

PROCEEDINGS OF THE 23rd ANNUAL WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

**Missoula, Montana
September 1975**



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CHAIRMANS OPENING REMARKS

TWENTY-THIRD WIFDWC - MISSOULA, MONTANA

Ladies and Gentlemen, Honoured Guests, it is my pleasure and privilege to welcome you to the 23rd WIFDWC here in Missoula, and to raise the gavel and declare this conference open.

A special welcome to persons attending WIFDWC for the first time. We are delighted that you have come - for two reasons. Firstly, as the years go by, there are additions to the emeritus and necrology rosters. And it is clear that the future of this organization lies ultimately in the hands of you, the newcomers. Secondly, we welcome, indeed solicit, your injection of newness into our conference and into our lives - before we too reach these rosters.

Informal and informative; loud, clear, simple unabashed truth; freedom from and freedom to; enthusiastic and entertaining; full of mighty might and righteous rhetoric. These are but a few feeble words attempting to describe your average WIFDWC or your average WIFDWC member. Fortunately, we've never had an average meeting nor known an average member and there are no specific rules, regs or rigamarole for newcomers to measure up to. The only requirement for full membership is participation; each in his own words, each in his own way. This is a challenge that changes with the times.

I can think of no better way to demonstrate the WIFDWC philosophy of freedom in communication than by my taking unfair advantage of the opportunity I now have as chairperson. With your, I hope, undivided attention and with you, I hope, locked in this room, I would like to express a thought or two I've had recently as to where WIFDWC is and where it could be going. Let me hasten to emphasize that I am not trying to set the tone or describe the theme for this meeting. Like all our meetings, this one won't have a recognizable theme or thread of continuity until some time after it is over. The thoughts I want to set before you are that I reckon we are on the horns of a dilemma. On the one horn is the need to preserve the unique 'not for publication' private-openness and free exchange of ideas that is the hallmark of WIFDWC; while on the other horn is the growing need not to "hide our light under a bushel". These are of course not new thoughts originating with me. I am sure our founding fathers and many subsequent adherents mulled and mused over them into the wee small hours many times. And it is perhaps for this reason above all that we too, from time to time, should consider the great WIFDWC Dilemma. Can we afford to remain private in these times when there is such a cry for scientists to speak up and engage their public? What is WIFDWC doing for the science of Forest Pathology in Western North American - in relation to what it could do if it set its mind to it? I believe we have reached a stage where we should go somewhat beyond talking only to ourselves. An opportunity is now at hand to let outsiders have a peek and snatch a word or two and, for us to listen more to what they have to say.

It is not necessary to prostitute ourselves to the public but only to feed them a nibble or two of what they so desperately hunger for at this time. I am confident that Forest Pathology and perhaps even WIFDWC itself would gain a very large and disproportionate benefit from making a relatively tiny compromise in this direction. Our meeting earlier this year with Forest Entomologists indicates a certain readiness to share and we should pursue it.

My real job as chairman has been and still is to get this meeting underway. I'm not sure if I'm helping or hindering at the moment but before I lose the floor altogether I want to thank Ed Wicker, our program chairman, and his 'volunteers' who have put together the program for this week. Without their untiring efforts and contributions this meeting would end in approximately 3 minutes from now. Also my thanks to Oscar Dooling and his helpers for looking after the myriad of items that come up in connection with local arrangements and to Jim Byler our Secretary, who's forthcoming job of creating the Proceedings is perhaps the toughest of all.

I'll now turn the chair over to Oscar who will introduce Lawrance Witfield who will say a few words under the title, Welcoming Address.

WELCOMING ADDRESS

Lawrence Whitfield, Deputy Regional Forester for Resources, USDA Forest Service Northern Region

Welcome to Missoula and the Forest Service's Northern Region.

Northern Regional Forester Steve Yurich is not able to attend your Conference sessions this morning because of other obligations. Steve asked that I extend to you his best wishes for an enjoyable and productive Conference. He shares your concern for the growing importance of forest disease work in resource management.

As land managers we in the Forest Service have long had a keen interest and concern for protecting our forest resources from diseases and insects. Our pathologists and entomologists in the Northern Region headquarters tell us that each year our 13 National Forests lose more wood to insects and diseases than is lost to forest fires. Even the non-professional, lay person can recognize the proportions of the problem when cast in those dimensions. Industry appreciates the impact of insects and diseases when we tell them these pests take more wood from the National Forests each year than is harvested in timber sales.

This destructive insect and disease toll is having a feeling impact on all of the resources in the National Forests: wildlife, water, wood, recreation, and forage. This impact is no respecter of land ownership. Insects and diseases don't stop at state and private property lines.

An expanding population and growing resource demands--coupled with a shrinking forest land base--all tend to multiply the significance of insect and disease control in land management.

But as specialists in this field, I'm telling you nothing new. However, I did want you to know that we share your concerns and interests. It is more than "lip service" when we wish you well in the work at the 23rd Annual Western International Forest Disease Work Conference.

Because a work conference is designed for sharing ideas and information, permit me to share an idea with you this morning. Pathologists and land managers must do more than talk to each other. It has to be a communication that involves more perception and understanding. We must be able to tell you what our management plans are for an area and you must help us understand the impact of diseases under the proposed management. This is essential if we are to reach agreement and understanding on a disease control problem and what the control options are.

As a land manager, I see your role as that of acquiring enough basic knowledge about the disease to provide sound guidance in planning

practical solutions. It is the land manager's responsibility to make sound application of your counsel.

This over-simplification sounds easy enough to the uninitiated. But there are complications. Some of the solutions you've proposed have not proven practical or workable. I think white pine blister rust control efforts in the 40's and 50's is a prime example. Other suggestions--for example dwarf mistletoe control--are proving both practical and economical. I'm sure you've made many other sound suggestions for practical disease control practices, but I fear that we land managers have not always listened. Or, if we were listening, we didn't listen well. I feel poor communications often proves as great a hurdle as the forest disease itself. Unfortunately land managers talk to themselves too much. We have to quite thinking in terms of "we" and "they." It has to be "us." Only then can we understand what we're saying, what our needs are and how we can apply this disease control understanding in land management.

Again, our best wishes for a successful and rewarding work conference.

KEYNOTE ADDRESS

by Larry Blasing, Inland Forest Resource Council

After I had accepted Oscar Dooling's invitation to speak to this group, I was faced with the problem of choosing a topic that would not be a repetition of information or problems that you were probably better versed on than I was. The usual problems of research, control methods and management applications are continually discussed and rediscussed and, I felt that I was in a poor position to be able to contribute much more than a discussion of recognized problems. In searching for a topic it occurred to me that we are standing at a cross roads in Forest Land Management, and that numerous possibilities for a change in direction are imminently present. Many things are occurring which may cause changes in our forest management plans which will in turn create changes in our needs and requirements for Forest Disease Management. In following this idea I have chosen to assess some of the more current issues in forest land management and their possible implications on the management and control of forest diseases.

There are numerous changes that are taking place both nationally and internationally that may change the management of our forest lands. In the United States we are just implementing the provisions of the Forest and Rangelands Renewable Resources Planning Act; in British Columbia, a Royal Commission on Forest Resources is reviewing the forest management policies in their region. We are in the process of defining the laws which direct forest management through the courts. The United States Forest Service is in the process of allocating lands to various uses through the land use planning process, while again in British Columbia, the BC Forest Service is performing a similar function through their folio system of land use analysis. We are all dealing with a new public that has become aware of the value of our forest resources and the management practices that sustain them. The public is often critical, skeptical, confused and vocal about the management practices that are applied to a specific situation. This public awareness is not restricted to the United States or North America, but surprisingly enough is developing into a major issue in the European and Scandinavian countries in Regions where Forest Management has been practiced for centuries. As an example, scandinavian foresters are finding that they are having to go back and re-educate and convince the public that their forest management practices are environmentally sound and in the public interest. There are many such events that are developing in almost daily occurrence which require forest land managers of all kinds to be current, to be knowledgeable and to develop flexibility in their management systems which can absorb these changes as they occur. Forest Managers no longer have the option of sitting in their own little office, doing their job and being unaware of anything else that happens around them. We are all going to have to develop a certain amount of salesmanship to promote our profession and our ability to practice that profession. To fail to do so will only give control of the management of our forest land to someone who is less qualified than the professionals.

Let us examine some of the current issues.

FOREST AND RANGELAND RENEWABLE RESOURCES PLANNING ACT

On August 17, 1974 the President signed into law the Forest and Rangeland Renewable Resources Planning Act (P.L. 93-378). This law was primarily directed at the management of our National Forest lands through the Secretary of Agriculture. The Secretary of Agriculture was directed to prepare renewable resource assessment. This assessment was to be completed by December 31 of this year and is to be up-dated in 1979 and each tenth year thereafter for forty years. This assessment was to include:

1. An analysis of present and anticipated uses, demand for and supply of the renewable resources with consideration of the international resource situation.
2. An inventory of present and potential resources with an evaluation of opportunities for improving their yield of tangible and intangible goods and services.
3. A description of Forest Service programs and responsibilities in research, cooperative programs, and management of the National Forests.
4. A discussion of Policy Law Regulations and other factors which influence and affect management.

One of the important things about this law is that it directs the Forest Service to look into the future and plan the management of their lands accordingly. Past Forest Service planning has failed to adequately accomplish this.

The Secretary of Agriculture is also directed to make and keep current a survey and analysis of present and prospective conditions and requirements for renewable resources. This analysis is to include such things as productivity, means of balancing supply and demand, and public need.

The Secretary of Agriculture is also directed to prepare and transmit to the President a recommended Renewable Resource Program.

This is also to be accomplished by December 31, 1975 and is to include:

1. An inventory of specific needs and opportunities for both public and private program investments.
2. Specific identification of program outputs, including a cost benefit analysis.
3. A discussion of priorities.
4. Personnel requirements needed to satisfy existing and ongoing programs.

In the development of the Land and Resource Management Plans under the Program, the Secretary of Agriculture is directed to use a systematic interdisciplinary approach to achieve integrated consideration of physical, biological, economic and other factors. He is also directed to make any information that is developed pursuant to this act available to states and other organizations for their planning efforts.

When Congress convenes in 1976 the President of the United States shall transmit to the Speaker of the House of Representatives and the President of the Senate the Assessment and the Program which were prepared under this Act, together with a detailed statement of policy which is to be used in framing budget requests for the Forest Service for the five or ten year program period. The President is directed to carry out the programs that are established under his statement of policy unless within sixty days upon the receipt of the assessment program and statement of policy, either House of Congress adopts a resolution disapproving the statement of policy. Congress has the authority to revise the President's statement of policy and use the revision in framing budget requests.

Beginning with the fiscal budget for the year ending September 30, 1977, requests presented by the President to Congress regarding Forest Service activities shall express in qualitative and quantitative terms the extent to which the programs and policies projected under the budget meet the policies approved by Congress. If a budget is presented which recommends a course of action that fails to meet the policies that were previously established, the President must state why he is requesting Congress to approve the lesser program.

In addition to the President's report to Congress, the Secretary of Agriculture is directed to prepare an annual report which evaluates the elements contained in the Program. This is to be submitted with the annual fiscal budget requests. These annual reports shall state in Qualitative and Quantitative terms what the progress is in implementing the program. This report will contain a cost benefit analysis and an evaluation of the balance between economic and environmental quality factors. The report must also contain plans for implementing corrective action and recommendations for any new legislation that they deem necessary.

The Congress has established that the year 2000 is the target year when the renewable resources of the National Forest System shall be in an operating posture whereby all backlogs of needed treatment for their restoration shall be reduced to a current basis and, the major portion of planned intensive multiple-use sustained yield management procedures shall be installed and operating on an environmentally sound basis. The budget request must reflect an orderly program to eliminate any backlogs. Congress also declares that a proper system of transportation to service the National Forest System shall be carried forward in time to meet anticipated needs. This will require additional budgeting requests and a positive program consideration to get the transportation system built.

This pretty much highlights the language of the Act. At this time the Secretary of Agriculture has prepared a draft copy of the assessment and program which is to be presented to the President on December 31. The public had an opportunity to review the assessment and program and to recommend any changes that they felt were necessary. The Forest Service is now in the process of evaluating the public comments and developing any changes that have become obvious as a result of the public's input.

It should be noted that the Forest Service had only a relatively short time, by bureaucratic standards, to prepare these documents for submission to the President. Since the Act was passed in August 27, 1974 and the reports are to be submitted to the President on December 31, 1975, this allows only about sixteen and one half months to prepare a major planning effort. Since there also needed to be time for public review before these documents were presented to the President, it is surprising that the job was accomplished with as much quality and detail as it was. The Assessment contained 385 pages and the Program contained 597 pages. In the brief review period that was allowed for public comment it was nearly impossible to effectively evaluate this great volume of material and provide a meaningful analysis. One of the key items that the public was requested to comment on was their preference for various level of output for various resource values. Now that this phase of the Act is completed, I am sure the Forest Service is working overtime to evaluate these comments and prepare the final program for submission to the President. I will not attempt to evaluate the content of the Assessment and Program, but will confine my comments to what we can reasonably expect from the final analysis.

Some of the key points that should be of most interest to those of you who are involved in disease research and disease management, is that there will be an assessment of research needs of all kinds and that priorities will have to be established for satisfying these needs. One of the analysis involved in the establishment of research priorities will have to be a cost benefit analysis and an assessment of the values to be gained from this research. In addition, you will be required to annually evaluate the results of what you have done along with some indication as to what you plan to accomplish. This should serve to eliminate many of the criticisms of research that have occurred in the past. The same types of analysis will have to be made for the management programs that are being attempted on the ground. But most important it gives you a time frame and schedule within which development must take place and as a result, the related disease problems can be prioritized and programs established which will accomplish our best levels of Disease Management.

ROYAL COMMISSION ON FOREST RESOURCES

Now let us take a look across the border to the north. The government of British Columbia has appointed a Royal Commission on Forest Resources to examine forest policies and management in British Columbia. The commission is traveling around the province looking at the basic concepts of forest management that are being practiced to determine whether or not any changes of policy should be made.

Among the things that are being examined is the tenure system that is used in British Columbia. For those of you who are not familiar with it, this system allows the Forest Service to make long term contracts on timber sales to established operators in the immediate vicinity. As an example, the Forest Service may sell a timber sale harvesting permit for one million cubic feet of logs to be harvested from a given area annually for a ten year period. They may also enter into long term contracts for the complete management of a tract of land. It is my understanding that the commission is questioning whether or not these types of timber sales programs are more desirable than other types of sales programs.

They are also discussing such items as the length of time for the liquidation of old growth timber and evaluation of rotation ages to determine whether or not allowable cuts are reasonable and sustainable. Both proponents and opponents of timber harvest are being consulted to better determine the public's feeling on these matters. It is quite possible that as the result of the research of this commission that some major changes in forest policy may be forthcoming for British Columbia. This in turn will have an impact on the management program and the priorities that are established for the various systems of management.

MONONGAHELA DECISION

In the United States we operate under a series of laws that affect Forest Management. The Organic Act of 1897 establishes the authority of the Forest Service to sell timber and provide wood and water for the needs of the American people. The Multiple Use Sustained Yield Act of 1960 provides that National Forest land will be managed for several resources and that they will be managed so as to provide a sustained yield of each. The Environmental Policy Act of 1970 as applied to National Forest land, directs that the responsible agency will evaluate the impact of its actions prior to any development and that the development will take place without any unnecessary degradation of environmental factors.

Throughout the history of forest management these laws have been accepted literally with very little concern as to how they were interpreted. The people that were responsible for management decisions were pretty much left to interpret the laws as they saw fit. We are now entering into a new era where the courts are being asked to define the parameters and intent of the various acts. Many of the preservation organizations that are opposed to any further development of National Forest lands are using the courts very skillfully to define various points of law in favor of their interests. Some of these litigations have had far reaching effects on the management of our National Forest

lands. As an example, the Land Use Planning Process and the preparation of Environmental Impact Statements as we now use them are largely the result of court decisions and interpretations of the basic laws. We will find increased use of administrative appeals and litigations to further define the role of Forest Management.

One of the key lawsuits that has taken place which involves the interpretation of one of the basic laws is commonly known as the Monongahela Decision. In a case known as the Isaak Walton League vs. Butz, the Court was asked to rule on language in the Organic Act. The Plaintiffs argued that the Forest Service was not operating under the literal interpretation of the Organic Act which stated that timber that is to be sold should be individually marked, of large growth and mature or dead. They argued that clearcutting on the Monongahela National Forest did not conform to this language. The Court upheld the Plaintiffs in a decision which obviously had severe implications for management of National Forest lands.

The District Court decision was appealed to the Fourth Circuit Court of Appeals. The Appellant Court upheld the District Court and created a serious question as to how the Forest Service could maintain a viable timber sales program. While at the present, the Court's decision only applies to the Monongahela National Forest, it is a relatively simple matter to extend the decision to the rest of the United States.

The Court's interpretation of the language which says that the trees must be individually marked, of large growth, and physiologically mature, or dead, eliminates the practice of clearcutting, intermediate harvest, any thinning or cultural work that does not come under the Knudson-Vandenburg Act, and even the Harvest of Christmas trees. This, of course, would create a whole new problem for the management or control of disease on National Forest lands. The literal interpretation of the Court's decision would effectively eliminate many of the practices that have been affected for the control of disease.

LAND USE PLANNING

Another process that is taking place on Forest lands both in the United States and Canada is the reassessment of Land Use Plans. The folio system of land analysis that is being used in British Columbia and the Land Use Planning System that is being carried out on National Forest lands are quite similar in nature. The agencies are making an interdisciplinary analysis of the lands capability to produce various resources. An analysis is also made of the conflicts between resource uses and the constraints that must be imposed because of various limiting factors. The net result of this analysis is that the agency must make a decision as to which resource uses will be allowed on a given tract of land and the level of management that these individual areas can sustain. Lands are being analyzed not only considering the physical resources, but the social resources as well. The agencies are attempting to sustain the various resource uses at the most

compatible level and allocate the land to the use of these resources as its capability permits.

As a result of this analysis, we are generally finding that the land base for any given resource use is shrinking. We are setting aside areas of commercial timber land for exclusive use for recreation. We are managing some forms of land for wilderness, a use which precludes developed recreation. We are restricting grazing from some watersheds to prevent possible degradation of water quality. Trade offs are being made for all resource values and as a result all resource users from forest lands find themselves in a land squeeze.

When looked at in its entirety we find that our Forest land base is being reduced through other means. Many areas are being withdrawn from use from forest resources because the land is being subdivided and used for the production of agricultural crops. Highway systems and utility corridors have restricted use on vast acreages. There are any number of additional reasons why our forest land base is becoming smaller. Each time one of these decisions is made, it places a different perspective upon the management of the forest resource.

NEW OR REVISED LEGISLATION

Just in case there are not enough things that are going on to keep the forest manager alert, we have a Congress or Parliament, as the case may be, which is impowered to enact new legislation. As an example, the House Agricultural Committee is currently re-evaluating the Federal Insecticide, Fungicide and Rodenticide Act. With the current emphasis on regulatory measures, along with pressures from groups who are opposed to the use of any of these items, it then becomes necessary for the forest manager to become actively involved in the formulation of Legislation so as to insure that reasonable and practical legislation is produced. Under the reconsideration of the Insecticide, Fungicide and Rodenticide Act, such things are being considered as licensed applicators, regulations for use of these substances, regulations for production of these substances, licensing requirements and authority for control. While there may be a desirable aspect to each of these categories, it is entirely possible that when the final legislation is produced the complexities and regulations that are required may make it impossible to use any form of synthetic control on any insect or disease problem. The people who are most concerned with the use of these substances must be involved in the development of their control and regulation, otherwise they may find that they are no longer available for their use. Once again the land manager can no longer afford to sit and be content within his own little world. He must become active at all levels of the implementation and formulation of Forest Policy if practical forest management is to survive.

PROGNOSTICATIONS

We have reviewed several of the current issues. There are many more which are similar in nature, all of which have the potential to create substantial changes in our current management systems. These changes will in turn necessitate other changes in the way priorities are established in Disease Management.

One of the certainties is that we will be dealing with a smaller land base than had been originally estimated. The competition for land for various resource uses has made it necessary to reduce the acreage allotted for any specific resource use.

Let us consider the timber resource. With a restricted land base we will be utilizing those acres which will be managed for timber much more intensively. Intensive management will be initiated more quickly than we had previously planned. This has numerous implications. The diseases that are increased by intensive management practices will become more significant. The pressure to get more wood fiber from a smaller acreage will create a greater need to prevent losses from these kinds of diseases. The repeated entries into a stand that are required to obtain maximum wood fiber production, offer increased opportunity for injury to residual trees and subsequent infection by disease.

With the trend toward more sophisticated logging systems and wider road spacing, there is increased chance for injury from long-line skidding systems. The trend of using line skidding systems instead of tractor skidding promotes the same trend. These problems should receive high priority for the development of solutions.

Several of the issues we discussed can cause a change in the age of timber that is harvested. Longer rotation ages may also be proposed. If any portion of the monongahela decision becomes common practice we will only be harvesting large, physiologically mature or dead trees. Public opinion predominantly leans toward longer rotations and preserving stands of old growth timber. If any of these things come about we will be dealing with longer rotations and older trees. This may mean that some of the disease problems that we felt were insignificant because of plans to manage younger stands of timber on shorter rotations, will now become more important. Diseases of old growth timber may become more significant.

The Monongahela Decision may also have additional ramifications. If the practice of clearcutting is restricted or eliminated this causes the Forest Manager to lose one of his greatest opportunities for the control of some diseases, particularly mistletoe. Without the opportunity to cut diseased trees that are neither large nor matured, the Land Manager is hamstrung in many of his efforts for disease control. How will we ever work toward a disease free stand?

The land use planning process that is occurring on National Forest lands and the folio systems of land analysis that is being utilized in British Columbia serve to contribute to most of the problems that we have discussed. As an example, the land use planning process in Region 1 of the U.S. Forest Service has already taken away more than 400,000 acres of land from the timber producing base. The process is probably less than one third complete. The same trend is being repeated in other regions in North America. This increases the pressure on the remaining timber resource that is designated for management. The level of management is being reduced on other areas through the land allocation process. In addition, special land use designations are providing for longer rotations in recreation areas and areas where key wildlife considerations are present. All of this serves to increase the pressure on the resource and the Manager.

Another problem is being increased where lands are set aside through the land use planning process for wilderness and other management systems which do not provide for the harvest of the timber resource. This provides a continuing source of disease spores which can infect adjacent stands.

Most of the disease problems that we have known in the past are still with us. There is some major policy action appearing some place which may negate any progress that has been made, or perpetuate problems yet to be solved. For these reasons meetings like this one become very important. Land managers must continue to discuss these problems and to update their level of knowledge. They are going to have to continue to actively seek solutions to the new problems which arise as well as continuing to improve on our methods of handling those problems to which we have found solutions.

Forest Land Managers must become aware of the changing conditions under which we operate. Otherwise we will find ourselves on the outside looking in with programs that do not fulfill our needs. We must also be prepared to participate in the development of forest land management policies at all levels to insure that professional expertise guides our destiny rather than emotion. We need the total involvement of our best experts using their best judgment to be certain that the best job of forest management is accomplished.

The pressures for increased Forest resource output are beginning to rise. This creates a corresponding pressure to provide solutions for our disease problems in forest management. While we are finding solutions to some problems, others are becoming more acute. Our losses from disease are tremendous and solutions to curb these losses must be found if we are to have any measure of success with intensive forest management. We cannot afford to relax our efforts to solve these problems or be passive and take the easy way out. Remember in Forest Management as in other endeavors if we are coasting there is only one direction we can go.

DISEASES OF CONTAINERIZED SEEDLINGS

Richard S. Smith, Jr. ^{1/}
Panel Moderator

Within the last few years there has been an increase in the mass production of containerized forest tree seedlings in greenhouses. The development of this new system has been rather sudden and in some cases the new technical knowledge needed for the most efficient use of the system has not kept pace. This is particularly true of plant pathology where the knowledge of the disease problems particular to this new system is just now being gathered and the supportive role that plant pathology can and must play has not had time to develop.

