodium (% Dry Wt.)					Chloride (% Dry Wt.)				
	Controls	None	Light	Medium	Heavy	Controls	None	Light	Medium	Heavy
Jeffrey Pine	.002	.03	.04	.03	.08	.02	.09	.27	.54	.86
White fir	.002	.02	.02	.04	.19	.05	.19	.30	.85	1.20
incense cedar	.001	.01	.04	.06	.07	.10	.33	.50	.99	1.39

Greenhouse tests were conducted with ponderosa pines and incense cedar to determine the effects of watering trees with salt solutions of known concentration. In general, symptom development (tip burning) occurred after 3-4 months at all concentrations (700, 2800 and 5600 ppm. NaCl) and symptoms were identical to those observed in the field.

Damage to the greenhouse trees was more severe at the higher concentrations of salt. After 5 months the following levels of mortality were observed among the greenhouse test trees:

<u>Salt Conc. (ppm)</u>	<u>Incense Cedar (%)</u>	<u>Ponderosa Pine (%)</u>
0	0	0
700	0	0
2800	10	44
5600	73	95

### Conclusions

In conclusion, it can be stated that use of highway deicing salts as practiced in the Lake Tahoe Basin is causing severe damage to and death of thousands of coniferous trees. The majority of these trees are within a 50 foot strip along these highways but some damage is occurring at greater distances. If this practice continues, additional tree dying can be expected and possibly other serious environmental problems including damage to other types of vegetation will arise.

## MAKING SPOT NEWS RELEASES FOR TELEVISION

Kenelm W. Russell <sup>1</sup>

The Department of Natural Resources has been a leader in the use of television releases to inform the public about interesting aspects of its function. At any one time the Department may have as many as fourteen films varying in length from one to three minutes in various stages of preparation or distribution. They cover many subjects such as Sea-Going Foresters or Fire-Prevention Messages. The television stations in the state readily accept and use these newspots and give them prime exposure time. Approximately 85 percent of those we make are utilized by the major stations in the state.

I have been making use of television to inform the general public about such things as drought, freeze damage, or Christmas tree diseases. The secret is not to make the film or the text yourself. Scientists are too used to writing scientific jargon and find it difficult to write a popular article. Let the information officer do this for you. Most successful films are done by a professional cameraman. Ours is an ex-TV cameraman with the unusual ability to put the story together on the spot. He will interview you then compose the shots and make them. Advance preparation is simply a phone call and a single date for shooting.

My total time for filming a typical spot is one to three hours filming time (depending on travel required) plus the cameraman's time splicing and preparing the film. Upon returning to the office I will generally draft a technically correct text which is then submitted to the information office.

The information office then edits and prepares the text in such a manner that the television newscaster can read it and keep up with the film. The description and length of each sequence is printed opposite the appropriate text. A new shot generally starts a new paragraph. It appears to work very well. A typical news release showing the times in the left hand margin is attached.

---

<sup>1</sup> Department of Natural Resources, Forest Land Management Center, Olympia, Washington

June 19, 1973

Robert G. Bates  
Director, Public Affairs  
Margaret E. Felt, PIO  
Telephone: (206) 753-5330  
(206) 753-6663

TIME: 1:53

FOLIAGE DISEASE THREATENING SCOTCH PINE CHRISTMAS TREES

VISUAL

TIME

AUDIO

WS healthy trees;  
pan to diseased  
trees inside  
yellow ribbon.

:15

A foliage disease caused by a fungus is seriously threatening Scotch pine Christmas trees in the Pacific Northwest. Department of Natural Resources' forest scientists are working closely with Christmas tree growers to identify infected trees and control the disease.

Ms diseased trees;  
pan to others

:08

The greatest danger is that once one tree becomes infected, it can spread to healthy trees.

CU diseased needles  
on tree

:03

The fungus attacks Scotch pine needles ...

WS diseased trees

:12

by shooting reproductive spores from the fungus fruiting bodies onto the needles. The spores lie there and after a rain, begin their destructive work. Although individual spores will not cover great distances . . . . wind and other factors enable them to move from one tree to another, which may gradually infect the whole Scotch pine plantation. The initial fungus infection is difficult to detect in clean, cultivated plantations.

CU healthy tree:  
pullback to WS

:13

The diseased needles soon die, turn a reddish brown color and fall from the tree. This color change, which occurs in the spring, and subsequent loss of needles, is creating considerable concern among Christmas tree growers.

CU diseased needles  
on tree; roll focus  
to CU of  
healthy  
needles on  
tree.

:17

-----more-----

<u>VISUAL</u>	<u>TIME</u>	<u>AUDIO</u>
Cu single infected needles	:12	The detection of the needle fungus in several Christmas tree plantations in the Pacific Northwest has united forest scientists and Christmas tree growers to combat it. Forest scientists from the U.S. Forest Service, Department of Natural Resources, Washington State University . . . . .
High WS of healthy	:18	and two prominent Christmas tree growers have been working closely to develop a safe and effective method of controlling and testing they have found a safe fungicide that will kill only the disease and not harm the rest of the environment. Properly applied, it stops the fungus and prevents its spread to healthy trees.
MS healthy trees	:05	Anyone suspecting the needle disease on their . . . . .
CU healthy needles	:10	Scotch pine plantation should contact their local Department of Natural Resources representative or county extension agent.

## ACTIVE PROJECTS

- Old And New -

(Addresses and affiliations for project leaders are given in the membership list in these Proceedings.)

### A. Forest Disease Surveys--General

- 56-A-1 Forest disease conditions in California (M. D. Srago). ✓
- 57-A-1 Forest disease sampling studies (G. W. Wallis).
- 58-A-1 Taxonomic and biological studies of Ascomycetes and Fungi Imperfecti (A. Funk).
- 71-A-1 Development of a dwarf mistletoe survey procedure for 15-to 40-year-old lodgepole pine stands (D. H. Brown)
- 71-A-3 Dermea pseudotsugae survey (M. Srago). ✓
- 71-A-4 Smog impact survey on the San Bernardino National Forest (N. MacGregor).
- 71-A-5 Aerial photography and root disease surveys (F. W. Cobb, J. Byler, J. Caylor). OK
- 71-A-6 Impact evaluation of white pine blister rust (J. Byler, N. MacGregor). OK
- 71-A-9 Appraisal of damage caused by forest pests in B.C. (J. A. Baranyay).
- 71-A-10 Detection and reporting, forest insect and disease survey (D. A. Ross (Formerly 68-A-1.))
- 71-A-11 Development of a continuous nursery disease survey (W. J. Bloomberg).
- 71-A-12 Disease sampling in Douglas-fir plantations (G. W. Wallis).
- 71-A-13 Monitoring nursery systems (L. W. Carlson).
- 71-A-14 Forest insect and disease survey in the Prairie Provinces, Yukon and Northwest Territories (W. G. H. Ives, R. A. Blauel, U. Hiratsuka, and H. R. Wong).
- 72-A-2 Survey of SO<sub>2</sub> damage to forest vegetation near ore smelters at Anaconda, Montana, and Wallace/Kellogg, Idaho (C. E. Carlson).

- 73-A-1 Developing survey methods for diseases in the nursery (K. W. Russell).
- 73-A-2 Rhizina undulata detection survey in northwest Washington - initial survey and permanent impact transects (K. W. Russell).
- 73-A-3 Rhizina undulata survey on National Forests of western Oregon and Washington (W. Thies and J. S. Hadfield).
- 73-A-4 Pest damage inventory (J. Byler and D. Hart).
- 73-A-5 Using the forest survey to obtain dwarf mistletoe impact data (J. L. Stewart).

B. Non-infectious Diseases

- 66-B-1 Susceptibility of western conifers to air pollution (R. V. Bega).
- 68-B-1 Detection of chronic photochemical oxidant injury to conifers by remote sensing (P. R. Miller, R. V. Bega, and R. Heller).
- 68-B-2 Physiological impact on ponderosa pine growing under natural conditions of chronic exposure to oxidant air pollution (P. R. Miller).
- 68-B-4 Effect of air pollution damage to ponderosa pine in Colorado (in collaboration with Colorado State University - J. M. Staley).
- 71-B-1 Influence of the forest canopy on total oxidant concentrations (P. R. Miller).
- 71-B-2 The effect of atmospheric effluents on the forest (R. Blauel, L. W. Carlson, D. Hocking, J. M. Powell).
- 72-B-1 Effects of smoke on forest disease fungi (J. R. Parmeter).
- 72-B-2 Susceptibility (and related symptoms) native southwestern forest trees and plants to SO<sub>2</sub> (M. Weiss?).
- 72-B-3 Chronic effect of photochemical oxidant air pollution on the composition of the ponderosa pine-sugar pine-fir forest cover type (P. R. Miller).
- 73-B-1 Effects of ozone on litter decomposition, nitrogen transformation, and phyllosphere microflora of Douglas-fir and red alder (K. C. Lu).
- 73-B-2 Effects of ozone on ponderosa pine dwarf mistletoe (A. campylopodum) (J. L. Stewart and R. Wilhour).

*Williams (new)*

C. Cone, Seed, and Seedling Diseases

- 53-C-5 Forest nursery diseases (W. J. Bloomberg).
- 60-C-1 Disease losses in redwood reproduction (J. R. Parmeter, Jr., and J. Davidson).
- 60-C-2 Isolation of soil and root fungi (J. R. Parmeter, Jr.).
- 68-C-2 Nematodes in forest nurseries (J. R. Sutherland).
- 68-C-3 Seed and seedling diseases, especially in nursery; and nursery management as affecting seedling health (D. Drake).
- 70-C-1 Nursery disease (H. Zalasky).
- 70-C-2 Effects of pest control practices on Douglas-fir seedlings (W. A. Sinclair).
- 71-C-1 Occurrence of endophytic fungi in conifer seedlings (W. J. Bloomberg).
- 71-C-2 Monitoring populations of *Fusarium* and *Pythium* spp. at the Wind River and Bend nurseries (D. Johnson and W. Theis). (Formerly 71-A-8)
- 73-C-1 Composting for organic matter additives at the nursery (K. W. Russell).
- 73-C-2 Pathology of forest seedlings in storage (J. C. Hopkins).

D. Root and Soil Diseases or Relationships

- 59-D-2 Root diseases--general (R. V. Bega and R. S. Smith, Jr.).
- 61-D-2 Fomes annosus (R. V. Bega and R. S. Smith Jr.).
- 62-D-2 Diseases of seed, seedlings and young trees (R. V. Bega and R. S. Smith, Jr.). (Formerly 59-D-1 and 61-D-1).
- 64-D-1 The ecology of Phytophthora cinnamomi Rands in forest soils (E. Trujillo and R. V. Bega).
- 64-D-2 The host range of Armillaria mellea on subtropical species (E. Trujillo and R. V. Bega).
- 65-D-1 The pathogenicity of Verticicladiella wagnerii to Pinus spp. (R. S. Smith, Jr.).
- 65-D-3 Inter-relationships between root-pathogenic fungi, especially Fomes annosus, and bark beetle infestations in coniferous forests (F. W. Cobb, Jr., J. R. Parmeter, Jr., R. W. Stark, D. L. Wood, and E. Zavarin).

