PROCEEDINGS OF THE 20th ANNUAL WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

Victoria, British Columbia
September 1972

Proceedings of the 20th Annual Western International Forest Disease Work Conference

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FOREWORD

The twentieth annual Western International Forest Disease Work Conference was held September 25-29, 1972, in Victoria, British Columbia, at the Wilson Inn. Eighty-two members and guests registered and 122 members and guests attended the banquet.

The conference was called to order on Tuesday, September 26, by the Chairman, Paul Lightle. Ross MacDonald, Program Manager, Forest Protection, Pacific Forest Research Centre, Victoria, presented the welcoming address.

Excellent local arrangements were made by Duncan Morrison, ably assisted by other researchers at the Pacific Forest Research Centre. Thursday was devoted to field trips organized by Gordon Wallis, R. B. Smith, and others.

The officers for the twentieth Western International Forest Disease Work Conference were:

Chairman - Paul C. Lightle

Secretary-Treasurer - Arthur H. McCain

Program Chairman - Laurence C. Weir

Local Arrangements - Duncan Morrison

PAST MEETING LOCATIONS AND EXECUTIVE COMMITTEES

Meeting		Executive Committee		
Date	Place	Chairman	Secretary-Treasurer	Program Chairman
1953	Victoria, B.C.	R. E. Foster	—	—
1954	Berkeley, California	W. W. Wagener	P. C. Lightle	—
1955	Spokane, Washington	V. J. Nordin	C. D. Leaphart	G. P. Thomas
1956	El Paso, Texas	L. S. Gill	R. W. Davidson	V. J. Nordin
1957	Salem, Oregon	G. P. Thomas	T. W. Childs	R. L. Gilbertson
1958	Vancouver, B.C.	J. W. Kimmey	H. R. Offord	A. K. Parker
1959	Pullman, Washington	H. R. Offord	R. E. Foster	C. G. Shaw
1960	Centralia, Washington	A. K. Parker	F. G. Hawksworth	J. R. Parmeter
1961	Banff, Alberta	F. G. Hawksworth	J. R. Parmeter	A. C. Molnar
1962	Victoria, B.C.	J. R. Parmeter	C. G. Shaw	K. R. Shea
1963	Jackson, Wyoming	C. G. Shaw	J. E. Bier	R. F. Scharpf
1964	Berkeley, California	K. R. Shea	R. F. Scharpf	C. D. Leaphart
1965	Kelowna, B.C.	J. E. Bier	H. S. Whitney	R. V. Bega
1966	Bend, Oregon	C. D. Leaphart	D. P. Graham	G. C. Pentland
1967	Santa Fe, New Mexico	A. C. Molnar	E. F. Wicker	L. C. Weir
1968	Coeur d'Alene, Idaho	S. R. Andrews	R. G. McMinn	J. L. Stewart
1969	Olympia, Washington	G. W. Wallis	R. L. Gilbertson	F. G. Hawksworth
1970	Harrison Hot Springs, B.C.	R. F. Scharpf	H. V. Toko	A. E. Harvey
1971	Medford, Oregon	J. A. Baranyay	D. A. Graham	R. B. Smith
1972	Victoria, B.C.	P. C. Lightle	A. H. McCain	L. C. Weir

IN MEMORIAM

HUBERT HARTFORD BYNUM, JR. 1925-1972

Hubert H. Bynum, Jr. (known to his many friends as Hart) was born October 1, 1925, in Centralia, Illinois, the son of Hubert H. and Mary Abels Bynum. He died February 6, 1972, at his home in Medford, Oregon. Hart married Velma Keeney July 15, 1948, at Crown Point, Indiana. Velma and their two daughters, Susan Holly and Jennifer Lou, survive him.

Hart graduated from Lew Wallace High School, Gary, Indiana, in June, 1943, and enlisted in the United States Marine Corps on July 6, 1943, where he soon completed radio school. He served in the South Pacific Theatre as a Field Radio Operator in amphibian tanks and saw action on Saipan, Tinian, Maui, and Iwo Jima. He was discharged December 5, 1945, with the rank of Private First Class. He enlisted as a Marine Reserve October 4, 1947, and was discharged August 29, 1952, with the rank of Corporal. During this period he was called to active duty September 13, 1950, to September, 1951, and sent to the Mediterranean Theatre. This assignment took him to Gibralter, Malta, France, Italy, Sicily, and Greece.

Hart started his higher education at Valparaiso University, Valparaiso, Indiana, where he spent the school year of 1949-50. After being released from the Marine Corps a second time, Hart went to Washington State University, Pullman, from 1951 to 1954 at which time he received a Bachelor of Science degree in Forestry and graduated *cum laude*. He was honored by membership in Phi Kappa Phi.

Hart continued his education at the University of Idaho, Moscow, from 1954 to 1956 where he had a Research Fellowship in Forest Pathology. He received a Master of Forestry degree in Plant Pathology.

After receiving his Master's degree, he accepted a job with the California Forest and Range Experiment Station at Berkeley on June 18, 1956, as a Forestry Aid. This launched his career as a forest pathologist. Hart worked for several years helping to formulate and initiate a new type of forest disease survey using randomly selected temporary plots in California. He was co-author of a Manual of Instructions for this survey and helped supervise its operation for several years. In addition, he did some work with heart rots, with the grafting of both white pine blister rust and dwarf mistletoe infection and was an excellent photographer of disease subjects, particularly the needle casts.

With his experience, knowledge, energy, and enthusiasm, he rose rapidly in the Station. On May 8, 1966, he was transferred

to Region 6 and stationed in Medford, Oregon (with another grade promotion) with specific responsibility for secondary screening projects on chemical control of white pine blister rust infections on 5-needled pines. In addition, Hart was to make biological evaluations of screening projects, train and give professional pathological advice to forest landowners and administrators in southwest and south central Oregon. He was also to visually inspect timber stands for diseases, and if any were found, to determine type of disorder, the limits and intensity of infection, and then recommend follow-up action.

Hart, with his background in disease survey, was a keen observer and reported several forest diseases on new hosts or in new areas. In February of 1967 he discovered an undescribed needle cast in a plantation in the Umpqua National Forest and later found it in several other plantations. Since the disease was causing severe defoliation and some mortality of ponderosa pine, Hart was responsible for initiating a joint study between Region 6, Pacific Northwest and Rocky Mountain Forest and Range Experiment Stations, to study the disease. This causal fungus has been described and named *Lophodermella morbida*.

Later, Hart received a commendation and a quality increase for his efforts in directing the study. Excerpts from the letter by his superior show how Hart always attacked a new job or problem — "pleased to approve a Quality increase for you, ... in recognition of your superior performance of duties during the past year ... The way that you performed your part of this study and the interest in the disease that you have radiated to others are largely responsible for this joint study being an outstanding example of the way research and administration can pool their resources in a problem-solving effort. The high level of initiative, originality, and professionalism you showed on this one problem is seldom encountered ... The Pacific Northwest and Rocky Mountain Forest and Range Experiment Station pathologists who have worked with you highly praise your work and cooperation, always referring to the extra dedication, enthusiasm and interest that you have to your job."

Hart was a member of the Mycological Society of America and Society of American Foresters; in addition to Phi Kappa Phi, he was also a member of Sigma Xi and Xi Sigma Pi; he was listed in the 11th edition of American Men of Science, Who's Who in the West 1969-1970, and the Dictionary of International Biography, 1970. He was an active, enthusiastic member of our own WIFDWC organization as indicated by the splendid job he did as Chairman of Local Arrangements at Medford, Oregon, last fall. Hart was the author of several published articles relating to forest diseases. His untimely death prevented the completion of his studies on the undescribed species of needle cast and the publication of the results.

DOUGLAS REED MILLER
September 1972

CHAIRMAN'S OPENING REMARKS

Twenty years ago an international meeting of western forest pathologists was held at the Forest Biology Laboratory in Victoria, B.C. Although the meeting was sponsored by the Canadian Division of Forest Biology and the United States Division of Forest Pathology, attendance was solicited from all 48 persons known to be actively engaged in the study of forest diseases in western North America.

Thirty-three delegates responded to the invitation. Representation was gained from Washington, Oregon, California, New Mexico, Utah, Colorado, Idaho, Montana, Alberta, and British Columbia.

The meeting was designed to provide an opportunity to review briefly all activities in forest pathology in western North America and was held in recognition of the many and varied problems in forest disease and of the values to be derived through evaluation of problems of mutual interest and concern.

Fifty-nine active projects were reviewed during the course of that first meeting. It was evident that parallel and related investigations were in progress and that much was to be gained from the formal review and informal discussions relating to policies, techniques, and methods which had been developed to contribute to their solution.

Thus, W.I.F.D.W.C. was born right here in Victoria and it is fitting that we have chosen to celebrate our 20th anniversary here. W.I.F.D.W.C. is a dynamic organization, else it could not have survived. The original membership of 33 has grown so that our now pared-to-the-bone membership roster contains 155 names, with somewhat more than half in attendance at each meeting. The original project list of 59 has grown to the neighborhood of 300 active projects, and we must now resort to panel presentations, which generally summarize where we stand on a few problems, rather than discussing individual studies. Much progress has been made by our membership toward solving problems in western forest pathology, but, as with most things, the more questions we answer, the more questions there are to be answered. As we learn more, we realize how little we know, and so it is with some pride, but a great deal of humility, we enter our third decade as an organization dedicated to providing a continuing opportunity for forest pathologists in western North America to exchange views on problems of mutual interest and concern in their fields as regards research, survey, control, and extension activities.

PAUL C. LIGHTLE
Chairman
20th W.I.F.D.W.C.

KEYNOTE ADDRESS

FOREST LAND MANAGEMENT FOR WOOD PRODUCTION

Grant Ainscough[1]

The common goal of the wood industry and of the public is sustained yield from forest lands. Industry must generate a profit by maximizing the allowable annual harvest and at the same time must minimize the impact on the forest for other uses. Many forest practices serve mutual goals and most others that conflict can be modified to minimize effects on such things as aesthetics, recreational and fisheries values. It is possible to provide both wood to meet social needs and other uses of the forest. Harvest and management practices based on biological information including disease incidence is essential. Careful planning of intensified forest practices on an extensive basis is necessary to fulfill the mutual goals. Clear-cutting is the only feasible method of harvest in the old growth coastal forest and in some situations such as when mistletoe is involved.

The challenge and criticism to forest pathology is to place more emphasis on the patient and less on the disease. Close attention must be paid to the bio-geo aspects of the forest habitat to identify factors which influence pest resistance and to understand forest pest problems. Forest management decisions must be supported by placing emphasis on disease resistance and management practices which help to minimize pest losses rather than on extensive, expensive and often impractical control measures. For example, in our silvicultural program considerable emphasis is placed on establishing and maintaining mixed stands which we expect to be much less vulnerable to insect and disease attack. The importance of matching species and provenance to site must not be underestimated. Some pathological research might be redirected, particularly in those cases where there is little chance of practicable control methods being applied. There is also a need for more communication between the forester and researcher to ensure that knowledge that scientists now have is effectively utilized by the field forester.

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[1]Assistant Chief Forester, MacMillan Bloedel, Limited.

PANEL I - WIFDWC; PAST, PRESENT AND FUTURE

Toby W. Childs,[1] Moderator

PAST - THE FIRST FIFTEEN YEARS

Raymond E. Foster[2]

The first 15 years of WIFDWC, from 1953 to 1967, cover its inception, birth, growth, and attainment of measurable stature.

I have been asked to look at this period in terms of our organizational pains, programming trends, and accomplishments.

Organization

Our first meeting in Victoria brought together 33 delegates from two Canadian provinces and eight western states. No formal agenda was organized, but delegates came prepared to review their pertinent regional problems. Following this review of some 59 problems, we concluded that a number of problems were of mutual interest and that we should establish ourselves as a working group to review the status of and progress made towards their solution. At our first meeting we participated in an overnight field trip to the Lake Cowichan Forest Experiment Station. Based on the success of this venture, we agreed that field trips should be an integral part of our future meetings wherever possible. In every sense our first meeting was the most important. If it had not been successful in generating sincere interest, WIFDWC would have died in childbirth.

The second meeting in Berkeley in 1954 saw our first attempt to bring ourselves closer to the forest entomologists. This was a move fostered largely by the Canadian Government representatives as a result of their then recent organizational changes which brought together pathologists and entomologists under one roof and administration for the first time. The WIFDWC efforts in 1954 to promote closer relationships with the entomologists can best be described as a fiasco, with little or no success in establishing areas of mutual interest. Although several further attempts were made to establish this rapport in subsequent years, nothing tangible developed. Question as to frequency of meetings arose and it was concluded that annual meetings should be arranged for at least the next several years, despite a minority opinion that meetings at less frequent intervals would be more appropriate.

The third meeting in Spokane in 1955 established a more formal programming, with panel speakers selected to contribute background papers and to lead subsequent discussions. This action contributed to more orderly programming and stimulated greater

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[1]Plant Pathologist (retired), Portland, Oregon.
[2]Forest Products Research Laboratory, Vancouver, British Columbia.

in-depth discussions. It also led to a seven-fold increase in the size of the conference proceedings with an associated problem of cost of their preparation. Our first formal committees were organized in 1955 and a major decision taken that we would not affiliate with other scientific groups, but rather retain our separate identity.

The El Paso meeting in 1956 attracted our first representative from Mexico and a very useful exchange of information resulted. The El Paso meeting, however, brought special problems in attendance. The number of members and guests attending, approximately 40, was consistent with the number attending earlier meetings, but a disproportionately large number were not actively engaged in forest disease research. Distressingly small numbers of representatives attended from some laboratories, notably those from Canada. This experience led to the general conclusion that meetings too far removed from the British Columbia-Washington-Oregon triangle should be avoided.

The Salem meeting in 1957 developed our formal charter with definitions of objectives, membership requirements, meeting locale, frequency of meetings, relationships with other groups, and other matters.

The sixth meeting in Vancouver in 1958, and the seventh in Pullman in 1959 introduced the concept of a general theme for the annual meeting. "Parasitism" reigned at Vancouver and "Forest Disease Research Serves the Forest Manager" held the center stage at Pullman. In 1959 it was agreed that an interim program chairman should be appointed to solicit recommendations on the agenda for the forthcoming conference as well as the meeting locale.

The eight meeting was held in Centralia in 1960. Attendance exceeded 60 for the first time and this level was maintained at subsequent meetings in Banff in 1961, Victoria in 1962, and Jackson Hole, Wyoming, in 1963. We reached an attendance level of 70 at Berkeley in 1964 and maintained this level at Corvallis in 1965, and at Bend in 1966, but fell back somewhat in the fringe area meeting at Santa Fe in 1967.

During the first 15 years we thus met at 13 different locations, saw our membership increase more than three-fold (from 48 to 157) and our attendance more than double (from the initial 33 to a peak of 78).

Programming Trends

It is of interest to note that our initial emphasis on decay in old-growth forests gradually shifted to other areas. Thirty-two percent of our formal projects were directed to problems of this kind at the start of the period, but 15 years later the percentage had dropped to nine. On the other hand, increasing

emphasis was directed to a number of problems in immature forests. Fifty percent of our effort went to this latter area in 1953, 70% went to it in 1967. Relative interest appeared to drop in surveys and in seedling and foliage diseases over the period but there was an increase in activity of over 250 percent in rusts, cankers, and dwarf mistletoe. In real numbers, there were only four studies on mistletoe in 1953, but 37 studies directed to this problem area 15 years later, a nine-fold increase.

Sustained interest was shown over the period in problems such as *Poria weirii* and *Cronartium ribicola*. Gradually increasing effort was directed to *Fomes annosus*, *Armillaria mellea*, and other *Cronartium* rusts. Some problems attained a prominent position quickly and dramatically, for example *Phytophthora cinnamomi* and pole blight, but then lost their star-billing to other more important problems. Impact and control studies, not appearing as such anywhere in listed projects in 1953, received increasing attention after the first flush of enthusiasm in antibiotics in 1953 with the initial promise shown by Actidione and somewhat later by Phytoactin. Biological control through manipulation of the normally occurring microflora aroused our special interest first in 1958 while tree selection, breeding programs, and silvicultural manipulations sustained our interest to varying degrees throughout the entire period.