The purpose of this panel is to exchange information from the various areas as to the diseases we have encountered and the success we have had in controlling them. We can then discuss the future needs, problems and priorities.

^{1/} Principle Plant Pathologist, Pacific Southwest Forest and Range Station, USDA Forest Service, Honolulu, Hawaii.

DISEASES OF CONTAINERIZED SEEDLINGS

Michael D. Srago ^{1/}

Today there is little literature on the diseases of containerized seedlings. Only one incidence survey has been conducted in the United States and Canada: Glenn Peterson in 1975. In April, Peterson mailed a questionnaire to nursery operators and researchers to obtain information on diseases occurring in containerized tree seedling nurseries. Among the questions asked were these four:

1. What diseases of containerized tree seedlings have you encountered?
2. What was the cause of these diseases (if known)?
3. Is chlorosis (yellowing) a problem?
4. Are the causes known?

The responses indicated that two significant biological problems were grey mold and damping-off, and that in many nurseries there was a chlorosis problem.

Grey Mold: Grey mold is caused by the fungus Botrytis cinerea, which is also a saprophyte. It is almost universally present on dead and dying plant (vegetable) matter. As a plant pathogen, the fungus usually becomes established on dead or moribund parts of a host plant; it then spreads into adjacent healthy tissues.

In the containerized nursery where there are prolonged periods of high humidity and cool temperatures, this fungus infects the juvenile bracts and lower shaded branches. Once established it proceeds downward into the stem, killing the tissue it infects. In the succulent one-year-old stem it forms a black sunken canker which eventually girdles the stem. Under most conditions, Botrytis can be seen as a thin grey web of mycelium on infected plant parts. From this mycelium and from infected tissue, tufts of black conidiophores arise bearing clusters of white to grey spores.

Some conifer species are so susceptible to Botrytis that the fungus directly infects healthy green tissue.

In his "Pathology of Trees and Shrubs," Peace lists Coast redwood and Giant Sequoia in the most susceptible host group, while placing Douglas-fir and western hemlock in the moderately susceptible group.

^{1/} Plant Pathologist USFS, Region 5, San Francisco, California

The conditions favoring the disease are high moisture levels and high planting densities, which limit air movement and raise the humidity around the seedlings. This condition exists essentially in many of the containerized green houses as the crowns close in the styrofoam blocks. When these conditions are combined with the susceptible species being grown in the western containerized tree nurseries, it is no wonder Botrytis is a major problem in containerized tree seedling nurseries.

Damping-Off: Damping-off appears to be an extensive, though not an intensive, problem in many of the containerized nurseries. This is especially true where the planting mixture used was vermiculite, or perlite and peat. In most instances, losses have been less than one percent. Where other types of planting mixtures, such as unfumigated top soil or humus, were used, the losses were higher.

Damping-off was attributed to Pythium, Rhizoctonia, Phytophthora and Fusarium. Most respondents did not specify whether the problem was pre-or post-emergence damping-off; where damping-off is a problem it may be a combination of both.

Pre-emergence damping-off is not readily observable: what is usually found is the end result. Post-emergence is readily observable. Infection characteristically occurs at or just below the ground line, resulting in a water-soaked or necrotic area on the succulent stem. In conifers this tissue collapses and becomes flaccid, and the seedling topples over.

Any condition that reduces seedling growth and vigor usually causes an increase in infection. Excessively wet growing media, restricted air flow that prevents the growing media from drying, and high temperatures (27-30^oC), especially with Pythium, favor damping-off. Nitrogen fertilizers applied before or during the period of seedling susceptibility may also increase losses.

Some other pathogens which have caused losses in containerized nurseries are Melampsora rust and Fusarium top blight on Douglas-fir, and Sirococcus strobilinus on white spruce. All these pathogens are favored by humid conditions. In many containerized nurseries where there is poor air circulation and overhead irrigation, the foliage remains moist for extended periods of time, increasing the possibility for successful infection by foliage pathogens.

Chlorosis: Chlorosis is common in many containerized nurseries. Its cause can be attributed to many factors: nutrient deficiency, excess, or imbalance; high ph; poor mycorrhizal development; pathogenic fungi; or pesticides.

In the responses received by Dr. Peterson, chlorosis was commonly attributed to high ph levels in the growing media, and/or iron deficiency. The problem was corrected by reducing the ph level to 5.5 or lower and spraying with iron chelate.

CONTROL OF DISEASES OF CONTAINERIZED SEEDLINGS

A. H. McCain^{1/}

The same organisms that cause disease of conifer seedlings grown in the traditional way in ground beds cause disease in containerized seedlings. However, there are differences in importance. As an example, Macrophomina phaseolina, a soilborne fungus, is not apt to be a problem in containerized seedlings since one of the requirements for pathogenicity is low soil moisture coupled with high temperatures.

For convenience and for practical purposes diseases of seedlings can be divided into those that attack aboveground parts (foliage and stem) and those that attack belowground parts (roots). Aboveground diseases of containerized seedlings might be the same as those grown in ground beds in the open since airborne pathogens are not restricted by overhead structures such as roofs of plastic or glass. In an ideal containerized greenhouse the humidity is controlled and theoretically condensation of moisture can be prevented and thereby the known airborne pathogens of conifers can be prevented from infecting. This degree of control has been achieved in greenhouses where chrysanthemums and roses are controlled entirely without the use of fungicides in many greenhouses through humidity control and air movement. These types of greenhouses are expensive and require considerable energy for operation. Most of the containerized nurseries that I have seen have not had the environmental controls necessary to prevent infection by airborne pathogens.

Location of containerized nurseries in areas where host-specific airborne pathogens do not occur seems to be a reasonable requirement for disease control. One host-specific airborne pathogen that should be considered is rust (gall, fusiform, and others). Location might also be considered in the case of non-host-specific pathogens such as the ubiquitous Botrytis cinerea. From experience it is known that B. cinerea is most troublesome in the coastal areas of California. This of course is related to high atmospheric moisture. Filtration of air to exclude spores has been suggested but it is not in general use and may not be practical.

Some degree of environmental control, that is humidity control, can be achieved in simple structures (greenhouses) by providing for good air movement through orientation of the structure, moving air by fans, plant spacing, watering practices (water when normal condensation might occur such as early in the morning so that the foliage is wet the shortest length of time).

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Fungicides can be very helpful in controlling B. cinerea. Where tolerance is not a factory benomy² is the outstanding fungicide. However, where the fungus has developed tolerance to benomyl, it is reported that the disease can become more intense with continued use of the fungicide. Chlorothalonil³ is effective against B. cinerea and several other pathogens of conifers. Mancozeb⁴ is also effective in the same way. I believe that it is desirable to alternate fungicides. There are two reasons for this. First, levels toxic to the plant are less likely to build up and, second, there is much less opportunity for selection of tolerant fungi.

The most important belowground or soilborne pathogens are Pythium spp., Rhizoctonia solani, and Fusarium oxysporum f. pini. Both Pythium and Rhizoctonia are present in practically all agricultural soils. Fusarium oxysporum f. pini, while perhaps not as widely distributed, has been implicated in death of containerized seedlings (Sequoia gigantea in California). All three can be eliminated from soil by heat or chemical fumigation. Recontamination by Pythium and somewhat less by Rhizoctonia is common, if not the rule.

All plant pathogens are killed in moist soil held at 60°C (140°F) for 30 minutes. High treatment temperatures are not desirable because many beneficial organisms which survive the 60°C treatment are killed. Ordinary steam treatment of soil rarely heats the soil much over 93°C (200°F). This is because air is entrapped in the soil. By intentionally combining air with steam lower treatment temperatures can be achieved. This can be accomplished in large transit-type cement mixers adapted for mixing soil. Steam is simply injected into the mixer until the desired temperature is reached.

Specially designed blowers and valving devices are available for treatment of soil in open containers or carts with plenums in the bottom for uniform distribution of the steam (Lindig®).

The most useful fumigant for treatment of soil mixtures is methyl bromide because it is fast acting, diffuses rapidly throughout the soil mass and dissipates when confinement is terminated. It must be confined and this is usually accomplished using polyethylene sheets. It should be pointed out that polyethylene sheeting is not impermeable to methyl bromide gas and losses through the film are significant, especially in the thinner sheets. Four mil (0.004 inch) thickness is probably best for pile treatment. When the gas is injected into field soils, a 2 mil cover

²Benomyl = methyl 1-(butylcarbamoyl)-2-benzimidazole carbamate; sold as Benlate®, Tersan® 1991 (turfgrass).

³Chlorothalonil = tetrachloroisophthatonitrile; sold as Daconil 2787®, Bravo® (food crops).

⁴Mancozeb = a coordination product of zinc ion and manganese ethylenebis-dithiocarbamate; sold as Dithane M-45®, Manzate 200®, Fore® (turfgrass).

seems to be sufficient. The amount required under a 2 mil thickness cover is greater than that required when a 4 mil cover is used.

Metham-sodium, also known as SMDC (sodium N-methyldithiocarbamate), sold in the U.S. as Vapam[®], is another fumigant sometimes used. It is a liquid that can be injected or mixed with water and drenched into the soil. It can also be used in "cement" mixers and in some other ways. Dazomet, also called DMTT (tetrahydro-3,5-dimethyl-2H,1,3,5-thiadiazine-2-thione), is generally sold as a powder (Mylone[®]) but is also available as a liquid concentrate. It is similar to metham-sodium in that in moist soil they both breakdown to form MIT (methyl isothiocyanate), the volatile toxicant. Diffusion of MIT is not as rapid as methyl bromide and the treatment time is longer. For best results, a gas-proof cover of polyethylene should be used when treating nursery soils.

MIT is also available dissolved in chlorinated C₃ hydrocarbons (Vorlex[®] = 20% MIT, 80% chlorinated C₃ hydrocarbons). It must be injected into soil and is not particularly adaptable to bulk treatment of soil.

Chloropicrin (trinitromethane) is now generally used in combination with methyl bromide; it also must be injected as is MIT because of slow diffusion. While methyl bromide-chloropicrin combinations have proven to be most effective for treatment of ground beds in conifer nurseries, the mixture is not suitable for bulk treatment of soil.

Methan sodium, dazomet, MIT, and chloropicrin all require about two weeks for treatment and aeration.

I mentioned that recontamination is the rule and treated soil is more readily recolonized than non-treated soil. It is very important that treated soil be protected from contamination. Sanitation is the name of the game. But in spite of sanitation, some Pythium may "get in". Certain soil fungicides have been very helpful in preventing recontamination of soil and in controlling Pythium and Rhizoctonia.

Ethazol, 5-ethoxy-3-trichloromethyl-1,2,4-thiadiazole, is sold as Terrazole[®], Truban[®] and Koban[®] (for turfgrass). It is used as a soil drench or mixed with the soil prior to planting. As a soil drench it is applied at the rate of 4 to 10 oz. (30%)/1000 sq. ft.; 5 oz. (30%)/1000 sq. ft. is probably adequate. Usually the product, which is either an emulsifiable concentrate or a wettable powder, is applied in 100 gallons water/400 sq. ft. These rates do not damage foliage and with many ornamental crops the chemical is metered into the water with irrigation.

Diazoben, p (dimethylamino) benzenediazo sodium sulfonate, sold as Dexon, is rather specific in controlling Pythiaceus fungi. Ethazol is also primarily active against water molds. Diazoben can be mixed with the soil as is ethazol, but it is usually applied as a drench at 100 ppm. It is light sensitive and decolorizes rapidly with loss of activity. It is best applied at night.

At this point I should mention a promising new fungicide for control of water molds, pyroxychlor [2-chloro-6-methoxy-(trichloromethyl) pyridine]. It will be sold as Nurelle for ornamental crops and as Lorvek. It is unique in that it moves into the roots from foliar applications. It is also absorbed by roots from soil applications. It acts as a protectant from within the root.

The most effective fungicide for control of Rhizoctonia solani is PCNB. However, it must be applied and mixed into the top inch or so of soil to be most effective. It probably will not be used in this way in containerized nurseries. It likely does some good applied as a drench to stop a rapidly moving epidemic. Benomyl at high rates will slow down Rhizoctonia and chlorothalonil should also slow it down somewhat.

Benomyl has been useful in controlling Fusarium oxysporum on other crops such as gladiolus (corm dip) and carnations. It probably will help in the control of Fusarium oxysporum f. pini.

Seed treatment with thiram or captan should not be overlooked. It is possible that some pathogens might be introduced on the seed.

MYCORRHIZAE AND CONTAINER SEEDLINGS

by
B. Zak ^{1/}

Mycorrhizae do indeed benefit the tree. They increase availability and absorption of nutrients, especially phosphorus. Recent studies have shown that ectomycorrhizae also protect fine absorbing roots from pathogen attack. There is also some evidence that mycorrhizae may resist attack by root aphids and nematodes and even protect the plant from phytotoxins produced by soil microorganisms. Under natural conditions, the tree would not be able to survive without mycorrhizae.

Seedlings can, however, be grown quite satisfactorily without mycorrhizae provided that adequate nutrients are supplied and that pathogens are controlled. Thus, nonmycorrhizal seedlings are successfully raised today both in fumigated and fertilized beds and with intensive culture in containers.

However, if we find the right fungi and develop successful and economical inoculation techniques, it may be desirable and advantageous to use mycorrhizae from the beginning to benefit the container growing stage. We might thus achieve biological control of root pathogens, and we might save enough in fertilizer costs to offset the expense of inoculation.

Actually, the greatest need for mycorrhizae is when the seedling is outplanted, not during the container growing phase. The nonmycorrhizal seedling planted in a forest area will normally develop mycorrhizae as new roots emerge; but depending on soil moisture and temperature, this may require several months. In the meantime, intake of water and nutrients may be deficient and nonmycorrhizal roots may be invaded by damaging fungi.

The nonmycorrhizal seedling planted on a site devoid of mycorrhizal fungi, such as a mining spoil or an area long treeless or never forested, will fare even worse. It will be without mycorrhizae for a longer period until infection occurs from airborne spores. If it survives, it will remain severely stunted until an adequate mycorrhizal root system is developed.

On the other hand, the mycorrhizal seedling, especially a container seedling with an intact, undamaged root system, will be able to function soon after planting. Its mycorrhizal roots will be better able to absorb water and nutrients from the soil, they will be more drought resistant, and they will resist attack by pathogens. The result should be quicker establishment and enhanced survival, especially on more difficult sites.

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The fungi which form mycorrhizae with conifers are many and varied. For example, it is estimated that at least 200 different species form ectomycorrhizae with Douglas-fir in the Pacific Northwest. Some fungi may benefit the tree more than others. Some may aid absorption of nutrients better, and some may protect roots from pathogens more effectively than others. Certain fungi may stimulate formation of a larger and more fibrous root system which should aid establishment and survival of the seedling after outplanting. Some mycorrhizal fungi may also help containerized seedlings in another way. Those which form abundant mycelium and rhizomorphs bind together potting material and roots into a firm mass making the root plug easier to handle after removal from the container. It is likely that some may even be "super" mycorrhizal fungi, capable of significantly stimulating the growth of both nursery and container seedlings.

Inoculation of the container seedling with a selected specific fungus should not be regarded as providing a permanent infection, or one that will endure long after outplanting. Rather, the condition should be viewed as a temporary one intended primarily to aid establishment and survival of the seedling. On the typical cutover site as new roots grow out into the surrounding soil, they will also be infected by indigenous mycorrhizal fungi which may gradually dominate the root system as the tree becomes older. Exceptions may be sites which are completely devoid of mycorrhizal fungi; but even on these, as the trees develop and modify their soil environment, various mycorrhizal fungi may become established by airborne infections.

A major obstacle to practical inoculation of nursery and container stock, however, is the lack of easy and reliable inoculation methods. Although it is fairly simple to introduce nondescript mycorrhizal fungi into nursery soil or container mix by incorporating soil and humus from the forest, it is not easy to establish pure cultures of specific fungi.

If we wish to develop mycorrhizae to benefit the seedling growing stage as well as outplanting survival, inoculation can best be done when medium is prepared and containers are filled and seeded. Or, we may find it more advantageous to simply grow the seedlings as they are now, under intensive culture with heavy fertilization, and inoculate when they are possibly two-thirds grown to produce mycorrhizae solely for outplanting.

The most feasible method at present is to inoculate the growing medium, such as a 1:1 mixture of vermiculite and peatmoss, with vegetative mycelium just before filling and seeding containers. The potting mixture must first be treated to suppress existing microorganisms which otherwise would hinder or prevent establishment of the mycorrhizal fungus. Fumigation with methyl bromide and low temperature aerated steaming are two possible ways; autoclaving and high temperature steaming should be avoided because of the likelihood of toxin formation.

Inoculum is prepared by growing the fungus for 1-3 months in a vermiculite-peatmoss medium wetted with nutrient solution. When ready, it is thoroughly leached with cold tap water to remove unused nutrients, and then mixed with the potting material. A ratio of 1 part inoculum to 9 parts container mix, by volume, has been satisfactory for some fungi tested. After filling containers and sowing seed, normal container-growing procedure is followed, except that fertilization must be reduced or mycorrhizae will not develop. The optimum nutrient level for best inoculation and best growth of seedlings is not known but can be expected to vary with both fungus and tree species. And, application of fungicides, such as benomyl to control Botrytis, may have to be curtailed.

Actually, spores would be the ideal inoculum if only we knew how to use them. We could apply them directly to the seeded containers in a water suspension, possibly by the overhead irrigation system, and thus inoculate seedlings at any stage of development. Or, we might coat seeds with spores just before sowing -- limited success has been reported with this method in nurseries. However, besides methods of inoculation, several important problems prevent the use of spores. Unlike vegetative mycelium, which can be grown at any time, spores are available only at certain times during the year--usually in the fall when sporophores are produced. And the occurrence and abundance of sporophores is erratic from year to year. Collection itself would be a major problem. A method of storing spores is needed to assure a ready supply of inoculum. Possibly freeze-drying may be the answer. And, too, we need to solve the problem of germinating spores of mycorrhizal fungi in the laboratory to check viability.

The all important question yet to be answered, however, is whether providing container seedlings with mycorrhizae will actually prove worthwhile--will it aid in the production of seedling stock, and will it significantly improve outplanting success? I think it will, and several container inoculation studies now underway may give us the answer to this question within the next 2 or 3 years.

Panel Presentation
at the
Western International Forest Disease Work Conference
entitled
"Root Diseases in the Northern Rockies"

The panel was composed of Dr. Partridge, University of Idaho as Moderator, Dr. Ralph Williams from the U.S. Forest Service at Missoula, Dr. Rosy Chacko from the University of Idaho, Dr. Elmer Canfield, from the University of Idaho, Dr. Kenelm Russell, representing the State of Washington from Olympia, Washington, Dr. Earl Nelson, U.S. Forest Service, Corvallis, Oregon, and Mr. John Schwandt from the University of Idaho.

We tried to hold this panel informally, allowing for as much interplay amongst the participants and from the floor as possible. Presentations were not formal and Dr. Partridge led off with a series of slides describing the situation as we have seen it in the northern Rockies including the obvious center as it appears from the air, the diffused center, and total stand deterioration. He proceeded then to ground symptoms of the same type in obvious centers, diffused centers, and in totally deteriorated stands. This was followed by descriptions of each of the major root problems as we've seen them, including *Armillaria mellea*, the principal problem, the *Poria weirii* complex, *Polyporus schweinitzii*, *Poria subacida*, *Fomes annosus*, *Verticicladiella wagnerii* and the report of *Rhizina undulata* in northern Idaho. He also quickly ran through a series of slides demonstrating the explosive technique used to excavate tree stumps for root examination.

Ralph Williams then showed another series of slides, again demonstrating the root rot centers we see particularly in northern Idaho but also into Montana. His demonstration utilized infrared as well as standard photography. He also presented figures including acreages and percentages of acres involved in the root rot problem, and indicated relationships between habitat types and the incidence of root disease. The impact of root diseases as outlined by independent studies by Ralph Williams and Art Partridge's group were very similar. Both found approximately 30% of stands affected.

In general the panel to this point outlined the complex organismal associations which often characterize root disease in the Northern Rocky Mountain area; the relationship between root diseases and insects, particularly bark beetles, and the diversity of symptoms resulting from both tree species reaction and organism interaction. The relatively infrequent fruiting bodies of most causal fungi was also noted as a feature of the root diseases in this area.

Following Dr. Chacko, Dr. Canfield gave a brief summary of the changes in nomenclature brought about by recent mycological work. He gave both the old and new names for the various fungi involved in root diseases (Table 1). This led to much discussion, as would be expected, amongst the audience and participants in the panel as to usage not only of scientific names but to the common terminology in root disease work. Consensus was that we should try to adopt some kind of a series of terms that would be readily understandable by scientist and the field worker as well.

Dr. Russell then enumerated his efforts in Washington in developing field trials for various control methods. These consisted of removing peripheral trees around root rot centers, planting with other species, planting alder in union with other species, conversion to other uses, modifying stocking, etc.

Finally, Dr. Earl Nelson summarized his view of how the diseases appear on the coast as compared to inland. The really big difference seemed to be the variety of organisms that we've experienced here in the Rocky Mountains versus the more specific organisms encountered in the individual centers on the Coast.

Table 1. Fungi Associated with Root Disease and Their Nomenclature.

- I. *Armillaria mellea* (Vahl.) Quel. Agaricaceae
Armillariella mellea (Fr.) Karst. Tricholomataceae
- II. *Collybia radicata* (Fr.) Quel.
- III. *Echinodontium tinctorium* Ell. & Ev. Hydnaceae
Echinodontium tinctorium Ell. & Ev. *Echinodontiaceae*
- IV. *Fomes annosus* (Fr.) Cke. Polyporaceae
Fomitopsis annosa (Fr.) Karst. Polyporaceae
Heterobasidion annosum (Fr.) Bref. Polyporaceae
- V. *Fomes nigrolimitatus* (Rom.) Egeland. Polyporaceae
Phellinus nigrolimitatus (Rom.) Bourd. et Galz. Polyporaceae
Genus *Phellinus* changed to Hymenochaetaceae
- VI. *Fomes pini* (Thore ex Fr.) Karst. Polyporaceae
Phellinus pini (Thore ex Fr.) Pil. Hymenochaetaceae
- VII. *Odontia bicolor* Alb. et Schw. Hydnaceae
Resinicium bicolor (Fr.) Parm. Corticiaceae
- VIII. *Polyporus montanus* (Quel.) Ferry. Polyporaceae
- IX. *Polyporus schweinitzii* Fr. Polyporaceae
Phaeolus schweinitzii (Fr.) Pat. Polyporaceae
- X. *Polyporus tomentosus* Fr. Polyporaceae
Inonotus tomentosus (Fr.) Gilbertson. Hymenochaetaceae
- XI. *Poria subacida* (Peck) Sacc. Polyporaceae
Perenniporia subacida (Peck) Donk. Polyporaceae
- XII. *Poria weirii* (Murr.) Murr.
Phellinu weirii (Murr.) Gilbertson. Hymenochaetaceae
Inonotus weirii (Murr.) Kotl. et Pouz.
- XIII. *Rhizina undulata* Fr. Pezizaceae
- XIV. *Stereum sulcatum* Burt. Thelephoraceae
- XV. *Verticicladiella wagnerii* Kendrick. Moniliales
- XVI. *Xeromphalina campanella* (Batsch. ex Fr.) Kuhn et Marie.
Tricholomataceae

ROOT ROT IN COASTAL AND INTERIOR FORESTS
OF THE NORTHWEST

by

Earl E. Nelson

In western Oregon and Washington, our most serious root disease problem is caused by P. weirii. There are differences between "annual" P. weirii root rot on the coast and in the Inland Empire because the fungus must interact with different environments or habitats. Not only can one find differences between east and west extremes, but gradations along the way. Perhaps the most abrupt change comes near the crest of the Cascade Range where changes in elevation, climate, and soils are reflected in species composition. West of the Cascades, stands are comprised largely of Douglas-fir with varying amounts of western hemlock. In these nearly pure stands one finds a "uniform" susceptibility of host, and rooting habits which are likely to encourage spread of the fungus. Root rot pockets frequently fill with brush, keeping out susceptible conifers. East of the Cascades, coniferous regeneration is common in root rot centers, and one sees continuous root rot activity. Mixed conifer stands of the crest and east slope of the Cascades seem to have root disease problems more closely related to those in the Inland Empire than to those of the coastal Douglas-fir stands only a few miles to the west.