- 66-D-1 Investigations on the occurrence and control of Fomes annosus butt- and root-rot of intensively managed stands (C. H. Driver).
- 66-D-2 Studies on the cytology and genetics of Fomes annosus (C. H. Driver).
- 66-D-3 Studies on the effects of site treatments (slash burning, fertilization, mechanical soil disturbance, etc.) on limiting the abilities of Poria weirii to infect the regenerating stand (C. H. Driver).
- 66-D-7 Comparison of Poria weirii survival in soil of a pure conifer stand to that of a mixed alder-conifer stand (E. E. Nelson).
- 66-D-8 Effect of nitrogen fertilizers on Poria weirii survival and populations of antagonistic microorganisms (E. E. Nelson).
- 66-D-11 Characterization and classification of mycorrhizae of Douglas-fir and other northwestern conifers (B. Zak).
- 66-D-12 Fungi associated with deterioration of unsterilized roots of forest-grown Douglas-fir (B. Zak).
- 66-D-13 Field trials to test effects of thinning on spread and intensification of Armillaria root rot in young ponderosa pine (D. Johnson).
- 67-D-1 Microbial and mycorrhizal factors inhibiting pathogenic root fungi in red alder-conifer associations of the Douglas-fir region (W. B. Bollen, K. C. Lu, and J. M. Trappe).
- 67-D-2 Selective culture of Poria weirii (E. E. Nelson).
- 67-D-3 Effects of phenolic compounds on P. weirii and their location in forest trees and soils (K. C. Lu).
- 68-D-2 Physiology of root-fungus interactions in the disease condition (D. Hocking).
- 69-D-1 Taxonomy of hypogeous mycorrhizal fungi (J. M. Trappe).
- 69-D-2 Stump infection by basidiospores of Poria weirii (E. E. Nelson).
- 69-D-3 Relative species susceptibility to Poria weirii infection (E. E. Nelson)
- 71-D-1 Impact of root diseases in Yosemite Valley (L. S. Felix, F. W. Cobb, J. R. Parmeter, Jr., and N. MacGregor).
- 71-D-2 Study of pinyon pine root rot (Verticicladiella wagnerii.) (N. Oshima).

- 71-D-4 The biology and control of Armillaria in ponderosa pine (L. F. Roth).
- 71-D-5 Root diseases of aspen in Wyoming (W. D. Ross).
- 71-D-6 Relationship between root pathogens, their hosts, and attack by bark beetles (C. W. McAnelly).
- 71-D-7 Poria weirii root rot: Biology and control (G. W. Wallis, D. J. Morrison) (Formerly 53-D-3).
- 71-D-8 Fomes annosus root and butt rot: Biology and control (G. W. Wallis, D. J. Morrison) (Formerly 65-D-2).
- 72-D-1 Determination of Poria weirii impacts on forest resources in west-side Douglas-fir stands. (J. Hadfield?)
- 72-D-2 Sparassis radicata and root rot of conifers in southern Arizona (K. J. Martin).
- 72-D-3 Armillaria mellea root rot: importance and biology (D. J. Morrison).
- 72-D-4 Identification, distribution and intensity of root rots in western Montana and northern Idaho (R. E. Williams). (Formerly 67-D-5).
- 73-D-1 Testing native conifer plantings for resistance to Poria weirii (K. W. Russell).
- 73-D-2 Testing red alder plantings to reduce Poria weirii development (K. W. Russell).
- 73-D-3 Alnus rubra as a biological control agent for Phellinus weirii (cooperative - Oregon State Univ. and PNW Station, E. Hansen and J. M. Trappe).
- 73-D-4 Long-chain fatty acids in roots and soils in relationship to survival and infection by Poria weirii (C. Y. Li).
- 73-D-5 Taxonomy and distribution of the endomycorrhizal fungi of the family Endogonaceae (J. M. Trappe).
- 73-D-6 Fomes annosus evaluation (M. Srago). ✓

#### E. Foliage Diseases

- 57-E-4 Life history studies of Elytroderma deformans (L. F. Roth).
- 66-E-1 A study of moisture and temperature relationships governing the establishment of pathogenic conifer foliage fungi (N. Oshima).

- 68-E-2 Needle diseases of conifers (J. M. Staley).
- 69-E-1 Needle lesions of Engelmann spruce (J. M. Staley).
- 71-E-1 Elytroderma deformans - Mortality and growth impact on Jeffrey pines (R. F. Scharpf and R. V. Bega).
- F. Stem Diseases Malformations, Witches-Brooms, Dwarfmistletoe, etc.
- 53-F-4 Dwarfmistletoe of ponderosa pine (L. F. Roth).
- 57-F-5 Environmental and host-parasite relationships of dwarfmistletoes (J. R. Parmeter, Jr., and R. S. Scharpf).
- 60-F-5 Life tables for ponderosa pine and lodgepole pine dwarfmistletoes (F. G. Hawksworth).
- 61-F-1 Eradication and thinning studies for dwarfmistletoe control in infected stands in western larch, Douglas-fir, and lodgepole pine (E. F. Wicker).
- 62-F-2 Field cultures with dwarfmistletoe (F. G. Hawksworth and T. E. Hinds).
- 62-F-7 Ecology of lodgepole pine dwarfmistletoe (F. G. Hawksworth).
- 62-F-8 Ecology of ponderosa pine dwarfmistletoe (F. G. Hawksworth).
- 62-F-9 Resin disease of lodgepole pine dwarfmistletoe (F. G. Hawksworth).
- 62-F-10 Silvicultural control of ponderosa pine dwarfmistletoe (F. G. Hawksworth).
- 62-F-11 Physiological studies of seed of dwarfmistletoe of ponderosa pine (K. Beckman).
- 62-F-12 Physiological studies of dwarfmistletoe of ponderosa pine. A comparison of metabolites in host and parasite (L. McDowell).
- 62-F-13 Ontogeny of the aerial shoots of Arceuthobium douglasii and A. campylopodum f. laricis (B. Jones).
- 63-F-1 Spread and intensification of dwarfmistletoe in ponderosa and Jeffrey pines in California (R. F. Scharpf, and J. R. Parmeter, Jr.).
- 63-F-2 Epidemiology of dwarfmistletoes on firs in California (R. F. Scharpf).

- 64-F-2 Development and pathogenicity of Hypoxyylon fuscum on northwestern species of alder (Alnus) (J. D. Rogers).
- 65-F-1 A study of the factors influencing reproduction and parasitism by Arceuthobium americanum Nutt. (J. A. Muir).
- 65-F-2 The effect of dwarfmistletoe on growth of western hemlock (K. W. Russell).
- 66-F-1 Field tests on cultural control of dwarfmistletoe by understory destruction and by species manipulation (J. S. Hadfield).
- 68-F-1 Silvicultural control of dwarf mistletoe in young lodgepole pine stands (J. A. Baranyay).
- 68-F-2 Effects of dwarf mistletoe on growth and mortality in immature ponderosa stands (F. G. Hawksworth and T. E. Hinds).
- 68-F-3 Silvicultural control of lodgepole pine dwarf mistletoe (J. M. Stewart, F. G. Hawksworth and T. E. Hinds).
- 68-F-5 In vitro culture of Arceuthobium spp. (E. F. Wicker).
- 68-F-6 Spread and intensification of dwarf mistletoe in young uni-storied stands of western larch, Douglas fir and lodgepole pine with controlled stocking (E. F. Wicker and C. D. Leaphart).
- 68-F-7 Properties of dwarf mistletoe-infected wood of ponderosa pine (D. M. Knutson).
- 71-F-2 Distinguishing living and dead endophytic tissues (D. M. Knutson).
- 71-F-3 Effects of light and temperature on development of dwarf mistletoe (D. M. Knutson).
- 71-F-4 Impact of dwarf mistletoe in released stand of red fir in California ✓ (N. MacGregor and R. F. Scharpf).
- 71-F-5 Incidence of dwarf mistletoe in red fir regeneration (N. MacGregor ✓ and R. F. Scharpf).
- 71-F-6 Growth impact, associated mortality, and spread and intensification of dwarf mistletoe in stands of Douglas-fir, lodgepole pine, and western larch (O. J. Dooling and E. F. Wicker).
- 71-F-8 Dwarf mistletoe control in rural and suburban residential developments (J. G. Laut).
- 72-F-2 Simulation of the effects of dwarf mistletoe on yields in uneven-aged ponderosa pine stands in Colorado (F. G. Hawksworth, T. E. Hinds, and C. A. Myers).

- 72-F-3 Pollination ecology of three species of dwarf mistletoe in northern Colorado (R. Penfield, R. E. Stevens, & F. G. Hawksworth).
- 73-F-1 Dwarf mistletoe evaluation in campgrounds (N. MacGregor).
- 73-F-2 Impact of dwarf mistletoe on Douglas-fir (D. M. Knutson).
- 73-F-3 Biology of Douglas-fir dwarf mistletoe (D. M. Knutson).
- 73-F-4 Wallrothiella on A. douglassii (D. M. Knutson).
- 73-F-5 Effects of dwarf mistletoe on yields in ponderosa pine in the Pacific Northwest (J. L. Stewart).
- 73-F-6 Dwarf mistletoe on hemlock (J. L. Stewart).

G. Stem Diseases - Stains and Decays

- 61-G-4 The Indian paint fungus in northern Idaho (A. D. Partridge).
- 63-G-3 A study of (Ophiostomaceae) wood staining fungi in North America (R. W. Davidson).
- 66-G-2 Hazard in red fir on federal recreational lands in California (L. A. Paine).
- 67-G-2 Microorganisms associated with brown stringy rot decay (Echinodontium tinctorium) (O. C. Maloy, J. D. Rogers, and D. Hudson).
- 68-G-1 The ecology of infection of hemlock and the true firs by Echinodontium tinctorium (D. E. Ethridge)
- 72-G-1 Poria carnegiea and decay of Saguaro cactus in Arizona (J. P. Lindsey).
- 72-G-2 Synoptic key to fungi causing decay in spruces in North America (K. J. Martin & R. L. Gilbertson).
- 72-G-3 Characterization and development of heartwood stain in Populus trichocarpa (A. A. Gokhele).
- 72-G-4 Studies of the host range and control of canker stain (Ceratocystis fimbriata f. platani) of plane tree (A. H. McCain).
- 73-G-1 Decay associated with logging damaged conifers in Oregon and Washington (P. E. Aho).
- 73-G-2 Role of N<sub>2</sub>-fixing bacteria associated with decay in white fir (P. E. Aho).
- 73-G-3 Tests of wound dressings on artificial injuries on western hemlock and sitka spruce (P. E. Aho).
- 73-G-4 Heart rots of upper-slope species in the Blue Mountains of Oregon and Washington (P. E. Aho) (Formerly 59-G-5).
- 73-G-5 Decay hazard in advanced regeneration of tolerant conifers in Oregon and Washington (P. E. Aho) (Formerly 59-G-6).

- 73-G-6 The role of microorganisms associated with bark beetles attacking conifers (H. S. Whitney). (Formerly 72-G-5).
- 73-G-7 The biology and pathology of Polyporus volvatus (C. G. Shaw).
- 73-G-8 Heart rots of white fir (A. concolor) in the Rogue River National Forest (P. E. Aho). (Formerly 64-G-1).

#### H. Stem Diseases - Rusts and Cankers

- 53-H-2 Testing progeny of resistant pines for susceptibility to white pine blister rust in the Inland Empire (R. T. Bingham).
- 54-H-4 Status-of-control plots (M. Srago and J. Byler).
- 56-H-6 Etiological, host-parasite, and ecological investigations of the Atropellis disease of lodgepole pine in Alberta (J. C. Hopkins).
- 61-H-1 Streamlining pollination and progeny test methods in breeding for blister rust resistance in western white pine (R. T. Bingham).
- 61-H-2 Breeding and selection for climatic adaptation in inter-species hybrids, toward accumulation of a pool of rust-resistance genes from other white pines of the world (R. T. Bingham).
- 62-H-1 Life cycles of western conifer rusts (R. G. Krebill and D. L. Nelson).
- 62-H-2 Taxonomy and identification of native pine-stem Peridermia (R. G. Krebill and D. L. Nelson).
- 63-H-5 Epidemiology of Cronartium comandrae. II. Relation of infection to environment (R. G. Krebill).
- 64-H-2 Conifer stem rusts: pathological histology (R. G. Krebill).
- 65-H-3 Western gall rust epidemiology, symptomatology, and life cycle (F. W. Cobb, Jr.; J. R. Parmeter, Jr; and D. L. Nelson).
- 65-H-4 Cytology of western gall rust fungi (R. G. Krebill).
- 66-H-3 Comparative physiology of varieties of western white pine with respect to their reaction to the blister rust fungus (R. J. Hoff).
- 66-H-4 Level and trend of natural inactivation of blister rust cankers (R. D. Hungerford and C. D. Leaphart).
- 66-H-5 Persistence of natural inactivation of blister rust cankers (R. D. Hungerford and C. D. Leaphart).