In-depth research into the background of some of our problems emerged slowly. Although there were early examples of probes into ecological relationships and isolated programs in taxonomy, studies in such areas as the nutritional requirements of *Tuberculina maxima*, and the physiology, epidemiology and cytology of *Cronartium* and the *Hypodermataceae* were to follow later. Similarly, although new techniques provided a continuing contribution to our program, the more dramatic moves into aerial color photography and ultra-microtomy had to await other developments in these fields.

Our program was far from static, rather it developed in some relationship to a more intensive management of the forest resource, to the increasing size of our group, and to our increased capability to respond to the more significant problems facing us.

Accomplishments

In my opinion, four accomplishments stand out clearly above all others:

1. We established, maintained, and improved through WIFDWC a mechanism for liaison between western forest pathologists. This mechanism improved communications and thus reduced our relative isolations. Individually and collectively we grew and benefited from an exchange of our work programs and exposure to different concepts. We encountered opinions which either

strengthened our own or caused us to pause and reflect. Personally we established relationships and friendships which grew and strengthened over the years.

2. We developed a clearing-house for the reporting of new problems and of progress on existing problems, often well in advance of formal publication. The mechanism of WIFDWC permitted us to avoid unnecessary duplication, alerted us to new situations, and stimulated cooperative efforts.

3. We gained through field trips and demonstrations a greater awareness of the manifestations of different forest diseases throughout a wide range of their distribution. This in turn led us into greater appreciation of their importance, their potential to cause damage, and their control.

4. We avoided the temptation to become a learned society; rather we retained our separate identity. We thus retained in sharp focus our primary objectives, a forum for exchange of information to lead us to a better understanding of major problems of mutual concern.

In welcoming you to our 10th conference in Victoria in 1962, I expressed the conviction that WIFDWC had been successful and that it could look forward to further progress in the future. I am now more than ever convinced that we are well prepared to face any new challenges that may arise.

THE PRESENT - VICTORIA 1972

Benton Howard[2]

Mr. Chairperson, Toby, that is — and Gentlepeople — Good afternoon.

I was resurrected from the *past* to talk about the *present*.

The present is merely the fleeting moment that connects the past and the future. So, I'll just make a few comments to bridge the gap between Ray Foster and Gus Loman and Dick Parmeter.

After last night I'm sure that some of us are glad that the past is past and that tonight is the future.

This being a political year in both our countries, naturally an opinion poll was in order. Therefore, I canvassed a number of pathologists in Oregon and Washington as to their thoughts on WIFDWC. Is the poll reliable? Probably as reliable as most.

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[2]4129 S.E. Stark, Portland, Oregon.

Here are the results — as usual no clear-cut answers — some good, some bad and many issues undecided.

Let's have the bad news (opinions) first. The consensus:

1. The Conference has become too formal. Too many "papers." Too many "speeches." Not enough time for free interchange of ideas, over-scheduled?

2. Too few "head knocking" workshop sessions.

3. Field trips are of doubtful value. Many have been "joy rides" — a well planned trip is okay, if on a specific problem area.

4. We don't focus enough on specifics. Too many generalizations.

5. Should early fall always be the time? Why not a spring or summer session?

Now for the good news!

1. The blend Research-Education-and-Control have been about right. Something for everyone.

2. Coordination has been good.

3. The "proceedings" are very good. Valuable and helpful documents.

Then the "undecided" or the "I'm not sure" boys. However, the ideas are worth thought.

1. Work sessions now and then. Should be few and be specific. They must be tightly structured and leader well prepared.

2. An occasional "interdisciplinary session" — again on a specific area of mutual concern with other scientists. Look at the whole universe.

3. Bring in a guest speaker now and then. In a related subject matter field.

4. Allow more time for floor discussion. Stimulate if necessary.

All in all more good than bad. But don't be complacent. We can be sure that Loman on Research and Parmeter on Education will have ideas. By the way, what happens to control in the future?

THE FUTURE ROLE OF RESEARCH IN FOREST PATHOLOGY

August A. Loman[3]

Introduction

If you look carefully at the program, you will see that I have been given the task of discussing the future role of research in WIFDWC. To keep my head as straight as possible on this subject, I have taken the liberty to replace the words "WIFDWC", which describe a conference of forest pathologists, with "Forest Pathology," which is a scientific discipline. The topic of my discussion is therefore "The Future Role of Research in Plant Pathology."

I will spend some time discussing my interpretation of a proposed Science Policy, the organizational framework for the various types of research, and the facilities in which scientific investigation will be carried out. All of these are, at this time, only Science Policy recommendations, that may or may not be implemented by the various governments we are going to have in the next 20 years. It is only in the light of this predicted framework, and in the light of the future of forest industrial development on this continent, that the future role of research in forest pathology can be discussed. This means, that the basis of my predictions may be subject to sudden change, for this basis itself is a prediction. I am therefore notifying you herewith that I am not going to be responsible for what I am about to say!

One of my basic assumptions is that our society, in the next 20 years, will still be profit-oriented. That those forces which are beginning to advocate zero population growth and zero economic growth will still be no match for the political and economic elites who are benefiting from the status quo.

Most of you will agree with me that the merits of science are presently experiencing a period of intense questioning and debate in the developed countries of the world. The current atmosphere of uncertainty pervades the entire spectrum of scientific endeavor: the physical sciences, the life sciences, and the social sciences.

Forest Pathology is but one of the many disciplines in the life sciences in which past accomplishments are being appraised in the light of current needs, and in which serious attempts are being made to formulate new policies which will be in phase with predicted increases in rate of change in technologically advanced societies such as ours. A discussion of the "future role of research in forest pathology" can therefore not be divorced from a consideration of the organizational and philosophical framework of a proposed Science Policy, which will have profound effects on all scientific

[3]Northern Forest Research Centre, Edmonton, Alberta.

work, not on forest pathology alone. Within the framework of predicted targets for Science Policy, I will make an attempt to predict what the future holds in store for research in our discipline.

In order to present my views in a structured way, I have found it necessary to define the various types of research in terms well known to all of you, and to discuss the proposed agencies and organizations that are believed to be particularly well suited to engage in these categories of research. For this part of my discussion, I refer to the Lamontagne Report, Volume 2, and less frequently to the so-called Meyboom Report, entitled "Science in a Changing Environment - Proposals for a Departmental Science Policy."

Research Defined

Scientific activities comprise all activities concerned with the creation of new knowledge in the physical sciences, the life sciences and the social sciences, or with the applications of scientific knowledge for useful purposes. Five classes of scientific activities are to be distinguished: (i) research and development, (ii) data collection, (iii) scientific information, (iv) testing and standardization, and (v) education. To date, forest pathology has covered this entire spectrum of scientific activities in the Federal research laboratories, in forest products laboratories, and in the universities. In the future, forest pathology will continue to be engaged in all of these activities, but there will be considerable shifts in emphasis from one class of activity to another. I will discuss one of the five categories mentioned above, namely research and development. I do realize that many forest pathologists are presently chiefly engaged in data collection and others in scientific information. Dick Parmeter will discuss education.

Research and Development

This class of scientific activity has its own spectrum of distinguishing characteristics, ranging from "pure" or basic research, to applied research, or technical innovation. *Applied research* may be defined as original investigations undertaken in order to gain new scientific or technical knowledge. This is directed primarily toward a specific practical aim or objective, which is market oriented. In industrialized societies, we tend to associate applied research or applied science with engineering, which is classed in the physical sciences. In forest pathology, research in the forest products laboratories would most closely approach the definition of applied research.

Basic research is conceptually divided into two types: (i) curiosity-oriented basic research and (ii) mission-oriented basic research.

(i) Curiosity-oriented basis research stands alone. The purpose of curiosity-oriented basic research is imposed by the inner logic of the discipline, and problems are chosen by the researcher

on the two criteria that (a) they are likely to be soluble and (b) the solutions will be relevant to current concepts in the discipline. In such research the problems cannot be defined by persons outside the discipline and the solutions are usually completely restricted to the framework of abstract concepts within the discipline. The proposed organizational base for curiosity-oriented basic research is the universities, but more about this later.

(ii) Mission-oriented basic research is less abstract and autonomous because the goal lies outside the particular scientific discipline. The actual scientific work is still done by the methodology of basic science, but its intrinsic purpose is mediated by an extrinsic purpose. The choice of extrinsic goals cannot be determined by the methodology of science. The objective of mission-oriented basic research may, for example, be a response to the technological requirements of a practical mission, and these requirements can even indirectly nurture the field of curiosity-oriented research. I will argue later that most of the published research in forest pathology in the last 20 years may be considered curiosity-oriented research which developed from a formulation of economically impractical mission-oriented requirements. The proposed organizational base for mission-oriented basic research will be Research Institutes administered by a National Research Academy.

The Development of a Science Policy Framework

How do responsible people in the Canadian Federal Government value scientific activities in society? They see three broad purposes in society: (i) cultural enrichment, (ii) economic growth, and (iii) public welfare. They feel that the main tasks of science policy can be most easily identified within the framework of these three major purposes. They state that cultural enrichment must increasingly become an aim of our society, and that scientific discovery and the advancement of pure knowledge is a vital element of our cultural life and civilization. They recommend that affluent societies in particular must encourage basic science for reasons similar to those demanding that they support the arts, that is to say, as a sector of high culture and disinterested intellectual activity. The Senate Special Committee on Science Policy lists the following main considerations as basic to the development of a Science Policy:

1. Curiosity-oriented, basic research is responsible for the life and progress of science.

2. The rate of increase in curiosity-oriented basic research activity in Canada during the sixties was one of the highest in the world. (You may remember that Bart Van Der Kamp warned us in 1969 in Olympia that the rate of growth of science was unhealthy and could not be supported by the country much longer.) As a result of this period of rapid growth, this country is now spending a higher proportion of its research and development budget on basic research than many other advanced countries.

3. We must therefore now enter a period of transition toward maturity in which emphasis is placed on *quality* rather than *quantity*.

4. We must not be hypocritical about the motives for our curiosity-oriented basic research activities. The goal, namely the development of science itself, should be clearly realized. It should not be necessary to put forward proposals for such work under the cloak of an extrinsic pragmatic goal.

5. Excellent or promising basic scientists must be strongly supported.

Research Facilities

Curiosity-oriented basic research will be carried out in universities and similar institutions of higher learning, mission-oriented basic research will be carried out in federal research institutes, and applied research or technical innovation and development will be carried out in private industry.

Universities

The basic function of universities and similar institutions will be teaching and research aimed at training students in scientific investigation and scientific methodology. The primary responsibility of university teachers will be teaching, not research. The publish or perish syndrome will be removed from the career development of university teachers.

Curiosity-oriented basic research will be carried out by scientists using university facilities. In principle, research scientists will not be responsible to faculty or students. Their salaries and research funding will be the exclusive responsibility of the Federal government, which will institute three grant-giving foundations, one each for the physical sciences, the life sciences, and the social sciences, to finance curiosity-oriented basic research.

Federal Research Institutes

Mission-oriented basic research will be carried out in Research Institutes. Problem recognition and the formulation of goals and objectives will be the joint responsibility of the "customer" (whether it be private industry or a provincial or state agency) and the research workers. Research projects will not be long-term, but short-term projects, and will probably be financed on a contract basis. Mission-oriented research projects will be tackled by teams of scientists rather than by individuals, and it is anticipated that these teams of scientists will dissolve at the completion of 2- or 3-year projects, and that new teams with different combinations of scientists will be formed at the commencement of new 2- to 3-year projects. It is also predicted that there will be an increased mobility of scientists, who may

be assigned to new research teams in other regions of the country. I personally feel that there will be a resistance in society against "suitcase careers," and that this aspect of future mission-oriented basic research will have to be very carefully evaluated in terms of public welfare, which is one of the three broad purposes of society, as responsible people in the Canadian Federal Government see it.

Industries

Applied research or technical innovation and development will be carried out by industry. This type of research will be almost exclusively of a technical, not a biological nature, and will therefore be of only marginal interest to the biologist. Forest products pathologists will have the closest contact with applied research.

Forest Pathology and the Future of North American Forest Industries

I realize that my discussion up to this point has been entirely oriented to the Canadian scene. However, it was recognized by Lamontagne and his Committee that no country lives in a vacuum, and that Canada in particular will reflect, to a considerable degree, the type of science policy that will develop in the United States.

So how does forest pathology in North America fit into this framework of Science Policy? Remember that we now make predictions about one scientific discipline, the future of which will not only depend on the implementation of the recommended Science Policy, but also on predictions of the development of forest industry in North America.

I will now make a few predictions about the future of forest industries.

1. The cost of labor will continue to rise. Mechanization of harvesting and processing will continue to offset high labor costs. The consequences of increased mechanization in tree harvesting and increases in labor costs are that individual tree treatment will become economically even more impractical than it is today. Hence forest disease control measures requiring individual tree treatment will become economically even more impractical in the future than they are today.

2. When annual harvests approach the annual allowable cut, forest disease problems associated with mature and overmature forests will be all but eliminated.

3. There will be an increase in the number of tree nurseries in North America. Pathology problems in seed storage, and seedling pathology, will be reduced to acceptable limits by improvements in tree nursery management and increases in numbers of nurseries will

hopefully, but not necessarily, provide potential jobs for forest pathologists.

4. Increases in production costs will increase the value of dimension lumber and pulp chips. Prevention of the deterioration of wood products in storage or in use will increase in importance. Forest products pathology has therefore a bright future.

5. There is a definite possibility that forest industries in North America will continue to face increasing public opposition to mechanized harvesting practices which imply clearcutting on an ever increasing scale. I think we will live to see American and Canadian forest industries expanding and harvesting more pulp and dimension lumber in tropical forests than in north temperate zone and subartic forests in the next 20 years.

The Future Role of Research in Forest Pathology

I have conjured up a future framework for you, on which forest pathology research depends. Let me now put meat on this skeleton.

1. Curiosity-oriented basic forest pathology research will be conducted mainly in universities. There will be no need to pretend that the results of curiosity-oriented basic forest pathology research will save American and Canadian forest industries or the public millions of dollars upon completion of the research project. The only justification for curiosity-oriented basic forest pathology research will be to increase our understanding of the processes of host-parasite interactions, or to increase our knowledge of the biology and physiology of trees subjected to biotic or abiotic stress. Only the best scientists will get financial support for curiosity-oriented basic forest pathology research. They will not be required to teach.

2. Mission-oriented basic forest pathology research will be conducted in Institutes for Life Sciences. There will be very close coordination, at the highest management level, with forest industries, and with provincial or state natural resource management agencies. Forest pathology problems will be identified, and the goals and objectives formulated by representatives of these agencies and forest pathologists at the highest management level. From a purely economic point of view, forest disease problems in western forests will be considered of minor importance, in view of skyrocketing labor and equipment costs, and in view of the fact that more sound wood is presently wasted in crude processing than is lost because of disease. We will therefore not see an increase in numbers of forest pathologists who are actively engaged in what we have up to now called mission-oriented research.

3. The bright note in predictions of future research in forest pathology is the work that will be carried out in forest products laboratories. As I mentioned earlier, the deterioration of dimension lumber in storage, or in use, or of pulp chips in

storage, represents a significant loss in investment. The goals and objectives of research projects in forest products pathology are therefore easily formulated, and there is *no* need to drift off into curiosity-oriented basic research because problem recognition, and the formulation of goals and objectives were done by pathologists without consultation with the industries they were supposed to serve. Because of their very close links with industry, however, forest products pathologists will be conducting research which will be partly mission-oriented basic research, but also applied research, since its goals and objectives are market-oriented, and therefore clearly formulated.

FUTURE - THE ROLE OF EDUCATION

John R. Parmeter, Jr.[4]

My charge today is to look into the future of WIFDWC from the standpoint of education (or possibly the future of education from the standpoint of WIFDWC — Larry wasn't too clear in assigning this topic). It should be noted at the start that I was certain the Russians could not win a single game with Team Canada, that the Olympic Committee would give the U.S. the gold medal in basketball, that the Democrats would not nominate McGovern, and that I'd have enough funds to pay for this trip to Victoria. For these reasons (and many more equally as fascinating), I will approach my topic with customary diffidence and conservatism.