Sporulation, at least with P. weirii, apparently occurs more readily in coastal than in inland forests. The significance of this difference hinges upon the importance of spore infections in the disease cycle which presently is poorly defined.

Research by A t Partridge and others in the Inland Empire emphasizes root rot complexes comprised primarily of A. mellea, P. weirii, and Fomes nigrolimitatus. One finds these same organisms in association in coastal forests as well. The main difference between coastal and interior forests seems to be in the intimacy of the association of various root pathogens. Partridge's group frequently has isolated more than one root pathogen from a single chip of rooted root wood. More frequently than not, P. weirii appears to act alone in coastal Douglas-fir or predisposes trees to further attack by A. mellea, a pathogen not considered primary in those stands.

I sincerely hope the briefness of this presentation will stimulate further thought and discussion which is the real purpose of this work conference.

NOTE

Mycologists, and plant pathologists as well, frequently find themselves somewhat confused and in disagreement with one another regarding scientific names applied to fungi. Whether one calls the fungus causing laminated root rot Poria weirii or Phellinus weirii is relatively unimportant as long as each of us realizes that the individuals we speak of are within our concept of a single species.

Because Phellinus (Poria) weirii is a biological entity, there are many similarities in the disease it causes whether it occurs in the far west or far east of its geographic extremes. The same might be said for Armillaria mellea, Fomes annosus, or any number of root disease fungi found in Northwest forests. Similarities are basically reflections of the biology of the pathogen. They are rather obvious to any of us here and need not be discussed in detail.

STATUS OF ROOT ROTS IN WASHINGTON:
RECOGNITION, MANAGEMENT AND INVESTIGATIONS

Kenelm Russell ¹

Management of stands infected with root rots ranks highest in importance to Pacific Northwest Forest Managers. Root rots account for 115 million cubic feet (646 million board feet) of loss annually in Washington and Oregon. This loss includes both growth loss and mortality (Childs and Shea 1967). A much more important impact and a long term one is loss in productivity of infected sites which prevents successful regrowth of the killed species.

More and more commercial forest lands are coming under intensive management. Some companies carry their management to units as small as two acres. Useable yield can be improved by thinning and fertilizing. Further yield can be realized by minimizing root rots through effective management techniques. Root rot prevention measures should share the same reasoning and status as other intensive management activities.

RECOGNITION OF ROOT ROTS

In Washington, we stress the importance of recognizing root rots and taking action before the fiber is taken by the disease. Recognition of a root rot infected area is perhaps the most important step towards minimizing its impact. Put simply, "Get there before the disease does". Recognition is stressed at inside staff sessions followed by small group field trips or "one on one" sessions in the woods.

Recognition west of the Cascades. Most foresters have access to a helicopter enabling them to distinguish root rot centers from the air. They know, for instance, that bear damage can be separated from *Phellinus weirii* in western Washington by the pattern of mortality. Bear damage is seen as scattered single tree mortality while root rot shows up in clusters around an opening. Fading trees in various stages of decline are also apparent.

On the ground, stand openings and ground cover changes (usually dense salal) with rotted stumps showing typical *P. weirii* laminations help confirm the forester's suspicions. He knows the difference between mycelial fans of *Armillaria* found beneath the bark and *P. weirii*'s buff colored superficial mycelium found on root surfaces. He also knows that red setal hyphae are a sure fire diagnosis of *P. weirii*. He tries to identify them without a hand lens because it's a rare forester who

Forest Land Management Contribution No. 188.

¹ Forest Pathologist, Washington State Department of Natural Resources, Olympia, Washington.

carries one. A simple scrape of the axe along a root to check for surface mycelium is all that is usually needed for identity of *P. weirii*.

Recognition east of the Cascades. Root rots are more subtle in eastside stands but they may be more devastating. Unlike easily delineated centers in westside forests, eastside infection center boundaries are not often discreet. They ramble. There are many more dead trees from other causes in eastside stands which makes identification a complex problem. Root rots seem to mix, with more than one species in the tree. A forester may be in a stand several times before he recognizes a problem. It is sometimes easy to assume that such an infected stand is "normal" for the area.

Once an overall problem is recognized, specific identification of root rots is similar to westside diagnosis techniques.

MANAGEMENT OF INFECTED STANDS: WESTSIDE

Precommercial thinning. During reconnaissance surveys, root rot severity and species must be noted. Stand condition should be noted in a permanent inventory system such as DNR's GRIDS.

Thinning will be done to discriminate against *P. weirii* by small patch clearcuts in larger root rot centers. All border trees will be cut at least one tree spacing beyond centers. Conversion of the small patch clearcuts to hardwoods is recommended to discourage development of brush.

When *Armillaria* is encountered, we may recommend thinning to wider spacing than usual. In western Washington, *Armillaria* does not usually cause widespread tree killing in large infection centers. It takes single trees or small groups of trees and is much more uniform in its distribution than *P. weirii*. Cutting all infected trees during a precommercial thinning appears to be a fair deterrent.

A better control for *Armillaria* is to remove tree, stump and all, but this is too costly for operational use. We tried this on a series of 28 year old western hemlock and Douglas-fir research plots. Mortality had been occurring at a regular rate prior to removal of stumps but no new mortality has occurred four years following the removal. This approach is apparently highly successful, but today's costs would prohibit stump removal in young stands of precommercial thinning size.

When disease centers are too numerous to warrant thinning, economic analysis may show conversion to hardwoods is best.

No operational decision has yet been made to apply borax to stumps to prevent *Fomes annosus*. I recommend borax application in research plots and recreational sites for stumps of all sizes. In typical western Washington hemlock precommercial thinnings, at least half of all freshly cut stumps become infected (Russell et al. 1973). The impact of this degree of infection to the crop tree is not completely understood yet. We lack detailed knowledge and documentation of the path of the fungus from the cut stump into the crop tree. We also do not know what size

the column of decay will be. Does it follow Shigo's principles (Shigo, 1975)?

Dry borax, when applied to freshly cut hemlock stumps in precommercial thinnings is nearly 100% effective during dry periods in preventing *F. annosus* (Russell et al. 1973). Stumps must be cut level for borax to be effective. Input from regional pathologists and managers is needed to reach a decision on whether to treat stumps operationally. Cost of borax is minute as the bulk of treatment cost is in labor. Estimated treatment is 15% of thinning cost. Labeling of borax by E.P.A. has been completed.

At this point, I am not recommending that foresters treat their precommercial thinnings with borax or any other chemical. When stump diameter averages 2 inches, incidence of *F. annosus* infection is reduced. Treatment of stumps in commercial thinnings is another question and is a question that is ready for a management recommendation by regional pathologists now.

Intermediate stand treatments. Commercial thinnings are done on a large scale in DNR. When root rot centers caused by *P. weirii* are encountered, we recommend marking for cut all trees within disease centers and all trees within one or two apparently healthy tree spacings from *P. weirii* killed trees. All dead and dying material is salvaged.

Resulting patch clearcuts will be regenerated with hardwoods or root rot tolerant conifers.

Stands with active root rot should be designated in GRIDS and entered for salvage at not less than 5 year or more than 10 year intervals depending on severity of root rot.

Armillaria usually does not cause large openings except in rare cases in westside forests. Trees can be marked out by knowing external indicators. When infestation is severe, entries will be made at 5 to 10 year intervals in order to salvage dying material.

Considerable commercial thinning is being done in western hemlock on both State and private land. Here, *F. annosus* is of major concern. Ridgetops or hillsides frequented by high wind should not be thinned as heavily. We have had examples of commercial thinning on such exposed slopes where the remaining timber blew down.

Careful thinning done in lee slopes with minimum wounding damage will respond well and will not suffer unduly from *F. annosus*. We have not yet recommended treatment of commercial thinnings with borax but probably will in the near future.

Careful analysis of infected stands will be made in order to designate their early harvest due to disease. Severely infected stands may be liquidated much earlier at an age when neighboring root rot free or lightly diseased stands are being commercially thinned. They would then be regenerated as described under the following section.

Final harvest stand treatments. Prior to, and immediately after final harvest cut, is the ideal time to control or reduce impact from root rots.

There are several alternatives for the forester at this point, all of which are better than regenerating with Douglas-fir when the original stand was Douglas-fir and the root rot is *P. weirii*. First, large and apparent root rot centers must be mapped. Infection centers should be smoothed and combined for later ease of management. Such information should be entered into a permanent inventory system such as GRIDS.

After the unit has been logged, mapped infection centers may be regenerated with root rot tolerant conifers or converted to hardwoods. For example, hemlock and western red cedar would be used in root rot pockets in a previous Douglas-fir stand if the site is suitable and animal damage is not severe. When the site could grow merchantable alder, it would probably be encouraged.

Occasionally, grass may be recommended in severely infected parts of clearcuts just to keep the areas free of non-productive brush. Where game management is important, this might be a good alternative.

Regeneration root diseases - Rhizina. This regeneration disease caused by the fungus *Rhizina undulata* kills newly planted seedlings in burned over cutting units. Overall, in Washington, the fungus is not a limiting factor to regeneration on burned units. It can, however, be an extreme local mortality factor and must be dealt with accordingly.

Generally, Rhizina problem areas are found from Mt. Rainier north along the westside of the Cascades. The fungus is not usually found in lower, flatland sites close to Puget Sound. We have not found it in the Capital Forest area near Olympia. On the Olympic Peninsula, the fungus can be found but tree killing is rare.

At this point, foresters are trained to recognize Rhizina in their early survival checks. In severe cases, they may be required to replant certain sites. When they suspect the disease may be a problem, they plant a larger number of trees per acre to compensate (Hoyer and Russell, 1976). Two to three years past burning finds no further Rhizina mortality. Replanting may be delayed up to three years if brush problems are not severe. When brush is severe it is a question of who gets the trees - Rhizina or brush and decisions must be made accordingly.

MANAGEMENT OF INFECTED STANDS: EASTSIDE

The approach to root rot reduction east of the Cascades is somewhat different from west of the Cascades. In some stands, particularly mixed conifer types in northeastern Washington, the impact from *P. weirii* is greater than westside. Near Glenwood, in south central Washington, *Armillaria* is limiting tree growth on a wide scale.

Root rot boundaries are not discreet under many eastside conditions. Foresters in root rot areas can be lulled into a false sense of security by accepting the severely infected stand as "normal" for the area. The

disease often runs rampant or helter skelter through the stands and a forester may make several trips into the infected stand before he realizes that something is wrong with it.

Major emphasis has been to train foresters to recognize root rot problem areas when they are marking. They may be instructed to favor root rot tolerant ponderosa pine, for example, in a *P. weirii* infection. Conversion to immune hardwoods is not possible in most eastside stands.

Plans are underway now to initiate a complete new management scheme to cope with the *Armillaria* problem near Glenwood. This plan will be initiated by mid 1976. Summertime or snow free marking will be stressed. It is important the ground be snow free because many important signs of root rot could otherwise be missed. Minimum spacings between healthy trees and infected stumps or dead trees will be used according to average stem diameter. As diameters go up tree spacings increase.

Barriers consisting of stump free zones will be made between actively advancing disease fronts at the edges of infection centers and healthy trees.

Trees to be harvested in active disease pockets will be pushed out stump and all.

INVESTIGATIONS ON ROOT ROTS IN WASHINGTON

My own philosophy on pesky root diseases like *P. weirii* is summed up in one word; aggressive! For years, we have identified the disease (all of them) then left the poor forester on his own without solid "what do I do now?" recommendations. Much empirical and in vitro data has become available in the last five years concerning root rots. It is time to field test that information in many ways and it must be replicated by more than one researcher.

Several DNR experiments are designed to do just the above. Three types of outplantings have been devised. One, near Olympia in the Capitol Forest, is testing alder-fir mixed plantations for *P. weirii* tolerance using a paired plot approach surrounding known infection centers.

A second experiment near Concrete, in northwest Washington is testing alder, spruce, white pine, hemlock, cedar and Douglas-fir tolerance to *P. weirii* infection on 24 replicated plots containing the disease.

The third outplanting of similar nature and the same disease is located in northeastern Washington near Republic. There, we are also testing tolerance to infection of lodgepole pine, white pine, engelmann spruce, Douglas-fir and ponderosa pine. Half of each plot has had all stumps removed that were infected with *P. weirii*.

A small plot of *P. weirii* infected ground near Olympia has been observed for 10 years. The fungus has successfully rendered over 30% of the forested plot unproductive to Douglas-fir. In one infection center, red cedar and western hemlock appear to be surviving. Either salal, willow, cherry and other non productive species now dominate the site.

A stump removal experiment in *Armillaria* infection centers has been done in the Willapa Hills area on the coast. New mortality has not appeared four years following stump removal in the 28 year old Douglas-fir, western hemlock stand. Stump removal appears to be a good deterrent to root rots.

A series of plots have been established in new plantations previously burned to assist in determining a training program for *Rhizina undulata*. The plots have been measured for three years. Mortality stabilized after the second year.

Two studies have been completed on *Fomes annosus* in Washington. Both have been published and are available from the Department of Natural Resources (Russell et al. 1975, Russell et al. 1974).

University of Washington experiments by C.H. Driver have been concerned with *P. weirii* and the effect of fire on it. Initial tests have shown 50% recovery of *P. weirii* from 2 x 2 inch blocks buried 2 inches deep while a fire was passed over the surface. Surface temperature was measured at 600°C. Fire is not a good control alternative for *P. weirii*. Other treatments in the same experiment are testing scarification and fertilization effects on the root rot. Results will not be available for several years.

Considerable effort by P. Morgan at the University has gone into development of diagnostic techniques for *R. undulata* as well as other research on the fungus. Methods for identifying the disease in the field are needed. Fruiting ascocarps are useful but are not always present. Characteristic rhizomorphs have shown promise. With the aid of a hand lens, a forester may soon be able to diagnose *R. undulata*. Practical guidelines for managers to minimize impact from this disease will be available during 1976.

Several years research by Oregon State University has gone into the *Armillaria* effort near Glenwood, Wa. Under Lew Roth's direction much has been learned. Stump removals, root rot barriers and marking guides are realities now. Stump treatments with fumigants are being tested. Lew's work over the past five years at Glenwood has made possible the preparation of initial management guides for *Armillaria* in that region.

A rather new root rot to Washington, *Verticicladiella wagneiri* has not yet made much of an appearance. It is most often found as single infected dying on dead trees here and there in plantations. No research on this disease is being done in Washington.

LITERATURE CITED

1. Childs, T. W. and K. R. Shea, 1967.
Annual losses from diseases in Pacific northwest forests. Pacific Northwest Forest and Range Experiment Station. Resources Bulletin PNW 20. 19p.
2. Hoyer, G. E. and K. W. Russell, 1976.
Attaining intensive management goals by stems-per-acre control in plantations. Washington State Dept. of Natural Resources. DNR Note No. 12. 6p.
3. Russell, K. W., J. H. Thompson, J. L. Stewart and C. H. Driver, 1973.
Evaluation of chemicals control infection of *Fomes annosus* in precommercially thinned western hemlock stands. Washington State Dept. of Natural Resources. DNR Report No. 33. 16p.
4. Russell, K. W., R. E. Wood and C. H. Driver, 1973.
Fomes annosus stump infection in ponderosa pine sapling stands of eastern Washington. Washington State Dept. of Natural Resources. DNR Report No. 27. 9p.
5. Shigo, A. L., 1975.
Compartmentalization of decay associated with *Fomes annosus* in trunks of *Pinus resinosa*. Phytopathology Vol 65: 1038-39.

PANEL - DETERIORATION OF INSECT AND FIRE KILLED TIMBER

Kenelm Russell,¹ Panel Chairman

These days we are constantly bombarded by headlines like "We're going to be short on timber by 2000", or "Long range timber shortage predicted", and "Forest Service annual cut to be reduced because of environmental pressure".

We may run short on timber - the kind we are used to. I doubt we will run short on fiber. Significant portions of our wood supply are often left behind or not salvaged. New ways of using insect or fire killed residues will reduce potential shortages. We must use as much of the available cellulose as possible. It is money in our pocket over the long run.

DETERIORATION OF BEETLE-KILLED ENGELMANN SPRUCE
IN THE ROCKY MOUNTAINS

Thomas E. Hinds²

Engelmann spruce (*Picea engelmannii* Parry) is a major component of the high-elevation forests of the Rocky Mountain region. Extensive stands of spruce extend from Alberta and central British Columbia south to New Mexico and Arizona. It grows in the highest and coldest forest environment in the western United States, characterized by annual temperatures of -50° F and 90° plus, and heavy snowfall. It is found at 2,500 to 3,500 feet in Canadian forests and at 9,000 to 11,000 feet in the southern Rocky Mountains (3).

Engelmann spruce occasionally occurs in pure stands but usually grows within 15 recognized forest types (8). The composition of the forest in which Engelmann spruce grows varies with elevation, exposure, and latitude. In the southern Rocky Mountains it is found with white fir, interior Douglas-fir, blue spruce, aspen, and occasionally ponderosa pine at its lower limits, and corkbark fir and bristlecone pine at middle and higher elevations. It extends above corkbark and subalpine fir, forming nearly pure stands at timberline. It is, however, found most typically in association with subalpine fir to form the Engelmann spruce-Subalpine fir forest type (8).

Engelmann spruce is one of the largest of the high mountain species where large dominants may exceed 40 inches in diameter and up to 150-160 feet

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in height. It is a long-lived tree, maturing in 300 years, yet trees over 500 years old are not uncommon. Average volume per acre may be practically nothing at timber line to 25,000-40,000 board feet on better sites, yet volumes as high as 80,000-100,000 board feet have been reported (8). Of the estimated 80 billion board feet of sawtimber size Engelmann spruce in the United States, 52 percent is found in the southern Rocky Mountains, and over one-third in Colorado alone (3).

Engelmann spruce is very susceptible to windthrow because of a shallow root system usually formed in soils underlain by impervious rock or clay subsoils. Old-growth spruce is especially susceptible to attacks by the spruce beetle (*Dendroctonus rufipennis* Kirby). The western spruce budworm (*Choristoneura occidentalis* Freeman) is another but less dangerous insect enemy.

The spruce-fir stands in the southern Rocky Mountains have periodically been ravaged by the spruce beetle. Beetle infestations usually have been in stands composed of older, larger diameter trees. When trees within these stands are blown down either individually, in scattered groups, or complete stands--as frequently happens--resident spruce beetle populations infest the windfallen spruce and may multiply to outbreak proportions. If an outbreak develops, the surrounding trees and adjacent stands may suffer varying degrees of mortality.

The earliest report of a spruce beetle outbreak in the west was by Sudworth in 1898. He reported that 25-40 percent of the mature spruce was killed on Grand Mesa (6) and the White River Plateau (7) in Colorado in about 1875. Between 1916 and 1918 an infestation of about 115,000 acres occurred on the Aquarius Plateau and adjacent Boulder Mountain in southern Utah (4). The most recent large outbreak in Colorado was during the early 1940's. This epidemic infestation on the White River Plateau expanded until nearly all spruce over 8 inches in diameter were killed (2). A similar infestation also occurred on the Grand Mesa where over 50 percent of the merchantable volume was killed. It has been estimated that 5 billion board feet of timber had been killed during the 1940 epidemics (8).

Many popular articles concerning the beetle epidemics indicated that the timber was destroyed. People in the lumber industry knew better. Much of the dead timber was, is still being, and can be salvaged in the future; but the question still remains as to how much and for how long in any particular area.

In late 1948, Mielke (4) studied the rate of deterioration of the beetle-killed spruce of the 1916-1924 infestation on Boulder Mountain adjacent to the Aquarius Plateau in Utah. Although he did not give rot volume losses in standing dead trees, he found that only 16 percent were down on the ground in about 25 years and that the dropout was gradual. Root and basal rots, which were limited to the basal 4 feet, were responsible for a loss of 77 percent of the trees that had gone down. Mielke also found that the moisture contents of both heart and sapwood had reached such a low level (below 22 percent) that decay fungi were unable to develop in trees which had been dead for three years or more. Season

check was the only defect of consequence in the dead spruce and this only a factor when trees were to be cut into lumber. Wood borer and pin-hole borer damage to the dead trees was slight. They were still cutting mine props from these old, dead standing trees in 1972.

The only other pathological study of beetle-killed spruce was started in Colorado in 1951 under the direction of Lake S. Gill, Ross Davidson, and Frank Hawksworth. The results of this study on the 1940 White River Plateau infestation were published in 1965 (1). Electric moisture meter tests confirmed Mielke's findings that the upper portions of the trunks were too dry for development of decay. Moisture content of the basal portions of the trees was considerably higher, however, and frequently ranged from 50-100 percent. Conditions thus remained favorable for decay in the basal portions of the dead standing trees.

The amount of decay in relation to time since peak beetle-caused mortality suggested that losses to decay in standing trees was leveling off at about 12 percent of the cubic foot volume 12 to 15 years after death. This loss, however, included some heart rot volume that was present before death plus a small undetermined amount after that time. Although the total amount of rot volume was apparently leveling off in the standing dead trees, the types of decay had changed over the years. Trunk rots showed no consistent relationships to time since the trees were killed. But basal sap and butt rots increased and accounted for more than two thirds of the decay volume in the actual volume of wood decayed, but in the structural weakening they cause, which allows the trees to be windthrown.

Decay in the Colorado dead spruce declines in relative importance as a deterioration factor after about 12 years when windthrow loss equals total decay loss. Thereafter windthrow volume loss becomes progressively more important. Fallen trees decay fairly rapidly, depending upon the proportion of the tree in contact with the ground, and are usually considered cull after 5 years. We have been observing windthrow in 4 areas on the White River Plateau since 1951 and to date, some 30 years after the infestation began, yearly losses to windthrow have averaged 1.7 percent of the volume and 2 percent of the trees. That is, approximately 50 percent of the original dead volume is on the ground after 30 years.

Salvage of this dead timber has not been too extensive nor too efficient. Windthrow on the Grand Mesa over the past 100 years have amounted to about one percent per year with 95 percent of the dead trees on the ground in 1971. Practically all of the dead spruce on the Aquarius Plateau had been cut over on a small scale for corral poles, fence and house logs, mine props, and some lumber by 1948. Windthrow on Boulder Mountain amounted to 63 percent in 1971, 50 years after infestation, yet small sales for mine props were still in progress. Salvage on the White River Plateau was mainly for pulpwood in the 1950's yet mine props are still being cut. It might be concluded that although dead trees will stand for over a century at these high elevations, salvage for maximum recovery should be accomplished by no later than 20 years after tree mortality. Salvage can continue after that period, however tree losses will accelerate to the point of diminishing returns.

Large infestations as in the past should not be seen again. Future infestations should be detected early enough so that infested trees are logged or chemically treated before an outbreak becomes extensive. Though this is not to say, however, that the importance of beetle-killed spruce has entirely diminished.

Spruce mortality caused by the endemic beetle populations, and the role the beetle plays in the ecology of the spruce type has really never been studied. John Schmid, entomologist at the Rocky Mountain Station, and I, examined these old infested stands and others in 1971 to study the development of spruce-fir stands following large spruce beetle outbreaks (5).