- 66-H-6 Numbers and kinds of resistance-genes and their relation to rust symptomatology (G. I. McDonald).
- 66-H-7 Precise estimates of heritability and combining ability of rust resistance (G. I. McDonald).
- 66-H-8 Development and pathogenicity of Hypoxyylon fuscum on northwestern species of alder (Alnus) (J. D. Rogers).
- 67-H-1 Etiology of aspen cankers (T. E. Hinds).
- 67-H-2 Epidemiology of Cronartium comandrae. III. Ecology of comandra (R. G. Krebill).
- 67-H-5 Blister rust physiology. I. Extraction of protein from white pine tissue (N. E. Martin).
- 67-H-7 Controlling level and uniformity of inoculations and infection by Cronartium ribicola toward reducing number of replicates and seedlings required for progeny testing (R. T. Bingham).
- 67-H-10 The epidemiology and aerobiology of the Comandra blister rust, Cronartium comandrae Peck (J. M. Powell).
- 68-H-1 Epidemiology of stalactiform rust of lodgepole pine (R. G. Krebill).
- 68-H-4 Chromatographic analysis of Cronartium ribicola pycnial fluid (E. F. Wicker).
- 69-H-2 Thinning and pruning western white pine to control the blister rust disease (C. D. Leaphart and R. D. Hungerford).
- 69-H-3 Distribution of blister rust infections in western white pine crowns (R. D. Hungerford).
- 69-H-4 Stimulation of aecia production by Cronartium ribicola in vivo in controlled environments (E. F. Wicker and A. E. Harvey).
- 69-H-5 Vegetative propagation procedures for Cronartium ribicola in vivo (A. E. Harvey).
- 69-H-7 Mode of action of Tuberculina maxima Rostr. in the inactivation of white pine blister rust cankers (E. F. Wicker).
- 69-H-8 Etiology of comandra rust--dwarf mistletoe infections in lodgepole pine (R. G. Krebill).
- 70-H-1 Canker diseases of poplar (H. Zalasky).

- 70-H-2 Nutritional and environmental requirements of axenically cultured *Ribes* tissues (A. E. Harvey).
- 70-H-3 Pure culture of *Cronartium ribicola* from its vegetative stages (A. E. Harvey).
- 70-H-5 Isolation and identification of the specific factors supplied by host tissues that are required for the independent survival and growth of *Cronartium ribicola* (A. E. Harvey).
- 70-H-6 The influence of blister rust *Cronartium ribicola* on the seasonal distribution of carbohydrates in needle and bark tissue of western white pine (B. L. Welch and N. E. Martin).
- 70-H-7 Amino acid utilization profiles for different isolates of *Tuberculina maxima* (E. F. Wicker).
- 71-H-1 Seasonal and yearly canker development (R. D. Hungerford).
- 71-H-2 Cytology and ontogeny of *Cronartium ribicola* (J. Y. Woo).
- 71-H-3 A serological study of Peridermia in the *Cronartium coleosporioides* complex (D. L. Nelson and P. B. Carter).
- 71-H-5 Forest tree rusts of western North America (Y. Hiratsuka) (Formerly 67-H-8 and 67-H-9).
- 71-H-6 Limb rust study (D. Nelson and M. Srago).
- 71-H-7 Septoria canker on poplar and progeny tests of introduced clones. (?)
- 72-H-1 Investigation of natural inactivation of white pine blister rust cankers in Europe (E. F. Wicker).
- 72-H-2 The ramification of bark tissues of *Pinus monticola* Dougl. by *Cronartium ribicola* J. C. Fischer (B. L. Welch and N. E. Martin).

I. Wilt and Blight Diseases

- 71-I-1 Dutch elm disease detection surveys in all municipalities in Colorado (J. G. Laut).

J. Defects and Decays of forest products

- 58-J-1 Deterioration of beetle-killed Engelmann spruce in Colorado (T. E. Hinds).

- 65-J-1 Incense cedar pocket rot: effects of infection and biology of the causal fungus (W. W. Wilcox).
- 66-J-3 Microbiology and pathology of wetwood in California firs (W. W. Wilcox).
- 68-J-4 Deterioration of stored pulp chips in outdoor piles (R. S. Smith).
- 68-J-5 Role of heartwood microflora in the breakdown of thujaplicin in western red cedar heartwood (B. J. Van der Kamp).
- 71-J-1 Defects and decays of forest products (W. W. Wilcox).
- 71-J-2 The evaluation of potential wood preservatives--Thiram and Thiram-Oxathiin mixtures (R. S. Smith and Mrs. C. B. Johansen).
- 71-J-3 An analysis of aspen chip deterioration during outside storage (R. S. Smith and Mrs. C. B. Johansen).
- 72-J-1 Decay and shock resistance of western red cedar transmission poles in service (J. W. Roff).
- 72-J-2 Utilization of decayed wood in pulp manufacture (J. W. Roff).
- 72-J-3 Degradation and preservative treatments of western red cedar shingles and shakes (A. J. Cserjesi and R. S. Smith).
- 73-J-1 Interaction of fungi and chemicals - pentachlorophenol (A. J. Cserjesi). (Formerly 66-J-2).

K. Miscellaneous Studies

- 66-K-8 Ecology of Tuberculina maxima (E. F. Wicker).
- 66-K-10 Nutritional requirements of Tuberculina maxima (E. F. Wicker).
- 67-K-1 Evaluation of boron treatment of lumber against decay (J. W. Roff).
- 67-K-2 Prevention of sapstain and mould on lumber (J. W. Roff).
- 67-K-3 Old growth western hemlock dieback in northwest Washington (K. W. Russell).
- 67-K-4 Host-parasite relationships (A. K. Parker).
- 67-K-7 Impact of hazardous tree failure on forested recreation sites (L. A. Paine).

- 67-K-8 Factors involved in mechanical failure of hazardous trees in recreation sites (L. A. Paine).
- 67-K-10 Effectiveness of hazard reduction programs on recreation sites - losses and various costs of protection (L. A. Paine).
- 71-K-1 Diseases causing mortality of aspen in the Gros Ventre elk wintering range (R. C. Krebill).
- 71-K-2 Death and decline of Ohia and Koa forests in Hawaii (R. V. Bega, O. E. Holtzman, and W. H. Ko).
- 71-K-3 Studies of Rocky Mountain fungi, with emphasis on parasitic fungi (W. G. Solheim).
- 71-K-4 Taxonomic and cultural studies in the forest fungi (A. Funk).
- 71-K-5 Forest disease: Diagnostic and taxonomic services and research (W. G. Ziller).
- 71-K-6 Species of Mycosphaerella on Salicaceae in western interior of Canada (H. Zalasky).
- 71-K-7 Winter injury in poplar - a histological study (H. Zalasky).
- 71-K-8 Prevention of winter injury to conifers and other hardwoods (H. Zalasky).
- 72-K-1 The pathology of Ohia decline in Hawaii (R. V. Bega).
- 72-K-2 Species susceptibility to mechanical failures on recreation sites - replacement of hazardous species (L. A. Paine).
- 72-K-3 Diseases of browse shrubs: preliminary assessment (R. G. Krebill).
- 73-K-1 Trees - development and people (K. W. Russell). Objective: To develop a guide on how to do it right for architects, planners, contractors, and homeowners.
- 73-K-2 Forest disease simulation model (W. J. Bloomberg).
- 73-K-3 Salt damage evaluation (M. Srago and R. F. Scharpf).
- 73-K-4 Fungi of Washington State and the Pacific Northwest (C. G. Shaw). (Formerly 63-K-1 and 66-K-7).

## Terminated Projects

### A. Forest Disease Surveys--General

- 53-A-1 Forest disease surveys in Alberta, the Rocky Mountain National Parks, and Northwest Territories (R. J. Bouchier).
- 53-A-3 Disease survey in British Columbia (A. C. Molnar and W. G. Ziller).
- 57-A-3 Exotic plantation studies (A. C. Molnar).
- 58-A-2 Studies of native and introduced Populus spp. (W. J. Bloomberg).
- 63-A-1 Root disease survey of windthrown trees (D. R. Miller).
- 66-A-1 Development of statewide surveys to determine the impact of forest disease in Washington (K. W. Russell).
- 66-A-2 White pine blister rust incidence survey (H. V. Toko and D. A. Graham)
- 67-A-1 Fomes annosus survey in eastern Washington (K. W. Russell and C. H. Driver, cooperatively).
- 67-A-2 Brewer spruce dwarfmistletoe survey (H. H. Bynum).
- 68-A-1 Forest Disease Survey in British Columbia. (J. H. Gimms).
- 71-A-2 Preliminary root disease impact survey (M. Srago, J. Byler, R. S. Smith and J. R. Parmeter, Jr.).
- 71-A-7 Development of root rot surveys for the Douglas-fir forest type. (L. C. Weir and J. S. Hadfield).
- 72-A-1 Survey for distribution of cankers caused by Tuberculina ulmea on Russian olive and Siberian elm in North Dakota shelterbelt plantings (O. J. Dooling).

### B. Non-infectious Diseases

- 68-B-3 Effect of frost damage on growth and form of Douglas fir. (J. H. Gimms).

### C. Cone, Seed, and Seedling Diseases

- 60-C-3 Rhizoctonia damping-off of nursery seedlings (H. S. Whitney).

- 64-C-1 Seedling diseases of forest nurseries in Hawaii (E. Trujillo).
- 68-C-1 The pathology of Douglas-fir seed: I. A test of effectiveness of fungicides in preventing fungal deterioration of seed stored in cones (G. Harvey).
- 68-C-4 Occurrence and biology of Rhizina root rot in British Columbia. (J. H. Ginns).
- 69-C-1 Seed and cone diseases of Sequoia sempervirens. (John N. Davidson and J. R. Parmeter, Jr.)
- 71-C-2 Histopathology of corky root of Douglas fir and the role of fungi in its development. (W. J. Bloomberg).
- 71-C-3 Chemical control of diseases of Douglas fir seedlings in the nursery. (W. J. Bloomberg).

D. Root and Soil Diseases or Relationships

- 53-D-2 Poria weirii root rot of Douglas-fir (T. W. Childs).
- 53-D-3 Poria weirii root rot of Douglas-fir (G. W. Wallis).
- 53-D-4 Characteristics and ecology of the root system of western white pine (R. G. McMinn).
- 53-D-8 Root diseases of forest conifers (W. W. Wagener).
- 55-D-2 Soil moisture in relation to the pole blight disease (C. D. Leaphart).
- 55-D-3 Mycorrhizal relationships of healthy and pole-blighted western white pine (R. L. Gilbertson)
- 59-D-1 Nursery and replant diseases (R. V. Bega and R. S. Smith, Jr.).
- 61-D-1 Nursery and reforestation diseases (R. V. Bega and R. S. Smith, Jr.).
- 62-D-1 Diseases of marginal ponderosa pine, pinon and juniper in Arizona and New Mexico (J. W. Riffle).
- 62-D-3 The epidemiology and host parasite relations involved in the charcoal root disease complex of Pinus lambertiana (R. S. Smith, Jr.)
- 63-D-1 Factors governing the rapid buildup of Armillaria mellea in conifer stands (O. K. Miller, Jr.).