In order to guess where we're going, it is necessary to consider past educational aspects of WIFDWC. We needn't go into the great "tape recorder debate" or the "student membership altercation". And it seems superfluous to review past panels and presentations dealing with education. These are duly recorded in the proceedings (excepting of course 1970). I've found these formal discussions to be valuable in crystallizing thoughts on the goals of education, student needs, and the needs of the profession. In the long run, the informal or unofficial contributions of WIFDWC to education have probably been the most valuable.

As an education of sorts, I've found that WIFDWC serves several important functions. First, it provides a means to keep abreast of current thought, activity, and research findings that I might not get around to reading about for years. It allows the incorporation into lectures of ideas and impressions that may not get into the literature at all. With Scotch, ideas can be expressed that would never be expressed with ink. WIFDWC also helps to inject a bit of "human interest" into lectures. After describing in detail the brilliant work of _____ (names

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[4]Department of Plant Pathology, University of California, Berkeley.

have been omitted to protect the guilty), it adds a touch of warmth and color to recount the time he fell off a table at a WIFDWC banquet. Finally, WIFDWC provides one of the few opportunities to compare notes with other educators on teaching techniques, changing attitudes, hair styles, and similar topics peculiar to academia.

From the point of view of the educatee (referred to here euphemistically as the student), WIFDWC is an asset in several ways. First and foremost, it presents an opportunity to see science and scientists in action (which has a good and a bad side, depending on where the action is). The arguments, the differences of opinion, the enthusiastic discussion of aims, goals, priorities and promises all give students insight that cannot be obtained in any other way. WIFDWC meetings also provide students a chance to get additional professional advice in areas they might judge their professor to be slightly deficient in. Few students are lucky enough to find a professor who knows everything. And, in this regard, workers who plan to return to school have a good opportunity to size up professors and programs before they decide where to go. In fact, WIFDWC banquets go a long way toward answering "all you've wanted to know about professors but were always afraid to ask".

WIFDWC helps students in two other areas of minor concern: thesis research and employment. Students often find time to compare research notes with other students or with authorities in various fields. It may be worth knowing that Frank Hawksworth has just completed enough research for a book on some topic a student was planning to develop for a thesis. When a student considers future employment, WIFDWC provides a chance to learn about job opportunities and what it's like to work for various agencies. Ed Wicker's eloquent remarks about the joys of budgeting and organization may be worth a thousand brochures.

And last but not least, WIFDWC is one of the few meetings that brings together research and management personnel. There the student may learn that the academic view of a disease problem may not be the only view and that, along with unanswered questions about the biochemical nature of host specificity, there may be other questions nagging the manager — like how to control disease damage.

The educational aspects of WIFDWC outlined above can be accepted as established fact. Before launching into the future, it remains to inquire why WIFDWC serves these functions so well. I think size and atmosphere sum up the critical attributes of WIFDWC. The group is sufficiently small that each member is readily accessible for discussions, and the atmosphere is sufficiently relaxed and informal that discussion is free and uninhibited. The scientist with a drink in one hand, gravy on his tie, and perhaps a lampshade on his head, is somehow easier to talk to than he would be at a formal meeting, although he may not be as easy to understand.

Looking to the future, I suspect that WIFDWC will remain a reasonably small group. There was a brief era when it looked like the numbers of western pathologists might multiply so rapidly that WIFDWC would be swamped. But recent budgetary reordering of priorities indicates that so long as purse strings are tight we're in no danger of untoward accretion.

Informality, or whatever you might want to call that relaxed, uninhibited relationship enjoyed by WIFDWC members, is very valuable. So far WIFDWC has managed to maintain this informality in the face of increased (but apparently arrested) growth and perhaps a tendency today to lose sight of the fact that men can relax and have fun with work they take seriously. Given the character of the present membership, it will be a long time before appreciable formality can be injected into our meetings without prompt deflation.

Assuming that WIFDWC will remain reasonably small and that the spirit of informality will prevail, I see a bright educational future for WIFDWC, not because it tries to be academic or educational, but precisely because it does not. The average year (if there is such a thing) presents the student with many opportunities to hear formal lectures or research papers, but the opportunities to hear scientists and managers come to grips with real problems in free-wheeling discussion are few. And I don't know where a student might go to acquire an educational experience comparable to a good WIFDWC banquet.

PANEL II - FOREST DISEASE SURVEYS

J. A. BARANYAY[1]
Moderator

Forest Disease Surveys provide background information about occurrence, distribution and variation of pest intensity and damage. This information is important to those responsible for the management of forests or working in extension or research, all of whom are engaged in some way in measuring the relationship of a pest to its environment. Though, in the past, this activity was not separated by a fancy name from general pathological activities, any study of forest pests could not avoid a fairly large survey element. Hence this activity in respect to Forest Pathology has existed for at least 70 years in North America.

The Proceedings of the first WIFDWC (1953) contain a "Review of Project Activities". Forest Disease Surveys were represented by five listed projects; this number increased to 12 in 1967. Survey problems were always discussed informally by interested participants during meetings. Two formal papers have been presented, both in Pullman in 1959. These were "Forest Disease Survey in B.C." by Alex Molnar and "The Disease Survey of California" by Hart Bynum. After this beginning, without formal continuation for 13 years, it is my pleasure to present to you a panel on Forest Disease Surveys by introducing panelists John Laut, Oscar Dooling, Alex Molnar and John Wear. John Laut will review the history of "Disease Surveys in Western North American Forests"; Oscar's topic is "The Kind of Disease Survey Information Needed by the Forest Manager"; Alex will discuss the "Status of Disease Surveys"; and John Wear, with a huge leap forward, will discuss what we can expect from "Remote Sensing of Forest Diseases".

DISEASE SURVEYS IN WESTERN NORTH AMERICAN FORESTS

John G. Laut[2]

In 1899, Hermann von Schrenk became the first official forest pathologist in North America when he was assigned to the Mississippi Valley Laboratory at St. Louis, Missouri. In 1902, Perley Spaulding and George Hedgecock were assigned to work with von Schrenk. In 1908, Hedgecock, who had collected in California previously, was assigned to conduct disease surveys on the National Forests. The

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[1]Pacific Forest Research Centre, Canadian Forestry Service, Victoria, B.C.
[2]Colorado State Forest Service, Fort Collins, Colorado.

first appointment in the West was in 1910 when E. P. Meinicke was assigned to the Forest Service Regional Office at San Francisco. This was followed by the assignments of J. R. Weir to the Northern Rocky Mountain area in 1911 and J. S. Boyce to the Pacific Northwest in 1920.

My purpose is to talk about the history of disease surveys in Western North America, not the history of forest pathology. However, in attempting to separate the two I found that, at least in the early years, they were one and the same. To quote Mr. C. Joergensen of the Columbia Cellulose Company when he spoke to this Conference at Pullman in 1959, "There was a time, about 100 years or so ago, when a forester could go about his business, happily unaware of tree diseases. He did not have...the uncomfortable feeling of killers, cankers, scabs, galls, wilts and diebacks lurking in the shadows, ready to strike at the first sign of weakness." My point is that the first pathologists spent most of their early time discovering problems and potential problems.

Most disease surveys were what I call reaction type — a problem was recognized, then it was examined, delineated and propounded upon — that is to say, surveyed. The most common terminology in this regard is intensive or extensive surveys. Perhaps the most descriptive terms are Detection Surveys and Assessment or Evaluation Surveys. It is desirable to keep the two separate in our minds.

In the United States, detection surveys generally were and still are essentially unorganized. Pathologists interested in a specific problem or problem area contributed general data and collections as they found them and as they had time to report them in publications.

This is not to negate the value or importance of this type of work. Most of our present knowledge of disease-causing organisms and their distribution, not only geographic but also ecologic, is rooted in the results of such surveys. It is impossible within the confines of this panel to list them all, but special note should be made of the white and pine blister rust surveys begun in 1922 in both the northwest states and in British Columbia. (This survey is of particular interest to this Conference. Dr. Bethel, in the early years of this work, was dispatched to Vancouver to coordinate the plan. Unfortunately, during the train ride he came down with the "flu". The end result was that he spent the entire visit in his hotel room visiting with and consuming the good whiskey of his Canadian colleagues. I submit that thus was born the WIFDWC - 30 years before the date we celebrate here this week.) Other surveys that have added not only data but, perhaps more importantly, specific methods and methodological philosophy to our working knowledge are the pole blight surveys of the 1950s in the Intermountain region and B.C.; the dwarf mistletoe surveys in the Southwest by Gill, Andrews and Hawksworth *et al.* in the early fifties; in the Intermountain and Rocky Mountain regions by Graham and Hawksworth; and

by Childs in the Northwest in the late fifties. The role of private industry must also be acknowledged and exampled by Weyerhaeuser's surveys of dwarf mistletoes in Oregon, carried out mainly by Keith Shea. One last example must be mentioned — the statewide general survey of forest diseases in California initiated by Reed Miller in 1958 which resulted in observation from over 18,000 trees in about 750 different plots. These are only a few of many. To those whom I may have slighted by omission, I can only plead lack of time.

Since 1951, the responsibility for what disease survey there is is given to a separate unit of the U.S. Forest Service from that of disease research. Since it is virtually impossible to chronicle the history of something that has not existed as an entity, let us now look briefly at the northern half of my assignment.

To speak of the Canadian Disease Survey and its history we must first discuss the Forest Insect Survey, because the development of one followed upon, depended upon, and now exists as one with the other.

Briefly, in 1928, during serious outbreaks of spruce budworm, larch sawfly and various bark beetles, Dr. Swaine, who was the first full-time forest entomologist in the Canadian Government Service, recommended the establishment of an "intelligence service functioning in cooperation and for forest industries". Attempts to set up such a service were made in 1931 and following years and yielded valuable but limited results. In 1936, a regional survey in Eastern Canada was begun by J. J. DeGryse, chief of the Forest Biology Division and in 1937, these insect surveys were established in New Brunswick and Vernon, B.C. These were followed by the establishment of survey centers in Saskatchewan (1940) and Winnipeg (1941). After a wartime lull, Insect Survey groups were set up at Calgary (1948) and Victoria (1949).

In the meantime, the Canadian pathologists were watching the Insect Survey with some interest. In British Columbia, limited general disease surveys, lacking quantitative basis, were conducted from 1940-45. During the following five years, a number of intensive surveys of specific diseases and forest types were conducted. The nucleus of the present sturcture of the Disease Survey was developed in 1951 and the following years.

A similar pattern was followed in the Alberta and Saskatchewan forest disease research laboratories. The year 1951 was significant for the Disease Survey. During that year the powers that be decided that there should be a disease survey set up parallel to and indeed in conjunction with the Forest Insect Survey. Late that year the first Annual Report of the Forest Insect and Disease Survey was published.

In October 1953, one month prior to the first work conference, a meeting of the chief pathologists at each of the Canadian

laboratories was held in Winnipeg. The general objectives of the Disease Survey were outlined as follows:

1. Maintain reconnaissance of known diseases and causal organisms;

2. Discover new diseases;

3. Study the interrelations of diseases with related factors.

At that meeting it was recognized that each survey unit required not only a general forest pathologist, preferably with strong ecological interests, but also someone who could provide authoritative identification of the causal agents. Thus we see, in the Report of the First International Western Forest Disease Work Conference, which anniversary we are celebrating, that Alex Molnar (the pathologist) reported on the reconnaissance and project activities, and Wolf Ziller (the taxonomist) reported on the identification and herbarium activities, of the Forest Disease Survey in British Columbia.

Such were the beginnings of the Forest Disease Survey in Canada — a formally organized unit of what is now known as the Canadian Forestry Service, designed to detect, diagnose and interpret forest diseases; and separated neither physically or philosophically from forest disease research, in fact assigned objectives requiring research. This last fact is frequently forgotten or ignored — disease survey is research in its own right as well as a valuable facility for non-survey-attached forest pathologists. Albert Szent-Gyorgyi[3] has recently defined research as — "going out into the unknown with the hope of finding something new to bring home —". Ask virtually anyone who has been connected with the Canadian Forest Disease Survey — this sense of adventure is what makes it fun — this is research, pure and simple.

Well to return from philosophy to history, what has happened in the last 20 years?

In 1959 at the Pullman work conference, Alex Molnar presented the objectives of the Disease Survey as:

1. To detect the occurrence of new or previously unrecorded diseases and disease agents affecting forest stands from seedling to maturity.

2. To identify the causal agents of disease.

3. To accumulate information on the geographical, seasonal and ecological distribution of agents of forest diseases.

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[3]Perspect. Biol. Med. 15:209, 1971. Also quoted in Science 177: 565.

4. To evaluate the nature and extent of host damage.

5. To interpret the findings of the forest disease survey and make recommendations for further study when warranted.

6. To publish the results of the survey.

Although these objectives were written specifically for British Columbia, it is fair to assume that they applied to the rest of Canada. Since that time, through many ups and downs, the objectives have not changed. Reworded, perhaps, but not basically changed.

We have already mentioned the staffing pattern established here in Victoria in the early years — namely, Molnar and Ziller. In the other areas of Western Canada, the Surveys were originally the responsibilities of research officers who had other duties — particularly Bob Bourchier in Calgary and Harry Zalasky in Saskatoon. Gradually the staff in the other two Regions were added: Joe Baranyay as the Disease Survey leader in Alberta in 1961 and Yasuo Hiratsuka as Mycologist in 1966. This author took over the combined Manitoba-Saskatchewan survey in 1964, where B. C. Sutton became the Mycologist in 1965. Meanwhile, Alex Molnar became Head of Forest Insect and Disease Survey in British Columbia —the first pathologist (and only) to break the stranglehold of the entomologists in this position. His position as Disease Survey leader was filled by a variety of short-timers until 1969, when Joe Baranyay moved west to his present position. Russ Blauel took over in Calgary and when the two prairie Regions were combined in 1970 into the present Northern Region based in Edmonton, he and Hiratsuka assumed their present responsibilities.

Operationally, the emphasis on one or more of the specific objectives has shifted in the various regions. These shifts, while varying in their time of occurrence, have all followed the same more or less logical sequence: first attention was given to detection — what is out there? and identification — what is it? As the inventories of local diseases and causal agents became more complete, more time was, is and, I presume, will be spent on evaluation — what are they doing? — although there should always be some detection work to monitor the general state of health of the forest.

Many disease survey people have been frustrated over the years, realizing that while most of the big survey organization was tied up with detection functions, their most meaningful contributions lay in specific surveys and in methodology studies to measure impact. This has been corrected in recent years by the designation of part of the survey organizations as a team for specific surveys and appraisal studies.

One other function of the Canadian Disease Survey is that of extension work. The diagnostic services offered have removed a large burden from the other research pathologists and have provided a needed service not only to forest agencies but also to the general public.

This, then is the Canadian Forest Disease Survey — from nebulous official beginnings in 1951 through to the development of a well-trained efficient field staff of para-professionals led by a group of highly proficient research people; an organization that has accumulated a mass of information about the forest. I can only leave it to the remaining speakers to judge it. If I may, however, I would quote and paraphrase Ken Watt, the population ecologist, upon his receipt of the Gold Medal of the Entomological Society of Canada for 1969.[4] "I wish to make an impassioned plea for the maintenance and increased sophistication of the Canadian Forest (Disease) Survey. This is...certainly one of the unique bodies of data in biology...It is noteworthy that most of the major advances in biology have been dependent on certain bodies of data that were unique, massive and collected according to a carefully thoughout design in order to reveal certain kinds of principals. I respectfully suggest that the Canadian Forest (Disease) Survey data may be in this same category but not enough analysis has been conducted yet to know."

What is the mass of data; who will use it? — I must yield to my fellow panelists.

Addenda

The appointment of W. H. Long to the Southwest area should be noted.

The extensive range-wide survey of ponderosa pine for twig-blight, started in 1934 in the southwest, should also be noted.

THE KIND OF DISEASE SURVEY INFORMATION NEEDED BY THE FOREST MANAGER

Oscar J. Dooling[5]

What Is Needed - General

Disease surveys should provide the forest manager with information needed to make overall management plans. Two levels of survey, extensive and intensive, should provide the information.

Extensive surveys should locate disease centers by causal agent and host(s). From these surveys, the pathologist could recommend to the manager the need for field checking or for an intensive survey. This would be similar to our present aerial insect damage survey.