The stands we examined varied in age from 77 to 278 years. The following basal areas we found in four of these selected stands may typify the development and demise of a spruce-fir forest over a period of three centuries:

	AVERAGE BASAL AREA (ft ² /acre)			
Average Stand Age: (Dom. & Codom. Spruce)	77	112	147	278
Live spruce	23	99	133	171
Dead spruce	145	15	20	94
Live fir	52	68	31	35
Dead fir	<u>9</u>	<u>33</u>	<u>51</u>	<u>33</u>
Total	229	215	235	333

Following a large beetle outbreak, the fir component which was present in the disturbed stand predominates for a period of 100 ± years. The fir then begins to die because of insects, diseases, and competition for growing space. The dead spruce by this time have fallen. From 100 ± to 150 ± years spruce begins to be the dominant species as fir mortality increases. The total basal area has remained essentially the same for the first 150 ± years when it then begins to increase because of the older living spruce. A normal stand mixture of spruce and fir is evident by about 200 years. By about 300 years the stand is predominantly spruce and once again very susceptible to a major beetle outbreak.

But what about the basal area in dead trees? The mortality of the predominant live fir of 100 ± years of age increases from 14 to 23 percent of the total basal area from stand age 100-150 ± years. The resident spruce beetle populations begin to build up again at stand age of 125 ± years. They then continue to kill scattered large individual trees throughout the stand. From stand age of 150 ± to 300 ± years, 9 to 28 percent of the total basal area is in dead spruce. The deterioration of these volumes of dead spruce and fir which amounts to 23-41 percent of

the total basal area in stands of 125 + to 300 + years of age should receive the same concern if total utilization of our forest resources is to be a reality.

The concern of spruce deterioration in the old infestations of the southern Rocky Mountains is really a concern of the past. The concern of spruce and fir mortality in the present stands should receive more attention. Present knowledge on the deterioration of beetle-killed Engelmann spruce is sufficient; that of subalpine fir inadequate. However, because a majority of these dead trees will remain standing for 20 years or more, the real problem is one of utilization.

LITERATURE CITED

1. Hinds, T. E., F. G. Hawksworth, and R. W. Davidson, 1965.
Beetle-killed Engelmann spruce-its deterioration in Colorado.
J. For. 63:536-542.
2. Massey, C. L. and N. D. Wygant, 1954.
Biology and control of the Engelmann spruce beetle in Colorado.
U.S. Dept. Agric. Cir. 944, 35 pp.
3. McSwain, G. A., R. R. Alexander and D. C. Markstrom, 1970.
Engelmann spruce. U.S. Dept. Agric., Ann. Woods-FS-264, 8p. (Rev.).
4. Mielke, J. L., 1950.
Rate of deterioration of beetle killed Engelmann spruce. J. For.
48:882-888.
5. Schmid, J. M. and T. E. Hinds, 1974.
Development of spruce-fir stands following spruce beetle outbreaks,
U.S. For. Serv. Res. Pap. RM-131, 15 p.
6. Sudworth, G. B., 1898.
Battlement Mesa forest reserve. p. 181-243. In Twentieth Ann. Rep.,
U.S. Geol. Surv.
7. Sudworth, G. B., 1898.
White River Plateau timber land reserve. p. 117-119. In Twentieth
Ann. Rep., U.S. Geol. Surv.
8. USDA Forest Service, 1965.
Silvics of forest trees of the United States. USDA For. Serv. Agr.
Handb. 271, 762 p.

METHODS FOR EVALUATING DETERIORATION OF LODGEPOLE PINES KILLED BY MOUNTAIN PINE BEETLES IN THE BLUE MOUNTAINS OF OREGON

James S. Hadfield¹

An outbreak of mountain pine beetles, *Dendroctonus ponderosae*, has caused massive mortality of lodgepole pines on approximately 920,000 acres in the Blue Mountains of Oregon. An estimated 746 million board feet of lodgepole timber has been killed from 1969 to 1975. It is anticipated that the outbreak will kill more than a billion board feet before it subsides.

The rate of deterioration of the dead trees is a major factor in devising fire protection, timber salvage and stand rehabilitation plans. Obviously, if the dead trees deteriorate very slowly prospects for utilization of large volumes are favorable, but on the other hand, fire danger will remain high in the outbreak area for many years. We were unable to answer questions on deterioration rates because very few utilization or deterioration studies have ever been conducted in beetle-killed lodgepole stands, so the decision was made to conduct an evaluation in the affected area.

Contacts with local foresters and the timber industry revealed that if the dead trees could be salvaged practically all would be chipped rather than be sawn for lumber. The trees are small, averaging perhaps 10 inches d.b.h. and they develop deep checks within a year after they are killed by the beetles. A reasonably good chip market exists close to the outbreak area and prospects for substantial expansion of this market are quite favorable. The evaluation plan we developed was oriented towards determining how long the dead trees would remain usable for products derived from chips.

A work plan describing four separate evaluations was prepared and the field work began in the summer of 1975.

Part A - Deterioration of standing dead trees.

Three evaluation areas separated by several miles, and containing stands severely attacked by beetles in 1974 were selected. In each area, 150 lodgepole pines were selected for each of six diameter classes. The trees had to have been killed in 1973 or 1974. All trees selected were numbered with metal tags and painted for easy relocation. Each examination year starting in 1975 and ending in 1995, 10 trees in each diameter class in each of the three evaluation areas will be cut. The down trees are marked off at 8.3 foot intervals from the butt to a 3-inch top. Total height of the trees is recorded. Notes are taken on presence and condition of needles, presence and condition of small

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and large twigs, condition of bark, and location and identity of any sporophores on the trees. Disks are cut from the trees at the butt end and each 8.3 foot interval up to a 3-inch top. Decay associated with the mountain pine beetle attacks is outlined on the face of the disks with a felt-tipped pen. Decay present in the trees prior to beetle attack is recorded as a separate item. Decay is distinguished from sound wood by probing with a sharp instrument or with a Shigometer. A small card of known size is placed on top of or along side each disk. The disks are then separately photographed from a fixed distance with a SX-70 Polaroid camera with color film.

The total surface area of the face of the wood disks and the surface area of decayed wood are determined by planimentering the disks in the photos with a digital planimeter connected to a desk-top computer. The computer is programmed to calculate total volume of the logs, decay-volume in the logs, total volume of the tree and decay-volume in the tree.

Use of the photos eliminates the need to take detailed measurements of surface area of decay from disks in the field or to bring the disks into a lab for the measurements.

Data from this part of the evaluation will be used to prepare graphs showing decay volume and merchantable volume in relation to tree diameter and years dead. Additional comparisons will be made of the deterioration rates for different positions in the trees.

A small number of the disks are brought to the laboratory to identify fungi and insects responsible for deterioration of the beetle-killed trees.

Part B - Deterioration of down trees.

We have observed that large numbers of beetle-killed trees fall within 5 years after their death. We suspect that these down trees will deteriorate more rapidly than standing dead trees. Part B of the evaluation will measure how quickly down trees deteriorate.

The three evaluation areas used in Part A are being used. Trees that have been selected, marked and cut in Part A will be used to simulate down trees. We will be working with 8.3 foot bolts which we believe will deteriorate quicker than whole trees since more surface area will be in direct contact with the ground. This will present the worst possible case from the standpoint of deterioration. Results from this part of the evaluation will tell land managers the minimum time they can leave dead trees on the ground before salvaging them.

We will be examining logs which have been on the ground from 1 to 9 years after the trees from which they were cut remained standing dead for 1 to 20 years. Disks will be cut from the center of the 8.3 foot bolts. The point of contact with the ground will be marked on the disks and they will be photographed in the same manner as disks taken from standing trees. Data analysis will also be the same.

A small number of disks will be analyzed to determine the identity of fungi and insects involved in deterioration of the wood.

Part C - How long will beetle-killed lodgepole pine remain standing?

This part of the evaluation is designed to determine how soon trees fall naturally after they are killed by mountain pine beetles.

A transect has been established in each of the three evaluation areas. On each transect 500 standing trees which were killed by beetles in 1973 or 1974 have been selected, marked, and their d.b.h. measured. Each year for the next 20 years these transects will be revisited to determine how many trees have fallen over.

Part D - Indicators of how long beetle-killed lodgepole pines have been dead.

Trees which we know were killed by beetles in each of the years from 1970 to 1975 will be photographed with 35 mm cameras from several positions. Photos will be taken of needles, twigs, bark and the entire trees from fixed distances. These photos will be assembled into a key to allow foresters to predict how long trees have been dead. The first key will be assembled in 1976; it will display trees which have been dead from 1 to 6 years.

The trees killed in 1970 will continue to be photographed each year for several years.

Most of the evaluation plots were established in 1975. The entire evaluation is scheduled to last at least 20 years, but frequent progress reports will be issued.

LOSS IN VOLUME AND VALUE FOR GRAND FIR LOGS FOLLOWING
TUSSOCK MOTH MORTALITY

Thomas D. Fahey¹

Since most of you are pathologists, I am happy to end this session with a real downer.

In cooperation with Boise Cascade, we took trees killed by the 1972 tussock moth outbreak, cut them into logs in late 1974, sawed the logs into lumber in early 1975, and dried and planed the lumber from these trees and a control sample of live trees. We found that there was a series of incremental losses in both product volume and value, which combined to cause a very substantial loss in total resource value. Both the return to the government in stumpage value and the return to Boise in product sales was large enough that all parties to the study were surprised by the actual amount of deterioration.

BACKGROUND

I am not going to talk about the tussock moth. The subject is suffering from overexposure. The information here could as well apply to spruce budworm or balsam wooly aphid mortality. I do not believe it applies to beetle killed timber within the same time frame. After beetle kill, deterioration would probably be much more rapid.

The sample consisted of 180 logs from 60 dead trees, killed by defoliation in the 1972 outbreak on two areas north and east of La Grande, Oregon. Some of these trees probably survived the 1972 defoliation and were finished off by the 1973 hatch. The control sample logs were from 150 live trees selected from five areas widely scattered throughout the Umatilla, Wallowa-Whitman, and Malheur National Forests.

This is a preliminary report. The report includes only those noncull logs that were sawn and from which lumber was recovered. No culls are included nor are any of the 35 small sound logs from which there was no recovery.

The trees were selected to cover the range in size, quality and defect that was available. I received an awful lot of help from both local Forest Service people and forest industry people in locating and selecting suitable areas for both the live and dead samples.

After the trees were selected,² data was collected on tree size, defect indicators as defined by Aho,² and information on clear and limby areas

¹ Pacific Northwest Forest and Range Experiment Station. Portland, Oregon.

² Aho, Paul E. Defect estimation for grand fir in the Blue Mountains of Oregon and Washington. USDA For. Serv. Res. Pap. PNW-175, 12 p., illus. Pacific Northwest Forest and Range Experiment Station. Portland, Oregon.

on the butt 32-foot log. After the trees were cut, the logs were measured and identified as were breaks, cull logs, long butts, and nonutilized tops. Some of the logs broke later in handling and these breaks or missing pieces will be identified by subtraction of the scaled length from these original field measurements. We know that both felling breakage and subsequent breakage in handling were worse in the dead timber than in the live, but have not calculated the difference at this time.

The study mill was Boise Cascade Corporation at La Grande, Oregon. The mill is one of the most modern and best equipped mills in the West. The headrig is a double cut with computer controlled carriage which corrects itself if forced more than .004 off the cutting line, and which selects cant sizes for the resaw. The resaw is a high strain quad band with a 1/8-inch kerf. The trimsaw and edger are conventional. I really can't say enough about the people. From the woods through the planer, the cooperation we received from both the management and the employees was outstanding.

I am going to talk about lumber grades for awhile. It is not an easy subject, but hang in there because it is only by going through lumber grades that we can get to dollars, which is what I really want to talk about. I am going to generalize a whole lot and only speak of things which are related to the deterioration following the death of the tree.

All of the lumber was graded surfaced dry by qualified graders under the supervision of a WPA Grades Inspector.

There were four sets of lumber grading rules used: The Select grades for clear lumber, while the Common, Light Framing; and Structural Joists and Plank grades were used for construction type lumber.³ I am going to talk from the Light Framing rules because that is where most of the volume was. Also, anything I say about Light Framing for the defects I am talking about applies equally to the other grading rules.

There were three vectors which affected lumber grade; ambrosia beetles, sap rots, and checking due to drying of the trees.

Selects

We can dispose of the ambrosia beetle and the Select Lumber grades simultaneously. Ambrosia beetles were very active in the dead trees on both areas averaging more than two entry courts/square foot as far up the tree as I could see. Select lumber grades invariably come from butt logs of grand fir, and usually from the very outer boards. These were the portions of the tree most affected by ambrosia beetles. We should have gotten somewhat less than 1 percent Select lumber from the dead trees; we got almost no Selects. I assume the ambrosia beetle was responsible for the degrade of the Selects to structural type grades. Ambrosia beetle holes or any discoloration associated with them would not be a grading defect in any other grade of lumber recovered in the study.

³ Western Wood Products Association. Standard Grading Rules for Western Lumber. No. 16, revised. Portland, Oregon. 1974.

There are three groupings of grades in the construction type lumber set that are significant. Standard & Better is the main structural lumber group. It is used widely for construction work where strength is a factor. Utility is normally used where strength is less critical. Economy lumber admits any combination of defects. It is used for rough and temporary construction. Any defect or combination of defects is allowed as long as the board holds together.

Factors in the Grades to Consider

Knots.--Knot size is limiting in both Standard & Better grades and in Utility grades. Some lumber is going to drop through the grade structure to Utility and Economy grades equally on both live and dead trees. This is due to knots being too large to be allowed in a piece of lumber of any higher grade.

There are two factors in the grades that we should be talking about since they are major factors in degrade of dead timber.

Rots.--Decay or unsound wood is very limited in Standard & Better grades. In Utility grade, unsound wood can equal thickness or width but is limited to one-third the cross section at any point.

Grain Separations

Lumber grading rules recognize three classes of grain separation, shakes, checks, and splits. Shakes occur in the tree, particularly in association with frost cracks and wetwood. Checks are usually due to stresses developed in drying lumber. Splits are usually mechanical damage but any separations at the end of the piece are graded as splits.

For Standard grade, separations through the board thickness are limited to 2 feet in length in the middle of the board and to 6 inches at the end of a 2x4.

In Utility grade, grain separations are permitted up to one-third the board length if not on the end and one-sixth the board length as an end split. On a 12-foot 2x4, a 6-inch split is Standard grade and a 23-inch split is Utility. Anything longer is Economy. Any board which has any of these defects beyond what is allowed in Utility is instant Economy.

There were several important defect indicators which were associated with both volume loss and degrade in the lumber from the logs.

The major cause of defect was the Indian paint fungus (*E. tinctorium* at that time) in both the live and dead trees. It was involved in the culling of many logs and considerable volume loss and lumber degrade in adjacent logs.

Basal scars will not be much of a factor because on most trees with basal scars either a long butt was left in the woods, or the log was a cull and is not included in this report.

Frost cracks were the most common defect indicator on both live and dead

trees. Most of these trees were obviously shaky when the log was cut. In addition, there are small shakes which do not show up until the lumber is dried.

In the dead trees the losses in volume and value were primarily due to drying checks with additional losses due to sap rots (*P. vulvatus*) and minor losses in value due to ambrosia beetles.

To Get From Lumber Recovery to Dollars You Need Prices

The prices we used for the structural grades of lumber in this report are 1968 prices (table 1). Standard & Better and Utility lumber maintain a pretty constant price relationship. The price of Economy fluctuates more widely and independently. Three months before the study was run, the price of chips was high and the price of Economy lumber was low. At that time any lumber that was obviously going to be Economy was sent directly to the chipper. Much less Economy grade lumber would have been produced if the study had been run at that time.

The prices for the week ending 10/10/75 (table 1), as opposed to the pricing used in the study, Standard & Better is up \$6. Utility is up \$8 and Economy is down \$4. If the chip market gets healthier, the price of Economy will rise, or Economy lumber will start disappearing from the market.

We are still talking lumber grades but we are now getting into the data. The actual percents of Utility and Economy for the live and dead timber are in table 2. The mean value for both Utility and Economy for live timber are very similar to the Martell California Study for old-growth white fir, and seem to be a pretty fair average for true firs.

There is a marked increase in both Utility and Economy lumber from the dead trees. Since the trees are similar in size and defect, the best explanation for these differences would be the deterioration since they died. The means are not as significant as they appear, because the loss in lumber grade was not consistent for all log sizes.

The total percent of Utility and Economy was much higher in small dead logs than in the small live logs (fig. 1). You'll notice on the 4- to 10-inch logs, the live logs have 30 percent Utility and Economy while the dead logs have 58 percent. As we get to the larger logs, the differences are much less. On the 26- to 30-inch logs, the Utility and Economy are about 34 percent of volume of live logs and 42 percent of the volume of dead logs. For logs from live trees, the percent of volume in Utility and Economy stayed relatively constant for all diameter classes. As for reasons, the small logs are primarily top logs and were showing some pretty serious checking, but little sign of sap rot. The largest logs are primarily butt logs which had little checking but did have large numbers of saprophyte fruiting bodies. The large dead logs have more Utility and Economy than the live logs but the differences are much smaller.

How did all this affect dollar values, is the real crux of the problem. Figure 2 is a plot of the average dollar value of each thousand board

Table 1.--Lumber prices used in this report and current lumber prices

Grade	Report (1968)	Current (10/75)
Standard & Better	125	131
Utility	68	76
Economy	40	36

Table 2.--Percent utility and economy for live and dead timber

Grade	Live	Dead
----- Percent -----		
Utility	21.05	27.33
Economy	11.66	20.40
Combined	32.71	47.73

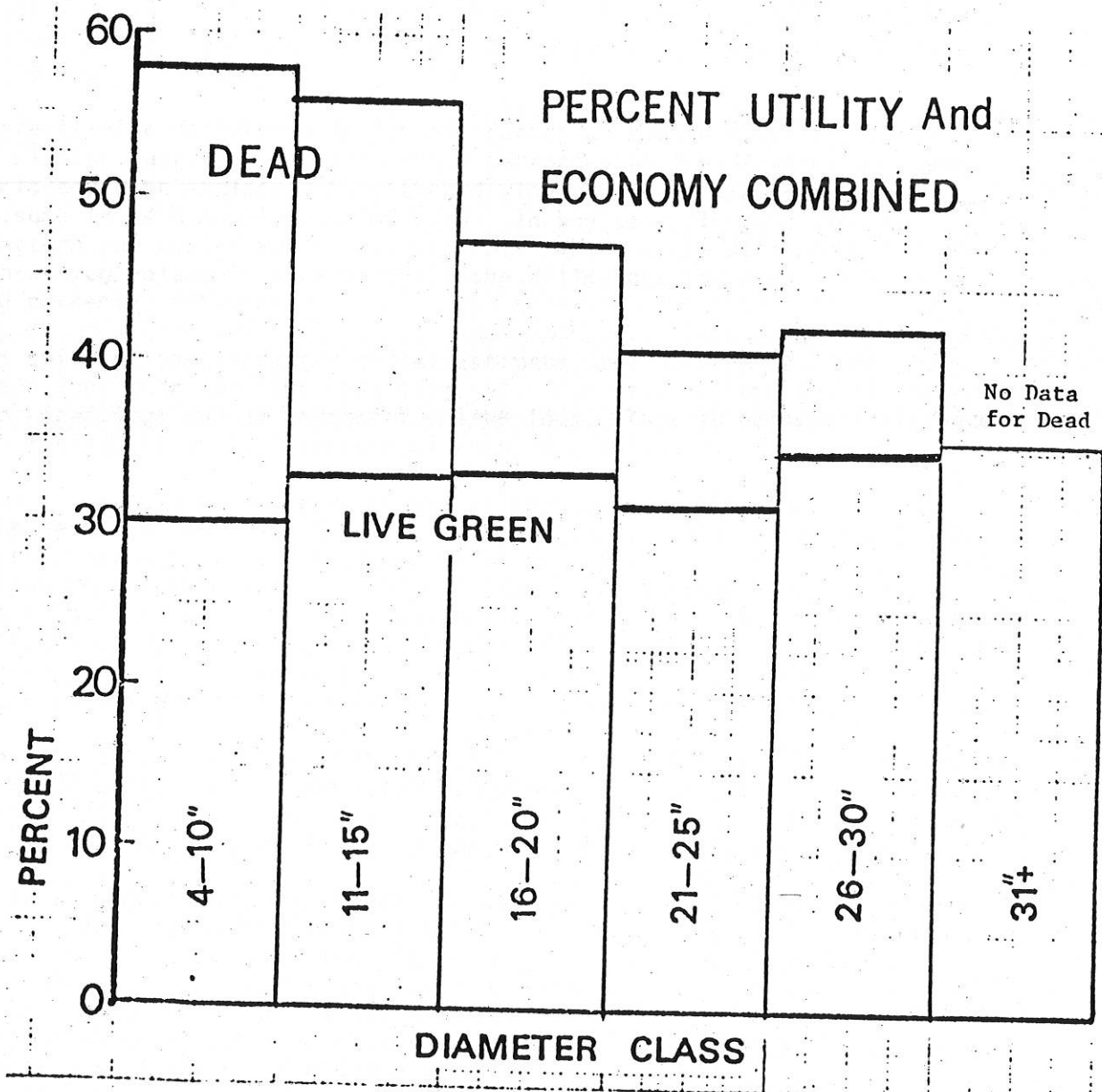


FIGURE 1 Total percent of utility and economy lumber by diameter class for live and dead timber.

feet of lumber over log scaling diameter. There is approximately a \$35/M average loss for logs less than 10 inches and a \$10/M loss for logs 25 to 30 inches. The average value difference for all logs is just about \$12/M board feet of lumber. Since the live logs averaged \$100/M lumber tally, this is equal to 12 percent of the value of the live logs. **Slopes.

Defect.--The difference in percent defect as scaled (fig. 3), shows a similar pattern. The difference decreases as log diameter increases. This could be explained by either drying checks or sap rots. I assume it is a combination of both. In any case, it is a classic pattern you would expect with sap rot. The average difference for the total log volume is 4 percent but the difference for small logs is 10 percent. **Slopes.

In spite of the increased defect estimate, the overrun was lower for dead logs than for live logs (fig. 4). The study volume was 27 percent for dead logs and 37 percent for live logs. That 10 percent difference in overrun is worth 7 percent of total log volume.

Now if we multiply overrun by the value/M lumber tally, we arrive at the value in dollars/M net log scale (fig. 5). This is the figure that most people would accept as the final figure for loss. It is reasonably close to the true loss. It ranges from approximately \$50/M for logs less than 10 inches to about \$12/M for logs larger than 25 inches. For the study as a whole, the average loss was \$25 or 18 percent of the log value/M board feet Scribner scale. That figure, as bad as it is, ignores the additional defect that is in that log scale figure.

To try to get a handle on the total loss in logs, I computed the average value/C cubic feet of gross cubic log volume. The value for live logs was \$77/C cubic feet and the value for dead logs \$60. The difference in value on this base was \$17 or 22 percent of total log value lost.

That is almost the bottom line but not quite. In addition there were losses due to breakage both in cutting the trees and in subsequent handling. I don't have any figures on these yet, but I am reasonably certain the loss due to deterioration from Spring 1972 defoliation to autumn of 1974 logging is going to come very close to 25 percent of the potential green value of these trees in terms of products only. Additional logging and milling costs per unit of production will, of course, have to be added to the loss of products to get the true economic loss.

To Sum Up.--We experienced about every kind of loss you can get in a study. Some have been quantified, some haven't. We know there is loss in logging and handling the logs, there is loss in scaled volume into the mill and loss in both product volume and in value of products coming out.