- 64-D-3 *Armillaria* root rot of *Ceanothus* spp. (J. Terry, J. D. Rogers, and C. G. Shaw).
- 65-D-2 *Fomes annosus*, is it a threat to immature stands in British Columbia? (G. Wallis).
- 66-D-6 Nutrient supplying potential of freshly fallen litter from alder, conifer, and alder-conifer stands (K. C. Lu and W. B. Bollen).
- 66-D-10 Secondary metabolic products of mycorrhizal fungi (J. M. Trappe and P. Catalfomo).
- 67-D-4 Investigation of the chemical thinning for control of *Fomes annosus* butt and root rot of precommercial western hemlock (K. W. Russell and C. H. Driver, cooperatively).
- 67-D-5 A survey of the coniferous root rots in Montana and northern Idaho (O. J. Dooling and D. H. Brown).
- 68-D-1 Distribution and losses caused by root rots in British Columbia. (J. H. Ginns).

#### E. Foliage Diseases

- 53-E-4 Needle diseases of white pine (W. W. Wagener).
- 53-E-5 The Hypodermataceae of conifers in British Columbia (W. G. Ziller).
- 54-E-1 Rhabdocline on Douglas-fir (C. W. Waters).
- 57-E-1 *Elytroderma deformans* (C. W. Waters).
- 62-E-1 Survey of needle cast diseases in the central Rocky Mountains (J. M. Staley).
- 62-E-2 Ontogeny and cytology of the species of Hypodermataceae of conifer in North America (C. C. Gordon).
- 63-E-1 Foliage disease of Christmas trees (J. D. Rogers).
- 64-E-1 Diseases of Christmas trees (E. Trujillo)
- 67-E-1 Foliage diseases of conifers in the Southwest. (P. C. Lightle).
- 68-E-1 Effect of *Elytroderma deformans* on growth of ponderosa pine. (J. H. Ginns).
- 68-E-3 Critical moisture and temperature relationships governing establishment of *Lophodermium ponderosae* in vivo and in vitro (N. Oshima and J. Dubin).

F. Stem Diseases (Malformations, Witches-Brooms, Dwarfmistletoe, etc.)

- 53-F-3 Biological studies of dwarfmistletoes in Alberta (J. A. Muir).
- 55-F-3 Dwarfmistletoe of western larch and lodgepole pine (C. W. Waters).
- 57-F-1 Dwarfmistletoe of western larch, lodgepole pine, and Douglas fir. (C. W. Waters).
- 57-F-2 Some studies of Douglas-fir mistletoe and tissue culture of the host (L. Blakely and C. W. Waters).
- 57-F-4 Dwarfmistletoes on ponderosa pine and Douglas-fir (K. R. Shea).
- 57-F-6 Fungus diseases of dwarfmistletoes (R. S. Scharpf).
- 60-F-3 Losses resulting from growth reduction and mortality in lodgepole pine stands infected by dwarfmistletoe, Arceuthobium americanum Nutt. ex. Engelm. (J. A. Baranyay).
- 60-F-4 Impact of dwarfmistletoe on ponderosa pine (K. R. Shea and T. W. Childs).
- 60-F-6 Effects of dwarfmistletoe on yields in young lodgepole pine (F. G. Hawksworth).
- 62-F-1 Ballistics of dwarfmistletoe seeds (T. E. Hinds and F. G. Hawksworth).
- 62-F-3 Taxonomy, hosts, and distribution of the mistletoes in the Rocky Mountains and the Southwest (F. G. Hawksworth).
- 62-F-4 Cytotaxonomic study of Arceuthobium campylopodum and A. vaginatum (Del Wiens).
- 62-F-5 Barriers to dwarfmistletoe infection in non-susceptible hosts (F. G. Hawksworth).
- 62-F-6 Effects of dwarfmistletoe on growth and mortality in immature ponderosa pine (F. G. Hawksworth, P. C. Lightle, and T. E. Hinds).
- 62-F-14 A study of the factors influencing seed production of Arceuthobium americanum on lodgepole pine (J. E. Nighswander).
- 62-F-15 Use of aerial photography in detecting dwarfmistletoe infected lodgepole pine stands (J. A. Baranyay).

- 64-F-1 Cytology and ontogeny of Arceuthobium douglasii, A. americana, and A. campylopodum f. laricis (C. C. Gordon).
- 67-F-1 Computer classification of Arceuthobium (D. J. Rogers).
- 68-F-4 Yield tables for mistletoe infected lodgepole pine (joint study R-2 and RM Stations, J. M. Stewart and F. G. Hawksworth).
- 71-F-1 Pruning dwarf mistletoe brooms from old-growth ponderosa pine. (N. MacGregor).
- 71-F-7 Resin disease of dwarf mistletoe on lodgepole pine. (W. R. Mark).
- 72-F-1 Epidemiology of dwarf mistletoe (A. americanum) on jack pine [Pinus divaricata (neé P. banksiana)] (J. Muir).

G. Stem Diseases - Stains and Decays

- 53-G-13 "Red stain" and decay of lodgepole pine injured by fire in Alberta (V. J. Nordin).
- 57-G-1 Loss factors for a continuous forest inventory in British Columbia (W. Bradshaw).
- 57-G-3 Significance of the black heartwood stains of yellow cedar (H. W. Eades and J. W. Roff).
- 57-G-4 Studies on Idaho wood-rotting fungi (R. L. Gilbertson).
- 57-G-10 Ecology of branch stub infection in aspen (D. E. Etheridge).
- 59-G-1 The influence of site on variations in red heartwood stain of lodgepole pine (J. E. Nighswander).
- 59-G-4 Red rot in young ponderosa pine (S. R. Andrews).
- 59-G-5 Heart roots of upper-slope species (P. E. Aho).
- 59-G-6 Pathology of advanced reproduction on upper slope clearcuts (P. E. Aho).
- 62-G-2 Red rot in merchantable ponderosa pine in the Black Hills (S. R. Andrews and T. E. Hinds).
- 62-G-4 Decay in advanced alpine fir regeneration in British Columbia II. In the Kamloops District (R. B. Smith and H. M. Craig).
- 62-G-5 Decay in young grand fir (O. C. Maloy).
- 62-G-6 Bark decomposition by four species of wood decay fungi (L. Reesman, M.S.U. Graduate Student).

- 64-G-1 Heart rots of upper slopes species (P. E. Aho).
- 65-G-1 Factors influencing resistance of lodgepole pine to attack by the bark beetle-blue stain fungi complex--pathological aspects (H. S. Whitney).
- 66-G-1 The effect of extracellular enzymes of lodgepole pine heartwood inhabiting fungi on the molecular structures of the fungitoxic stibenones pinosylvin and pinosylvinomono-methylether, and of the flavanones pinobanksin and pinocembrin (A. A. Loman).
- 67-G-1 Causes of cull in the mixed conifer stands of the Southwest (P. G. Lightle).
- 71-G-1 Incidence of heart rot associated with tussock moth white fir top kill (R. F. Scharpf).
- 72-G-5 Factors influencing resistance of lodgepole pine to attack by the bark beetle-blue stain fungi complex; pathological aspects (H. S. Whitney). (Formerly 65-G-1).

H. Stem Diseases - Rusts and Cankers

- 53-H-4 Blister rust canker development following artificial and natural inoculation (A. D. Partridge).
- 53-H-6 Forest tree rusts of British Columbia (W. G. Ziller).
- 54-H-2 Rate of growth of white pine blister rust cankers on sugar pine in California (D. R. Miller).
- 54-H-3 White pine blister rust (G. M. Harvey).
- 54-H-5 Summary of disease survey and scouting data (D. R. Miller)
- 54-H-7 Test fungicides for protection of white pines (C. R. Quick).
- 54-H-8 Search for blister rust-resistant white pines (C. R. Quick).
- 54-H-9 Appraisal and prediction of timber losses caused by blister rust (D. R. Miller).
- 54-H-10 Analysis of physical and ecological site factors contributing to high rust hazard (C. R. Quick).
- 55-H-2 Tests of fungicides to inhibit blister rust development on the leaves of ribes bushes (C. R. Quick).

- 55-H-4 Effect of microclimatic conditions on the distribution and spread of white pine blister rust in California (R. V. Bega).
- 56-H-4 Distance spread and rust losses to sugar pine associated with prescribed control standards (D. R. Miller).
- 57-H-2 Vegetative propagation of sugar pine for disease resistance tests (C. R. Quick).
- 57-H-4 The relation of bark moisture to the development of Cryptodiaporthe canker of willow (J. E. Bier).
- 58-H-2 Western tree rusts of Coleosporioides complex (W. W. Wagener).
- 58-H-3 Cronartium top-kill in ponderosa pine (K. R. Shea).
- 59-H-1 Cronartium comandrae rust on lodgepole pine in Wyoming (E. A. Andrews).
- 63-H-1 Differentiation of live from dead hyphae of Cronartium ribicola. I. Supravital staining (J. W. Koenigs).
- 63-H-2 Differentiation of live and dead hyphae of Cronartium ribicola. II. Tissue culturing (J. W. Koenigs).
- 64-H-1 Derma dieback of Douglas-fir in the Cariboo Region, British Columbia (A. K. Parker).
- 65-H-2 Treatment and sampling of western white pine trees for bioassay of Acti-dione (C. D. Leaphart).
- 65-H-5 Cytospora canker associated with dieback of dwarfmistletoe infected branches of red fir in California (R. F. Scharpf and R. S. Smith, Jr.)
- 66-H-1 Feasibility of establishing white pine tissue explants and/or subcultures infected with Cronartium ribicola in axenic culture (A. E. Harvey)
- 66-H-2 Nutritional and environmental requirements of axenically cultured western white pine tissue (A. E. Harvey).
- 66-H-9 Biological control of western white pine blister rust (E. F. Wicker, R. Williams, and C. G. Shaw).
- 66-H-10 Secondary screening of chemicals for control of white pine blister rust on sugar pine (H. H. Bynum).

- 67-H-3 Establishing Cronartium ribicola in axenic culture (R. D. Hungerford).
- 67-H-4 Development and implementation of an assessment program for screening potential therapeutic agents against white pine blister rust (A. E. Harvey).
- 67-H-6 Blister rust physiology. II. Concentration change of metal cations associated with infection in western white pine (N. E. Martin).
- 67-H-8 Stem rusts of pine--basic cytological, taxonomic and life history studies (Y. Hiratsuka, and J. M. Powell).
- 67-H-9 Taxonomy and biology of forest tree rusts in western North America with special emphasis on the species of Pucciniastrum, Chrysonyxa, and Melampsora (Y. Hiratsuka).
- 67-H-11 A study of larch canker (Phomopsis sp.) in seedlings and sapling stands of western larch (H. V. Toko and C. E. Carlson).
- 68-H-2 Nuclei of Jeffrey pine limb rust fungi. (R. G. Krebill and D. L. Nelson).
- 68-H-3 Insect vectors of aspen cankers (Coop. with Colorado State University, T. O. Thatcher - N. G. Hussain).
- 68-H-5 Translocation of dye in western white pine infected with blister rust (C. D. Leaphart).
- 68-H-6 Pectic enzymes associated with blister rust (N. E. Martin).
- 69-H-1 Temperature measurement of white pine tissues: Healthy and infected with Cronartium ribicola Fisch. (R. D. Hungerford).
- 69-H-6 Factors affecting formation of Cronartium ribicola aeciospores in vitro (A. E. Harvey)
- 70-H-4 Nutritional and environmental requirements of white pine tissue cultures infected with Cronartium ribicola (A. E. Harvey).
- 71-H-4 Frequencies of field resistance to Cronartium ribicola and of canker inactivation in Pinus monticola (J. C. Hopkins).