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[4]Canadian Entomologist 101:1238, 1969.

[5]Supervisory Plant Pathologist, Division of State and Private Forestry, USDA Forest Service, Missoula, Montana 59801.

Intensive surveys should provide the manager with basic information on the disease(s) and what the alternatives are. This would include alternative control measures (if any), and what he can expect without control. The intensive surveys should be designed to collect disease conditions by vegetative habitat type. (Any relationship between disease and habitat type would be extremely valuable to managers involved in long-range planning.)

What Is Needed - Specific

Some of the specific items of information needed are:

1. Causal agent - scientific and common name.

2. Host(s) - tree species and alternate.

3. Part of tree affected.

4. Map or aerial photo showing extent and location.

5. Is it an economic disease?

6. Control possibilities - effectiveness and cost.

7. Control alternatives, including probable effect if not controlled.

Who Should Do Surveys

Forest managers think the actual collection of data should be accomplished by their field personnel. This is valid; all we need to do is design the proper techniques of data collection and train field personnel in the method and recognition of signs and symptoms. Review, evaluation, and interpretation of the field data is the responsibility of the pathologist. Based on his interpretation, he can then make recommendations to the manager.

What Use Will Be Made of Surveys

After the pathologist makes his recommendation to the manager, the information would be used by the manager to determine:

1. Whether control should be attempted.

2. Benefit/cost ratio of control.

3. Whether to shorten rotation.

4. Whether to take other management action that might have either beneficial or adverse effects on the problem.

5. What type of harvest/regeneration system to use — even-aged or all aged (clear-cut or selection).

6. Type and extent of slash disposal (whether to destroy stumps to eliminate infection centers).

Specific Diseases Land Managers Need Information On

1. Dwarf mistletoes.—What are the management implications, based on the present management direction, of harvesting stands by systems other than clear-cutting? Specifically, they need fairly detailed maps of intensity and distribution of the infestations within stands.

2. Root rots.—Which roots are causing damage and where? Is the severity of damage related to habitat type? Can they be detected before mortality reduces the value of the stand? What are possibilities of salvage?

3. Canker diseases.—How severe are they? How much volume loss is occurring? What are the possibilities of salvage?

4. Adverse environmental effects.—Air pollution damage; winter damage; drought damage. How much damage? Where? Possibilities of salvage?

STATUS OF DISEASE SURVEYS

A. C. Molnar[6]

Introduction

Disease survey deals with a number of aspects of the measurement of diseases in relation to their hosts and I should sort them out a bit for you before considering the state of the art. First of all, in their operational role, it is desirable to distinguish between detection and appraisal because we are much better equipped to deal with the former than the latter. Detection is concerned with finding the pest and putting a tag on it while appraisal deals with the complex task of determining "how much" and "where how much." I should also refer to the term "survey methodology" because most of us are concerned not only with measuring but also with improving the efficiency of measuring. I shall mention the term "extension" briefly only because most often the people involved in disease surveys are also involved in interpreting and advising on forest pest situations, but I won't be concerned with that aspect here.

A few brief comments on the customer and his needs. Most of us have to cater to quite a few:

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[6]Head, Forest Insect and Disease Survey, Pacific Forest Research Centre, Victoria, B.C.

Politician: For budget control, background to determine research priorities, demand for information, etc.

- Generally broad estimates.

- Relative significance of pest.

- Broad estimates of annual and periodic losses.

- Broad trends in spread and intensification.

Forest Manager: For accuracy of forest inventories and to provide bases for prevention and control decisions and to guide prescription of forestry procedures.

- Diagnosis - what is it?

- What will it do?

- Hosts?

- Where is it in the management unit?

- How much damage now, and potential?

- Trends likely?

- What can I do and what will it cost?

- What did I do wrong (why me?)?

(Specific needs of managers will vary.)

Scientist: To acquire survey information required to attain specific research goals.

- Geographic distribution, especially regarding climatic constraints.

- Host range in nature.

- Habitat relations.

- Phenologic relations.

- Other cyclic relations.

- Biological controls, etc.

Teacher: In research activities same as for scientist. Disease survey in its techniques is closely tied to forest mensuration, for obvious reasons, but carries with it the additional level of complexity related to diagnostic difficulties and the added peculiarities

of disease population distribution. The basic unit is the individual tree. The biggest operational problem is the extremely large area involved in any extrapolation.

Present Capabilities

Detection Surveys

Earlier I distinguished between detection and appraisal and indicated we are generally better equipped in detection. The early efforts in plant science research generally concentrate on the discovery and classification of species and the description of their characteristics. Our experience was no different. So, we have discovered at least our important diseases and have learned to recognize them. We have accumulated a good deal of information on their distribution. We continue to apply detection techniques to discover new occurrence and especially to get an annual consensus of those which fluctuate from year to year, such as climatic damage and foliage disease. Fortunately these are generally spectacularly symptomatic and highly amenable to aerial detection techniques.

We have considerably more difficulty with root diseases, cankers, mistletoes and decays and have generally resorted to specific ground samples in detection surveys.

A special comment on diagnosis. We are in excellent shape when it comes to identifying the fungus, or whatever, associated with disease specimens submitted and readily diagnose all our important pests. We have more difficulty diagnosing and correctly assigning cause to environmental or environmentally-conditioned problems.

Damage Appraisal

With regard to damage appraisal or impact surveys, we are concerned with *how much* (accuracy of forest inventory) and *where* (delimiting the damage for some type and some level of management decision and action). Appraisal surveys must be adequate first of all to determine if some action is needed and then must be able to pinpoint where and what level of action is needed and possibly to provide background data for cost/benefit assessments. The detail of information and intensity of sampling required will depend on the purpose of the work, whether for broad policy decision or for the action on the specific forest management unit.

There are a number of factors influencing our capability in appraisals:

1. Background knowledge of the characteristics of the organism in question and the nature of its impact on the individual tree.

Obviously this will vary with organism or class of damaging agent. Status variable with the disease but steadily improving.

- Root rots: good except possibly for hidden defect.

- Decays: good in most cases, hidden defect fairly well taken care of by indicator classes and cull factors.

- Foliage diseases: inadequate but improving; much more work needed.

- Broom rusts: require work, given low priority because not considered serious.

- Mistletoes: big improvement in recent years; should be in good shape soon.

- Blister rusts: good for *Cronartium ribicola* but inadequate for native rusts.

- Cankers: with a few exceptions impact on individual tree needs better definition.

There are a wide range of minor diseases which can be readily diagnosed but lack definition for impact. I think quite properly they have been given a low priority in studies.

2. Ease of field recognition.

While we cannot change the symptoms of a pest we may be able to improve our perception of them by a better understanding of symptoms or the use of special techniques, i.e. remote sensing. Various forms of hidden defect and nondistinctive or obscure symptoms comprise our main problems.

- Root rots: good shape except for hidden defect. I'll ask the root-rot experts and John Wear with his remote sensing to bring us up to date in the discussion period.

- Decays: really difficult problem with regards hidden defect but I believe we have learned to live with this handicap making use of external indicators and by development of cull factors.

- Foliage diseases: Generally excellent. Admirably suited to aerial mapping.

- Broom rusts: good, but inadequately tested.

- Mistletoes: good, but a good bit more work required in the use of aerial surveys and aerial photo interpretation.

- Blister rusts: W.P.B.R. good; natives good ground recognition but aerial needs work.

- Cankers: ground observation good; aerial observation and air photo techniques need work.

3. Availability of statistically valid sampling techniques.

I believe this is the area of our poorest performance, and there is a very good reason for this. With the complexity of the superimposed host-causal agent population distributions, we can rarely afford to take sufficient samples to qualify our data for statistical analysis. I am aware that there are exceptions and it would be worthwhile to bring them up during the discussion period. I shall be pleased if this afternoon's panel on disease impact refutes my comments. I won't take the time to discuss the list of disease types with reference to the statistical validity of sampling techniques. We have all used various types of strip and plot cruises and point sampling techniques to size up a disease situation. The success of such enterprises was generally closely related to our success in defining the impact of the pest on the individual tree, the validity of the damage classes we established and the possibilities available for extrapolating our results.

Disease Survey Methodology Studies

In conclusion I would like to make a few comments concerning the areas where I feel future emphasis in disease survey methodology studies should be placed.

1. Definition of the impact of diseases on individual trees as a basis for stand impact. Without this, everything else is guess work.

2. Bring to bear the efforts of statistical and mensurational experts directly on these problems as a part of the team.

3. Put special efforts into discovering and developing possibilities for extrapolation of samples. Site relationships and various adaptations of aerial photographic and remote sensing techniques are obvious approaches. Modeling techniques, especially in problems related to growth loss holds promise.

4. Team work with ecologists and tree physiologists needed to intrepret and define environmental and environmentally conditioned diseases and the relative significance of secondary agents.

Work in the Pacific Forest Research Centre, under Joe Baranyay, has made a good start on defining the impact of specific diseases on individual trees especially dwarf mistletoes and defoliators. A start has also been made to utilize modeling techniques in measuring tree growth and growth impact. The next step leads to adapting these results to the assessment of these pests on a stand basis. To do this we will need help from mensurationists and statisticians. The ultimate goal: to devise damage appraisal techniques usable by the forest manager.

REMOTE SENSING OF FOREST DISEASES

J. F. Wear[7]

Detecting and measuring the effect of diseases on our forest resources is a continuing problem that faces forest pathologists, foresters and earth resource managers throughout the world. By using remote sensing devices from aircraft and earth satellites, it seems highly probable that satisfactory aerial survey techniques can be developed to acquire data on the distribution of forest disease centers. The result will be more precise information that will help forest managers salvage distressed timber and alter management plans to minimize tree mortality of our valuable forest resources.

The term "remote sensing" refers to acquiring information about specific objects or phenomena by an information-gathering device not in intimate contact with the subject under investigation. Our own remote sensors — eyes, ears and nose — are useful, but are surprisingly limited in storage and retrieval of the data gathered. Many of the new remote sensing techniques are tied in with our space-age technology and have extended our limited capabilities. We have built a variety of specialized instruments and improved products to take and record needed information. We have new aerial camera and vidicon systems, improved photographic films, thermal scanning and mapping devices, infrared and high frequency radio detectors, high resolution radar systems, suborbital aircraft, and earth orbiting spacecraft and specialized satellites. A few slides will illustrate some of the remote sensing capabilities currently in use.

Scope of Remote Sensing

1. Electro-magnetic spectrum.
2. Panchromatic photography.
3. Black-and-white infrared photography.
4. Color photography EK 2448.
5. Color infrared EIR 2443 photography.
6. Thermal IR 3.5 - 5.5 μ.
7. Radar imagery.

Visual reconnaissance surveys at low altitudes from helicopters and slow flying aircraft have long been accepted as a simple, low-cost, generalized method for detecting and sketch-mapping major insect and disease outbreaks. Forest Pest Control aerial observers are well-trained in identifying various timber

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[7]Remote Sensing, U.S. Forest Service, Portland, Oregon.

types and the appearance of attendant insect, disease, fire and other miscellaneous phenomena that defoliate, partially destroy or kill trees on forested areas in the United States and Canada. Some of the disease syndromes that are detected visually include: dwarf mistletoe in Douglas-fir, spruce, white fir and hemlock; blister rust in white pine; needle cast diseases in larch, Douglas-fir and ponderosa pine; root rot diseases in young stands and cut over areas; Dutch elm disease and oak wilt damage; smog pollution damage to ponderosa and lodgepole pine. Many of these disease occurrences are only visible from the air under heavy to severe damage intensities. Aerial observer experience is a highly critical factor in deriving reasonable reconnaissance survey information. Detailed evaluations of damage intensity and distribution at critical centers, of course, require more costly and sophisticated remote sensing techniques, such as special types of aerial photography combined with field checking.

Aerial photography with special film-filter combinations has been the primary remote sensing instrumented media exploited by foresters and forest pathologists to increase the efficiency of forest disease surveys.

Meyer and French (1967) found color infrared photography best for detecting dwarf mistletoe infection centers in black spruce stands of north-central Minnesota. Although groups of dead trees and openings in the forest canopy could be seen on panchromatic or color photography, delineation of dying trees around these groups and in small pockets beyond were interpreted best on the CIR. A photo scale of about 1:7000 is recommended for this problem area. Meyer and French also found that Dutch elm disease centers were adequately detected on CIR film at a photo scale of approximately 1:10,000. Furthermore, they found CIR film provided good detection of oak wilt infections at a photo scale of 1:6000. Incidence of disease in hardwoods has generally been detected more readily and accurately than in conifers. This is because of the more rapid and pronounced physiological changes occurring in the parenchama layer of the stressed leaves of hardwoods.

In lodgepole pine, Baranyay (1968) found that Ektachrome Aero film at a photo scale of 1:7900 was effective in discriminating heavy infection centers but that a larger scale (1:2400) was needed to detect dying trees (discolored foliage and branches) and witches' broom in the upper crown. However, the potential of CIR was not determined because of the poor quality of the imagery. New data may now be available on this film from some additional studies that Baranyay has been conducting in lodgepole pine.

Murtha and Kippen (1969) found that CIR photography revealed *Fomes annosus* infection centers in Canada. Hadfield (1970) reports that CIR film shows effectively pines killed by *Fomes annosus*.

A cooperative research and development program of the U.S. Forest Service and NASA that would have possibly developed survey

techniques to detect previsual symptoms of *Poria weirii* root rot in Douglas-fir and hemlock has been phased out. Aerial photographic experiments with various types of film-filter combinations were unsuccessful in consistently detecting dying trees, except in the very late stage of decline.

Thermal scanning techniques for measuring temperature differences between healthy and diseased trees were also inconclusive because the temperature differences were so slight — at best only about 2°F. An operational survey in most forest areas would involve so many different sites, hydrological anomalies and physiological regimes that a consistent temperature pattern for discriminating healthy and diseased trees seemed unlikely.

The discovery of positive signature indicator of root rot disease on aerial photography in the high Cascades of Oregon gave strong impetus to remote sensing studies from another approach. Analyzing openings in the forest canopy and developing criteria that would identify centers of root rot infection would provide practical aerial survey methodology not currently available. Even though this type of survey would not provide information on infection centers at the initial onset of the root rot, forest managers would be able to adjust management practices, change cutting and/or salvage priorities to maximize the use of distressed timber on the edge of these openings, and to reassign campground and recreation sites to afford greater protection to the public.

The signature consists of an unusual phenomenon of bare ground in a half round circular shape surrounded by trees. A small signature (early *Poria* stage) may be from 100 to 150 feet in diameter and range upward to 700 feet. A conglomerate of openings gives the appearance of a ringworm pattern and may range upward to 3000 feet. Determining the cause of the openings in the forest canopy involved a multidisciplinary group of scientists and foresters. Openings can be the result of insect or disease activity, unusual geomorphological features such as rock outcrops, bare soil, or water deficient strips. The team ground-checked several openings in different age classes of the Douglas-fir-hemlock type. The preliminary interpretation that the openings were caused by root rot disease was verified and has been further substantiated by ground surveys of many plots in 1971.

Good interpretative judgements are required to identify *Poria* openings in different parts of the Douglas-fir subregion. The striking appearance of the circular bare ground indicator in the high Cascades of Oregon was the primary criterion for identifying root rot centers throughout the Northwest. A *Poria* signature in the early stage is a "hole" in the forest canopy with dead and downed trees jackstrawed in the center and standing trees in various stages of deterioration at the edges of the opening. Stand openings increase radially from the center of infection. The circular bare-ground signature is readily discerned where brush and other vegetative species do not invade. At lower elevations

and on better timber sites (lower Cascades and Coast Range), small trees (primarily hardwoods) and brush invade rapidly to obscure downed trees and decrease interpretation accuracy. Both large and small pockets of bark beetle-killed trees in various stages of deterioration in the forest stand may also confuse interpretation.

As a first step in establishing study sites in Oregon and Washington, some 8200 panchromatic photographs, covering approximately 30 million acres on 12 National Forests, were intrepreted for likely root rot infection centers. Three test sites, each encompassing 9 square miles of pole and saw-timber stands and a variety of site, slope, elevation and disease conditions, were selected on the basis of this overview. Two test sites are in the high Cascades of Oregon (Waldo Lake and Olallie Lake) and one is in Coast Range of Oregon near Divide Lookout.