In order of occurrence we lost:

- 4 percent of scaling volume
- 7 percent of product volume/unit scale
- 12 percent of product value on top of those two

FIGURE 2. Value in dollars per thousand board feet - lumber tally by diameter

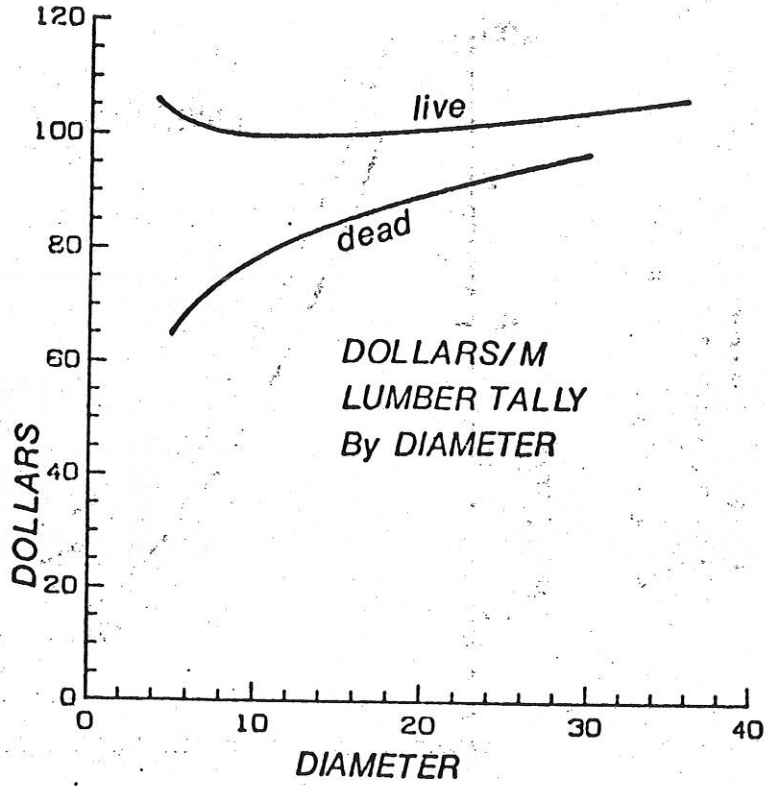


FIGURE 3. Defect percent in: $\frac{\text{gross scale-net scale}}{\text{gross scale}}$ by diameter class

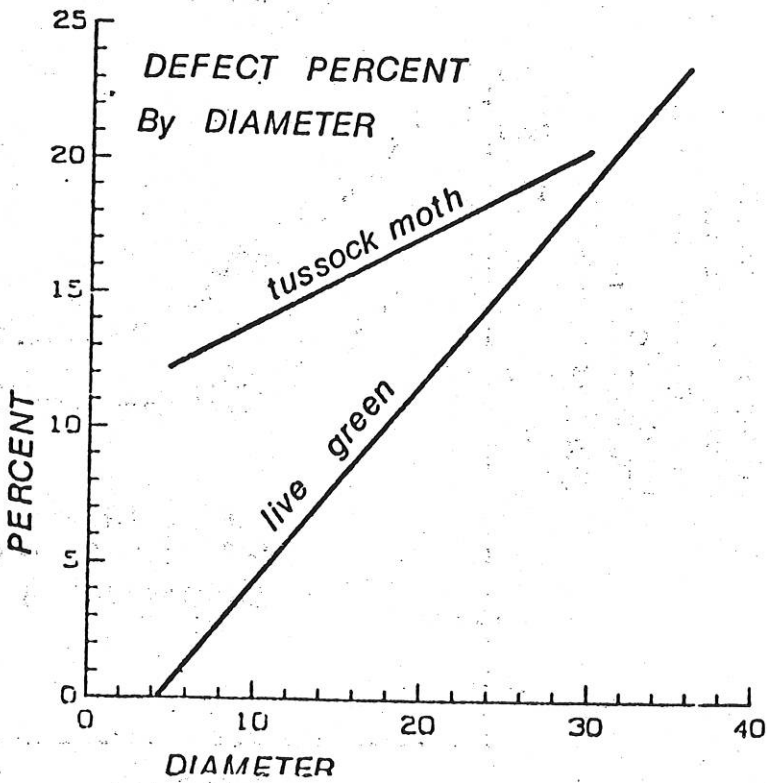


FIGURE 4. Overrun percent, formula:

$$\frac{\text{Lumber Tally}}{\text{Net Log Scale}} - 1 \times 100$$

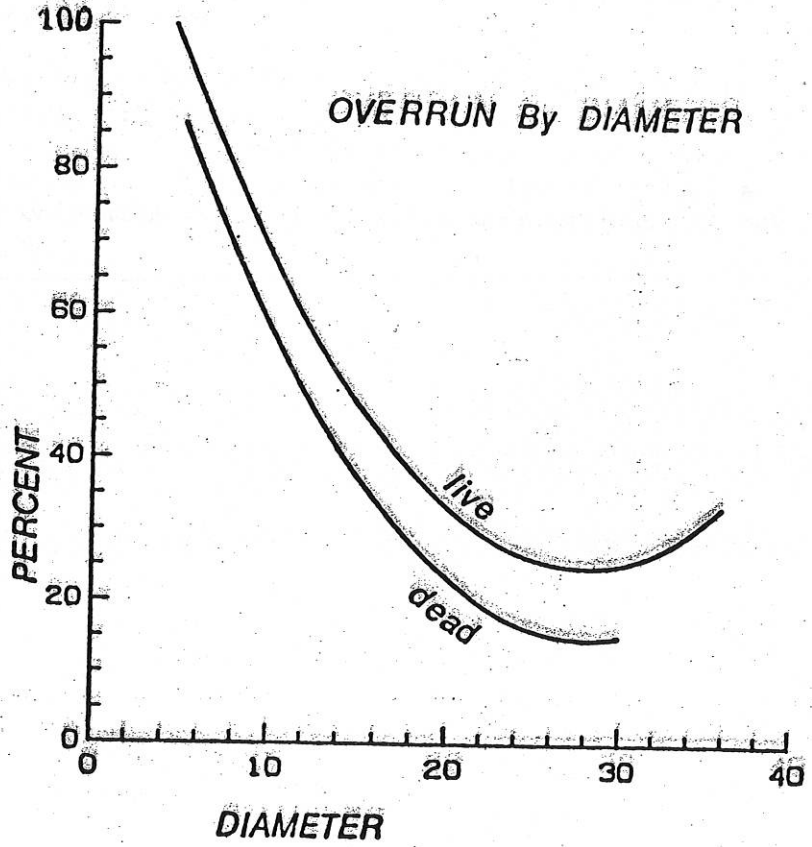
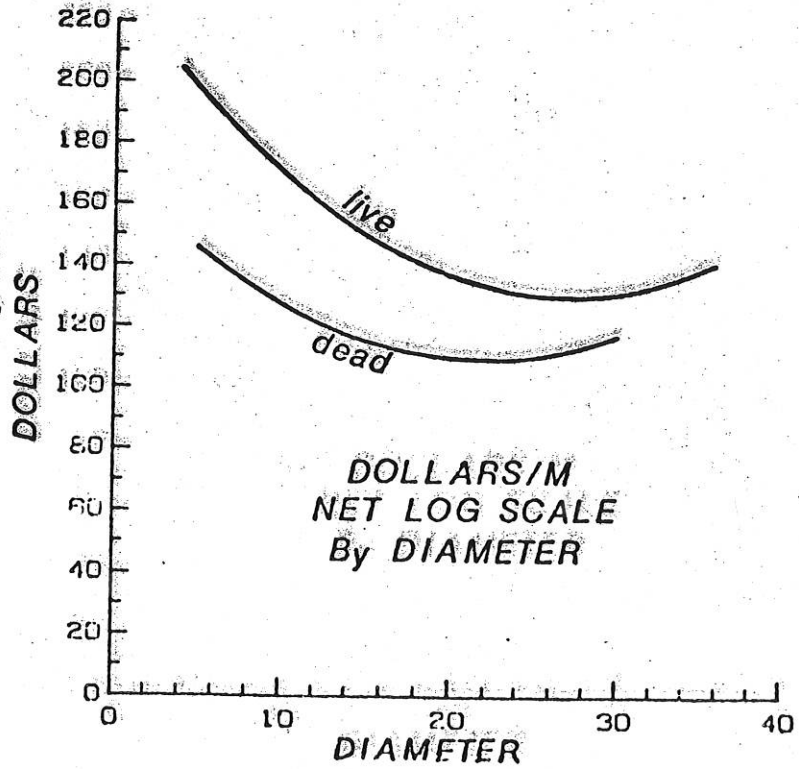


FIGURE 5. Value in dollars per thousand board feet net log scale:

$$\frac{\text{Total Value}}{\text{M Net Log Scale}}$$



All of these losses are cumulative and most concentrated in the smaller logs and I suspect that most of the logging and handling losses will also be concentrated in the small logs.

The item that gives me the problems is that I can't square the 4 percent difference in log defect with the 22 percent difference in log value. Apparently much of the value loss which is attributed to biological deterioration has already occurred due to physical deterioration, and any rots which occur only make the deterioration more obvious but not more real.

UTILIZATION AND DETERIORATION OF LOGGING RESIDUE
IN THE NORTHERN REGION

by

David P. Lowery

According to Forest Survey reports, the volume of salvageable dead timber on the commercial forest lands of the Northern Region is approximately three-and-a-half-billion cubic feet. This figure is probably conservative because the data were gathered in the 60's. Annual mortality in the Region for the year 1970 was estimated to be 276 million cubic feet or 1.1 billion board feet of sawtimber. In north Idaho alone, it has been estimated that 300 million board feet of white pine is killed annually.

In the Northern Region insects account for most of the tree mortality. The Douglas-fir beetle, larch casebearer, spruce budworm, and mountain pine beetle are the major insect pests. Commercial species most affected by insect attacks are lodgepole pine, Douglas-fir, western larch, Engelmann spruce, whitebark pine, and limber pine. The white pine is a victim of both mountain pine beetle and blister rust.

Theoretically, if all dead trees could be salvaged, the annual timber supply from the Region could be increased by 45 percent. Unfortunately, very little dead wood is salvaged because the dead trees are scattered and often inaccessible. The large quantity of dead material in our commercial forests constitutes an untapped reservoir of raw materials.

In the Northern Region, dead wood decays far more slowly than in many other areas. Trees that were insect or disease killed in the 20's and 30's are still standing or have begun to topple over and jackstraw on the ground. Several factors contribute to the durability of dead material and slash. Moisture content for standing dead trees averages 10 to 18 percent; trees in contact with the ground, 20 to 25 percent. Such low moisture contents barely support the growth of wood decay fungi.

Another factor closely related to moisture content of dead wood is the climate of the Region. Western Montana has an average annual rainfall of 18 inches, a mean temperature of 43°F and a mean relative humidity of 40 percent. North Idaho is somewhat moister having 28 inches of rainfall, a mean temperature of 45°F and a mean relative humidity of 53 percent. Most of the moisture falls as snow and the summers are relatively dry. At the higher elevations frost and snow can occur in any month of the year. As a result of these climatic conditions, the growth of fungi and the biological breakdown of the postharvesting slash is necessarily slow, however, the degradation in Idaho is probably much more rapid than in Montana.

Studies of slash deterioration have been made in California and the Pacific Northwest a number of years ago, but the transfer of these results to this Region would be subject to gross error because of our environment. A year ago, an intensive investigation of slash deterioration was initiated on the Coram Experimental Forest a few miles south and east of Glacier National Park, in larch/Douglas-fir. This study will determine the fungi responsible for deterioration as well as measure, for the first time, microclimatic conditions that may affect the fungi growth. Of course, this study is of too recent an origin for results to be available.

Sometimes it is desirable to know how long the tree has been dead. In an Alaskan study, needles, branchlets, secondary branches, primary branches, bark, and bole--the criteria used by the Forest Survey--were used to make this determination. Needle fall, which marks the start of disintegration, is followed by the breakdown of the branch system. The smaller branchlets are the next to go with the larger, primary branches last. The bark remained intact for about 5 years before any noticeable sloughing occurred. After 7 years, about half of the trees had a portion of the bole gone. The application of this information to this area would be questionable where, as has been mentioned earlier, trees dead 30 or 40 years are still standing with no visible signs of decay. Studies of this type are needed for this area since time since death can have a marked effect on utilization.

Residue utilization, too, is a relatively new research area. Because of the tremendous quantities of slash now available and that are occurring annually, new methods of utilizing this material are necessary. Increasing use of this material by sawmills, pulpmills, and other manufacturing plants can only make a small dent in the supply. Fortunately, harvesting and processing economics are changing rapidly, mainly because of the energy crisis, and the prospect for slash utilization is more favorable today than ever before.

At this point, a review of current dead timber utilization practices seems appropriate. About a year ago at the instigation of Utah Power and Light Company several Forest Service pathologists evaluated dead lodgepole pine trees to determine suitability for utility poles. They found the trees suitable, which led to acceptance by the utility.

As a result of more stringent Forest Service regulations, purchasers of public timber are being required to remove more of the dead material. Some of these trees are being mixed with green trees and manufactured into lumber in the usual manner. To enhance purchaser acceptance of this material, the Region has incorporated a number of dead trees in each of the mill scale studies that have been made during the last few years. This practice will be continued with future studies, as well. The resulting information will provide some indication as to what quantity and values can be recovered from the dead trees.

A year or so ago, during a paper shortage scare, a local paper mill began to utilize dead and defective trees as a source of chips. Generally, wood chips from these trees proved to be entirely suitable for pulp and paper. This material does pose some manufacturing problems, but all appear to be surmountable.

A small number of dead trees are being used by the house-log industry. Dead trees can be used immediately whereas green trees have to be peeled and seasoned prior to use.

At this time, there is no commercial demand for tops and branches, nor does there appear to be a future demand for this material. Because this material contains most of the nutrients in the tree, it would perhaps be best left in the forest and allowed to decompose or be burned, thereby providing nutrients for the next tree crop.

SPECIAL REPORT: AN EPIDEMIC OUTBREAK OF PHOMOPSIS
ON DOUGLAS-FIR IN A CALIFORNIA FOREST NURSERY

Robert V. Bega ^{1/}

Fortunately it has been quite some time and even then sporadic since we plant pathologists in California have been able to report to you on new and unusual diseases. This does not of course consider the outbreak of Dutch Elm Disease which we finally got, but in this instance to a nursery disease (Phomopsis) on Douglas-fir. This disease has been reported in Canada, the Pacific Northwest, and the Central and Eastern States of the United States. These reports recorded the disease on species such as Western Hemlock, Western Red Cedar, and Eastern Juniper. An outbreak of Phomopsis recently occurred on Douglas-fir in a U.S. Forest Service nursery in northwestern California, in a high rainfall, fog belt environment.

More than 4 million seedlings were lost or heavily infected when we got our first report and request for assistance in July of 1975. Douglas-fir in this particular nursery is held as 2-0 stock and 57 of which were dead first-year stock. The 2-0 seedlings ranged from apparently healthy to declining to dead. Out planting was scheduled for 1976 on six national forests and on BLM land in Oregon and northern California.

R.S. Smith, Jr., with the cooperation of Art McCain of the University of California, had prescribed a spray schedule for Phoma in 1974-75 for this particular nursery. Unfortunately, the nursery could not follow the schedule during the critical months of September-April 1974-75. The fungicide prescribed would also have been effective on Phomopsis.

I wasn't sure what I was going to look for, even though several years ago I trained and guided others in nursery diseases. I used four types of media for isolations: 1. V-8 juice agar, 2. guava juice agar, 3. malt agar and 4. H₂O agar with lactic acid. I cultured material from the top, soil line, and roots of all 288 seedlings. The isolations showed 67% Phomopsis and 10% Phoma, all from needles and stem. To my dismay, nothing exciting from the roots, not even nematodes. Several of the Phomopsis isolates came from "so-called" apparently healthy seedlings that showed few if any cankers or lesions. In most instances the root system was adequate, but the leader had been killed-back, resulting in what I call "bushes" rather than trees. The major question is--as you will recall from the rather divided audience discussion--do we send these "bushes" out to the field to be planted? My own recommendation was heavy culling.

I do not as yet know whether it is wise to ship such infected seedlings out to the field. Are we producing a mass of inoculum in the field, or will the bushes put on a dominant leader and eventually become trees? In a second phase, I plan to evaluate diseased seedlings in the field.

^{1/} Principal Plant Pathologist, Pacific Southwest Forest and Range Experiment Station, Berkeley, California.

SPECIAL REPORT:
CURRENT STATUS OF OHIA FOREST DECLINE
IN HAWAII

Robert F. Scharpf

Within the last decade or two, thousands of acres of ohia rain forest on the Island of Hawaii are suffering a severe epidemic decline (3, 13). Loss of these forests will have a major impact on watershed, timber, wildlife, and recreational values. Thus, the present decline is of serious concern to various land management agencies.

However, the present problem is not the first recorded instance of noticeable ohia death and decline. Other instances of dramatic decline and death of ohia forests have been recorded in the past (1, 4, 11, 12, 13). The cause(s) of past and present decline, however, are only partially understood or unknown. Only relatively recently has an active research program been undertaken to determine the cause(s) of decline.

In the early 1970's research was begun on the cause(s) of the present decline by the Institute of Pacific Island Forestry (USFS), University of Hawaii, and Bishop Museum. To date the cause(s) of the decline are still not known. Various root, leaf, and twig fungi, leaf and twig feeding insects, nematodes, and low soil fertility have been implicated or involved with dead or dying ohia trees to one degree or another (5, 6, 8, 9, 10).

However, most of these agents or factors were not found consistently associated with or are not considered to be principal factors in the decline.

The factor that has received the greatest amount of attention in the last few years as the principal causal agent of decline is the root rot fungus, Phytophthora cinnamomi, a known tree pathogen elsewhere in the world. This fungus has been consistently found in soil and on roots of trees in decline areas and has been shown to be pathogenic to ohia under greenhouse conditions (2, 7). However, this organism is also found in non-decline forest areas on Hawaii and also in "healthy" ohia forests on several of the other Islands.

The current working hypothesis is that P. cinnamomi is not the sole causal agent of decline but is predisposing ohia trees to attack by a native insect (round-headed borer) Plagithmysus bilineatus. This insect is endemic and indigenous to the Island of Hawaii and appears consistently associated with dead and declining trees.

In order to effectively deal with the ohia forest decline problem, a multidisciplinary approach, using a team of research specialists, was developed in 1975 under the general direction of the Institute of Pacific Islands Forestry in Honolulu (figure 1). The team so far consists of plant pathologists at IPIF and UH and an entomologist at Bishop Museum. Plans are to recruit other team members. The team,

operating under a 5-year research and development plan to determine cause and control of ohia forest decline, is currently planning and conducting studies along the lines of the before mentioned working hypothesis.

Two studies are currently in progress: 1) The presence and populations of P. cinnamomi in declining and non-declining ohia forests in Hawaii and 2) the relationship between boring insects, root rot, and ohia decline symptoms on the Island of Hawaii. Monitoring of the progress of decline on permanent transects is also being continued by IPIF and the Hawaii Division of Forestry.

Further information on the current status of the ohia decline research program can be obtained by contacting:

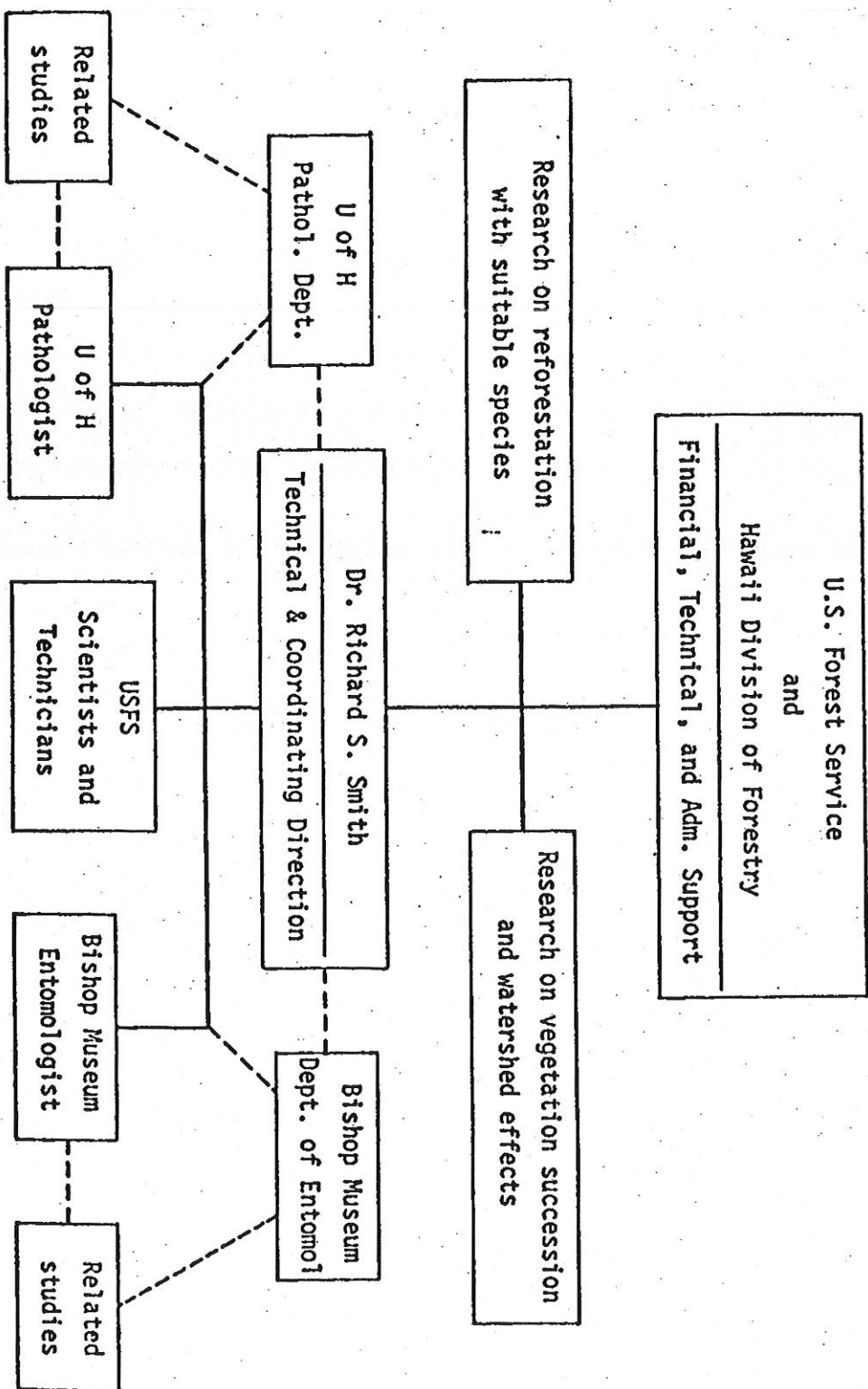
Dr. Richard S. Smith
Institute of Pacific Island Forestry
1179 Punchbowl Street
Honolulu, Hawaii

LITERATURE CITED

1. Anonymous. 1911. Report of the Committee on Forestry for the year ending Sept. 30, 1911. P. 8-9. Hawaiian Sugar Planters Assn.
2. Bega, Robert V. 1974. Phytophthora cinnamomi: Its distribution and possible role in ohia decline on the Island of Hawaii. Plant Dis. Repr. 58(12): 1069-1073.
3. Burgan, Robert E., and Robert E. Nelson. 1972. Decline of ohia-lehua forests in Hawaii. USDA Forest Service, General Tech. Report PSW-3, 4 p., illus. Pacific Southwest Forest & Research Expt. Sta., Berkeley.
4. Davis, C.J. 1946. Note on forest insect conditions. Hawaii National Park for the year 1946.
5. Gressitt, J. Linsley, G. Allan Samuelson, and Clifton J. Davis. 1973. A study of the borers of koa and ohia trees on the Island of Hawaii, 7 p., Bernice P. Bishop Museum, Honolulu.
6. Holtzmann, O.V. and W.H. Ko. 1975. Determine and study the pathogens, insects, and other factors causing the epidemic decline of ohia and koa forests in Hawaii. Final Report--USFS, PSW Grant No. 3 to Univ. Hawaii.
7. Kliejunas, John T. and Wen-Hsiung Ko. 1973. Root rot of ohia, Metrosideros collina subsp. polymorpha, caused by Phytophthora cinnamomi. Plant Dis. Repr. 57(4): 383-384.
8. Kliejunas, J.T. and W.H. Ko. 1974. Deficiency of inorganic nutrients as a contributing factor to ohia decline. Phytopathology 64: 891-896.
9. Kliejunas, J.T. and W.H. Ko. 1975. The occurrence of Pythium vexans in Hawaii and its relation to ohia decline. Plant Dis. Repr. 59: 392-395.
10. Laemmlen, F. and R.V. Bega. 1974. Hosts of Armillaria mellea in Hawaii. Plant Dis. Repr. 58: 102-103.
11. Lyon, H.H. 1909a. The Maui forest trouble. Hawaiian Planters Record., p. 92-95, illus.
12. Lyon, H.H. 1909b. The forest disease on Maui. Hawaiian Planters Record., Vol. 1, p. 151-159, illus.
13. Petteys, Edwin Q.P., Robert E. Burgan, and Robert E. Nelson. 1975. Ohia forest decline: its spread and severity in Hawaii. USDA Forest Service Research Paper PSW 105.