I. Wilt and Blight Diseases

- 53-I-1 Pole blight of western white pine (C. D. Leaphart).
- 53-I-3 Pole blight of western white pine (R. G. McMinn, and A. C. Molnar).
- 58-I-1 Dendroclimatology of western white pine in the Inland Empire region (C. D. Leaphart).

J. Defects and Decays of Forest Products

- 53-J-1 Deterioration of slash of lodgepole pine in Alberta (V. J. Nordin).
- 54-J-1 Occurrence and relative significance of fungi decaying wood in service (R. S. Smith and J. W. Roff).
- 60-J-1 Relation of wood inhabiting fungi to preservatives (J. W. Roff, and A. J. Cserjesi).
- 63-J-1 Deterioration of Douglas-fir logs (R. B. Smith, and H. M. Craig).
- 65-J-2 The use of gas chromatographic methods for carbon dioxide detection in the respiration of fungi attacking wood (R. S. Smith).
- 66-J-1 Effectiveness of Boron diffusion treatment vs. advance of heartrots in stored unseasoned lumber (J. W. Roff).
- 66-J-2 Interaction of fungi and chemical preventives (J. W. Roff).
- 68-J-2 Taxonomy and cultural characters of wood destroying fungi in western North America (J. H. Ginns).
- 68-J-3 Establishment of threshold concentrations of fungicides for lumber (J. W. Roff).
- 69-J-1 Basidiomycetes associated with decay of ponderosa pine in the Southwest (R. L. Gilbertson and A. B. Budington).

K. Miscellaneous Studies

- 53-K-1 Survival of fire-damaged trees (W. W. Wagener).
- 54-K-1 An undescribed disease on Rocky Mountain juniper (C. W. Waters).
- 54-K-2 Vegetative propagation of disease-resistant western white pine (C. W. Waters).
- 56-K-2 Disease surveys of pathogenicity tests on selected clones of poplar, including introduced varieties (J. E. Bier).

- 57-K-2 Bio-assay of "Agri-mycin-100"-treated Pacific silver and noble firs (K. R. Shea).
- 58-K-1 Tests of systemic fungicides (G. M. Harvey).
- 59-K-2 Control of forest disease by systemic fungicides (G. M. Harvey)
- 60-K-2 Systemic fungicides in Douglas-fir (L. C. Weir).
- 62-K-1 The taxonomy, comparative morphology and ecology of fungi of arid lands (P. D. Keener).
- 63-K-1 Fungus flora of the state of Washington and the Pacific Northwest (C. G. Shaw and H. Goree).
- 63-K-2 The isolation, purification, and measurement of the antibiotic Phytoactin or its derivatives from treated plant tissues (S. O. Graham, C. G. Shaw, A. E. Harvey, M. Stoner, and S. Gurusiddaiah).
- 63-K-3 Life cycles of Ascomycetes with special emphasis on cytology (J. D. Rogers and S. Jong).
- 64-K-3 The time required for Tuberculina maxima to inactivate blister rust infections on western white pine (J. W. Kimmey).
- 65-K-2 The incubation period of Tuberculina maxima Rostr. (J. W. Kimmey and E. F. Wicker).
- 65-K-3 Fungi associated with Peridermium cerebroides Meinecke on Pinus radiata D. Don (J. W. Byler, F. W. Cobb, Jr., and J. R. Parmeter, Jr.).
- 65-K-5 Survey of naturally inactivated lethal-type blister rust cankers on young western white pine in the Inland Empire (J. W. Kimmey).
- 65-K-6 The effect of treating western white pine stands with antibiotics on the normal fungal population (O. K. Miller, Jr.).
- 66-K-1 The isolation, purification, and measurement of the antibiotic Phytoactin, or its derivatives from treated plant tissues (S. O. Graham, C. G. Shaw, and M. Stoner).
- 66-K-2 Physiological impact of treatment of western white pine seedlings with Phytoactin (A. E. Harvey, cooperative study with Washington State University, Pullman).
- 66-K-3 Effect of Phytoactin on several Basidiomycetes in culture (O. K. Miller, Jr., and J. W. Koenigs).

- 66-K-4 Investigations of cultural problems in the production of Christmas trees from natural stands (J. P. Nagle, R. W. Dingle, J. D. Rogers, E. P. Breakey, D. O. Turner, and B. Jones).
- 66-K-5 Investigation of nuclear phenomena in selected Ascomycetes (J. D. Rogers, C. G. Shaw, R. Duran, and Shung-Chang Jong).
- 66-K-6 Biologic control of western white pine blister rust (C. G. Shaw, C. D. Leaphart, E. F. Wicker, and R. Williams).
- 66-K-7 Fungus flora of the state of Washington and the Pacific Northwest (C. G. Shaw and L. Grand).
- 66-K-9 In vitro reaction of Tuberculina maxima to cycloheximide and Phytoactin (E. F. Wicker).
- 66-K-11 Overwintering capabilities of Tuberculina maxima on white pine blister rust cankers (E. F. Wicker).
- 67-K-5 Silvicultural control of Atropellis piniphila (L. C. Weir).
- 67-K-6 Silvicultural control of Poria weirii (L. C. Weir).
- 67-K-9 In-season tree failure on California recreational areas (L. A. Paine).
- 67-K-11 Application of immunofluorescent method for identification of forest fungi (Y. Hiratsuka).
- 67-K-12 An information service for biochemistry and control of plant parasite systems.--A research project in automatic storing, searching, and information retrieval (T. K. Burgess, S. B. Locke, C. G. Shaw, A. E. Harvey, and C. D. Leaphart).
- 72-K-4 Stand evaluation of past spruce beetle infestations (J. M. Schmid and T. E. Hinds).

Effects of dwarf mistletoe on the wood properties of lodgepole pine.--(D. D. Piirto, M.S. thesis).

Histological and histochemical effect of ozone on conifer needle tissue (P. R. Miller).

Rate of upward advance and intensification of water and hemlock mistletoe (UBC).

Survey of hazards in campgrounds, principally those caused by forest tree diseases (?).

Collection of stand data in dwarf mistletoe infected lodgepole pine (Hawksworth).

COMMITTEE ON FOREST DISEASE RECREATION HAZARD  
REPORT ON COMMITTEE ACTIVITIES

Peter Gaidula, Chairman<sup>1</sup>

As a result of last year's meeting of the Forest Disease Recreation Hazard Committee in Victoria, B. C., the Committee undertook several projects. The first of these is preparation of a training outline for field personnel in detection, evaluation and control of tree hazards within recreation sites. Mike Srago of Region 5, Forest Service, San Francisco, and Al Tegethoff of Region 4, Ogden, were asked to take on this assignment. They have prepared an initial draft which will now be reviewed by members of the Committee. After comments and suggestions are received, we hope to have this training outline completed some time during the coming year.

Our second project involves preparation of a literature list pertinent to the subject of tree hazards in recreation sites. This will be a list of selected publications and articles which can be used by those dealing with tree hazards, whether in detection, evaluation and control phases or in training of personnel to carry out these activities. Dave Graham undertook this assignment and has prepared a preliminary basic list which will now be expanded on by Committee members. We hope this list will be brought to more final form during this coming year.

RESEARCH ACTIVITIES

In addition to the fine presentation on Aspen presented yesterday by Tom Hinds, there are two research projects specific to the problem of tree hazards that I will mention at this time:

The first concerns the Fomes Annosus problem at Yosemite National Park, which will be the subject of a paper by Neil MacGregor Friday. Therefore, I will not comment further on this project at this time.

The second concerns the work by Lee Paine at the Pacific Southwest Forest and Range Experiment Station. I have a report from Lee Paine which I would like to read at this time.

The experiment station and the Recreation Site Hazard Research program are suffering from the same lack of money as other agencies. We have dropped from a total of 6 part-time and full-time personnel engaged exclusively in recreation hazard to a single individual

---

<sup>1</sup>California Department of Parks and Recreation, Sacramento, California.

for the present. Consequently, field requests are being answered more slowly, and much time is taken by essentially clerical work. Research studies and related activities are necessarily delayed.

One new Research Paper is now in print: Administrative goals and safety standards for hazard control on forested recreation sites, USDA Forest Service Research Paper PSW-88 / 1973, by Lee A. Paine. Another study near completion shows the relative susceptibility of various California tree species to unexpected failure. This is essentially an examination of the proportion of a species population which fails during the use-period on recreation sites. Total population data is most difficult to find. If you are aware of any significant body of such data for recreation sites, please let the experiment station know.

Damage potentials of tree failures are currently available in a Research Paper on hazard evaluation. The data base is now greatly increased over that available for the current tables. Consequently, analysis is underway to extend the tables and, if possible, to provide separate tables for important genera. These will eventually be issued as an addendum to Research Paper PSW-68 / 1971.

The station expects to enter the field of recreation hazard in urban forestry as soon as additional help is available. A program is being set up to include regional, county, city, and Public Utility parks, and larger city street and parkway agencies. This will be operated separately from the State and Federal recreation site hazard program, and will be restricted to the West Coast for the first year, at least. We anticipate that the problems, the range of species, and the possible actions in response to problems will differ greatly from the situation on State and Federal lands.

#### 1972 COMMITTEE MEETING

The Committee held its annual meeting last night in Room 401 with 19 in attendance. As at last year's meeting, once again the subject of training of field personnel took up considerable time. The group agreed to review the training outline mentioned earlier. There were some good ideas on visual aids brought out. These include the Narrator 1,000; the Slide-on-Sound manufactured by 3M, and the use of video tape.

How to communicate more effectively with, and to motivate personnel in the recreation and safety functions toward instituting tree hazard control programs on a more systematic basis.

This was discussed at some length. In addition, the group felt that there is a need for top-level policy formulation and more specific guidelines for administration and execution of tree hazard control programs in many of our organizations.

The literature list, which I mentioned earlier, was discussed and plans to have Committee members expand it were made.

The members declared themselves in favor of having next year's Conference at Lake Tahoe Area in California, and furthermore in conjunction with that meeting, having a field trip to view areas with potential tree hazard problems.

The Interim Program Chairman, Ken Russell, was present and took note of this Committee recommendation for consideration.