Each of the three test sites has been covered with three types of photography and a wide variety of photo scales ranging from 1:4000 to 1:192,000. Film types include Aero color negative film (2445) for either color or black-and-white prints or transparencies, and color infrared (2443) with Wratten #15 filter.

From a total of 72 plots for each test site, eight were randomly selected for each film type-photo scale take in 1971. A total of nine combinations were delineated and interpreted on the 1971 photography. Three additional smaller scales were taken in June 1972 to determine the upper limits of successful photo interpretation prior to checking ERTS, an imagery that will soon be available. On the 1971 photography, each plot was interpreted only once by each of five interpreters for presence of *Poria* root rot, thus removing a possible source of bias commonly found in multiple, sequential photographic interpretations of the same area on different film types and photo scales. The same type of replicated photo interpretations will be used to evaluate the upper limits of photo scales for detecting and estimating *Poria* infection centers.

Results of the five interpretations on the 1971 photography show that larger photo scales do not materially improve accuracy. Relatively small differences likewise occur with different film types. Somewhat less accuracy was attained on the Olallie Lake test site. Lowest accuracy was on the Coast Range site area, where abundance of brush and hardwood tree species obscured downed trees and ground details. Additional aerial photography is planned this fall after seasonal foliar drop on brush, hardwoods and herbaceous species has occurred. Greater accuracy in identifying *Poria* centers is expected if additional ground details can be discerned and incorporated into signature criteria.

Waldo Lake Test Site

Film type	Photo scale		
	1:31,680	1:15,840	1:8000
Black-and-white	85.0	60.0	77.5
Color	82.5	70.0	40.0
Color IR	77.5	52.5	77.5

The Earth Resources Technical Satellite (ERTS) has been polar orbiting the earth since late July at an altitude of 503 miles above the earth's surface. Every 18 days it passes over the same earth point to provide replicated imagery if the area is free of clouds. Unfortunately, some failures have occurred in the basic equipment and the total expectations of the data collecting systems will not be realized.

The Multi Spectral Scanner (MSS) is the primary instrument giving us imagery as good as was provided on the Apollo 9 satellite. From 500 miles the field of view is 260 feet operating across four channels, i.e. green (.5-.6), red (.6-.7), near infrared (.7-.8), and infrared (.8-1.1). Imagery that has been studied by a few researchers indicates a resolution of about 250 feet. Each of the four channels can be printed in black-and-white or its spectral band. A special laser printer can provide a color print-out reconstituted from the three color negatives. ERTS primary investigators are provided black-and-white prints to study and select specific target areas for further work on color imagery, either as a composite or individual spectral bands. This imagery is prepared for the principal investigators at Goddard Space Center, Maryland. Other users of resource imagery can obtain prints from a new reproduction center located at Sioux Falls, South Dakota. Five orbital passes have been made by ERTS so far and image data are now starting to be studied by the principal investigators. Two problems, clouds over the test areas and reproduction system hangups, have slowed availability of imagery for real time analysis. No reproduction schedule is available for ordering prints from Sioux Falls.

The Return Beam Vidicon (RBV) system of three vidicon cameras images an area of 100 x 100 nautical miles in three spectral bands but has yet to function on the ERTS program. The primary MSS tape recorder system failed, which, in turn, short circuited the RBV. The MSS backup tape recorder is providing the imagery from ERTS.

NASA Ames is providing some U-2 imagery in CIR, using an RC-10 aerial camera (9x9) for 1:120,000 scale imagery and a Vinten 70 mm camera for 1:300,000 scale imagery of several selected areas. An area lying between Eugene and Salem, Oregon, and extending from the high Cascades westward to the Pacific includes the two *Poria* root rot test sites of Olallie Lake and Divide Lookout. This imagery should be available shortly for study this winter.

A forecast of benefits obtainable by the 1980s from spacecraft for remote sensing of forest and rangelands has been made by R. C. Wilson, a 30-year veteran of photo interpretation and remote sensing. He contends that space sensors will provide large amounts of data on major land classifications; moderate amounts of data on timber and range inventories, fire weather forecasting and snow field monitoring; and small but significant amounts of data on detailed land classification, inventory of wildlife habitat, recreation resource inventories, monitoring water cycles, pollution and erosion, and evaluating damages to forests and ranges. Resolution quality must be better than 100 feet from the satellite sensors (currently 250 feet) to be an effective tool in forest pest control surveys. It is quite likely, however, that satellite imagery combined with suborbital imagery from aircraft will provide considerable information to monitor major areas of insect and disease outbreaks. Wilson does not anticipate space imagery resolution to be better than 100 feet by the 1980s.

In conclusion, it seems apparent that remote sensing from satellites is going to significantly benefit our underdeveloped and developing countries as contrasted to our more developed countries such as the United States and Canada. Greatest interest and benefits will be derived from land classification and range inventory as it relates to the production of food rather than production of wood fiber. For our comprehensive surveys of the many pests that affect our forest resources, we are going to continue using imagery from suborbital aircraft and extensive and intensive field analyses.

MODERATOR'S SUMMARY

From the foregoing survey history, the need for Forest Disease Surveys was recognized on both sides of the border, but it developed in two directions. This was due to differences in management of crown land and geographical location.

In the United States, the Forest Service is part of the operational forest management. Disease survey activities are concentrated on problem analyses, initiated by the Pest Control Unit, and most of the field work is carried out by staff of the National Forests. The interpretation of data and management recommendations are made by Pest Control. Authority is in their hands.

In Canada, crown land is managed by the provincial Forest Services, and the Canadian Forestry Service does the preliminary survey and research with limited aid from provincial or industrial organizations. Survey findings and research results are conveyed to the provincial authorities for management decisions and the role of the Canadian Forestry Service is advisory. Since all the basic work has to be done by the federal organization, a distinct group

at each research center, the Forest Insect and Disease Survey was developed. Initially, most of the activities of these groups were concentrated on disease detection. The fact that all forests up to the Tundra were under the jurisdiction of the regional survey groups had some bearing on this. Later it was recognized that meaningful work came from specific surveys dealing with recognized problems, and the Forest Disease Surveys were divided into four groups in British Columbia. These are detection, damage appraisal, survey methodology and diagnostic services.

Though the organization of the two Disease Surveys is somewhat different, the ultimate objectives of both are the same: to provide the necessary information on disease conditions to forest managers and thus initiate management procedures to decrease losses.

PANEL III - DISEASE IMPACT

David A. Graham[1]
Moderator

Because of the likelihood of overlap between the subjects covered by the survey panel this morning, Joe Baranyay and I got together early last spring and agreed that (1) his panel would cover detection efforts only (the determination of what and how much), and (2) we would cover impact determination efforts only (not detection surveys as such).

As you have observed, it is difficult to keep the two topics separate. Since they strayed over into our subject a little, I am sure that discussion during this panel relating to either topic will be pertinent.

We are quite fortunate in having members on this panel who have been spending a great deal of time trying to determine the impact of a particular forest disease. I will introduce them to you individually just prior to their presentation. Each have been allotted time for questions after they finish. I hope in this way to stimulate discussion and keep you from having to remember your questions too long.

The impact of forest disease in Oregon and Washington was recently described by two members who are in the audience today — Jim Stewart and Keith Shea. Jim and Keith put it this way in their recent booklet "Forest Diseases of the Northwest":

> DISEASES reduce forest productivity in Oregon and Washington by over 400 million cubic feet (3.1 billion board feet) each year. This impact equals almost 13 percent of the annual growth and is equivalent to lumber for over 200,000 average homes.
>
> Dwarf mistletoes, root rots, and heart rots are the principal diseases but others—foliage diseases, cankers, and stem rusts—are increasingly important. Noninfectious diseases—air pollution, climatic extremes, and nutritional disorders, for example—also cause sizable but unmeasured losses.
>
> Forest tree diseases cause *growth loss*—growth that would have occurred if a disease was not present, *mortality*—trees that die because of

[1]Branch Chief, Insect and Disease Control, Division of Timber Management, U.S. Forest Service, Portland, Oregon.

> disease, and *cull*—wood made unusable by disease. Diseases also destroy aesthetic values, create hazardous conditions in campgrounds and public use areas, and seriously disrupt long-term forest management plans.

These are the same figures used in the 1967 publication "Annual Losses from Disease in Pacific Northwest Forests" by Toby Childs and Keith Shea. This at least tells us that our forest disease impact data has not changed in the last 5 years, which may be encouraging; but as we all know only too well, these figures leave a lot of unanswered questions. Most of these have already been asked today. Where should our control emphasis be? Which disease is most important? What diseases rate priority research attention? Etc.?

As many of you know, most of the Forest Pest Action Councils in the West, within the past few years, have presented resolutions to the effect that the need for more precise forest insect and disease impact is most urgent. These are sent to the Chief of the Forest Service, Universities, Congressional Representatives, and other similar entities. This concern was also reflected in a 1971 resolution by the Western Forestry and Conservation Association which reads as follows:

> The Western Forest Pest Committee recognizes that reliable pest impact information is essential for sound management decisions and environmental protection. Such information is *unknown* for most pests. The Committee urges that the U.S. Forest Service, in cooperation with the western State Foresters, Universities, and industry develop adequate survey and evaluation methods. The Committee further recommends that the U.S. Forest Service use these methods to assemble reliable pest impact data for inclusion in the next national inventory of forest resources.

About a year prior to this, the U.S. Forest Service at the Washington, D.C., level stepped up efforts to resolve the need for better insect and disease impact information. This was brought into focus mainly because of the need for a revised timber resource estimate (an updated TRR). The estimation of "net growth" is the goal of this effort. In order to get this, of course, we must be able to determine and predict insect and disease losses. Several unanswered questions quickly come to mind:

1. What will the insect and disease impact be in managed forests when certain cultural practices are undertaken? (Timber production is now being projected on the basis of several different levels of management.)

2. What data are needed to better measure the insect and disease impact? Why is this needed? How will it be used? (Setting of research and action program priorities—both national and local.)

3. What is the insect and disease nonmortality loss (much larger than the mortality loss)?

4. What is the level of damage where control action is required (economic thresholds)?

5. How much can the impact be reduced by applying present control technology?

As a result of a meeting held in Washington, D.C., in April of 1971, a number of specific assignments for determining the impact of certain diseases and insects were made for the U.S. Forest Service Regions and Areas as follows:

Region 1	- Spruce budworm
Region 2 & 3	- Spruce bark beetle
Region 4	- Mountain pine beetle
Region 5	- Dwarf mistletoe - PP (So. California)
Region 6	- Root diseases *(Poria weirii)*
Region 10	- Blackheaded budworm
NES&P Area	- Scleroderris canker
SES&P Area	- Fusiform rust

A special task force committee appointed at the meeting developed guidelines on what values and resources were to be considered. The basic concept and hope is that if the assignees can come up with the methodology for the assigned pest, the same methods (maybe only slightly modified) can be used for other pests in the same group. For example, if we can determine how to measure the impact of Poria root rot, we should be able to more or less use the same techniques for other root rots.

In February of this year, the U.S. Forest Service took up this impact question again at a nationwide meeting in Arizona (Marana Air Park). Over 60 people attended from the Forest Service Pest Control groups and Research Stations, Universities, State Forester Offices and private industry. There were also two or three from Canada.

The first task attempted was to define the term "impact." This seems simple enough, but I want to illustrate, if I can, how elusive this subject is by giving you a sample of some of the definitions that were developed by the various geographic teams assigned to this task.

1. Impact occurs when effects of insects and diseases result in a response by people.

2. Impact is the ability of particular practices or agents

to change wood yield from some established norm, either positively or negatively.

3. Impact is the departure from attaining management objectives, including aesthetics, wildlife, timber, recreation, water, and range.

4. Impact is the summation of the decreases in forest resource benefits, *as defined by a policymaker*, over a specified planning period resulting from the action of insects and diseases.

5. Impact is the net effect of diseases, insects, and other forces of change on current social, economical, and ecological forest resource values.

The group settled on a definition something like this:

> Impact is defined as the cumulative net effect of pests on specified forest resources and trees that results in a present or future change in management objectives or action.

I think a more or less direct quote from some of the introductory material also developed by the group at that meeting sets the stage for this panel very nicely. I have changed it only very slightly to meet our situation here. I think it is very representative of the current opinion—at least in the United States—on where we are on this subject.

Forest diseases affect forest resource uses, values, and productivity in many ways. The cumulative net effects are limiting and disruptive to program planning and execution in all functions and levels of forest land management organization. Insect and disease effects relate to (1) forest inventory, (2) forest management planning and decision making, (3) economic analyses of timber and related resource uses and outputs, (4) environmental enhancement, modification and protection, (5) forest pest control planning and action programs, (6) forest insect and disease research orientation, organization, and direction, and (7) overall integration of research and action programs. More broadly, insects and diseases have major ecological, economic, and sociological impacts on all aspects of private and public forest resource management in the United States.

We do not have an adequate system for measuring, evaluating, and predicting insect- and disease-caused impacts on the forest resources of the Nation. Basically, we lack a clear understanding of the concepts and practical implication of pest impacts in the total space-time frame of the resource management process. The data from past work and present data inputs are incomplete. Specifications for the kind and quality of data needed, criteria for interpretation and evaluation, and bases for value judgements have not been established on a sufficiently broad scale. We have some, but not all, of the knowledge and methodology needed to fill these

voids and develop an effective, integrated forest disease impact survey and evaluation system.

The need for adequate forest disease impact inputs into all planning and operations is urgent. Public concern for the rationale and justification of forest pest control decisions and the methods used for control are increasing. The balance of production-, protection-, and utilization-oriented activities is under close scrutiny by individuals and groups within and outside the government and industry. Reliable pest impact information is needed to: establish priorities for research and action programs; make benefit-cost, biological, and postcontrol evaluations; develop the scope of pest detection efforts; and prepare meaningful environmental impact statements for pest control projects (needed for Federal projects). We need an adequate impact data and information base for both research and action programs *now*. Whether we are researchers, control administrators, or educators, I believe our future, and in fact our very existence, depends on it.

Our four panel members have some of the answers which they will present to you now.

IMPACT OF ROOT ROTS IN YOUNG DOUGLAS-FIR PLANTATIONS

G. W. Wallis[2]

The material upon which this paper is based was obtained, for the most part, from detailed observations on three plots, comprising approximately 21 acres, established in three plantations on Vancouver Island, British Columbia. The paper by Foster and Johnson (1963) provides details of the stand and of plot establishment. Their assessment of diseases present at the commencement of the study was as follows: needle casts, terminal bud injury and terminal dieback - present but damage was such as to be of minor concern; frost and sunscald injuries - common in all areas, appeared to act as favorable entrance courts for wood decay fungi, particularly *Stereum sanguinolentum;* root rots - common, affecting over 20% of the trees in one area, 95% of the infections were attributed to *Armillaria mellea.*

We have been following the progress of disease in these plots for 11 years, i.e. from stand age approximately 15 to 17 years to 26 to 28 years. Root rot-wise, this period will probably be one of the most interesting in the life of the plantations.

No new diseases were recorded, from those reported originally,

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[2]Pacific Forest Research Centre, Victoria, B.C.

during the study period. Needle casts and terminal bud injury continued to be classed as of minor concern. Dieback of the main stem and associated laterals in the upper crown occurred on a few trees in the three areas. In most cases, dying back continued over a number of years; however, all trees eventually recovered and secondary leaders took over from the original terminal. Isolations from affected tissues implicated the canker fungi *Diaporthe lokoyae* Funk, *Dermea pseudotsugae* Funk, and *Xenomeris abietis* Barr as the causal organisms.

Trees with severe sunscald and frost injuries, and growing in the stands adjacent to the plots, were dissected 8 and 11 years after the injuries occurred. Contrary to the original findings, the injuries did not serve as suitable entrance courts for wood decay fungi, or if fungi did become established, their development was extremely limited in hemlock as well as Douglas-fir.

Armillaria mellea, Poria weirii, and *Fomes annosus* were responsible for most root rot infections recorded throughout the study period. *A. mellea* continued to dominate the incidence of infections. Of most interest, however, was the fact that of the 1000 odd trees with active *A. mellea* early in the study, 25% had callused and were classed as healthy by the end of the examination period. In addition, 60%, although not completely recovered by the final examination, had active callus. Dissection of trees in this latter category and growing in the stands adjacent to the plots indicated that these trees would recover fully in time or would recover with only minor amounts of butt rot. We were not able to find any correlation between site or crown class and the ability of a tree to callus *A. mellea* infections.