FIGURE 1.--INSTITUTE OF PACIFIC ISLANDS FORESTRY

GENERALIZED ORGANIZATION FOR OHIA FOREST DECLINE RESEARCH



SPECIAL REPORT: VEGETATION MAPPING PROCEDURES USING THE FACILITIES
AT THE EROS DATA CENTER

by

Robert E. Burgan and Edwin Q.P. Petteys

To begin, I will show a few slides that illustrate the problem to which we applied the vegetation mapping procedures employed at the EROS Data Center.

Basically the problem is that an average of about 6000 acres of ohia trees are dying each year on the windward side of the island of Hawaii. (Slide #1) Although this is the area of most severe tree death, the problem does exist to a lesser extent on other parts of this island, and also on other Hawaiian islands.

We recently made a survey to define the location, extent and rate of spread of tree death. (Slide #2) By photointerpretation of 1954, 1965, and 1972 aerial photographs, we found that the area of severe decline, shown in red on this map, increased from 300 acres in 1954 to about 85,000 acres in 1972. The total area surveyed was 200,000 acres. Conversely the area of healthy forest, shown in green, declined from 75,000 acres in 1954 to 32,000 in 1972. Perhaps a few slides will show what these forests look like now. (Slides 3,4,5, and 6)

Since your colleagues Dick Smith, Bob Scharpf, Bob Bega and others are, or have been, involved in determining the cause of the decline, I'll leave speculation on that to them and proceed on to another question. Since there are something like 5000 introduced plant species growing in Hawaii and only about 2000 native species, we wondered what, if any, vegetational succession has taken place where the ohia forest canopy has been lost. This ultimately led to investigating satellite imagery and the processing techniques available at the U.S. Geological Survey's EROS Data Center at Sioux Falls, South Dakota. (Slide #7)

Before we describe our activities at the Data Center, let's briefly discuss remote data collection methods in general. There are two basic ways to collect remotely sensed data:

(1) image-oriented data such as standard aerial or satellite photographs, and

(2) numerically oriented data recorded on magnetic tape.

Utilization of image-oriented data, or standard photographs, normally depends on the talents of a skilled photointerpreter. However, both computers and a photointerpreter are used in the processing of numerically oriented data.

A visual presentation of numerical data is not obtained unless it is processed by a minicomputer and displayed on a TV screen.

Numerical data obtained from satellites, in our case the LANDSAT II, are collected in four spectral bands, two in the visible and two in the infrared region of the spectrum.

The imagery system in the satellite looks at discrete areas of about 1.1 acres of the ground. The average light intensity reflected from that 1.1 acres is assigned a numerical value and recorded separately, on magnetic tape, for each spectral band. Thus, a scene of a large area is a composite of these 1.1-acre elements, called pixels.

This information is periodically transmitted to ground receiving stations. Then it is put into a computer-compatible format. At this point, the information can be fed directly into a computer for analysis or can be displayed visually on a TV screen.

An example of the equipment required to process taped data and display them visually is the IMAGE 100 that we used in Sioux Falls. (Slide #8)

(Point out the tape drives, minicomputer, IMAGE 100 control panel, CRT, transparency digitizer, separate TV monitor and 35mm camera.)

Satellite data recorded on the computer tape are read by the tape drives, processed by the minicomputer, and transmitted to the TV monitor, shown in this closeup. (Slide #9)

We obtained a computer tape of a February 1973 scene of a portion of the windward side of the island of Hawaii. These data were loaded into the minicomputer and appeared on the TV monitor, one band at a time. (Slide #10) This shows band 5 after it has been loaded. Each band can also be contrast stretched to bring out the detail. (Slide #11) This slide shows band 5 during the process of stretching.

After all four bands have been loaded into the minicomputer, a false color composite can be produced on the TV monitor. A specific color is assigned to three of the bands, and they are all superimposed on the monitor screen at the same time. (Slide #12) This is a contrast-stretched color composite of bands 1, 2, and 4. The study area is outlined in black.

Meaningful interpretations of the data require the skills of a knowledgeable photointerpreter, armed with adequate ground truth data.

To break the project area into manageable units, we divided it into a north half (Slide #13) and a south half (Slide #14). For each half of the project area, we delineated various vegetation types such as remnant ohia forest, healthy ohia forest, fern types, grass, and so on.

The IMAGE 100 was trained to recognize each vegetation type by using a moveable cursor to locate and "train on" points of known vegetation.

This permitted the IMAGE 100 to define the spectral signature of that particular kind of vegetation, search the entire scene for similar areas, and display them all on the TV monitor. Each vegetation class was assigned a different color code, and a map was produced for each. (Slides #15 through #23) Although we have illustrated the north area, this process was also performed for the south area.

As well as this visual display, the IMAGE 100 also provides area statistics for each of the vegetation types delineated. (Slide #24)

LARSYS

Another method to locate and determine the area of these vegetation types involves the use of computer processing, using in this case a computer program called LARSYS. Briefly, LARSYS is used to group areas that either have similar spectral characteristics or that the photointerpreter just wishes to group together.

We began our use of the LARSYS program by selecting two training areas. (Slides #25 and #26) The first step is a spectral grouping of all the pixels (remember each pixel is about 1 acre) into 20 classes. Each class is assigned a symbol, and the results are printed as a symbol map of the training area. (Slide #27) Each symbol represents a mapped pixel. Groups of the same symbol were outlined on this map. The exact location of each group of symbols was found on the IMAGE 100 TV monitor by reference to the X and Y coordinates of two corners of the symbol group. (Slide #28) This is an example of group of symbols located and outlined on the TV monitor.

The vegetation type represented by each such symbol group was identified by locating these areas on 1:12,000 scale 1972 color photos, from which accurate photointerpretation was possible. Thus, we determined that, for example, dashes on the computer printout represented rockland, dollar signs, and equal were dense ohia forest, and so on.

This resulted in a grouping of the 20 spectrally classed symbols into 16 classes of interest to us, that is, various vegetation types, clouds, cloud shadows, rocklands, and so forth.

At this point, some of the vegetation classes were reasonably similar-- such as remnant ohia and scattered ohia with a grass/fern understory. So by lumping similar classes together, the number of classes was reduced from 16 to 12.

We then identified, to the LARSYS program, the symbols that were to be grouped together; so the resulting computer-produced map of the training area was composed of only 12 symbols.

At this point, it was decided that no further justifiable grouping of vegetation types could be made. Each was unique. However, since our objective was to determine the changes in vegetation that were occurring

as a result of ohia decline, one additional grouping was done to separate those classes within which we felt most vegetational changes had occurred, from those classes of little or no change. After resubmitting these classes to LARSYS for grouping, the resultant computer map of the training area was composed of only seven symbols.

This computer map was subdivided into 100 sample areas. (Slide #29) Another printout produced by the LARSYS program provided the number of points in each of the seven categories, for each of the 100 sub-sample areas. A statistically sound sample of 20 of the 100 areas was selected with probability proportional to size. That is, the largest categories were most likely to be selected. Remember the largest category we have at this time represents the area in which the greatest vegetational changes have occurred. This was the area most important to us, so it was sampled most heavily, while the rockland, sugarcane, clouds, and so forth were sampled less. Each of the 20 sample areas was 400 acres.

Each of the 400-acre sampling areas was then delineated on the standard aerial photographs that were available. (Slide #30) These were: 1954 and 1965 black and white photos, and 1972 color photos.

At this point, the computer has been used only to aid in selecting sample areas to be manually photointerpreted. This is as far as we have progressed to date. However, to continue the procedure, manual photointerpretation of the 1972 color photos will provide a summary of the number of acres in each vegetation type for each sample area. This information will be used to refine the computer classification of vegetation types in the 20 sample areas. Once the computer classification of the training areas is satisfactorily refined so the results produced are compatible with the manual interpretations, the computer will classify the vegetation types for the entire project area. Then, we will have a vegetation-type map and acreage statistics based on the data gathered by LANDSAT in February 1973.

The same sample areas will be photointerpreted on the 1954 and 1965 photos, as on the 1972 photos, to develop a summary of the number of areas in each vegetation type in these years. This information will be expanded to develop acreage figures for the entire project area. Thus, by comparing acreages in each vegetation type for 1954, 1965, and 1973, we can determine the vegetation changes, if any, during this time period.

We also employed yet another method to obtain a current vegetation map of the project area. However, this method also employed the LARSYS program and was similar to the method just described. Basically, it involved selecting a different set of 20 randomly located 400-acre subsamples within the training area. The difference here is that probability proportional to size was not used, so each sample plot had an equal chance of being selected.

This group of 20 sample plots was also located on the 1972 photos. These 20 sample plots of 400 acres each will be photointerpreted to provide a summary of the number of acres of each vegetation type, for each sample area.

Then using the manually determined acreages as the independent variable, and the computer-classified acreages as the dependent variable, we will develop a linear regression to correct the computer classification within the training area. The vegetation classes from the training areas will be combined into one vegetation classification scheme that will be applied to the entire project area. In this way, the computer will produce another map and acreage statistics of the present vegetation on the entire project area.

In summary, a 1973 vegetation-type map and acreage statistics of the project area will be produced by each of these methods:

- (1) Classification using the IMAGE 100.
- (2) Classification using the IMAGE 100, the LARSYS computer program, a sampling scheme based on probability proportional to size, and standard aerial color photographs.
- (3) Classification using the IMAGE 100, the LARSYS computer program, a purely random sampling scheme, a linear regression and standard aerial color photography.

In addition, the plots selected for manual interpretation, by the method of probability proportional to size, will also be photointerpreted on the 1954, 1965, and 1972 photos. This will permit an assessment of vegetation changes in the project area between the years 1954 to 1973.

ATTAINING INTENSIVE MANAGEMENT GOALS BY STEMS-PER-ACRE
CONTROL IN PLANTATIONSGerald E. Hoyer and Kenelm W. Russell¹INTRODUCTION

The Department of Natural Resources has for several years defined and used differing specific forest management options (referred to as regimes) which produce significant yield differences (2). These management regimes are the basis for estimating yield in our sustainable harvest analysis (1). This report shows the relationship between a management regime and DNR's stand establishment program. The tables explain how the manager determines the number of trees per acre to plant to achieve DNR's management goals. It is important to remember that we are describing a *system*. The numbers can change to fit any organization's management goals. Even within the organization's operating area the numbers will change due to stand, terrain and climatic differences.

MAXIMIZING YIELDS

Maximizing productivity in intensively managed stands depends partly on full stocking of each acre and partly on resulting tree size. Trees must reach a given minimum size before they are useful. The art of thinning is a balance between tree stocking and size; both are carefully considered in the make-up of the regime described here.

A REVIEW OF MANAGEMENT REGIMES

Many management regimes have been defined and examined by DNR but only one is described here (regime No. 518). The work has been updated with the most recent research findings (3,4).

The regime is precommercially thinned at age 15. The number of trees retained maximizes productivity under specific limitations defining the regime. Regime No. 518, considers "pulp" (8" DBH trees) as the assumed minimum merchantable limit for future stands. Other regimes have different minimum limits.

THE REGIME FROM A PLANTATION VIEWPOINT

These regimes can be viewed in another way. Rather than considering time of precommercial thinning as the starting point, we can extend the time frame and consider them as beginning at plantation establishment.

Forest Land Management Contribution No. 187.

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Stands under various regimes could be planted at spacings that provide the number of stems-per-acre we desire and include those we would eliminate after precommercial thinning at age 15. This necessitates allowances for mortality. Mortality patterns vary in stands under four age groupings.

- a. Age 0-5
- b. Age 5-15
- c. Age 15 to first commercial thinning
- d. Commercial harvest to final liquidation

Age 0-5 is the stand establishment period when considerable mortality occurs from animals, disease, competition and weather. From age 5-15 stand establishment is fairly complete. Mortality slows and number of stems reduces at a much slower rate than the 0-5 year age group. After 15 years and into final harvest, natural mortality is slower but may remain steady with periodic increases usually due to root rots or animals such as mountain beavers and bears.

Subsequently, in this report we estimate mortality from the oldest age group described above down to the youngest age group separately.

CONTROL, IN TERMS OF STEMS-PER-ACRE (SPA)

Spacing control is the manager's chief tool for altering stand development. It can be applied either when planting or by precommercial thinning at a later age. Spacing control can be expressed in several ways; as number of stems-per-acre (SPA), or in terms of the equivalent to a 10 x 10 average spacing. We use SPA here.

TABLES 1 AND 2 TAKEN A STEP AT A TIME

Tables 1 and 2 are designed to be used together to provide proper background information and an understanding of the systems. Table 2 tells how many trees per acre to plant. Begin use of the tables by knowing the site index.

Refer to Table 1, the starting point for determining plantation SPA. The regime description, mortality, and other factors are given in the left half of the table. Number of stems-per-acre by 50-year site index is given in the right half.

Line numbers are used to describe each segment of the table. Line 1 shows the number of trees needed just prior to the first commercial thinning or final harvest. For example, line 1 you read 550 expected trees per acre for site index 90. Site index 150, on the other hand, only requires 400 trees. These are minimum trees needed for assumptions made but mortality has so far been neglected.

Line 2 shows the estimated number of trees per acre that will probably die between age 15 and the first commercial thinning or final harvest. In our example (regime 518) mortality varies from 15-40 trees.

TABLE 1. DOUGLAS-FIR STEM-PER-ACRE GOALS AND MORTALITY ASSUMPTIONS:
AGE 5 TO HARVEST

INSTRUCTIONS:				
1. Select management regime, find plantation site index, read appropriate stems-per-acre (Line 4).				
2. Proceed to Table 2.				
REGIME NO. 518				
DESCRIPTION: Age 15 precommercial thinning, 6-8" pulp option; commercial thinning followed by final clearcut				
	SITE INDEX (50 YEARS)			
	90	110	130	150
LINE:	STEMS-PER-ACRE			
1. Trees needed at first commercial thinning	550	500	450	400
2. Mortality, age 15 to first com. thin. (3)	40	30	20	15
3. Mortality, age 5-15 (3)	15	15	15	15
4. Total stems-per-acre needed, age 5	605	545	485	430
5. Mortality, age 0-5				
	Refer to Table 2			

TABLE 2. STEMS-PER-ACRE (SPA) TO PLANT ALLOWING FOR MORTALITY:
AGE 0 TO 5

INSTRUCTIONS:												
1. Under selected regime and site index from Table 1, go to _____ and find desired stems-per-acre, age 5.												
2. Determine applicable mortality factors under _____												
3. Add pertinent factors to line 4 to arrive at planting stems-per-acre.												
4. Do not exceed maximum-minimum stems-per-acre limits _____												
REGIME NO. 518												
	SITE INDEX (50 YEARS)											
	90	110			130			150				
Line 4	Desired Stems-Per-Acre - Age 5											
	605	545			485			430				
Line 5	Age 0-5 Mortality Factors - stems-per-acre											
	LOW	MED.	HIGH	LOW	MED.	HIGH	LOW	MED.	HIGH	LOW	MED.	HIGH
Rabbit	15	60	150	15	55	135	10	50	120	10	45	105
Deer	5	30	90	5	30	80	5	25	70	5	20	65
Elk	15	60	150	15	55	135	10	50	120	10	45	105
Mountain Beaver	15	60	150	15	55	135	10	50	120	10	45	105
Rhizina	0	35	70	0	30	65	0	30	60	0	25	50
Other Root Rots	0	5	10	0	5	10	0	5	10	0	5	10
Competition-Vegetation	0	30	90	0	30	80	0	25	70	0	45	105
Adverse Climate	10	45	90	10	40	80	10	35	70	10	30	65
Expected Naturals	0	60	150	0	55	135	0	50	120	0	45	105
Line 6 - Maximum-minimum												
SPA allowed - DO NOT EXCEED	600-800			545-745			485-685			430-630		

Note: Numbers in () refer to literature cited.

Line 3 shows mortality that occurs in the age 5-15 juvenile category. We estimate an additional 15 trees. Adding lines 1, 2, and 3 equals line 4, the number of trees we would like to have at age 5. Mortality from age 5 to harvest has now been accounted for. Line 4 does not account for mortality in the age 0-5 establishment category. These estimates are shown in Table 2.

Refer now to Table 2 for the same site index used in Table 1. Note that stems-per-acre are the same numbers from line 4, Table 1.

Mortality estimates are shown under line 5. They are based on percentages of actual losses detected in specific disease surveys and estimates based on research and forest management experience. They provide a basis for estimating number of trees needed for each individual plantation. Such an estimate is better than having top management dictate a single average number of trees per acre to be planted in each plantation regardless of varying conditions. This system provides precise individual unit planting prescriptions depending on its own mortality factors.

Field foresters should develop a working knowledge of mortality in their respective units based on past plantation success, experience and occasional outside help (pathologists, etc.). Mortality will vary depending on planting stock used, season, slope, aspect, soil and other critical stand-by-stand conditions.

When all applicable mortality factors are added together, there is a possibility of having an excessive number of trees per acre planted. When a good cone crop or adjacent seed source indicates the maximum number of naturals will occur, then the number of trees to be planted could be less than Line 4. Line 6 indicates maximum and minimum limits. The upper limit was determined by adding 200 SPA to Line 4 values. When the sum of expected mortality factors exceeds these limits we recommend staying within Line 6 limits. The manager may need to replant that particular plantation under unusual conditions.

EXAMPLE - HOW MANY TREES/ACRE DO I PLANT?

Now, let's consider a typical planting unit. Refer to Table 1 and because the terrain is not steep and the site is quite good you decide regime 518 most nearly fits the stated DNR management goals (Remember there are other regimes to use.) Site index of the logged stand was 130. Line 1, Table 1 shows you need 450 stems-per-acre at the first commercial thinning. Lines 2 and 3 indicate an additional 35 trees per acre will die between age 5 and time of commercial thinning giving 485 trees. Now look at Table 2 to help decide expected losses in the 0-5 year age class.

Under site index 130 we find the same line 4, 485 trees, our starting figure. Look at your plantation critically and decide the impact of each mortality factor. For rabbits you pick a medium 50 trees - scratch it on your hard hat. Elk - nothing. Mountain beaver - high, 120 trees (your neighboring plantation was clobbered). Rhizina - 0 because you are in a nondetected area. Root rot - high, 10 trees. Adverse climate - moderate, 35 trees (you noticed considerable freeze damage across the valley and you are on a SE slope). Expected naturals - medium, 50 trees.

Now, total everything - you find you must plant 650 trees per acre to account for all mortality. This falls within the limits of line 6 and should be used.

SUMMARY

Remember that this is a concept and a system. The numbers can be changed depending on management goals and local mortality factors. This paper describes the logical thought processes a reforestation expert uses to determine the number of trees or stems-per-acre to establish on a given cutting unit.

LITERATURE CITED

1. Chambers, Charles J. Jr. and Edward R. Summerfield, 1975.
Sustainable Harvest Analysis, Fiscal Years 1976 and 1977. State of Washington, Dept. of Natural Resources, Olympia, Washington. Harvest Regulation Series Report No. 6, 115 pp.
2. Hoyer, G. E., 1975.
Measuring and Interpreting Douglas-fir Management Practices (Explanation of a Simulation Technique, its Results and Meaning). State of Washington, Dept. of Natural Resources, Olympia. DNR Report No. 26, 80 pp.
3. Reimer, D. R., 1974.
MacMillan Bloedel Ltd., Canada. Personal correspondence.
4. Wiley, Kenneth N. and Marshall D. Murrery, 1974.
Ten-year Growth and Yield of Douglas-fir following stocking control. Weyerhaeuser Forestry Research Center, Centralia, Washington. Weyerhaeuser Forestry Paper No. 14, 88 pp.

NEW AND MODIFIED PROJECTS

USDA Forest Service

Region 2

Tom Landis reported on several projects completed during this past year. Two detection surveys were conducted, one on the distribution of Verticicladiella root disease in Colorado and one on the spread of oak wilt (Ceratocystis fagacearum) in the Plains States. Verticicladiella was found infecting pinyon (P. edulis) throughout western Colorado, based on aerial survey and ground checks. It appears that this disease is restricted to the western slope as no positive identifications were made in eastern Colorado, where Armillaria mellea was found to be the major root disease. In the oak wilt survey, this fungus was positively identified in one new county in Nebraska and two new counties in Kansas. This survey will be the last oak wilt survey performed in this Region because it appears that this disease has reached its ecological limits in the eastern Plains.

Work on nursery problems at Mt. Sopris Nursery revealed that excessive nitrogen fertilization can lead to chlorosis and stunting in lodgepole pine (P. contorta) beds.

Containerized ponderosa pine (P. ponderosa) seedlings were inoculated with Pisolithus tinctorius, a mycorrhizal fungus to improve planting success. These seedlings are being grown for planting on off-site locations where it is hoped that this fungus will serve as a buffer to help the seedlings adapt in their new environment.

Reports on these projects will be completed during the coming winter and should be available soon after.

Dave Johnson reported that an administrative study had been initiated to determine the impact of comandra blister rust (Cronastium comandrae) on lodgepole pine stands in northern and western Wyoming. The data will be incorporated into an existing computerized stimulation yield program for lodgepole pine. The ultimate goal of the study is to develop silvicultural guidelines for the land manager in making administrative decisions for infected stands.

A training program for the recognition of hazardous trees in recreation sites is being developed. An illustrated brochure will be available sometime next year.

Region 3

In 1974 we initiated a cooperative study dealing with partial cutting in aspen stands. Cooperators presently include Regions 2, 3, and the Rocky Mountain Forest and Range Experiment Station. Permanent study plots have been established in New Mexico and Colorado. The study objective is to determine the pathological effects of wounding on residuals in partially cut aspen stands. Preliminary results indicate up to 80 percent of the residual trees are sustaining logging-related wounds. We expect a preliminary report to be forthcoming in 1976-1977.

Popularized guides to identifying aspen diseases and mistletoes in the Southwest are being prepared. We are aiming for the general public as our audience. Both guides will be illustrated.

We will be designing and testing a sampling method for use in gathering basic information in two-storied, mistletoe-infected ponderosa pine stands. Basic data will be used as input for the simulated yield program SW4LD2.

Pacific Northwest Forest & Range Experiment Station

Control of Phellinus (Poria) weirii with soil fumigants (G.M. Harvey). Chemical control of Rhabdocline pseudotsugae in plantations (G.M. Harvey). Control of Phellinus (Poria) weirii by mechanical removal of inoculum (W. Thies).

Pacific Southwest Forest & Range Experiment Station (Hawaii)

Relationships between Phytophthora cinnamoni, Plagithmysus bilineatus, tree vigor, and ohia decline in forests of Hawaii

Diseases of exotic forest trees planted in Hawaii.

Intermountain Forest & Range Experiment Station

1. INT Project 3251

Study Title: Evaluation of temperature and moisture regions in relation to fungal activity, decay rate & type and associated fungi on logging residues.

Principal Investigators, R.D. Hungerford, INT. and M.J. Larsen, FPL.

Synopsis: Various size classes of fresh (2 years old) residue material will be sampled to evaluate the kinds of decay organisms. Continuous monitoring of temperature and water potentials will be done at various locations within the residue material. Tests of temperature and moisture requirements of various species will be carried out to evaluate their potential for residue bioconversion. Their evaluations will be carried out under several cutting and residue removal treatments.