## HIGHLIGHTS OF 1973 DWARF MISTLETOE RESEARCH

## I. Taxonomy, Hosts and Distribution

- a. A collection of Arceuthobium americanum on Pinus contorta was made from the Bearpaw Mountains in north-central Montana. This area is quite isolated from other forested areas. (Oscar Dooling, USFS, Missoula)
- b. Chihuahua pine dwarf mistletoe (Arceuthobium gillii) found in the Animas Mountains in southwestern New Mexico. This is the first record of A. gillii from New Mexico. (F. G. Hawksworth, RM Station; M. J. Weiss, SW Region).
- c. A number of localities of Arceuthobium cyanocarpum were found in the Bighorn Mountains in northern Wyoming. This parasite of limber pine was not previously known from this area. (D. H. Brown and J. Walters, USFS, Denver)

## II. Physiology and Anatomy

- a. We are preparing for publication a report on the morphological relationship between the host phloem and sinker cells of Arceuthobium tsugense. We have also made progress in an investigation of the ultrastructure of cells of the endophytic system of A. tsugense. In the near future, we plan to complete comparative ultrastructural studies of host phloem ray cells in healthy and infected host tissue. We are working on microradioautographic techniques to study interspecific translocation of soluble organic substances in western hemlock infected with A. tsugense. We have studied epidermal cellular characteristics in the aerial shoots of A. tsugense and have begun investigating the vascularization of the aerial shoots of A. tsugense. (Clyde L. Calvin and M. Carol Alosi, Portland State University)
- b. A study of the biochemical properties of the viscin of A. tsugense is underway. At present we have determined that viscin is probably not protienaceous, as evidenced by the lack of ninhydrin + compounds. Preliminary results suggest that it is a complex carbohydrate related to pectin. Subsequent to a better understanding of the properties of the viscin of A. tsugense, a comparative examination will be made among A. campylopodum, A. douglasii, and A. tsugense. (P. Paquet, Portland State University)
- c. Chemical analyses of dwarf mistletoe nectar (Arceuthobium abietinum) showed an unusually high concentration of sugars (average 87 percent). The sugar concentration of most plant nectars is about 20 to 30 percent. Dextrose and fructose were the main sugars in the dwarf mistletoe nectar from pistillate flowers. Sucrose and maltose were also present but in much

smaller quantities. Studies are continuing on analyses of other species and to compare the nectar from pistillate and staminate flowers. (J. W. Brewer, Colorado State University)

- d. Research to determine the effects of water stress on the physiology of dwarf mistletoes is being continued. Included are studies to determine the influence of water availability on (1) the partitioning of water and carbohydrates between the host and parasite, (2) respiratory gradients, and (3) sucrose breakdown by the parasite. (Jim Fisher, Colorado State University)
- e. Pollen of Arceuthobium americanum, A. cyanocarpum, A. divaricatum, and A. vaginatum subsp. cryptopodum has been collected over the past year from recently opened staminate flowers and placed in several different media in an attempt to induce germination in vitro. Sugars (sucrose, raffinose, dextrose, glucose, and fructose), ions (Ca, B, K, H, and Mg), and growth regulators (I.A.A., G.A., and kinetin) in various concentrations have been included in the artificial media tested. Simulation of the sugar content of mistletoe nectar has also been tried and tested. Various mixtures of sugars, ions, and macerated pistillate flowers have been prepared and tested. Almost all tests have yielded negative results so far. A combination of 10% sucrose, 10% glucose, and 10% dextrose produced some slight germination of A. americanum pollen (approx. 5%), but these results could not be duplicated in subsequent tests. Any suggestions or ideas for further work would be well received. (Bob Mathiasen, Colorado State University)

### III. Lifecycle Studies

- a. As first noted during the 1972 WIFDWC field tour to my "small tree" infection study near Cowichan Lake, Vancouver Island, an early frost damaged hemlock dwarf mistletoe fruit. Seed dispersal was reduced considerably though not as sharply as in 1970. The number of seeds intercepted expressed as a percentage of fruit counted before dispersal was 12.2 for 1969, 0.1 for 1970, 19.3 for 1971, and 1.5 for 1972. In both 1970 and 1972 frosts were experienced in mid to late September. (R. B. Smith, Victoria)
- b. Douglas-fir seedlings inoculated in the greenhouse with dwarf mistletoe seeds did not produce aerial shoots in the expected time period (3-6 months is typical for A. campylopodum, A. tsugense, A. americanum and A. abietinum). This behavior corresponds to field observations of long latency of infection in this species. (Knutson, PNW Station)
- c. Intensification of mistletoe in thinned Douglas-fir stands. Plots were established in precommercially thinned (18 x 18') stands on the Malheur National Forest. Tree growth and mistletoe development will be measured. (Knutson, PNW Station)
- d. A study to determine the possible effect of ozone on the mistletoe infection progress, shoot growth and seed production was started this fall. Inoculated ponderosa pine seedlings are being exposed

to ozone in clear plastic tents and will be observed through mistletoe seed production. (Wilhour and Steward, PNW Station)

- e. Hudler, George W. Seed dispersal and spread of eastern dwarf mistletoe (Arceuthobium pusillum). Masters Thesis, Univ. of Minn., 49 p. 1973.  
Abstract: Seed dispersal of Arceuthobium pusillum began in the first week of September and continued until the first frost, usually in the last week of September. The mean horizontal distance traveled by discharged seeds was 5.4 feet. One seed traveled 45 feet. The majority of seeds discharged in the first 3 hours after sunrise. Seed expulsion was triggered by rising temperature during that time. Immature dwarf mistletoe fruits did not discharge seeds when subjected to temperatures less than approximately 30 F. Seeds oozed from the fruit or remained attached to the pedicel. In 1970, low temperatures on August 31 resulted in nearly complete abortion of dwarf mistletoe fruits. Canada jays and red squirrels were implicated as potential vectors of dwarf mistletoe seed. Both species had seeds on their bodies when they were trapped. Only 6.5% of 3,200 seeds placed on healthy black spruce in September 1971 had germinated by August 1972. Most of the seeds were dislodged from the branches on which they were placed within 3 weeks after placement. Approximately 25% of the 3,200 seeds were invaded and killed by fungi. The mean annual rate of lateral spread of dwarf mistletoe on black spruce in 13 plots was  $2.8 \pm 1.4$  feet per year over a 4-year period. Host stand characteristics had no effect on dwarf mistletoe spread. (G. W. Hudler, Colorado State University)

#### V. Effects on Host

- a. Analysis of tree mortality in mistletoe infected Douglas-fir on the Okanogan National Forest. Mortality will be compared for mistletoe infected vs. uninfected trees on old inventory plots which were read in 1957 and 1967 and will be reread next summer. (Knutson and Stewart, PNW Station)
- b. Small (8-20" dbh) mistletoe infected Douglas-fir trees on the Rogue River National Forest were measured to determine whether bole taper above a witches broom was less than below a broom. Unanalyzed data seems to compare with Shea's report (For. Res. Note 50, Weyerhaeuser Co., 1963) for old growth Douglas-fir that taper is independent of broom location. (Knutson, PNW Station)
- c. Attempts were made to relate crown characteristics of infected Douglas-fir (8-20" dbh) with diameter growth in hopes of developing a mistletoe intensity rating system. No correlations resulted. The best indication of growth decline was the number of brooms in the top half of the crown. (Knutson, PNW Station)
- d. The 10-year reading was made on the manzenita chute plantation - dwarf mistletoe spread and impact plots this fall. The data have not been analyzed yet but it appears that some interesting results are obvious. The most striking is the fact that very little

mortality of Jeffrey pines in the plantation occurred even among trees most severely infected with mistletoe. Other observations not yet substantiated by a critical analysis are that intensification of the mistletoe occurs from infections within the crown rather than from adjacent trees or from overstory infection and that infections that result in brooms are by far the most damaging to the tree both in terms of growth loss and deformation. Trees with a single infection of this sort appear to be much more severely damaged than other trees with numerous localized branch infections. (R. F. Scharpf, PNW Station; J. R. Parmeter, Univ. Calif., Berkeley)

- e. The 15-year reading was made on the red fir-dwarf mistletoe inoculation plots this fall. Preliminary results show that: So many infections were present on the inoculated trees (cumulative infections) plus the fact that many tags were missing from infections for one reason or another that it was impossible to determine accurately how many new infections occurred this year. However, our previous findings seem to be holding true. No noticeable reduction of either height or radial growth was present regardless of the fact that hundreds of infections were present in the lower crown. Also the trees were growing in height faster than the rate of upward spread of the parasite. Thus the parasite is being limited to a smaller and smaller proportion of the living tree crown. Few bole infections were present and brooms on red fir develop very slowly. Reduction of infections is also taking place by Cytospora abietis killing infected branches and by squirrels girdling the branch at the infection in the winter. Thus, considerable mortality of infections is occurring which may bring about a slowing down of the rate of intensification with time. (R. F. Scharpf, PNW Station; J. R. Parmeter, Univ. Calif., Berkeley)

## VI. Ecology

- a. For the third year in a row (see 1971 and 1972 reports), A. douglasii seeds failed to survive the winter near Williams Lake in the Cariboo District of British Columbia. This is about 150 miles northwest of the known northern extent of this dwarf mistletoe. In the Okanagan within the natural range of A. douglasii, germination of planted seeds from the same seed lot was 82%. (R. B. Smith, Victoria)
- b. The study of the distribution of Arceuthobium douglasii on the west slope of the Oregon Cascades is nearing completion. A report, which will identify each of several locations where the parasite was found, will appear soon. The initial study of the impact of birds on the distribution of Arceuthobium seeds has been completed and the work is being prepared for publication. The potential for certain species of birds to move seeds is high. A study has just begun which will examine the effect of various levels of insolation on the production of seeds by A. douglasii. The study of the response of germinating seeds of A. campylopodum to nonhost species continues. The response is being compared with the normal response on Pinus ponderosa with attention being focused on the various stages of the infection process, and the means of infection. (R. O. Tinnin, A. Garcia, P. Zilka, Portland State University)

## VIII. Control-Biological

- a. A study of Wallrothiella on A. douglasii was started 1972-73 to evaluate this fungus as a biocontrol agent. We'll study the infection process (time of year, phenological state of the mistletoe plant, length of time). It appears to us that Wallrothiella has an Aureobasidium conidial stage (confirming Dowding's observations, 1931). (Knutson and Hutchins, PNW Station)
- b. Field trials designed to evaluate the effectiveness of Nectria fuckeliana var. macrospora in controlling hemlock dwarf mistletoe were carried out in March and August. Established infections were sprayed with a blended aqueous media containing the fungus. Non-treated infections are being observed as controls. Results from the March inoculations have been negative so far. First observations of the August inoculations have not been made. (A. Funk and R. B. Smith, Victoria)
- c. In an attempt to determine the possible use of resin disease fungi (see last year's committee report) as a practical control, a series of spray tests were begun. Inoculum of Alternaria alternata, Aureobasidium pullulans, and Epicoccum nigrum were sprayed on 1,500 infections of Arceuthobium americanum and A. vaginatum cryptopodum in three areas of the Roosevelt National Forest and Colorado State Forest. No detailed results to date but casual inspections in late August indicated a number of "takes" from the June series of inoculations. (J. G. Laut, Colorado State Forest Service)
- d. The plant bug Neoborella xanthenes was recently described from Arceuthobium americanum in Colorado (J. L. Herring, Proc. Entomol. Soc. Wash. 74:9-10, 1972). The insect has since been found to occur also in Arizona and Wyoming. Several new hosts noted include: A. cyanocarpum, A. douglasii, A. divaricatum, and A. microcarpum. (F. G. Hawksworth, U.S. Forest Service; Bob Mathiasen, Colorado State Univ.)

## IX. Control-Silvicultural

- a. An attempt to develop a computer program for obtaining gross impact data from forest inventory records in Region 6 was initiated this year. If successful this program should be applicable to other regions who are recording the "6-class rating" for each tree during the forest inventory. (DeMars and Stewart, PNW Station)
- b. An economic evaluation of the costs and benefits of dwarf mistletoe control in southwestern ponderosa pine is underway. This is a cooperative effort between the Pest Control Unit of the Southwestern Region, Dr. Dennis Schweitzer, Economist at the Intermountain Station, and the pathology and mensuration projects at the Rocky Mountain Station. Growth predictions will be based on previously published yield simulations for infected stands (Station Paper RM-87). Although our initial efforts will be with southwestern ponderosa pine, we anticipate that the techniques developed will

also be applicable to other forest types. (F. G. Hawksworth, RM Station; M. J. Weiss, SW Region)

## X. Surveys

- a. An administrative study of sampling techniques in dwarf mistletoe-infected lodgepole stands compared three survey designs--the third nearest tree (with 2- and 4-chain intervals between sample points), one percent, and Stage II inventory survey. Tree density, in combination with the incidence of dwarf mistletoe, is a key factor in the LPMIST simulated yield program. The precision of any survey design in estimating tree density will therefore determine the precision and reliability of the simulated yields. Analysis of the data collected in this study shows the third nearest tree design using a 2-chain spacing gives the most precise measurement of tree density. There was relatively little sampling variation between any of the surveys in estimating the incidence of dwarf mistletoe. Further analysis of data indicated that examination of only the third nearest trees or a maximum of four trees per plot rather than all twelve trees, provided equally precise estimates of percent infection. The modified third nearest tree design with observations on only the third nearest trees using a 4-chain spacing will give, on the average, acceptable precision at a reasonable cost. (Jim Walters and Don Brown, USFS, Denver)

## XI. Miscellaneous

- a. The Computerized Hawksworth Mistletoe Index is operable and requests for literature searches have been processed at PSW with few problems. Nearly 6,000 citations are now in the information bank, and much editing has been done although some minor errors still turn up in a few citations. The users' manual we had planned to have out by the this time is not yet completed. Therefore, requests for information or questions about the index for the time being will have to be submitted to PSW or RM. Following is a tabulation of the requests for searches by users over the past 2 years and part of 1973:

<u>Year</u>	<u>No. users</u>	<u>No. searches</u>
1971	10	22
1972	10	24
1973	21	27

(R. F. Scharpf, PSW Station; F. G. Hawksworth, RM Station)

## INTERIM PROGRAM REPORT

Kenelm W. Russell<sup>1</sup>  
Chairman

I received the following topics as considerations for the proposed combined 1974 meeting.