The number of infection centers attributable to *A. mellea* increased about 50% during the 11-year study period and the number of trees with active infection more than doubled. The number of trees per infection center, however, increased only from 1.7 to 2.3. Most of the increase occurred in the first six years of the study period.

We attempted to forecast the significance *A. mellea* would have in the stands when they reached 40 years of age and assuming they would be brought under management with a stocking of 185 trees per acre. If the centers did not increase in size but all trees with active infections but no callusing died, only two openings in all three plots would be created which would be large enough to accommodate a 40-year-old tree. If all trees with active infection, including those with callus, died, the number of openings which would accommodate a 40-year-old tree would increase to only five in all three areas.

Poria weirii and *Fomes annosus*, being responsible for less than 5% of the root rot infections at the first examination, accounted for nearly 22% of the root rot by the end of the study. The number of infection centers increased seven-fold, the number

of infected trees increased 13 times, and the number of infected trees per center doubled. Openings of up to 16 trees were recorded in the more badly infected areas. Trees infected by *P. weirii* showed a high rate of mortality and no evidence of callusing of infections, similar to that noted for *A. mellea*, was found.

In predicting the effects of *P. weirii* and *F. annosus* in the stands at age 40, with a stocking of 185 trees per acre, we assumed the incidence of infection centers would remain constant but the existing centers would enlarge at a rate similar to that which occurred during the period of examination. In two of the areas, the openings created would not be of concern to managers as they would not be large enough to accommodate significant numbers of 40-year-old trees. In the third area, where *P. weirii* was well established, four openings per acre would be created which would be large enough to accommodate a 40-year-old tree. The largest openings would accommodate 4 to 5 trees 40 years of age.

MEASURING DISEASE IMPACT IN RECREATION SITES

Neil J. MacGregor[3]

Presented by Leonard Felix[3]

The National Forests of California contain about 2,500 developed recreation sites that occupy 22,000 acres. These sites can accommodate up to 400,000 visitors at one time. Other Federal, State, and County facilities probably would bring the number of forested sites in California to at least 5,000 and their capacity to more than one million. In addition, much forested land in the state is managed for extensive visitor use. (The National Forests alone contain more than one million acres in this category.) Thus, the task of measuring disease impact in California's recreation sites is a big one. Today I shall outline briefly the early efforts of the California Region of the Forest Service in getting on with this job.

First, we should distinguish between recreation forests and timber forests: the former are managed mainly for the direct personal use of visitors, the latter for commodity production. Each yields a "product," although that of the recreation forest is the more difficult to measure. Nevertheless, the "yield" of a recreation forest can be determined (or estimated), so that the same methods of impact evaluation that are applied to timber

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forests can be applied as well to a recreation forest.

The California Region, cooperating with the PSW Station and the University of California has begun two impact evaluations in developed recreation sites: one for *Fomes annosus* in Yosemite Valley, and one for dwarf mistletoe in four selected campgrounds in southern California. Both evaluations are based on the same set of assumptions:

1. Trees and associated vegetation provide a forest setting without which a site would be much less "productive."

2. The pathogen will affect some or all of the trees, in time altering the character of the forest setting; changes in the forest setting may be adverse, neutral, or even beneficial.

3. The site as a whole has a dollar value, as if it were a privately owned investment property.

4. Impact is represented by the net change, brought about by the pathogen, in the total dollar value of the site.

In practice, this evaluation process will be carried out in the following way:

1. Assuming the site to be privately owned, and using whatever criteria are most applicable, estimate its present market value.

2. Estimate the effects of the pathogen, considering only those functions of the host trees that are recreation-oriented; these functions include providing shade, visual screening, and scenic interest. Express pathogen effects as the extent to which the recreational usefulness of the site will be reduced.

3. Adjust the factor from step 2 for the time at which the damage is expected to occur. Assume that damage occurring immediately will have the greater dollar impact than the impact from damage occurring in the future.

4. Estimate and discount to the present additional management expenses resulting from the disease. The cost of removing dead trees or of reforestation are examples of such expenses.

5. Compute impact as illustrated in the following example:

Value of Site: $400,000

Utility Reduction: 30%

Time Adjustment: 50%

Other Expenses: $10,000

IMPACT = ($400,000)(.30)(.50) + $10,000 = $110,000

In principle the impact value computed in this way represents the maximum expenditure for control that can be justified economically.

Yosemite Project. The *Fomes annosus* evaluation in Yosemite Valley is nearing completion. It is being carried out as a cooperative project by the California Region and the University of California. In 1971 Leonard Felix, then a post-doctoral fellow in the Department of Plant Pathology, located and mapped about 100 infection centers in developed sites within the Valley. From early maps some centers were dated to the mid-1930s. In the course of the project all developed sites in the Valley were carefully searched for evidence of the disease. When all necessary information on these centers has been assembled, a team representing the Region, the University, and the Park will attempt a center-by-center evaluation of this condition.

Dwarf Mistletoe Project. The dwarf mistletoe project is being carried out by an interdisciplinary team drawn from the Region, the Station, and the University. The team includes foresters, plant pathologists, landscape architects, recreation specialists, and land managers. The team will visit four campgrounds on three National Forests in southern California, and will make the estimates required for the impact equation.

PORIA ROOT ROT IMPACT DETERMINATION

David W. Johnson[4]

I. Introduction

Poria weirii incites a serious root disease of many Pacific Northwest conifers. Douglas-fir west of the Cascade Range is the most economically important and widespread host. The primary damage caused by the fungus is tree mortality, although growth reduction and butt rot also occur.

In the past, surveys conducted to determine the importance of Poria root rot have been restricted to measuring impact on timber volume production, most often in heavily infected stands. This study was initiated to develop methodology for measuring impact of an important disease on our forest resource. Impact data gained from such studies can be used to establish research priorities and support funding.

II. Objectives

This past summer we tested methods of estimating impact of

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[4]Division of Timber Management, U.S. Forest Service, Portland, Oregon.

Poria on three major forest resources, including timber, recreation, and wildlife in west side Douglas-fir stands on the Gifford Pinchot National Forest. Hopefully, this methodology can be adapted for use with other important root disease fungi, including *Fomes annosus* and *Armillaria mellea*.

III. Survey Limits

Poria weirii has a large geographic and host range. Its possible impacts on various forest resources are numerous and complex, thus limits by necessity were imposed on the survey. We considered only the major economic and management impacts of the disease. Its scope was limited as follows:

A. Forest type - Douglas-fir, coastal form.

B. Land area - Gifford Pinchot National Forest which contains numerous *P. weirii* infection centers in the Douglas-fir type.

C. Time - Estimate impact for the existing situation only; no forecasting attempted.

D. Resource impacts - The net impact of *P. weirii* will be evaluated quantitatively or qualitatively for:

1. Timber volume.
2. Stand composition and stocking.
3. Fire hazard.
4. Wildlife habitat.
5. Undesirable effects on humans and constructed facilities.

Whenever possible, monetary values will be assigned to the impacts.

IV. Survey Design

As a survey design, we chose to use the permanent Timber Management Inventory Plot System (1). Inventory data obtained from these plots is used for preparing timber management plans, including the allowable cut. These data served as the source for measuring impact of *Poria* on the timber resource.

The basic sample for the inventory plots consists of field plots located on a systematic grid 1.7 miles square. Each field plot consists of 10 sample points distributed over 1 acre and located at the apexes of equilateral triangles with 70-foot sides. At each of these points, data are collected on species, size, and quality characteristics of the trees present. Tree mortality and damage estimated to have been caused in the last 5 years are recorded by broad categories of causal agents such as insects, diseases, fire, animal, weather,

suppression, logging, and unknown.

Information on each field plot is stored on computer cards and tapes.

V. Field Plot Selection

Data print-outs were requested for all plots. The last inventory on the Gifford Pinchot National Forest was conducted in 1969. The data print-out from 814 plots distributed over the entire forest were scanned for plots likely to contain disease-caused mortality (possibly Poria root rot) and unknown-caused mortality in Douglas-fir. Of the 814 plots, 74 fit the criteria for Douglas-fir mortality (disease- and unknown-caused).

Inventory photos were used to relocate the field plots. The original plot records were used to determine the number and location of dead trees. Of the 74 plots selected for visitation, 58 were checked (16 could not be found or were inaccessible).

Each numbered tree on the plot was examined for evidence of *P. weirii* (wind-thrown trees, buttressed roots, incipient decay, ectotrophic mycelium at the root collar, laminated decay, and setal hyphae).

Of 58 plots visited, seven contained suspected *P. weirii*-infected trees. The age of these stands ranged from 14 to 60 years old.

VI. Impact Determination

A. Timber - Impact of Poria root rot on timber resources and related values will be determined by the following methods:

1. Timber volume - An estimate of Douglas-fir mortality attributed to *P. weirii* on the Gifford Pinchot National Forest will be made by subtracting the volumes of individual infected trees from the total plot volumes to get net volume. These figures represent mortality, not growth losses.

2. Stand composition - The impact will be estimated by comparing species composition inventory data (numbers and types of tree species and understory vegetation) of *P. weirii*-infected plots to uninfected plots. No monetary values will be assigned.

3. Stocking - The impact will be estimated by comparing stocking inventory data (numbers and density of stems per acre) of *P. weirii*-infected plots to uninfected plots. No monetary values will be assigned.

4. Fire hazard - This impact will be measured by estimating the "rate of spread" and "resistance to control." These estimates will be made by following the procedures given in the

"Guide for Fuel Type Identification," United States Forest Service, Region 6, 1968, 48 p. (2).

Fuel type identification has been completed for all areas on the Gifford Pinchot. Field plots with *Poria*-caused mortality will be reevaluated to determine if the disease has caused a change in the fuel type classification.

For impact of *P. weirii* on the other resources, very little quantitative data is available. Systems for measuring impact of any disease have not been developed; therefore, consultation with specialists in recreation, watershed, and wildlife are necessary.

B. Recreation

Trees killed or weakened by *P. weirii* in forested recreation areas present a potential hazard to the public. The weakened root systems of infected trees make them susceptible to windthrow. Both property damage and bodily injury to recreationalists may occur if a *Poria*-infected tree falls while the site is occupied.

All forested, developed campgrounds and picnic sites with Douglas-fir as a major species on the Gifford Pinchot will be surveyed and presence of *P. weirii* noted. Detailed data will be gathered on the level of hazard presented by infected trees and the cost of cleanup using the procedures outlined by Lee Paine in "Accidental Hazard Evaluation and Control Decisions on Forested Recreation Sites" (3).

Hazard is rated as the product of the probability of failure, the probability of impact, the damage potential of the possible failure (based on d.b.h. and type of failure expected — limb, upper or lower bole or root) and target value.

If the hazard exceeds an administratively established control level, removal of that tree will be recommended and cost determined.

Of a total of 66 acres on the Gifford Pinchot, 34 have been checked and 8 had *Poria*-infected trees. These areas will be used for detailed studies on recreation impact.

C. Wildlife

Poria weirii may have a number of possible indirect impacts on wildlife. The disease creates stand openings and an "edge effect" which may be favorable to various forms of wildlife. There are changes in tree species composition of the stand as the more susceptible species are killed and replaced by more resistant species.

An evaluation of *P. weirii* impact on wildlife is thus mainly qualitative. In order to obtain some measure of impact, a series of paired plots will be established, one plot on a *Poria* epicenter, the other adjacent to but not within the infected area. The major browse and forb species, density, and use by deer will be noted in each series of paired plots. Infected and noninfected plot data will be compared to determine differences in vegetation and carrying capacity for wildlife.

VII. Summary

I want to stress that this past summer's approach to the problem was a first attempt, and several problems arose that need to be resolved.

A. Problems encountered

1. The existing systematic sampling schemes, including the TMI plots, as they exist at present do not provide adequate information on individual disease problems in a form that can be utilized for impact measurements such as we attempted this past year.

2. The patchy distribution of the disease does not lend itself to survey by current systematic sampling methods.

3. It is believed that *Poria* does have an impact on growth of its host; however, methods to measure this impact need more emphasis.

4. In general, there are few guidelines available on impact determinations for any disease. Additional research input is needed.

B. Suggestions for the future

Further refinements in survey techniques are needed. Currently in Region 6 our inventory people are developing a comprehensive inventory system called the "Siuslaw Model." This system utilizes inputs from permanent inventory plots, individual stand exams, and other surveys to describe allowable cut and silvicultural prescriptions. A priority rating system is imposed on the system to determine stand treatments and timing of treatments.

Pathologists and entomologists should also have inputs into this system and make their needs known during the developmental stages of models such as this. Hopefully we can benefit from such input and obtain more meaningful estimates on impact of various forest pests.

Literature Cited

1. U.S. Forest Service. 1969. Field instructions for

integrated forest survey and timber management inventories in Oregon, Washington, and California.

2. U.S. Forest Service. 1968. Guide for fuel type identification, R-6. 48 p.

3. Paine, L. A. 1971. Accident hazard evaluation and control decisions on forested recreation sites. USDA Forest Serv. Res. Paper PSW-68. 10 p.

THE GROWTH IMPACT OF DWARF MISTLETOE IN MANAGED PONDEROSA PINE STANDS ON NATIONAL FORESTS IN OREGON AND WASHINGTON

James S. Hadfield[5]

As late as the mid-1950s, cutting of large, old growth was the only timber management activity conducted in many ponderosa pine stands in Pacific Northwest National Forests. The objective of this cutting was to remove as many high-risk trees, as characterized by the Keen risk rating system, from as large an area as possible. Millions of acres of overstocked understory stands were not treated except for partial overstory removal. Today, however, intensive silvicultural treatments such as tree selection, stocking control, and brush control are commonplace. For example, approximately 40,000 acres of overstocked ponderosa pine stands on National Forests in Oregon and Washington were precommercially thinned last year. Each year the acreage increases and treatments become more intensive.

The result of the silvicultural treatments has been to increase the growth rate so that trees reach a merchantable size in a much shorter period of time than they would in an unmanaged stand. The rotation age for ponderosa pine is now 80-120 years, depending upon the site. It is no longer necessary to grow trees for 200 or more years. Trees 12 inches in diameter are merchantable.

Most of the ponderosa pine stands receiving the treatments are overstocked with as many as 3,000-4,000 stems per acre. Despite their small average diameter the trees are often 20-50 years old. More than 50 percent or in excess of 20,000 acres of the stands thinned in 1971 are infested by the dwarf mistletoe, *Arceuthobium campylopodum*. The infestations typically originated from the overstory which has since been harvested or destroyed. The Forest Service policy in Oregon and Washington is to control the dwarf mistletoe in these stands by cleaning in conjunction with

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thinnings. No thinning is supposed to be conducted until all the overstory has been removed. If the stand has an average leave tree diameter less than 5 inches and is heavily infested, the recommendation is to destroy the stand and regenerate with dwarf mistletoe-free trees.

Information on the growth impact caused by dwarf mistletoe infestations on old-growth unmanaged ponderosa pine has been provided by Shea (1964) and Childs and Wilcox (1966). Childs and Edgren (1967) documented the impact on growth and form of pines averaging 107 years old at the time of the measurements. Unfortunately, little is known about the growth impact in stands which will receive one or more silvicultural treatments during their rotation. A number of questions on the effects of dwarf mistletoe in these stands need to be answered. For example:

Does ponderosa pine dwarf mistletoe cause an unacceptable growth retardation in infected dominant or codominant trees thinned to a spacing of at least 18 by 18 feet?

What amount of dwarf mistletoe can a released pine tolerate and still maintain satisfactory growth?

Is there a diameter limit where it would be more desirable to release an infected tree rather than destroy it?

Is the apparent lack of or small difference in growth rates between light to moderately infected and uninfected trees that have been released from competition just temporary or will it persist until the trees become merchantable?

What are we buying with dwarf mistletoe suppression money in small diameter ponderosa pine stands?