2. Project: 3251

Study No: INT-3251-2-D

Study Title: Impact of Harvest and Post Harvest Methods, including prescribed burning and intensive utilization, on Forest Microbiology.

Principal Scientists: A.E. Harvey, INT., M.F. Jorgensen, Mich. Tech. Univ., and M.J. Larsen, FPL.

Synopsis: This study includes the investigation of decay processes, mycorrhizae formation, nitrogen conversions, and pathogen activities as interrelated and integral processes critical to the function of forested ecosystems. The primary objectives of the study are to determine the specific role of wood residues, in the form of decayed, decaying or burned materials on the above processes. Resultant information will provide base data to predict the effects of intensive utilization and fire on post harvest site quality.

Rocky Mountain Forest & Range Experiment Station

Quantification of rates of spread and intensification of dwarf mistletoe in ponderosa pine stands - G. Dixon and F.G. Hawksworth.

Canadian Forestry Service

Pacific Forest Research Center

Most of the studies initiated by Joe will be continued by Allen Van Sickle. As time permits, data will be examined, analysed, and summarized for local reports or publication.

eg. "Roadside survey for lodgepole pine dwarf mistletoe in the Caribou forest district": file report in preparation.

eg. "Silvicultural control of dwarf mistletoe in young lodgepole pine stands in Alberta and B.C.": 1973 and 1974 data being summarized, final survey planned for 1976-77. I will soon communicate with Frank Hawksworth about this.

eg. "Impact studies on hemlock and lodgepole pine dwarf mistletoes" some data analysis hopefully planned for this winter.

eg. "Appraisal of damage caused by forest pests in B.C."
68-F-1 Silvicultural control of dwarf mistletoe in young lodgepole pine stands (G.A. Van Sickle).

NOTE: Members may be interested that *Scleroderris* canker of pines (*Gremmeniella abietina*) has been confirmed at Canal Flats on ponderosa pine, and near Penticton on white bark pine. This follows Doworth's discovery near Jasper, Alberta in 1974. In all three cases the disease had apparently been present for a number (10?) of years with flagging of branches and some mortality of young stems evident.

Universities

University of California

Dick Parmeter and his students are completing their biological evaluation of *Fomes* (*Fomitopsis*) *annosus* in Yosemite National Park, interrelationships between *F. annosus* and *Scolytus ventralis* throughout the Sierra Nevada, rate of spread of dwarf mistletoe in true fir on the Stanislaus National Forest (where fishing is still excellent), effects of smoke on spore germination and infection, and effects of photochemical air pollution on the fungal floras of foliage and litter in the San Bernardino Mountains. New projects this year involve (1) uprooting incense cedars (*Libocedrus decurrans*) to correlate crown symptoms with degree of root decay by *F. annosus* in this hitherto little studied species and (2) trying to develop a technique for detecting infection without pulling out the roots.

Fields Cobb and his students continue investigations on the ecology of root diseases in the mixed conifer forests of California. As before, special emphasis has been on interrelationships between *Verticicladiella wagnerii* and bark beetles in the Sierra Nevada and *F. annosus* and air pollution in the San Bernardino Mountains. Studies on the effects of air pollution on damping off organisms were also continued. A cutting study was initiated in cooperation with the Michigan-California Lumber Company to determine the efficacy of limiting loss due to *V. wagnerii* and bark beetles in such a manner.

Colorado State University

1. The Biology and Epidemiology of *Thyronectria Austro-Americana* on *Gleditsia Triacanthos*. (G. Hudler and N. Oshima)
2. Movements of Wilt-inducing organisms through grafted roots. (N. Oshima and G. Hudler)

States

Montana - Dept. Natural Resources and Conservation, Division of Forestry

New Project. Insect and Disease Survey in Urban Areas of Montana.

Investigators. Steve Kohler, State Div. of Forestry, Montana
Oscar Dooling, U.S. Forest Service

TERMINATED PROJECTS

USDA Forest Service; PNW

- 73-A-5 Using the forest survey to obtain dwarfmistletoe impact data (Stewart).
- 66-D-7 Comparison of *P. Weirii* survival in soil of a pure conifer stand to that of a mixed alder-conifer stand (Nelson).
- 67-D-2 Selective culture of *P. weirii* (Nelson).
- 68-F-7 Properties of dwarfmistletoe-infected wood of ponderosa pine (Knutson).
- 71-F-2 Distinguishing living and dead endophytic tissues (Knutson).
- 71-F-3 Effects of light and temperature on development of dwarfmistletoe (Knutson).
- 73-G-4 Heartrots of upper-slope species in the Blue Mountains of Oregon and Washington (Aho).
- 73-G-8 Heartrots of white fir in the Rogue River National Forest (Aho.)

University of California; Berkeley

Doug Piirto, working with Wayne Wilcox at the Forest Products Laboratory in Richmond, is presently terminating studies on tree failure of giant sequoia.

Forest Pathologists at the University of California do not intend to become involved in Dutch elm disease work.

REPORT OF COMMITTEE ON FOREST DISEASE RECREATION HAZARDS

Peter Gaidula - Chairman

The Forest Disease Recreation Hazards Committee held a meeting on October 28, 1975, at 8:00 p.m. in Missoula, Montana.

Reports on several committee projects were given. The status of the outline for training field personnel in tree hazard recognition and evaluation was discussed by Mike Srago, who has been in charge of this project. A draft has been reviewed by committee members since the previous conference in February 1975. The committee hopes to have this project in final draft sometime this winter.

The status of a second project, the preparation of a selected literature list on forest disease recreation hazard problems, was discussed. Dave Graham, who was not present, has prepared an initial list which has already been reviewed by the committee members. The committee chairman is now combing through a lengthy list that Dr. Lee A. Paine of the Pacific Southwest Forest and Range Experiment Station has provided to the committee. The committee hopes to have this project in final form this winter.

The committee discussed the idea that a panel on forest disease recreation hazards be placed on next year's conference program. The group seemed to be against having a panel as such; however, they favored proposing to the interim program chairman the inclusion of several papers on this subject area. One specific suggestion made by Ken Russell was that a paper on new techniques in hazard detection be given by Alex Shigo, including, among other things, explanation of the use of the Shigometer. Russell also suggested that another possible subject by Shigo could cover CODIT, meaning the compartmentalization of decay in trees.

Several members gave brief reports about their projects. Mike Srago reported that he and Dick Parmeter are working on a preliminary guide--pictorial in nature--to aid in detection of Fomes annosus in incense cedar. This is a follow-up of some earlier work that he has been doing in Yosemite Valley. Dave Johnson is preparing a training program for field personnel to aid in detection and evaluation of tree hazards.

The chairman gave a brief report of Dr. Lee Paine's work. Dr. Paine now has enough data to allow expansion of his tables on damage potential, which are given in his publication, Accident Hazard - Evaluation and Control Decisions on Forested Recreation Sites. Dr. Paine's collection of tree failure data from urban areas is continuing. In addition, collection of data from forested sites is also continuing.

DWARF MISTLETOE COMMITTEE REPORT

HIGHLIGHTS OF 1975 DWARF MISTLETOE RESEARCH

Ed Wicker, Chairman

I. Taxonomy, Hosts, and Distribution

- a. The Douglas-fir dwarf mistletoe, Arceuthobium douglasii was discovered in Guadalupe Mountains National Park, Texas. This is the first collection of this Texas-size mistletoe in the State. (F. Hawksworth, USFS, RM Station, Fort Collins).
- b. Trips made to northern Mexico and to southern Mexico and Guatemala in 1975 have greatly expanded our knowledge of the dwarf mistletoes in those countries. Three new species were discovered and descriptions of them are now being prepared for publication. Two additional species were found in Mexico for the first time: A. divaricatum and A. guatemalense. Also the known host and geographic ranges were expanded for several taxa (F. Hawksworth, USFS, RM Station, Fort Collins, and D. Wiens, University of Utah).
- c. Studies are being conducted on the biology, taxonomy, hosts, ecology and distribution of the three Arceuthobium taxa that parasitize white pines (Pinus aristata and P. strobiformis) in the Southwest. We will attempt to classify the parasite on P. aristata which has been previously classed as A. cyanocarpum. Pinus strobiformis is parasitized by two species (A. blumeri and A. apachecum) but in different parts of the host's range. (R. L. Mathiasen, University of Arizona and F. Hawksworth, USFS, RM Station, Fort Collins).

II. Physiology and Anatomy

- a. The effect of water stress on water potentials of ponderosa pine and Arceuthobium vaginatum was determined under field conditions throughout the year. Water potentials were also recorded in a growth chamber. Results from both field and laboratory studies showed that a water potential gradient affording a net movement of water to the parasite usually steepened with stress. Toward the end of the drying cycle, the host showed tissue water potentials ranging from -20 to -25 bars while parasite potentials were usually less than -30 bars. Results of a similar study where lodgepole pine seedlings infected with A. americanum were subjected to substrate potentials of 0, -3, -6, -9, -12, and -15 bars, showed the same trend. At 0 bars, the water potential gradient between host and parasite was -3.5 bars while at a substrate potential of -15 bars, the gradient approached -6 bars. The pressure chamber provided reliable estimates of water potential. (J. T. Fisher and C. P. P. Reid, Colorado State University).

- b. Transpiration of lodgepole pine seedlings and dwarf mistletoe shoots (A. americanum) was determined in situ at substrate water potentials of 0, -3, -6, -9, -12, and -15 bars. Host branchlets and parasite shoots were enclosed in temperature controlled cuvettes through which a stream of air having a known absolute humidity flowed. A differential psychrometer was used to determine transpiration by sensing the absolute humidity of air before entering and after leaving the cuvettes. Water loss was monitored in the dark and for 8 hours following the initiation of the light period. Results showed that as host stomatal closure became noticeable, the parasite continued to transpire at a rate more than 3 to 4 times that of the host. Parasite transpiration in excess of that of the host possibly helps to maintain a water potential gradient between host and parasite that is favorable to the parasite. In addition, dwarf mistletoe shoots usually transpire more than host needles during the dark period. Dwarf mistletoe shoots bearing fruits transpire more than shoots without them. (J. T. Fisher and C. P. P. Reid, Colorado State University).
- c. The viscin coating of seeds from Arceuthobium tsugense was analyzed histochemically and enzymatically. The results indicated that the viscin is composed of two components. The first is a mucilaginous pectic compound which surrounds the entire seed and accounts for a number of observed phenomena such as stickiness, water holding capacity, and the ability to undergo repeated drying and rehydration. The second component is made up of a large number of cellulose strands which are attached to the endocarp and run throughout the pectic coating. Scanning electron micrographs show that they may be important in maintaining the integrity of the pectic coating. (P. Paquet, Portland State University).
- d. The nutritional physiology of dwarf-mistletoes is being studied. Techniques for culturing excised aerial shoots on nutrient agar, as well as grafting are being used to establish mature mistletoe plants onto sand cultured host trees. These techniques will hopefully enable me to rigorously define nutritional conditions and observe any limiting factors if present. These studies will be combined with field studies of soil mineral content to establish possible relationships. (P. Paquet, Portland State University).
- e. Studies have been started on the photosynthetic capacity of seeds of Arceuthobium spp. from the state of dispersal until the radicle contacts host phloem tissue. (S. Gustafson and R. Tocher, Portland State University).
- f. Work continues on content and the seasonal variations in the neutral lipids of Arceuthobium spp. Aerial shoots. (Hwa Chen and R. Tocher, Portland State University).

III. Life Cycle Studies

- a. Studies of bird dissemination of Arceuthobium vaginatum subsp. cryptopodum on Pinus ponderosa were continued in 1975, but results were not as encouraging as those of the previous year. This was partially due to seed dispersal occurring 3-4 weeks later than normal at the Manitou Experimental Forest in Colorado. A substantial but undetermined amount of seed discharge was aborted by freezing temperatures. Mountain chickadees and pygmy nuthatches are still suspect as the primary vectors. Thirty-two satellite infection centers have been located in ca. 150 h of healthy pine adjacent to A. vaginatum infection centers. Satellite centers range in size from one tree to 0.5 h and have been found up to 180 m from the nearest infection of comparable age. Color-banded birds are being used to determine habitat preference and territory establishment. (G. W. Hudler, Colorado State University).

IV. Host-Parasite Relations

- a. Analyses to mathematically quantify the rates of spread and intensification of Arceuthobium vaginatum in various kinds of ponderosa pine stands were begun. A combination of long-term Arizona, Colorado, and New Mexico permanent plots and temporary plots data will be used. We will attempt to define the effects of stand conditions (even-aged, 2-aged, vs. uneven-aged), stand density, etc. (G. Dixon and F. Hawksworth, USFS, RM Station, Fort Collins).
- b. Studies are continuing on population dynamics of dwarf mistletoes on true firs (Abies) in California. Data on infection, buildup, and spread of mistletoe resulting from inoculations made in 1957, 1960 and 1963-67 will be analyzed this winter. (R. F. Scharpf, USFS, PSW Station, Berkeley, and J. R. Parmeter, U.C. Berkeley)

V. Effects on Hosts

- a. A manuscript on yield simulation in mistletoe infested 2-aged and even-aged ponderosa pine stands is in press as an RM Station Paper. Studies are continuing toward development of yield simulation for irregular (uneven-aged) stands. (C. Myers, C. Edminster, and F. Hawksworth, USFS, RM Station, Fort Collins).
- b. Field data has been collected for incorporation into a simulated yield program to predict effect of dwarf mistletoe on ponderosa pine in the Pacific Northwest. Data will be fitted to the program being developed by DeMars and Barrett for healthy stands to produce tables similar to those developed by Meyers and Hawksworth in the Rocky Mountains. (D. DeMars and E. Nelson, USFS, PNW Station, Corvallis).

- c. We conducted an evaluation in several dwarf mistletoe infested lodgepole pine stands in the lodgepole pine/needlegrass basins on the Fremont National Forest to determine if dwarf mistletoe was responsible for the stands producing less than 20 cubic feet of fiber per acre per year. Growth basal area readings were taken of dominant trees in all seven dwarf mistletoe infection intensity classes. Dwarf mistletoe was not responsible for the low stand productivity. (J. Hadfield, USFS, R-6, S&PF, Portland).
- d. In 1970 three 100-tree plots were established in infected ponderosa pine stands which had been precommercially thinned in 1969 and 1970. The plots were remeasured in 1975. The data will be analyzed soon to determine the relationship between degree of infection at the time of release to subsequent tree growth. (J. Hadfield, USFS, R-6, S&PF, Portland).
- e. Data were taken for the 10-year record of spread and intensification of dwarf mistletoe in western larch. These plots are established in eastern Washington and western Montana and represent levels of mistletoe infections, spacing of host, and tree species mixture. Detriment to host is being assessed in terms of tree heights and diameters. (E. Wicker, N. Martin, J. Wood, USFS, INT Station, Moscow).
- f. Studies of impact of dwarf mistletoes on true firs are continuing. Permanent plots have been established and will be monitored periodically. Data on effect of dwarf mistletoe on height and radial growth of firs will be analyzed this winter. Additional studies are planned to determine mortality of firs with various rated levels of infection and at intervals following release logging. Insects, Annosus root rot, logging damage and other factors besides mistletoe will also be evaluated in relation to mortality. (R. F. Scharpf, and G. Ferrell, USFS, PSW Station, Berkeley; Neil MacGregor, R-5, S.F.)
- g. Studies on mortality of high value Jeffrey pines on recreational sites with various levels of dwarf mistletoe are continuing. Studies are too new to yield meaningful results, however, for a 2-year period mortality has been higher for Jeffrey pines on the Cleveland National Forest in Southern California than for Jeffrey pines located on the Lake Tahoe Management Unit in the Northern Sierra Nevada. (R. Scharpf, USFS, PSW Station, Berkeley, and Neil MacGregor, R-5, S.F.)

VI. Ecology

- a. In an attempt to determine the climatic factors governing the northern limits of Arceuthobium vaginatum in Colorado, recording stations have been established just within and outside the northern limits. Marked differences were found in seed germination within the mistletoe range (ca. 90%) vs seeds planted 3-4 miles away (ca. 10%), but we have not yet correlated this

with climatic factors. (F. Hawksworth, USFS, RM Station, Fort Collins).

- b. A literature review of the relationships between fires and dwarf mistletoes, including both mistletoe ecology and prescribed burning, was published in RM Station General Technical Report RM-14, 12 p., 1975. Also, a study was begun to compare the amount of fuels on the forest floor in lodgepole pine stands with and without dwarf mistletoe (M. E. Alexander, Colorado State Univ., and F. G. Hawksworth, USFS, RM Station, Fort Collins).
- c. Production of mature fruit has occurred for the following additional combinations of parasite and host resulting from inoculations described in the 1971-74 reports: (1) A. tsugense from shore pine on lodgepole pine in the Interior Western Hemlock Zone. (2) A. tsugense from western hemlock on western hemlock in the Interior and Coastal Western Hemlock Zones. (3) A. americanum from lodgepole pine on lodgepole pine in Interior and Coastal Western Hemlock Zones. So far nothing has adversely affected the development of A. tsugense in the Interior or of A. americanum on the Coast, even though these are quite unnatural geographic locations for the two species. All fruit-bearing infections have been cut off or bagged to prevent spread. The bags, made of a Dacron fine mesh netting, have proven effective for this purpose and for following seed dispersal and germination. (R. B. Smith, Pacific Forest Res. Centre, Victoria).
- d. The study of the effect of various levels of insolation on the production of seeds by A. douglasii, is continuing. Additionally, the study of A. campylopodum at the early stages of infection is continuing inasmuch as technical difficulties will allow. We have also begun to look at A. tsugense with respect to its response to insolation in open and closed stands. A number of parameters have been and will continue to be investigated. (R. Tinnin, Portland State University).
- e. Investigations into the ecology of Douglas-fir dwarf mistletoe (Arceuthobium douglasii) in Oregon are being initiated. Intrastand patterns and environmental factors controlling distribution will be examined. Review and comment on control procedures will also be included. (R. Hufstader, Portland State University).

VIII. Control - Biological

- a. A cooperative PL-480 project is underway with the Commonwealth Institute of Biological Control in Pakistan to determine the insects associated with dwarf mistletoes (Arceuthobium oxycedri and A. minutissimum). To date several insects have been found

which exert some degree of biological control. Feeding tests are underway to determine the specificity of the insects found on dwarf mistletoes. The project should identify potential candidate insects that might be tested later in North American introductions. (R. E. Stevens and F. G. Hawksworth, USFS, RM Station, Fort Collins).

- b. A series of 1,750 dwarf mistletoe infections of Arceuthobium americanum and A. vaginatum were sprayed with water-suspensions of Alternaria, Pullularia, and Epicoccum and a mixture of all three in an attempt to induce "resin disease" in 1973 and 1974. Tests were made in 4 areas in the Roosevelt National Forest and the Colorado State Forest. Reisolations of the fungi from sprayed infections, natural resin disease cankers, and apparently non-resin-diseased infections and analyses of the results of the results of the inoculations are being made. Examinations of a long-term resin disease observation plot indicate that natural infection was very high in 1975. (J. G. Laut, Colorado State Forest Service, and F. G. Hawksworth, USFS, RM Station, Fort Collins).
- c. Efforts are underway to identify a Geometrid found this summer which appears to eat only aerial shoots of Arceuthobium douglassii. This looper was observed only on the Malheur National Forest, Oregon. (R. Tinnin, Portland State Univ., and D. M. Knutson, PNW Station, Corvallis).
- d. First level studies on the basic biology of Wallrothiella on A. douglasii were completed. A paper is in press describing its behavior and our methods for culturing on artificial media and for field inoculations. Cultures have been sent to the American Type Culture Collection. (D. Knutson and A. Hutchins, PNW Station, Corvallis).
- e. Comparative studies of Septogloeum on Arceuthobium tsugense, A. abietinum, and A. campylopodum are continuing. (A. Hutchins and D. Knutson, PNW Station, Corvallis).
- f. A single larva, tentatively indentified as the thicket hair-streak butterfly, Mitoura spinetorum Hewitson, was found feeding on Arceuthobium americanum on the Lolo National Forest. Adult moths have been collected from the area before, but this is the first known larval collection. The larva has pupated and will be held for adult emergence and positive identification.

IX. Control - Silvicultural

- a. A 10-year examination was made of plots established in 1965 to determine the practicability of sanitation of young (20-40 years old) lodgepole pine stands with various intensities of mistletoe. The results of the examination will be analyzed this winter. (F. Hawksworth and T. Hinds, USFS, RM Station, Fort Collins, and D. Johnson and T. Landis, USFS, R-2, Denver).

- b. Pruning-from-the-top is successful in sanitizing pole-size ponderosa pine of dwarf mistletoe. A description of our methods and results of applications to 30 trees is in press for Journal of Forestry. (D. Knutson, PNW Station, Corvallis).
- c. Mistletoe intensification plots in Douglas-fir thinnings (18x18) on the Malheur National Forest, Oregon, were reread this summer. Data have not been analyzed, but our impressions are that some trees showed a severe decline in the 2 years since plot establishment. (D. M. Knutson, PNW Station, Corvallis).
- d. Dwarf mistletoe can seriously reduce tree growth. The percentage of infected hemlock within 30 ft of infected residual overstory trees near the Oregon coast increased rapidly with stand age, especially after 10 years of age. Infected unmerchantable trees should therefore be destroyed during or as soon after harvest as possible. (G. Stewart, PNW Station, Corvallis).
- e. A post-control evaluation of dwarf mistletoe suppression in several campgrounds was made within the past year. In total, 271 dwarf mistletoe-infected trees (classes 1, 2, and 3; 6-class system) located in three campgrounds were pruned in 1971. The 1975 examination revealed several factors that will assist pathologists in planning future mistletoe control projects in recreation areas. Pruning mistletoe-infected trees was successful, in that the percentage of trees examined which had either no infections or a mistletoe rating of 2 or less was 92, 91, and 82 percent, respectively, for the three campgrounds. The reduction in pruning success in the third campground (82%) was caused by locating pruned trees near infected overstory trees. Pruning appeared to reduce mistletoe infections most successfully on class 1 and 2 trees, with reduced effectiveness on class 3 trees. (J. Walters, USFS, Albuquerque).

X. Surveys

- a. Revision of the simulated yield program (SWYLD), which provides yield tables for even-aged and two-storied stands of ponderosa pine in the Southwest, is in the final stages. Stands in four National Forests were selected for use in implementing the SWYLD2 program. The third nearest neighbor sampling system was used to gather input data for the program in areas to be precommercially thinned. A total of 1,317 plots, taken in seven different locations, will provide basic input data for the 2,108 acres of mistletoe-infected, even-aged ponderosa pines surveyed this year. Management decisions will be obtained from Ranger Districts involved, and yield tables will be provided to the land manager. A follow-up survey to determine the effectiveness of yield tables is planned for surveyed areas after they are thinned. Future plans include designing and testing survey procedures to be used for data collection

in two-storied stands. Implementation of the simulated yield program in mistletoe-infected, two-storied stands also is forthcoming. (J. Walters and E. Sharon, USFS, Albuquerque).

- b. Managers on National Forests in eastern Oregon and eastern Washington have a dwarfmistletoe problem of unknown magnitude. While growth reduction caused by dwarf mistletoe cannot yet be estimated, estimates were made of trees infected and land area with infected trees, using existing 10-point plot survey data for the Deschutes National Forest. The proportion of commercial forest land area with infected trees is estimated to be .476 and the proportion of trees infected on this infested area is estimated to be .308. Type mapping the forest and making similar estimates for the four resulting strata indicated that the lodgepole pine stratum should be considered first for dwarf mistletoe treatment (other things being equal). (D. DeMars, PNW Station, Corvallis).
- c. A disease survey conducted in 29 lodgepole pine stands in Oregon and Washington revealed that 31.4 percent of all the trees 1.0 inches d.b.h. and larger were infected by dwarf mistletoe, 20 of the 29 stands were infected. (J. Hadfield, USFS, R-6, S&PF, Portland).