1. Role of root diseases and their interaction with bark beetles in forest succession.
2. Influence of air pollution on diseases and insects of forest trees.
3. Recreation hazards related to insects and diseases.
4. Dwarfmistletoes and insects (vectors, parasitism, etc.).
5. Beetle vectors and their relationships with blue stains, wood rot, *Polyporus volvatus*, wilts or others.
6. Deterioration of insect killed timber under various stand conditions. For example, Colorado, eastern Washington and west Cascades slopes all have different rates of deterioration.
7. Region 5 Pest Control Inventory System. Designed for both insects and diseases. This system is combined with normal forest inventory (see Neil McGregor for detail).
8. Management tools available to the land manager to assess impact (Biological economics, etc.) from insect and diseases on forest trees. This would include simulation programs, impact studies, recreation research that is now available.
9. Availability and utilization of forest inventory data for the detection, evaluation and suppression of insects and diseases.
10. Evaluation of insect and disease suppression projects. Don Brown will volunteer to report on dwarfmistletoe evaluation in Region 2.
11. Registration of pathologists - do we need it? Is it a good thing? (See October or September Phytopath News, 1973).
12. Publish the proceedings. This may be a good suggestion as a one time affair. Various government agencies may wish to pick up the tab. This would be comparable to the soil borne diseases publication done at Berkeley several years ago edited by Bob Bega.

The interconference committee compiled a list of cooperative insect-disease projects and should be referred to by the new chairman

---

<sup>1</sup> Forest Land Mgmt. Center, Rt. 4, Box 490, Olympia, Washington.

## PUBLICATIONS

- BARANYAY, J. A. 1973. Sampling techniques and damage appraisal in Canada. In: Abstracts of Papers 2nd Int. Congr. Plant Path. Am. Phy. to Path. Soc., St. Paul, Minn.
- BARANYAY, J. A. 1973. Dwarf mistletoe as a factor in the management of lodgepole pine forests in western Canada. In: Proceedings of "Management of Lodgepole Pine Ecosystems." Wash. State Univ. (In press).
- BARANYAY, J. A. 1972. Rhizina root rot of conifers. Pac. For. Res. Centre, Can. For. Serv., Victoria, B. C., Pest Leaflet 56.
- BARANYAY, J. A., & N. G. BAUMAN. 1972. Distribution maps of common tree diseases in British Columbia. Pac. For. Res. Centre, Can. For. Serv., Victoria, B. C. Info Rept. BC-X 71.
- BOLLEN, W. B., & K. C. LU. 1970. Sour sawdust and bark - its origin, properties, and effect on plants. U.S. Forest Serv., Res. Pap. PNW-108, 13 p.
- BOLLEN, W. B., & R. F. TARRANT. 1970. Effect of Zectran on microbial activity in a forest soil. U. S. Forest Serv. Res. Note PNW-124, 11 p.
- BOLLEN, W. B., & K. C. LU. 1969. Douglas-fir bark tannin decomposition in two forest soils. U. S. Forest Serv., Res. Pap. PNW-85, 12 p.
- BOLLEN, W. B., K. C. LU, J. M. TRAPPE & R. F. TARRANT. 1969. Influence of Sitka alder on soil formation and microbiological succession on a landslide of Alpine origin at Mount Rainier. U. S. Forest Serv. Res. Note PNW-103, 5 p.
- CARPENTER, STEVE, & JAMES M. TRAPPE. 1969. Endomycorrhizae of *Thuja plicata*. Oregon State Univ. Abstracts.
- CATALFOMO, PHILIP, & JAMES M. TRAPPE. 1970. Ectomycorrhizal fungi: A phytochemical survey. Northwest Sci. 44(1): 19-24.
- CHILDS, T. W., & EARL E. NELSON. 1971. Laminated root rot of Douglas-fir. U. S. Forest Serv. Pest Leaflet 48:7 p.
- DITTRICH, WILLIAM J., & JAMES M. TRAPPE. 1970. Natural Areas--Needs and opportunities. Sym. Northwest Scientific Assoc. 43rd Ann. Mtg., Salem, Oreg.

- EDGREN, JAMES W., & JAMES M. TRAPPE. 1970. Growth of Douglas-fir, ponderosa pine, and western larch seedlings following seed treatment with 30 percent hydrogen peroxide. U. S. Forest Serv. Res. Note PNW-130: 6 p.
- ETHERIDGE, D. E. 1973. Wound parasites causing tree decay in British Columbia. Pac. For. Res. Centre, Can. For. Serv., Victoria, B. C. Pest Leaflet (In press).
- ETHERIDGE, D. E., & H. M. CRAIG. 1973. A bilayer plate technique to detect broad-spectrum antagonism in microorganisms and its application to wood-inhabiting fungi. Can. J. Microbiology (In press).
- ETHERIDGE, D. E. 1972. True heartrots of British Columbia. Pac. For. Res. Centre, Can. For. Serv., Victoria, B. C. Pest Leaflet No. 55.
- FUNK, A., R. B. SMITH & J. A. BARANYAY. 1973. Canker of dwarf mistletoe swellings on western hemlock caused by *Nectria fockeliana* var. *macrospora*. Can. J. For. Res. 3:71-74.
- FURMAN, THOMAS E., & JAMES M. TRAPPE. 1971. Phylogeny and ecology of mycotrophic achlorophyllous angiosperms. Rev. Viol. 46(3): 119-225.
- GERDEMANN, J. W., & JAMES M. TRAPPE. 1970. *Endogone incrassata*: A zygosporic species with hollow sporocarps. Mycologia. LXII(6): 1204-1208.
- HAWKSWORTH, FRANK G. 1973. Dwarf mistletoes (*Arceuthobium*) of coniferous forests of the world. Proc. Eur. Weed Res. Coun. Symp. Parasitic Weeds, p. 231-235.
- HAWKSWORTH, FRANK G., & CLIFFORD A. MYERS. 1973. Procedures for using yield simulation programs for dwarf mistletoe-infested lodgepole and ponderosa pine stands. USDA For. Serv. Res. Note RM-237, 4 p.
- HO, I., & J. M. TRAPPE. 1973. Translocation of  $^{14}\text{C}$  from *Festuca* plants to their endomycorrhizal fungi. Nature New Biol. 244: 30-31.
- ILNYTZKI, S., & J. R. SUTHERLAND. 1973. Corky root disease of Douglas-fir seedlings: Post-plant nematicide trials to control *Xiphinema bakeri*. Bi-monthly Res. Notes, 29(3): 18-19.
- LI, C. Y., K. C. LU, J. M. TRAPPE & W. B. BOLLEN. 1972. *Poria weirii*-inhibiting and other phenolic compounds in roots of red alder and Douglas-fir. Microbios 5: 65-68.

- LI, C. Y., K. C. LU, J. M. TRAPPE & W. B. BOLLEN. 19-2. Nitrate-reducing capacity of roots and nodules of *Alnus rubra* and roots of *Pseudotsuga menziesii*. Plant and Soil 37: 409-414.
- LI, C. Y., K. C. LU, J. M. TRAPPE & W. B. BOLLEN. 1972. Formation of p-hydroxybenzoic acid from phenylacetic acid by *Poria weirii*. Can. J. Bot. 51: 827-828.
- LI, C. Y., K. C. LU, J. M. TRAPPE & W. B. BOLLEN. 1970. Separation of phenolic compounds in alkali hydrolysates of a forest soil by thin-layer chromatography. Can. J. Soil Sci. 50: 458-460.
- LI, C. Y., K. C. LU, J. M. TRAPPE & W. B. BOLLEN. 1970. Inhibition of *Poria weirii* and *Fomes Annosus* by linoleic acid. Forest Sci. 16(3): 329-330.
- LI, C. Y., K. C. LU, E. E. NELSON, W. B. BOLLEN & J. M. TRAPPE. 1969. Effect of phenolic and other compounds on growth of *Poria weirii* in vitro. Microbios 31: 305-311.
- LIGHTLE, P. C., & F. G. HAWKSWORTH. 1973. Control of dwarf mistletoe in a heavily used ponderosa pine recreation forest: Grand Canyon, Arizona. USDA For. Serv. Res. Pap. RM-106, 22 p.
- LIGHTLE, P. C., & ESLIE H. LAMPI. 1973. Herbicides ineffective in controlling southwestern dwarf mistletoe. USDA For. Serv. Res. Note RM-242, 3 p.
- LOCK, W., & J. R. SUTHERLAND. 1973. Fungicide seed-treatment field trials in 1972. Pacific Forest Res. Centre, Victoria, B. C. Internal Rept. BC-X-44.
- LOOMIS, R. C. 1973. Disease detection survey, air pollution, Arizona and New Mexico. USDA Forest Serv., Reg. 3, Div. Timber Manage. 118 p. (unpublished office report).
- MARASAS, W. F. O., & JAMES M. TRAPPE. 1973. Notes on southern African Tuberales. Bothalia 11, 1 & 2: 139-141.
- MILLER, ORSON K., & JAMES M. TRAPPE. 1970. A new *Chroogomphus* with a loculate hymenium and a revised key to section *Floccigomphus*. Mycologia LXII(4): 831-836.
- NELSON, EARL E. 1972. Effect of urea and wood shavings on populations of soil microfungi, especially *Trichoderma* species. Microbios 5: 69-72.
- NELSON, EARL E. 1971. Invasion of freshly cut Douglas-fir stumps by *Poria weirii*. U. S. For. Serv. Res. Note PNW-144, 6 p.