The most reliable and statistically valid approach to answering these and similar questions would be to establish a series of permanent plots in pine stands with varying degrees of dwarf mistletoe infestations. Several site classes, spacings, diameter limits, aspects, etc., would have to be represented. The degree of dwarf mistletoe infection and appropriate tree size and quality characteristics would be recorded prior to treatment. The progress of the plots would then be followed for several years after application of the treatment.

A small number of plots of this nature were established approximately 15 years ago by a silvicultural research project in the Pacific Northwest Forest and Range Experiment Station. Although no data has been published, many of the released infected trees appear to be growing well inspite of heavy dwarf mistletoe infections. Similar plots have recently been established by the Branch of Insect and Disease Control.

A major drawback of these plots is they do not provide

utilizable information until they have been established for at least 10 years, perhaps longer. They should be followed until the trees become merchantable or so slow growing that further data collection would be unwarranted. Rather than postpone treatment in large acreages of infested ponderosa pine stands until the permanent plots could provide the necessary information, it seems more desirable to seek out and test much shorter term impact assessment methods.

This past summer the Branch of Insect and Disease Control started an administrative study to measure the growth-impact of dwarf mistletoe in previously thinned pine stands.

Records were searched and requests were made to several eastside Oregon and Washington National Forests to locate some of the earliest thinnings. Large-scale thinning began in 1958; however, many of these stands were thinned to an 8 by 8 or 12 by 12 foot spacing. Release was negligible with these spacings so the search was restricted to thinnings which more closely approximated today's standards. A number of stands which had been thinned as early as 1960 were located on four National Forests. Ten stands with dwarf mistletoe infestations were selected for the study. Four of the stands had been used by Flora, in an economic analysis of dwarf mistletoe control. The treatment in these four stands involved removing all trees with visible dwarf mistletoe infections. Some infected trees had been pruned if they were needed for stocking. In some stands, dominant and codominants with a small number of infections were selected as leave trees. Other stands were thinned strictly on a spacing criteria with little apparent attention having been paid to dwarf mistletoe.

The date and type of each treatment was recorded for all ten stands. One-hundredth acre circular plots were established at specified intervals on parallel transects covering the stands. The following data were recorded for each tree on the plot.

1. DBH
2. Height
3. Crown class
4. Radial growth since treatment
5. Dwarf mistletoe rating
6. Ability of the leader to respond to release

The number of stumps in each plot were recorded. An estimate was made of the dwarf mistletoe infestation intensity in the stand surrounding the plot.

Every tenth tree examined in the stand was felled and cut into five sections of equal length. The following data were recorded from the lower cross-section of each of the five pieces:

1. Number of annual rings
2. Width of three inside the bark annual ring radii
3. Width of three annual ring radii before treatment
4. Radial growth since treatment

The height growth since treatment was determined by measuring to the branch whorl formed the season of the treatment.

These data are to be used to calculate tree volumes prior to and after treatments.

If an infected tree was dissected, several of the infections were clipped off. These infections were then cut through the thickest part of the swelling to determine the approximate date of the infection. This information was to be used to estimate the degree of infection at the time of the treatment.

A total of 883 trees were measured on approximately 450 acres. The preliminary results indicated that radial growth and height growth decreased with increasing dwarf mistletoe infection rates. However, many trees appeared to be responding to release in spite of dwarf mistletoe ratings of 3 through 5. Similar findings were reported by Shea and Belluschi (1965) in a report titled, "Effects of dwarf-mistletoe on diameter increment of immature ponderosa pine before and after partial logging." The data also indicated larger trees are more likely to be infected than smaller trees.

By utilizing this approach we were able to take advantage of a maximum of 12 years of interaction between the dwarf mistletoe and the released trees. If we had decided to establish permanent plots and impose the thinnings ourselves, we would have to wait until 1984 to collect comparable data. Further efforts are planned to locate stands thinned 20 to 30 years ago. The study will be expanded to include other tree species.

We feel a number of improvements can be made in this approach. Felling every tenth tree proved to be very time consuming and resulted in little additional information. In the future, increment cores will be taken from all trees to measure radial growth response. Dating infections also proved to be of little value. We are more interested in measuring growth response than dwarf mistletoe intensification. A basal area reading should be taken on the plot center to measure the amount of competition exerted on the plot trees.

There are some serious drawbacks to the methods we employed. In six of the ten stands, we did not know what the degree of dwarf mistletoe infestation was at the time of treatment. It was not possible to determine accurately the degree of the infections in the leave trees at the time of the thinnings. We were able to make rough approximations of the degree of infections by dating the infections and recording their locations in the crown. It

was not possible to accurately determine what types of trees were cut. We were forced to rely on scanty records and to examine trees and stumps which were often partially decomposed.

The growth impact data collected in this study will be used to help develop cost-benefit evaluation for thinning in dwarf mistletoe-infested ponderosa pine stands. Accurate cost data for thinning in infested stands are available but until now very little data were available on the benefits accruing from such treatments.

It is our belief that by examining past treatments, being cognizant of their shortcomings and by establishing long-term plots, we can make accurate assessments of the impact of dwarf mistletoes in managed stands, regardless of the species.

Literature Cited

1. Childs, T. W., & E. R. Wilcox. 1966. Dwarfmistletoe effects in mature ponderosa pine forests in south-central Oregon. J. Forestry 64:246-250.

2. Childs, T. W., & J. W. Edgren. 1967. Dwarfmistletoe effects on ponderosa pine growth and trunk form. Forest Sci. 13: 167-174.

3. Flora, D. F. 1966. Economic guides for ponderosa pine dwarfmistletoe control in young stands of the Pacific Northwest. U.S. Forest Serv. Res. Paper PNW-29.

4. Shea, K. R. 1964. Diameter increment of ponderosa pine infected with dwarfmistletoe in south-central Oregon. J. Forestry 62:743-748.

5. Shea, K. R., & P. G. Belluschi. 1965. Effects of dwarf-mistletoe on diameter increment of immature ponderosa pine before and after partial logging. Weyerhaeuser Forest Paper 4, Centralia, Washington. 7 p.

PANEL IV - QUALITY IN THE FOREST AND IN THE PRODUCT

J. W. Roff[1]

Discussion centered around the concept that wood quality in forest products relates to its intended use in service and not necessarily to its appearance as seen in the forest. Because the quality of wood from the forest may be modified in industrial processes, potential defects related to the tree may lose their significance, thus increasing the proportion of the forest crop that can be utilized, or create other problems in service.

As background for the discussion Mr. Jack Walters, Forest Manager of the University of British Columbia's 12,000 acre research forest, outlined plans for future development. Because of pressures of population growth he foresaw urban development up to the forest boundaries. Intensive forest management will be carried out only on the most productive sites, fertilized in part from sewage. Sawtimber of present species will be cropped in 50-year rotation. For the most part, the remainder of the forest will be for recreation.

There was concern for the possible effect of the high nitrogen content of the fertilizer upon rhizomorph development and occurrence of root rot. Cellulose content and tracheid length resulting from the expected growth acceleration had not been studied.

Tony Cserjesi, Western Forest Products Laboratory, dealt with the production of extractives by the tree and the possibility of modifying this by forest management, depending upon whether low extractive material was favored as in pulp or high extractive for durability of the wood. The future of forest products as a source of chemicals now supplied through mining or the petro-chemical industry was indicated.

While there was a possibility of manipulating genetics of trees to produce a product suited for the purpose required, it was felt that the most desirable quality, as far as manufacturing was concerned, was that of uniformity in the raw material.

Dr. Wayne Wilcox, Forest Products Laboratory, University of California, Berkeley, speaking on "Apparent and hidden defects in products" noted that forest quality can be affected by agents which upset growth, reduce stocking and destroy existing volume and this impact can be measured and hopefully controlled by modified management practices. Quality in the product, however, is more difficult to estimate in early stages of manufacture, particularly when "apparent defects" seen in the log are not apparent afterwards but "hidden" defects not previously observed until manufacture, eventually render the product unsuitable for use.

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In white fir, in California, two common conditions, wetwood and dwarf mistletoe, come under the "apparent defect" category. Each is readily seen in the tree or sawn log. Wetwood yielded higher than average values for specific gravity and toughness in lumber. Mistletoe-infected trees yielded lumber of similar grade and quality to that from uninfected specimens. The assumption is made that quality in the forest, form and increment and possibly tree species distribution, are chiefly affected by these "apparent defects," hopefully they are controllable by management practices.

Hidden defects like incipient decay enter into forest products often because of lack of recognition of symptoms. These may have been evident in the forest but became obscured along the way from stump to stud. Very serious losses result but, hopefully, will become less common in younger, managed forests. Ring shake, leading to longitudinal separation of wood along the grain, is another condition which may become visible on white fir only after final manufacture. A possible association of shake with *Scolytus* beetle was suggested.

Mr. Jack Roff, Western Forest Products Laboratory, noted that a forest may be called upon to do many things from preventing erosion, concealing campers to providing material for structures or fibre products. Graceful tree forms, a quality revered by otherwise frustrated foresters was of little consequence to one concerned with holding soil. Despite the traditional reverence for Douglas-fir in the West, both as a tree and as a product, it was suggested that greater effort should be made in planting and managing western red cedar forests because of the high losses from *Poria weirii* which are forecast in Douglas-fir (and western hemlock) immature stands.

A rapid rate of growth is common in young cedar stands and while the strength properties for the lumber are inferior to fir or hemlock, it has a favored market position as finish and cladding because of appearance and durability. In spite of its lower specific gravity, utilization of cedar for pulp (now 20 percent of the B.C. kraft production) continues to increase. Former objections to the wood quality, relating to shorter fibre and higher extractive content have been overcome through modifying the pulping process.

As far as pulp material is concerned, once problems of bringing trees to harvestable age are mastered, presence of decay in logs appeared of little significance, provided white rots were concerned and provided that no voids from rot appeared. On-going research suggested that losses in the tree from common organisms such as *Fomes pini* and *Echinodontium tinctorium* may not be apparent in terms of yield and strength of kraft pulp made from such incipiently decayed material.

Sapwood-heartwood relationships, moisture content and rate of growth were seen as factors in wood products quality which

may be readily affected by forest management. Modification of industrial practices in seasoning wood, in wider use of preservatives and of engineered truss design and laminated wood members may be required to maintain utility standards.

In the face of competition from other products, concrete, steel and plastic, it was felt that the wood-using industry could continue to produce an economical product as long as it was supplied with a sufficient volume of solid but not necessarily disease-free wood.

APPARENT DEFECTS AND HIDDEN DEFECTS

W. Wayne Wilcox[2]

Introduction

All of us — from forest manager, to wood-product producer, to consultant (such as the forest pathologist), to consumer — are concerned with the problem of wood defects. We want to produce the greatest volume of wood products of the greatest utility, value and reliability that we can from every acre of commercial forest land. As forest pathologists we concern ourselves primarily with agents which reduce stocking, upset desired species mixes, reduce growth, or destroy present volume. We can look at a decay column in a log and determine how much of that log is unfit for use in most wood products. We can even look at a standing tree and, from external indicators, estimate the volume of wood substance that will probably be unacceptable for many uses.

But there is one group of defects that we now approach with considerable uncertainty of knowledge. When dealing with this group, the information available from the standing tree or bucked log is inadequate to accurately predict the effect and importance that a certain condition may have on production and the quality of the final product. The group may be said to consist of two parts: the *hidden defect* (which is not visible in the tree or log but which exerts its effect during processing or use) and, for want of a better name, what I would like to call the *apparent defect* (a condition apparent in the tree or log which could reasonably be expected to cause problems during processing or use, but which, in fact, does not). These defects are difficult to study, but with production costs and demand for wood products steadily increasing while pressure for reduction of area available for wood production also increases, I think we must study them. I hope that during the present discussion we might, as a group, list a number of such defects worthy of study, and increase our understanding of

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[2]Forest Products Laboratory, University of California, Berkeley 94720.

the potential importance of each one. To get the thought processes started I'd like to briefly discuss a few wood-defect problems that I have selected as being of critical importance.

Hidden Defects

I shall discuss hidden defects rather quickly not because they are not important but primarily because I haven't worked much in this area, although I hope to. Perhaps the most familiar hidden defects are decay columns shorter than the length of a log for which there are no external indicators. Here, however, I would like to point out an insidious problem that may be of even greater importance in some species — that of ring shake. Gene Pong, of the Log Grading project of PNW at Portland, and I have been studying defects in California white fir for several years and all the data I will be presenting today apply specifically to this study. A problem that one quickly notices when dealing with white fir, whether in the sawmill, on the veneer lathe, or in the laboratory while preparing specimens, is that a log, cant, or bolt will sometimes inexplicably fall apart while being cut, with the severance following the direction of a given annual ring. There will be no flaw or separation apparent on the ends or sides of the piece, but on the next cut it falls apart. Why? How can this be predicted? How can this problem be controlled or reduced? When such severances occur in specimens in the lab, I have observed frequently that somewhere along the plane of failure there is an overgrown *Scolytus ventralis* cambial-patch kill. Is ring shake in white fir always associated with *Scolytus* injury? If this is so, how can an entire slab or bolt sever when the patch or patches involve such a small amount of the failure surface? Could the problem be averted by controlling *Scolytus* in white fir, or could *Scolytus* be controlled? I don't know, but I think we should know. Hidden defects are insidious, for they rob us of volume and quality that, up until the last moments of processing, we thought we had.

Apparent Defects

Loss in this category occurs when we see a defect which we presume will adversely affect quality or use and which causes us to unnecessarily allocate the material to a less valuable use than usual. On the other hand, serious loss in product reliability and serviceability may result from defects which can be recognized in the forest (and even accounted for in determining merchantability) but which are not re-recognized during or after processing. I would here like to include both the above types of defect under this category, and to discuss in somewhat greater detail an example of each upon which I've been working.

Wetwood in white fir

Several years ago I became aware of complaints about excessive wetness in the core of white fir logs. Some thought this wet core was responsible for severe checking during drying, that it probably

was incipient decay, and that it warranted a scale deduction as a defect. Recognizing that many of the symptoms were similar to the wetwood in hardwoods which apparently is associated with defect and is considered a bacterial stem disease, I decided to study the problem. In California white fir wetwood symptoms are most severe and most typical in the center of butt logs or at most in the lowest two 16-foot logs. We found a bacterium associated with this zone (1, 2) but couldn't find that it was doing anything to the wood — even the pit membranes with which the bacterial cells were in contact were perfectly intact. The wood at the center of butt logs was slightly wetter on the average than other wood in the stem (3) and took considerably longer to dry, but once dried it had some of the most favorable properties of any wood in the tree — for example, in high specific gravity and toughness values. So, instead of leaving wetwood in the forest or demoting the cut wood to a lesser use, we should dry it longer and rejoice that it was there.

Mistletoe in white fir

Mistletoe, particularly dwarf mistletoe, is a serious tree killer and deformer. Srivastava and Esau (4) and others have shown that dwarf mistletoe infection causes severe xylem cell abnormalities of a nature that would lead one to expect strength, shrinkage, and other wood properties to be adversely affected. In fact, Piirto (5) found, for dwarf mistletoe-infected lodgepole pine, that the moduli of elasticity and rupture and work to the proportional limit were lower in infected than in noninfected wood. Curiously enough, he also found that noninfected wood from infected trees had properties inferior to wood from noninfected trees. Clearly, here is a pathological condition that we should carefully identify in the raw material and segregate for alternate uses at the processing plant. Or should we?

During our study of white fir we found some noticeably swollen and readily identifiable mistletoe cankers, some of which contained decay. But for each such canker there were several more which had no swelling or were slightly sunken, so that only a skilled observer could detect them. However, even the wood containing quite noticeable cankers wasn't treated any differently at the sawmill. Decay pockets may have caused the sawyer to handle the log differently, but boards from logs having mistletoe cankers joined the green chain just like any other boards. Surely then, by keeping track of every board arising from the 20 trees included in the study, we should have seen a drastic difference between these inferior boards and normal boards in the original grades they received and in the degrade and loss they underwent during drying and further processing. We should have — but we didn't!

When degrade was segregated log by log into four defect classes (6)— no defect, dwarf mistletoe, true mistletoe, and "other defects" (consisting of frost cracks, cankers other than mistletoe cankers, and bleeding from branch stubs in the standing tree), slight differences were apparent, but were not statistically significant. We

then determined the distribution of grades resulting from the total volume of logs in each defect category (6). More volume in clear and shop grades came from dwarf mistletoe and other defect logs than from non-defect logs, while true mistletoe logs produced much less volume in these grades than did non-defect logs.