XI. Miscellaneous

- a. The FAMULUS information retrieval system of the world mistletoe literature is now operational in both Berkeley and Fort Collins. The system presently contains over 6,600 references, including about 2,000 on Arceuthobium. About 300 new citations are added annually. The long-promised "users-guide" for the system is still not available but we welcome requests for runs, which can be made in either Berkeley or Fort Collins. (R. F. Scharpf, USFS, PSW Station, Berkeley, and F. Hawksworth, USFS, RM Station, Fort Collins).

DISEASE CONTROL COMMITTEE
HIGHLIGHTS OF 1975 CONTROL INVESTIGATION

I. SEEDLING DISEASES

A. Damping off of nursery and container seedlings.

Hosts: Douglas-fir, Sitka spruce, white spruce, western hemlock and lodgepole pine.

Causal Organisms: *Pythiums*, *Fusariums* and others

Control: Chemical

Development Stage: Field trials

Tested whether chemical seed treatments are related to seed quality, e.g., poor quality seeds which germinate slowly "need" fungicides more than high quality seed (fast germinator seeds). Field trials failed to detect significant interaction between seed treatment and seed quality. (Sutherland, J., Pacific Forest Research Centre, Victoria)

B. Seedling root rots.

Hosts: Common PNW nursery species

Causal Organisms: *Pythiums* and *Fusariums*

Control: Chemical

Development Stage: Operational

Reporting excellent results on routine soil fumigation of the Bend nursery. This nursery had severe disease problems until fumigation began. Trial fumigation also being done at Wind River Nursery. (Hadfield, J., USFS, R-6 Portland)

C. Seed and seedling diseases in container trees.

Hosts: Douglas-fir, western hemlock and Sitka spruce

Causal Organisms: *Pythiums*, *Fusariums*, *Rhizoctonia*

Control: Chemical

Development Stage: Semi-operational, pot trials, greenhouse

Our approach has been to change from seed treatment to treatment of the small area surrounding the seed. Captan-benlate mixes are quite good when applied to the top centimeter of the container about 3 weeks following germination. We use no chemical until then. Recommend use of airless paint sprayer for precise disease control in the greenhouse. (Russell, K., DNR Olympia)

D. Mycorrhizal inoculation of seedlings.

Host: Douglas-fir

Causal Organism: *Lycoperdon*, sp. (puffballs)

Control: Biological

Development Stage: Greenhouse flat trial

Direct application of fresh sporocarps of *Lycoperdon* puffballs to standard peat-vermiculite mix (2% by weight) gave excellent growth response and possible disease resistance. Seedlings

appeared mycorrhizal. Ht. growth increased 2.5 times, root wt. doubled, stem caliper increased by more than half. Nearly plantable container seedlings were grown in 135 days. Spore applications of *Pisolithus tinctorius*, cut Douglas-fir roots and control treatments did not show similar growth response.

II. FOLIAGE DISEASES

A. Lophodermium needle-casts of scotch pine.

Host: *Pinus sylvestris*

Causal Organism: *Lophodermium* sp. (including *L. pinastri*)

Control: Chemical

Development Stage: Operational field trial

We showed this season that sprays of maneb during the rainy season were effective in providing disease control in addition to that obtained with the summer spray schedule only. Since the ca. monthly schedule costs only 2.5¢ per tree per year (total cost of machine, chemical, & labor!!), a reduction in spray frequency is not so much economically desirable as it is desirable from convenience to the grower. So far no partial spray schedule has been as economically attractive as the continuous schedule. Control in the nursery has been excellent, but not perfect. (Staley, J., Rocky Mtn. Sta., Ft. Collins)

B. Diplodia tip blight of pines.

Host: Pines (Austrian, ponderosa, Scots, & others)

Causal Organism: *Diplodia pinea* (Kickx)

Control: Chemical

Development Stage: Operational

Infection was evaluated during three growing seasons in which Bordeaux mixture was applied to Austrian pines different numbers of times and on different dates. Most of the infection of new shoots occurred from the time buds opened to just before needles broke through needle sheaths (ca. 24 April through 8 May in eastern Nebraska). One fungicide application during this period reduced infection 51%; two applications reduced infection 87%. Applications made 15 May and later were ineffective. (Peterson, G.W., Forestry Sciences Lab., Lincoln, Nebraska)

III. STEM DISEASES

A. White pine blister rust.

Host: *Pinus monticola*

Causal Organism: *Cronartium ribicola*

Control: Silvicultural

Development Stage: Field trips

Five year data has been collected from all plots. Data being prepared for preliminary analysis (Wicker, E., R. Williams and R. Hungerford, INT Sta., Moscow)

B. White pine blister rust.

Hosts: *Pinus monticola*, *Pinus lambertia*

Control: Genetic

Development Stage: Operational

Western white pine and sugar pine are operationally evaluated for resistance to infection by *C. ribicola*. Resistant individuals are used to provide seed for reforestation. (Hadfield, J., USFS, R-6 Portland)

IV. ROOT ROTS

A. Laminated root rot of Douglas-fir.

Host: Douglas-fir

Causal Organism: *Phellinus (Poria) weirii*

Control: Biological

Development Stage: In vitro

Tests are being conducted of red alder extracts against this pathogen. The substance, isolated and identified by Dr. J. Karchesy of OSU, is to be a polymer of epicatechin linked C-C 4, 6-(4,8-) and a diarylhepianoid xyloside given the name of oregonin. Oregonin, 1,7-bis (3, 4-dihydroxyphenyl) heptane-3-one-xylopyranoside, represents a new type of glycoside compound. No results yet. (Lu, K.C., Forestry Sciences Lab., Corvallis)

B. Laminated root rot.

Host: Western conifers

Causal Organism: *Phellinus weirii*

Control: Biological

Development Stage: Field trial

No results yet. (Li, C.Y., Forestry Sciences Lab., Corvallis)

C. Laminated root rot.

Host: Douglas-fir

Causal Organism: *Phellinus weirii*

Control: Silvicultural

Development Stage: Field trial

Established a stump removal study to reduce incidence of *P. weirii* in the succeeding stand. The area involved is about three acres of 40 year old Douglas-fir. Cooperator is Starker Forests. (Thies, W., PNW Sta., Corvallis)

D. Phytophthora root rot.

Host: Port Orford cedar

Causal Organism: *Phytophthora lateralis*

Control: Chemical

Development Stage: Greenhouse pot trials

Attempts being made to determine whether *P. lateralis* can be controlled in cedar seedlings by a systemic fungicide. No results yet. (Pratt, R., Dept. of Botany, OSU, Corvallis)

- E. Annosus root rot.
 Host: Ponderosa pine
 Causal Organism: *Fomes annosus*
 Control: Chemical
 Development Stage: Operational
- Powdered borax was applied to fresh stumps in an area where annosus root rot is killing trees. No testing planned.
 (Hadfield, J., USFS, R-6 Portland)
- F. Annosus root rot.
 Hosts: Western Hemlock, Douglas-fir
 Causal Organism: *Fomes annosus*
 Control: Chemical, biological
 Development Stage: Field trial
- Chemical testing has been completed. Results are being analyzed for degree of protection of stumps. Biological protection involves selection of candidate fungi and experimentation of conditions required for successful stump infection. (Morrison, D., Pacific Forest Research Centre, Victoria)
- G. Black stain root disease.
 Host: *Pinus edulis*
 Causal Organism: *Verticicladiella wagnerii*
 Control: Silvicultural
 Development Stage: Field trial
- No results yet. Trial plot established 1974.
 (Helburg, L., Colorado State Forest Service, Ft. Collins)
- H. Armillaria root rot.
 Host: Ponderosa pine
 Causal Organism: *Armillaria mellea*
 Control: Chemical, Silvicultural
 Development Stage: Operational, Field trial
- Guidelines for marking young-growth ponderosa pine for *Armillaria* control during commercial thinning are now being applied by St. Regis at Glenwood, WA on an operational basis. These are based on root excavations by Terry Shaw and on a pilot control study by Lew Roth & Len Rolph.
- Injections of old *Armillaria* infected stumps (young-growth) with soil fumigants is proving effective in killing the fungus in such stumps. (Filip, G., Shaw, T., and Roth, L., OSU)
- V. RECREATION SITE HAZARD TREES
- A. Hazard trees in recreation sites.
 Hosts: All tree species
 Causal Organisms: All
 Control: Mostly silvicultural and direct, such as pruning, etc.
 Development Stage: Data collection, ongoing

Working on collection and analysis of data and factors involved in tree failures and accidents in recreation sites nationwide. Some agencies have adopted our methodology as a management tool. (Paine, L., PSW Sta., Berkely, CA)

TWENTY-THIRD ANNUAL WIFDWC MEETING - FIELD TRIP

October 30, 1975

AM - Tour of Hoerner-Waldorf Pulp and Paper Mill, Missoula, Montana.

- Tour of Northern Forest Fire Lab, Missoula, Montana

PM - Tour of Aerial Fire Depot and Smoke juniper Center, Missoula, Montana.

- Tour of U.S. Plywood Mill, Bonner, Montana

- Tour of U.S. Plywood Containerized Greenhouse, Bonna, Montana.

INTERIM PROGRAM SUGGESTIONS

1. Ed Wicker suggests a panel ca 4 hours on "Where we are, What we've achieved, and Where we're going," in terms of dwarf mistletoe control in the West.
2. Ken Russell, Roger Hungerford, John Laut, Oscar Dooling suggest panel on "Habitat types" or other quantitative and/or qualitative site factors in relationship to specific management alternatives or disease problems.
3. Jim Byler suggests a panel on disease-related genetics programs including whitepine blister rust and needle diseases (Gerald McDonald would be good).
4. Dan Miller suggests having a panel of "on-the-ground foresters" to discuss needs of the land manager in terms of disease problems. (I can visualize a discussion encompassing everything from disease or problem recognition to actual disease control.)

Along these same lines, Jim Byler suggests a discussion or presentation of "What are the major disease problems in the various Western Regions?" Perhaps a regional representative could prepare and present such information for each Region, province, or country.

5. Pete Gaidula suggests a panel concerning high hazard trees in recreation areas. This could include: (a) Techniques for problem recognition (including a demonstration by Al Shigo of the Shigometer), (b) Methods for prevention or removal of hazard trees, etc.
6. I would suggest a panel on actual and/or potential disease problems in natural or artificial reforestation, and possible control alternatives. (This may partially tie in with the genetics panel.) Suggest Charles Driver as moderator.
7. Clint Carlson suggests panel on political and biological implications of energy development in the Pacific Northwest.

After talking with a number of individuals, it seems that the consensus is to have panels where everyone can attend and participate (no workshops). Also, panels should be allowed 3 to 4 hours so that there is no shortage of time for discussion.

NEW PUBLICATIONS

- AHO, PAUL E. 1974. Defect estimation for grand fir in the Blue Mountains of Oregon and Washington. USDA For. Serv. Res. Pap. PNW-175, 12 p., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.
- AHO, PAUL E., R. J. SEIDLER, H. J. EVANS & A. D. NELSON. 1974. Association of Nitrogen-fixing bacteria with decay in white fir. In Proceedings of International Symposium on N₂-Fixation, Published by Washington State University.
- AHO, PAUL E. & ANITA HUTCHINS. 1975. Microorganisms from the pith region of suppressed grand fir understory. (Abstract). In Proceedings of the American Phytopathological Soc., Volume 1, 1974; Pub. by the Amer. Phytopathological Soc., 3340 Pilot Knob Road, St. Paul, Minnesota. 55121.
- AHO, PAUL E., RAMON J. SEIDLER, HAROLD J. EVANS, & P. N. RAJU. 1974. Distribution, Enumeration, and Identification of Nitrogen-Fixing Bacteria Associated with Decay in Living White Fir Trees. *Phytopath.* 64(11):1413-1419.
- AHO, PAUL E. 1974. Decay. In Environmental Effects of Forest Residues Management in the Pacific Northwest, a State of Knowledge Compendium. USDA For. & Range Exp. Sta., Portland, Oregon.
- AHO, PAUL E. & PHILLIP SIMONSKI. 1975. Defect estimation for white fir in the Fremont National Forest. USDA For. Serv. Res. Pap. PNW-196, 12 p., illus. Pacific Northwest Forest & Range Exp. Station, Portland, Oregon.
- AHO, PAUL E. & JAMES HADFIELD. 1975. How to estimate defect in white fir in southwestern Oregon. USDA, For. Serv., PNW Station Informational Brochure, 16 p., illus. Pacific Northwest Forest & Range Experiment Station, Portland, Oregon.
- AHO, PAUL E. & JAMES HADFIELD. 1975. How to estimate defect in grand fir in the Blue Mountains of Oregon and Washington. USDA, Forest Serv., PNW Station Informational Brochure, 16 p., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.
- ALEXANDER, MARTIN E., & FRANK G. HAWKSWORTH. 1975. Wildland fires and dwarf mistletoes: A literature review of ecology and prescribed burning. USDA For. Serv. Gen. Techn. Rep. RM-14, 12 p.
- CURTIS, D. J. & D. W. JOHNSON. 1975. Forest Pest Conditions in the Pacific Northwest, 1974. Insect and Disease Control, State and Private Forestry, Pacific Northwest Region, Forest Service. 29 p.

- FUNK, A. 1975. Stem cankers of young Douglas firs associated with larval feeding galleries of Laspeyresia pseudotsugae (Lepidoptera: Olethreutidae). European J. of Forest Path. 5: 143-146.
- HARVEY, GEORGE M. 1974. Epidemiology of Lophodermella morbida in plantations of ponderosa pine in western Oregon. Ph.D. dissertation submitted to Oregon State University.
- HARVEY, GEORGE M. 1974. Epidemiology of Lophodermella morbida in plantations of ponderosa pine in western Oregon. (Abstract). Dissertation Abstracts International 35(3):1144-B.
- HARVEY, GEORGE M. 1975. Sugar pine seedlings not protected from blister rust by chemotherapeutants. U.S. Forest Service Research Note PNW-249, 4 pp.
- HAWKSWORTH, FRANK G. 1975. Tree diseases. p. 406-407, In Yearbook of Science and Technology, 1974. 460 p. McGraw-Hill, N.Y.
- HAWKSWORTH, FRANK G., JAMES T. FISHER, & ROBERT L. MATHIASSEN. 1975. An unusual occurrence of Arceuthobium cyanocarpum on ponderosa pine near Boulder, Colorado. Plant Dis. Rep. 59(9):758-759.
- HINDS, T. E., & R. W. DAVIDONS. 1975. Two new species of Ceratocystis. Mycologia 67(4):715-721.
- HINDS, T. E., & R. G. KREBILL. 1975. Wounds and canker diseases on western aspen. U.S. Dep. Agric., For. Pest Leafl. 152, 9 pp.
- JOHNSON, D. W. 1975. The Major Causes of Loss of Seeds Sown in 1972 at the Wind River Nursery, Carson, Washington. Tree Planters' Notes 26(3):14-15, 28.
- JOHNSON, D. W. & C. A. BIGELOW. 1975. Effects of Soil Treatments on Fungal Populations and Ponderosa Pine Seedling Survival at the Bend Nursery. U.S. Forest Service, State and Private Forestry, R-6. Office Rept. 11 pp.
- JOHNSON, D. W. & R. D. HARVEY, JR. 1975. Seed Protectant Fungicides for Control of Douglas-Fir and Ponderosa Pine Seedling Root Rots. Tree Planters' Notes 26(2):3-6.
- NELSON, EARL E. 1975. Survival of Poria weirii on paired plots in alder and conifer stands. Microbios 12:155-158.
- NELSON, E., & H. FAY. Effect of temperatures on growth and survival of high and low elevation isolates of Phellinus (Poria) weirii. Northwest Sci. 49:119-121.

- PETERSON, GLENN W., & C. S. HODGES, JR. 1975. Dothistroma needle blight: A problem in production of landscape pines. Am. Nurseryman 141(12):11, 94-96.
- PETERSON, GLENN W., & C. S. HODGES, JR. 1975. Phomopsis blight of junipers. U.S. Dep. Agric., For. Pest Leaflet 154, 6 pp.
- PETERSON, GLENN W., & RICHARD S. SMITH, JR. 1975. Forest nursery diseases in the United States. U.S. Dep. Agric., Agric. Handb. 470, 125 pp.
- SAFRANYIK, L., D. M. SHRIMPTON, & H. S. WHITNEY. 1974. Management of Lodgepole Pine to reduce losses from the mountain pine beetle. Can. For. Service. For. Tech. Rept. 1: 26 pp.
-
- _____. 1975. An interpretation of the interaction between lodgepole pine, the mountain pine beetle and its associated blue stain fungi in western Canada. In "Management of Lodgepole Pine ecosystems: ed. O. Baumgartner. Wash. State Univ. Co-op. Ext. Serv. (1):406-428.
- SAFRANYIK, L., D. M. SHRIMPTON, & H. S. WHITNEY. 1975. Mountain Pine Beetle Bibliography. Pac. For. Res. Centre, Victoria. Rpt BC-X-126: 69 pp.
- SRAGO, M. & ROBERT F. SCHARPF. 1974. Know your forest disease--Salt damage to roadside conifers In Forest pest conditions in California. - 1974. A publication of the California Forest Pest Control Action Council.
- SCHARPF, ROBERT F. & WILLIAM MCCARTNEY. 1975. Viscum album in California--Its Introduction, Establishment, and Spread. Plant Dis. Rep. 59(3): 257-262, illus.
- 7 SCHARPF, ROBERT F. & H. H. BYNUM. 1975. Cytospora canker of true
1 firs. USDA Forest Service Forest Pest Leaflet No. 146. June 1975.
- SCHEFFER, T. C., A. F. VERRALL, & G. M. HARVEY. 1971. Fifteen-year appraisal of dip treating for protecting exterior woodwork: effectiveness on different wood species and in various climates. Material und Organismen 6 Bd., 1971 Heft 1 Verlag: Duncker und Humblot, Berlin 41.
- WHEELER, MARGARET M., DESMOND M. S. WHEELER, & GLENN W. PETERSON. 1975. Anthraquinone pigments from the phytopathogen Phomopsis juniperovora Han. Phytochemistry 14:288-289.

MINUTES OF THE BUSINESS MEETING
October 29, 1975

The meeting was called to order by Chairman Stu Whitney. He reviewed the status of the Minutes and Treasurer's Report from the Monterey Meeting. They were not available at the meeting, but had been reviewed by phone with Gene Amman in Ogden. They are part of the proceedings that were at the printers. There was no important unfinished business except the question of selection of the meeting location for 1976.

The financial situation is unclear but in the black. There was a carryover of about \$85.00 going into the Monterey meeting, and we were assured of a surplus at that meeting. The amount is unknown since the cost of printing the proceedings is unknown.

Whitney called for 3 motions:

1. To defer approval of the minutes of the 22nd WIFDWC until the 24th meeting.
2. To approve reimbursement of approximately \$15.00 to Whitney and Byler for the long distance phone charges to find out what was in last years minutes.
3. To recommend that future secretaries file a copy of the minutes of the business meeting with the incumbent secretary to insure continuity in the event that the proceedings do not appear before the next meeting.

Bob Bega so moved. Larry Weir seconded. The motion carried.

The status of the committee reports was reviewed. All are either available now or will be available shortly for inclusion in the proceedings.

The Secretary-Treasurer reviewed the decision made in Monterey to select the meeting location two years in advance. Oregon was selected as the site for the 1976 meeting at Monterey.

Bart Van der Kamp read an invitation on the part of the members in Victoria to come to British Columbia for the 1977 meeting. Tom Laurent moved, Walt Thiese seconded a motion that the invitation to BC in 1977 be accepted. The motion passed.

Ed Wicker was appointed by the Chairman to replace Don Leaphart as "keeper" of the list of current research and action projects.

A list was made of members who retired since the previous meeting. They are: Don Leaphart; Ray Foster; Jack Roff; Dave Etheride; Dick Bingham.

The guidelines state that if such persons are no longer practicing forestry that they be made honorary members of WIFDWC. Since there were no objections the Chairman so appointed these persons.

Tom Laurent read a statement ^{1/} from the historian, Gordon Wallis. The statement contained a motion that the historian solicit pictures from past WIFDWC gatherings. The motion Wallis made was seconded by Larry Weir and it carried by a voice vote.

The Chairman asked for nominations for WIFDWC officers for the coming year. Frank Hawksworth nominated Lewis Roth for Chairman. Ed Wicker moved the nominations be closed and Bob Bega seconded. The motion carried and Lewis was selected.

John Laut nominated Ken Russell for Secretary-Treasurer. Ed Wicker moved nominations cease. Bob Bega seconded. His election was declared.

Ken Russell suggested that consideration be given to compiling information on new techniques into a "WIFDWC Cookbook." It was suggested that such an action be considered by those who develop next years program.

Hawksworth mentioned Buchanan's manuscript on history of forest pathology in Western U.S. and British Columbia. The meeting passed a motion endorsing this work and expressed the desire to see it brought to publication. The chairman of WIFDWC will send a letter to the Chief of the Forest Service endorsing publication.

1/ The statement is attached to the minutes

FROM YOUR HISTORIAN

A reminder

Records the secretary feels may have some value in the future operation of WIFDWC or of historical significance should be submitted to the historian.

Spare copies of the Proceedings (not more than 20) should be submitted to the historian.

A suggestion

Some years back, your historian solicited contributions, in the form of anecdotes, correspondence, pictures, etc., which would be of value in compiling a history of forest pathology in the West. Unfortunately, the submissions were so few as to make the task meaningless. However, I still would be happy to receive any material people feel would be pertinent.

What would be the groups feeling toward attempting to draw together a group of pictures on past WIFDWC gatherings? Some members have already sent me some slides and pictures, for which I wish to express my thanks. However, I am sure many other members have pictures which would be of interest to the group and of considerable historical value in the future. If a motion is in order, I would move that the historian send out a notice soliciting pictures from past WIFDWC gatherings which members feel would be worth keeping in a central file. Where it is necessary to duplicate the pictures, the cost will be borne by WIFDWC.

Gordon Wallis

WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

Treasurer's Report

Balance on hand following twenty-first WIFDWC meeting (1973).....\$ 87.63
Balance from Joint WIFDWC/WFIWC meeting (Spring 1975)....\$1,209.25
WIFDWC Share (based on attendance at Joint Meeting).....\$ 423.24
Cost of WIFDWC of printing proceedings\$ 345.95
Balance on hand from Joint Meeting\$ 77.29

Twenty-third Annual WIFDWC Meeting Receipts:

Registration (56).....\$308.00
Banquet Tickets (61).....\$457.50
Field Trip Lunches (43).....\$ 67.85
Total...\$833.35

Twenty-third Annual WIFDWC Meeting Expenses:

Village Motor Inn.....\$527.55
Bus Rental.....\$ 93.50
Field Trip Lunches.....\$ 80.00
Telephone Call.....\$ 15.03
Entertainment.....\$ 37.50
Miscellaneous.....\$ 3.56
Total....\$757.14

Balance from Twenty-third meeting....(833.35 - 757.14).....\$ 76.21
Balance on hand following Twenty-third Meeting.....\$241.13
Interest paid to March 31, 1976.....\$ 4.35
Total.....\$245.48

Deposits held:

Washington State Employees Credit Union
P.O. Box 1324
Olympia, WA 98507

Report from

Western International Forest Disease Work Conference Ad Hoc Committee
on the joint meeting between the WIFDWC and the WIFIWC.

The concensus from both entomologist and pathologists attending this conference was that many programs overlapped in time sequence so that it was impossible to attend many interesting conferences. A suggestion has been made to limit the scope of presentations and the general subject areas covered more severely than was done at this conference. Also, the attendees felt that some of the papers were not properly prepared for public presentation prior to the conference and that outlines should be provided so that the participants have an ideas of what will be covered by each panel or paper. The most frequent complaint was that many papers were excessively long for the subject matter which they contained and in some cases illustrations were poor and presentations mediocre. The overall feeling is that this sort of conference in joint session is extremely valuable but that it would become tedious if repeated frequently. Most people felt that 3-year intervals would be about right for this sort of joint conference.