- NELSON, EARL E. 1970. Effects of nitrogen fertilizer on survival of *Poria weirii* and populations of soil fungi and aerobic actinomycetes. Northwest Sci. 44(2): 102-106.
- PETERSON, GLENN W. 1-73. Dispersal of aeciospores of *Peridermium harknessii* in central Nebraska. Phytopathology 63: 170-172.
- PETERSON, GLENN W. 1973. Infection of *Juniperus virginiana* and *J. scopulorum* by *Phomopsis juniperovora*. Phytopathology 63: 246-251.
- POWELL, J. M. 1973. Comandra blister rust in Canada and our knowledge of the epiphytology of the fungus. 2nd Int. Cong. Plant Pathology, Minneapolis, Minn. Abstracts of Papers. No. 0232.
- POWELL, J. M. 1973. Can we control comandra blister rust on pine with biological organisms? 2nd Int. Cong. Plant Pathology, Minneapolis, Minn. Abstracts of Papers. No. 0233.
- POWELL, J. M., & N. W. WILKINSON. 1973. *Pinus mugo*, a new host for comandra blister rust. Plant Dis. Repr. 57: 283.
- POWELL, J. M. 1972. Insects collected from the toadflax *Comandra umbellata* ssp. *pallida* (Santalaceae) infected by the rust *Cronartium comandrae* in southern Alberta. Can. Field-Naturalist 86: 81-83.
- POWELL, J. M. 1972. Seasonal and diurnal periodicity in the release of *Cronartium comandrae* aeciospores from stem cankers on lodgepole pine. Can. J. For. Res. 2: 78-88.
- POWELL, J. M. 1972. Additional collections of *Tuberculina maxima* on pine stem rusts in western Canada. Can. Plant Dis. Surv. 52: 139.
- POWELL, J. M., H. R. WONG & J. C. E. MELVIN. 1972. Arthropods collected from stem rust cankers of hard pines in western Canada. Environment Canada, Northern For. Res. Centre, Edmonton, Alberta. Info. Rept. NOR-X-42. 19 p.
- POWELL, J. M. 1971. Incidence and effect of *Tuberculina maxima* on cankers of the pine stem rust, *Cronartium comandrae*. Phytoprotection 52(3): 104-111.
- POWELL, J. M. 1971. Daily germination of *Cronartium comandrae* aeciospores. Can. J. Bot. 49: 2123-2127.
- RIFFLE, JERRY W. 1973. Effect of two mycophagous nematodes on *Armillaria mellea* root rot of *Pinus ponderosa* seedlings. Plant Dis. Rep. 57: 355-357.

- ROSS, D. A., J. A. BARANYAY & R. L. FIDDICK. 1973. Important forest insects and diseases, British Columbia Region. In: Forest Insect and Disease Survey, Annu. Rept. 1972. Env. Canada, Can. For. Serv., Ottawa.
- ROTH, L. E., H. H. BYNUM & E. E. NELSON. 1972. *Phytophthora* root rot of Port-Orford-cedar. USDA For. Serv. Forest Pest Leaflet. 131.
- RUSSELL, K. W., J. H. THOMPSON, J. L. STEWART & C. H. DRIVER. 1973. Evaluation of chemicals to control infection of stumps by *Fomes annosus* in precommercially thinned western hemlock stands. Washington Department of Natural Resources. DNR Report No. 33.
- RUSSELL, K. W., R. E. WOOD & C. H. DRIVER. 1973. *Fomes annosus* survey of young ponderosa pine stumps in eastern Washington. Washington Department of Natural Resources. DNR Report No. 34.
- RUSSELL, K. W. 1972. Nursery soil disease assay. In: Proceedings, Joint meeting of the Western Forest Nursery Council and Intermountain Forest Nurserymen's Association held at Olympia, Washington.
- RUSSELL, K. W. 1971. Precommercial thinning and dwarf-mistletoe control. In: Proceedings of precommercial thinning of coastal and intermountain forests in the Pacific Northwest, held at Washington State University, Pullman, Washington. February 3 and 4, p. 23-40.
- RUSSELL, K. W. 1971. Root rot influences management of ice storm damaged timber. Washington Department of Natural Resources. DNR Note 3. 3 p.
- RUSSELL, K. W. 1969. Forest Diseases. Woodlands handbook for the Pacific Northwest: A guidebook for PNW Woodlands Management. 2nd edition. p. 206-213.
- SCHARPF, ROBERT F. 1972. Light affects penetration and infection of pines by dwarf mistletoe. *Phytopathology* 62(11): 1271-1273.
- SCHARPF, ROBERT F. 1972. Know Your Forest Diseases -- *Elytroderma* needle disease of pines.
- SCHARPF, ROBERT F. 1971. Forest pest conditions in California. A publication of the California Forest Pest Control Action Council.
- SMITH, ALEXANDER H., & JAMES M. TRAPPE. 1972. The higher fungi of Oregon's Cascade Head Exp. For. and vicinity--I. The genus *Phaeocollybia* (Agaricales) and notes and descriptions of other species in the Agaricales. *Mycologia* LXIV(5): 1138-1153.

- SMITH, R. B., J. A. BARANYAY & E. V. MORRIS. 1972. Three new host records for dwarf mistletoes in British Columbia. *Can. Plant Disease Surv.* 52(4): 137-138.
- SUTHERLAND, J. R., & L. J. SLUGGETT. 1973. Corky root disease of Douglas-fir: Relation of *Xiphinema bakeri* nematodes to symptom severity and observations on seedling tissue and soil nutrients. *Can. J. Forest Res.* 3(2): 299-303.
- SUTHERLAND, J. R., L. J. SLUGGETT & W. LOCK. 1973. Association of some physical and chemical properties of nursery soils with corky root disease. *Bi-monthly Res. Notes*, 29(3): 19.
- SUTHERLAND, J. R., L. J. SLUGGETT & W. LOCK. 1972. Corky root disease observed on two spruce species and western hemlock. *Tree Planter's Notes* 23(4): 18-20.
- SUTHERLAND, J. R. 1972. Book Review. *Economic Nematology*. J. M. Webster (ed.) Academic Press, London and New York, 563 p. *Forestry Chronicle* 48(6): 327.
- TARRANT, ROBERT F., & J. M. TRAPPE. 1971. The role of *Alnus* in improving the forest environment. *Plant & Soil Spec.* p. 335-348.
- THIERS, HARRY D., & JAMES M. TRAPPE. 1969. Studies in the genus *Gastroboletus*. *Brittonia* 21(3): 244-254.
- TRAPPE, JAMES M. 1972. Parasitism of *Helvella lacunosa* by *Clitocybe schlerotoidea*. *Mycologia* LXIV(6): 1337-1340.
- TRAPPE, JAMES M. 1972. Regulation of soil organisms by red alder: A potential biological system for control of *Poria weirii*. *OSU Sym.*: 35-51.
- TRAPPE, JAMES M., & J. W. GERDEMANN. 1972. *Endogone flammicorona* sp. nov., a distinctive segregate from *Endogone lactiflua*. *Trans. Br. Mycol. Soc.* 59(3): 403-407.
- TRAPPE, J. M., & JAMES W. KIMBROUGH. 1972. *Elaphomyces viridiseptum*, a new species from Florida. *Mycologia* LXIV(3): 646-649.
- TRAPPE, J. M., & GASTON GUZMAN. 1971. Notes on some hypogeous fungi in Mexico. *Mycologia* LXIII(2): 317-332.
- TRAPPE, J. M., & GASTON GUZMAN. 1971. A newly determined species of *Elaphomyces* from Oregon. *Madrono* 21(3): 128-130.

- TRAPPE, JAMES M. 1971. A synopsis of the *carbomycetaceae* and *Terfeziaceae* (Tuberales). Trans. Br. Mycol. Soc. 57(1): 85-92.
- TRAPPE, JAMES M. 1971. Biological control -- Forest diseases. USDA: 2 p.
- TRAPPE, JAMES M. 1971. The ascus in taxonomy and Phylozeny of the Tuberales. 1st Intern. Mycolo. Cong. Abstracts. United Kingdom.
- TRAPPE, JAMES M. 1971. The ecological basis for truffle cultivation and potential for expanded production. 1st Intern. Mycol. Cong. Abstracts. United Kingdom.
- TRAPPE, JAMES M. 1971. Root pruning conifers in nursery beds: Does it increase survival potential? Tree Planters' Notes 22(3).
- TRAPPE, JAMES M. 1970. Hypogenous macrofungi and mycorrhizae. Proc. 17th Western Int. Forest Dis. Work Conf., Olympia, Washington. Sept. 23-26, 1969.
- TRAPPE, JAMES M. 1969. Mycorrhize-forming ascomycetes. Proc. 1st North Amer. Conf. on Mycorr. Misc. Pub. 1189: 19-37.
- TRAPPE, JAMES M. 1969. Studies on *Cenococcum graniforme*. I. An efficient method for isolation from sclerotia. Can. J. Bot. 47: 1389-1390.
- TRAPPE, JAMES M., & ROBERT F. STRAND. 1969. Mycorrhizal deficiency in a Douglas-fir region nursery. Forest Sci. 15(4): 381-389.
- WICKMAN, BOYD, & ROBERT F. SCHARPF. 1972. Decay in white fir top killed by Douglas-fir tassock moth. Pacific Northwest Res. paper 133, 9 p.
- YOUNG, J. L., I. HO & J. M. TRAPPE. 1972. Endomycorrhizal invasion and effect on free amino acids content of corn roots. Agronomy abstracts.
- ZAK, B. Tuberculate Ectomycorrhiza of Douglas-fir, *Pseudotsuga menziesii* + *Rhizopogon vinicolor*. Abstract.
- ZAK, B. 1972. Flotation of excised root and fungal cultures on liquid media. Can. J. Micro. 18(4): 536-538.
- ZAK, B. 1971. Detoxication of autoclaved soil by a mycorrhizal fungus. U. S. Forest Serv. Res. Note PNW-159: 4 p.

- ZAK, B. 1971. Characterization and classification of mycorrhizae of Douglas-fir. II. *Pseudotsuga menziesii* + *Rhizopogon vinicolor*. Can. J. Bot. 49: 1079-1084.
- ZAK, B. 1969. Characterization and classification of mycorrhizae of Douglas-fir. I. *Pseudotsuga menziesii* + *Poria terrestris* (blue- and orange-staining strains). Can. J. Bot. 47: 1833-1840.
- ZAK, B. 1969. Characterization and identification of Douglas-fir mycorrhizae. Proc. 1st North Amer. Conf. Mycorr. Misc. Publ. 1189: 38-52.

## BUSINESS MEETING

October 3, 1973

### Committee Reports

1. Dwarf Mistletoe. The report was distributed to members and will be included in the Proceedings. Ed Wicker is Committee Chairman.
2. Forest Disease Recreation Hazard. Chairman Peter Gaidula submitted his report which will be included in the Proceedings.
3. Interim Program. Interim Program Chairman, Ken Russell submitted his report which will be included in the Proceedings.
4. Disease Control. The Disease Control Committee was reestablished. Ken Russell is the new Chairman.

### Minutes

Minutes of the previous meeting were accepted as they appeared in the 20th Proceedings.

### Secretary-Treasurer's Report

The enclosed Financial Statement was presented.

### Old Business

The status of the 18th Proceedings was discussed. Jim Stewart volunteered to look into the matter and will report to the Chairman by December 31, 1973.

### New Business

Joint Conference. The membership voted to hold the Joint WIFDWC and WFIWC meeting in California sometime between February 15 and April 15, 1975. The membership also indicated that they preferred that all sessions of this meeting be held jointly, except for business and committee meetings.

S.A.F. Working Group Reorganization. Don Brown mentioned the recent Society of American Foresters Working Group reorganization. He urged individual participation in the Pathology Working Group.

Honorary Life Members. Stuart R. Andrews, Paul C. Lightle, and Wolf G. Ziller were voted Honorary Life Members of WIFDWC.

Election of Officers. Bob Bega was elected Co-Chairman. John Muir was elected Secretary-Treasurer.

Commendation

The Local Arrangements Committee which included Frank Hawksworth, John Laut, and Don Brown was thanked for the fine arrangements. The Program Committee chaired by Bob Gilbertson was thanked for an interesting and informative program. Members also found the Field Trips interesting and informative.

FINANCIAL STATEMENT - 1973

Bank balance October 1, 1972 \$ 180.45

Income:

Registration

Regular	43	\$430.00
Honorary	3	--
Students	8	--
Guests	14	--

Banquet Tickets

58 @ \$8.00	464.00
-------------	--------

Extra Tour Tickets

18 @ \$8.50	153.00
-------------	--------

Miscellaneous

	1.25
	<u>\$1048.25</u>

Expenses

Banquet	\$522.00
Bus	257.20
Barbecue & Show	300.00
Coffee	52.50
Mailing Expenses (Nov. 72)	9.37
	<u>\$1141.07</u>

Bank Balance - October 9, 1973 \$ 87.63