We began to worry a little about these data, however, because of the different locations of the defects. True mistletoe in white fir tends to be most apparent in the small logs at the tops of trees, dwarf mistletoe occurs throughout the length of the stem, and the other defects just mentioned are associated primarily with lower logs. Analyzing the distribution of heights and diameters of the logs in each defect class proved that our worry was well-founded — in fact, analysis of variance showed that log diameter accounted for more of the total variation than did defect. We then treated grade distribution and volume data on a log-by-log basis by analysis of covariance and adjusted for the effect of diameter (6). After adjustment the only differences attributable to defect which were statistically significant were in the shop- and dimension-grade categories. The only significant pairwise comparison between the no-defect category and any of the defect categories was in the shop grades between no-defect and dwarf mistletoe logs. This difference was in the opposite direction from that which would be consistent with a hypothesis of detrimental effects by dwarf mistletoe. We must conclude from this that either the defects considered here have no deleterious effects upon wood quality, or that present methods for detecting such defects are inadequate. The latter idea seems to me the most likely.

But there is a similar and probably even more serious detection problem which can be illustrated by another example. This example takes us back to hidden defects, as the mistletoe example did basically. I recently was consulted in a lawsuit involving failure of a Douglas-fir ceiling joist. The piece of joist that was brought to me for examination looked bright and sound, had a clearly legible structural grade stamp on it, and was terminated by a brash failure. The joist had failed without warning under the weight of a carpenter, severely injuring him. Microscopical examination revealed that despite the good external appearance of the piece, there was incipient decay present, most probably from heart rot in the standing tree. The case was settled out of court for in excess of $50,000. Like the mistletoe example discussed, this was another case in which the problem might have been diagnosed in the woods but which lost its identity going through the sawmill. Stress grading might not solve all problems of hidden and apparent defects but who presently knows what else could? Despite this, the industry is not even using the stress-grading technique to achieve what quality control it could provide. Are wood producers concerned about the reliability of their product? If they are, there is a significant role to be played by forest pathologists in helping them identify and diagnose important apparent and hidden defects.

Literature Cited

1. Wilcox, W. W. & C. G. R. Schlink. 1971. Absorptivity and pit structure as related to wetwood in white fir. Wood & Fiber 2: 373 - 379.

2. Wilcox, W. W. & N. D. Oldham. 1972. Bacterium associated with wetwood in white fir. Phytopathology 62:384-385.

3. Wilcox, W. W. & W. Y. Pong. 1971. The effects of height, radial position, and wetwood on white fir wood properties. Wood & Fiber 3:47-55.

4. Srivastava, L. M. & K. Esau. 1961. Relation of dwarf-mistletoe *(Atceuthobium)* to the xylem tissue of conifers. II. Effect of the parasite on the xylem anatomy of the host. Amer. J. Bot. 48:209-215.

5. Piirto, D. D. 1971. The effects of dwarf mistletoe on the wood properties of lodgepole pine. M.S. Thesis. Colorado State Univ., Fort Collins. 78 p.

6. Wilcox, W. W., W. Y. Pong, & J. R. Parmeter. 1973. Effects of mistletoe and other defects on wood quality in white fir. In preparation.

THE SCIENTIST IN THE SOUTHWEST ENERGY PROGRAM

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Resource managers in this day and age of public concern are being faced with a dilemma much in the manner of St. Peter when he decided to take a short vacation into the country from his arduous duties as tender of the pearly gates. Returning in a few days he was amazed to discover that the neighbor had moved the common boundary fence inside St. Peter's yard. Peter decided to go and talk the matter over with the neighbor. Judging this to be a case of trespass he asked Lucifer why he had moved the fence? To this the devil replied insolently, "I just wanted to and I did it," in a tone indicating "and what the h--l are you going to do about it-". St. Peter, being a man of peaceable disposition and not taken to violence, said he would get an attorney to determine in court this infraction of law and get an order to return the fence to its proper location. To this the devil laughed and laughed with great glee. St. Peter asked him why the laughter as this was no laughing matter. To this the devil replied, "And where are you going to get your attorney?"

The dilemma in which natural resource managers find themselves during this period in time is a product of the age, not of the managers, or individuals, but for want of a better term, it is a devil's brew concocted over many years by chance, by ignorance, and/or combinations of these circumstances to which we all are contributors.

During the next few minutes I hope in a very limited way to interpose into your rather specialized deliberations a few notes, not entirely harmonious or acquiscent with your philosophy, but which may hopefully bring to your attention the frustrations of an administrator and resource manager who must contend with this tower of Babel in a wilderness in which you as scientists and the public, often a very vocal one, seem to have less in common as time goes on.

Let me hasten to add here that these notes are not intended as a criticism of your actions by any means but are intended rather as a critique of our actions as scientists, as resource managers and administrators at a time when we need some soul searching over individual and corporate responsibilities in our society.

Natural resource utilization is part of modern man's progressiveness. However, the careless utilization of these resources has engendered in our modern society a questioning of the term progress and triggered a small segment of this society into rebellion.

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[1]National Park Service, Santa Fe, New Mexico 97502.

A prime example of resource utilization on a massive scale largely because of necessity is involved in the present southwest energy program. Recently, during the past year, this program has been opposed by many conservationists in the United States. I am citing this as a typical problem presently. This is just one of the many others no doubt which you as forest scientists will need to consider in the future decades. So, I am exposing you to a problem that has developed with a growing population in the southwest United States. Briefly, this population increased by 54.8% or over 2,296,000 persons in the states of Utah, Arizona, Colorado, Nevada, and New Mexico alone in the 1960 to 1970 period. Understandably with this burgeoning growth a demand for additional electrical energy developed both for use in these five states and for exportation to the southern California megalopolis.

Design and siting difficulties of nuclear power plants in the West in time to meet this increasing electrical power demand necessitated a search for alternative energy sources for the period of the 1970s to 1990s. Therefore this thermal power development program was undertaken by the utility industry to provide the needed electrical energy from vast, largely untapped coal deposits in the Colorado River basin.

The United States Government participation in this thermal generating plant program was approved by Congress in September 1968 through authorization of the central Arizona project. The first coal fired plant was an alternative to construction of two dams on the Colorado River for hydro-power production which was opposed by conservationists. Further, the Federal Government also became involved in the program as a contracting agent to supply water for the thermal plants and issuing permits for the needed right-of-ways over public lands.

Presently there are in existence 64 generating plants with production capacities of 20 megawatts or greater within the Southwest power complex. In addition to those 64 power plants there have been completed additional coal fired plants of major size 100 megawatt or greater in New Mexico, Nevada and Arizona. Also, additional plants of major size are under construction, planned or programmed by the power industry to be located in Colorado, Nevada, Wyoming and Arizona that will boost the total production capacity to 7,172 megawatts. The daily coal consumption to achieve this production level is estimated to be nearly 75,000 tons. To bring our problem into somewhat sharper focus let us consider a 13,300 megawatt production level that will be achieved possibly by 1980 through operation of the earlier units supplemented by 13 additional units at the plants now under construction and proposed for construction. The 26 production units within this developmental framework will consume 145,000 tons of coal per day. The daily emission of particulates, depending largely on degree of plant efficiency and the installation and operational integrity of control equipment, may range from as high as 146 tons per day to as little as 85 tons per day. Again,

depending on efficiency of and the control equipment, the emission of sulphur dioxides may range from a high of 1,610 tons to as low as 1,300 tons per day. Nitrogen oxide emission will approximate 1,200 tons per day, while nearly 18,000 tons of ash will be created daily through the combustion process.

Again at a future period it may be expected that when and if the development of 30,000 megawatts be reached, daily coal consumption for electric power may total in the neighborhood of 290,000 tons. Emission of particulates, oxides, and trace elements will increase accordingly.

The fuel necessary to fire the recently constructed, now building and the proposed plants will come largely from native sources close by the generating sites.

While no firm estimates have been made with regard to ultimate acreages of the mined areas, a majority of all coal required will be by strip mining. The magnitude of the field may be envisioned by the requirement of nearly 75,000 tons of coal per day for present production and an estimated 146,000 tons of coal per day required for plants presently being constructed, and the need of 290,000 tons for possible projected future expansion in the 1990s.

The Colorado River Basin area containing this energy source is a region of contrasts and extremes with unique land forms and features. In quick perspective, this region runs the gamut of rich forest lands punctuated by 14,000 foot peaks to sweeping plateaus cut by steep sided canyons; of fertile valleys or arid desert sands; of Death Valley and Salton Sea more than 200 feet below sea level. Within this area is found the Grand Canyon of the Colorado River and Lake Mead, the largest reservoir in the Western Hemisphere created by Hoover Dam, one of the engineering marvels of the world. To the north is the great Salt Lake; to the east the majestic bordering Rockies. Within this area are the outstanding examples of forest wilderness as embodied in the Bridger National Forest located in Wyoming's Wind River Mountains, and the Wasatch and Ashley National Forests spanning Utah's Uinta Mountains, the only major chain in the United States with an east-west orientation.

Also the National Park Service administers in this area a total of 58 national parks, monuments, recreation areas, historic sites and memorials.

This whole area contains examples of all life zones found in the United States with the exception of the tropical zone of southern Florida.

Annual mean temperatures range from a low of 27°F or less in the Boreal Zone typical of the high mountains of Wyoming, northern Utah and Colorado to highs of 74°F in the lower Sonoran Zone of

Southern California, Nevada, Arizona and New Mexico. Similarly, annual precipitation averages from the highs of as much as 60 inches in the north to as little as 1.5 inches in the extreme southern desert areas. Plant and animal life range across the entire scope of living things typical of these zones.

For our purpose as forest scientists, forest and plant pathologists, let us consider that plant life organisms tend to accumulate certain materials such as mercury, uranium, thorium, and other heavy metals. These materials are often found locked in coal, and through the combustion process, are released into the atmosphere. As an example, the concentration of mercury in the coal being burned presently is approximately the same as concentrations of the metals in other rocks of cretaceous age in the Colorado Plateau area. This means that as a result of possible future levels of energy production, which may utilize approximately 145,000 tons of coal daily, there may be a regional emission of mercury on the order of 6 to 24 tons per year.

The ultimate impact of mercury and other trace metals on ecosystems is largely unknown.

Soil algae and lichens are agents that stabilize surface crusts in dry areas where macro-vegetation and higher plants are lacking. Algae-stabilized surface crusts have been found to play a role as nitrogen sources in arid regions when bacterial nitrogen fixation is lacking. So, changes in crust forming organisms due to pollution factors could have an effect on nitrogen availability to higher plants.

Sulphur dioxide, abundant in stack emissions from coal and oil fueled industrial plants, is recognized as one of the pollutants causing damage to vegetation under certain conditions of humidity and temperature. The effects may be chronic or acute. This gas is toxic to some plant species in concentrations above 0.1 to 0.2 ppm, the effect being dependent on length of exposure time. Chronic injury to plants is caused either by rapid absorption of sulphur dioxide somewhat less than the amount needed to cause acute symptoms, or by exposure for a long period of time to sub-lethal concentrations usually under 0.4 ppm. It must be recognized that the individual plant species vary markedly in their sensitivity to pollutants, some being quite tolerant while others are damaged by various concentrations of SO_2. The greatest effect of SO_2 on plants has been demonstrated where they are grown on sandy soils in regions characterized by high temperatures and high humidities which encourage high rates of transpiration. Experiments demonstrate that a plant may be unaffected by exposure to concentrations of the oxides of sulphur and nitrogen alone in a range of 300 to 800 percent of normal. In a combination, however, exposure to these two gasses destroyed the plant.

In these few moments we have reviewed very briefly a very present problem. Studies have been initiated by a few in our scientific community that may hopefully in time resolve certain problems connected with pollution and pollution damage.

Secretary of the Interior Roger Morton has expressed grave concern over this problem and has directed investigations to determine the magnitude of environmental deterioration from the utilization of low grade coal deposits in electrical energy production. From these investigations, however, we find that very few studies exist which are aimed to determine the effects of sulphur oxides and nitrogen oxides on native plants in cool, arid and semi-arid areas of western North America.

It is evident that additional work needs to be done to fully ascertain the scope and degree of impact of air-borne pollutants on the American Southwest vegetation. It is equally evident that one of the great oversights of the past century and possibly the last two decades of scientific investigations is the failure to adequately monitor our environment.

The present problems in the development of fossil fuel power plants are environmentally significant. The questions we need ask ourselves are not new. Our past mistakes are evident and they are not comforting. So let us somewhat coldly and candidly question ourselves ...Where and when did our scientific acumen fail when the ponderosa pine stands of the Sierra Nevada range began to show distress from ozone damage; or Los Angeles smog began to destroy the citrus groves, and the vineyards in the Imperial Valley? Did we begin studies to determine conditions distressing vegetation in western forests before the establishment of smelters and power plants; before the masses of people began to migrate into the more open spaces of the West?

How much baseline information have we collected in the case of possible vegetation damage and air and water pollution from fossil fuel utilization in power plants in the Southwest?

Our retort, of course, is the classic stock answer "We were not required to get involved" and "We were not informed officially."

Unfortunately, I foresee the excuse that our administrative policies forbid action on this "frontier of concern beyond our specialization" as unacceptable to the public, their representatives in Congress, or the resource manager and the administrator.

The ivory tower sanctity to which many of us migrated as specialists has little place in this age of real problems. The umpteenth and final bridge between what is known and the unknown will not wait in the case of realistic and pressing problems of our society. Problems we are not resolving but allowing to proliferate into many new problems.

The expanding research pouring out of government agencies and our academic centers can mean little to the resource manager unless these are oriented to present day management needs.

I have a feeling that we missed the boat during critical times in history when we could have, and we should have, voiced meaningful questions to our peers and initiated studies, valid studies, that would have provided valuable data to the presently sophisticated research systems.

As I look over this fence of Lucifers I have an uneasy feeling that history will not buy the excuses we may have to offer for our failure to provide practical and valid solutions to environmental and ecological problems born from man's excesses; that man will not accept our idealism; that man expects results for every dollar he expends on research, meaningful research, for problems of this generation and future generations of man. Mark my words, gentlemen, Lucifer is moving his fence on our yard!

The membership in this The Western International Forest Disease Work Conference are basically problem oriented people. However, as forest pathologists and as scientists you should not be tied entirely to the stocks of specialization; your interests should include the sciences — the broad field of generalization in the sciences — and let me leave you with this final somber thought — unless you, we, and our contemporaries can become generals to meet the demand to interpret in meaningful terms the fateful energies involved in a future society, man could by this hour have written his own orbituary!

BARK AND WOOD STRUCTURE AND PROCESS OF FORMATION OF ABIOTIC CANKER

Harry Zalasky[1]

Frost-killing of vital vascular tissues has a great potential in canker inception in exotic and native trees. If recurrent, it may reduce the food reserves at a critical time in the spring, or it may reduce the capacity to store food in the autumn. Continuous devitalization often leads to mortality. The genera *Populus* and *Pinus*, both having a wide geographic distribution, were chosen for anatomical study because of the prevalence of canker, dieback, loss of leader and stem deformation in young and pole-sized trees. In order to obtain a full picture of host response to winter injury a study of temperature records and of structure of rejuvenated bark and wood in injured stems seems indispensable.

Incidence of Frost

In many parts of the North Temperate zone, fall frost signifies the approach of winter and occurs during an autumn transition. In the northern Rocky Mountains, foothills and boreal forest, autumn transition begins in the latter part of August in many isolated valleys where air drainage is poor. It lasts longer in the high foothills and Rockies in the lower latitudes where winters are shorter but the frequency of warm spells and cold spells also increases. In the plains country east of the Rockies, a similar pattern exists, except the autumn transition is shorter and the frequency of warm spells and cold spells decreases in the winter months. The latter anomalies are confined almost entirely to November and March in the northern latitudes and eastern longitudes of the Canadian Plains.

The spring transition covers a period from the middle of March to the end of June in the Rockies and high foothills and during April and May in the Plains area. In general, the frequency of temperature fluctuation increases partly because of chinooks and partly because of warming trends throughout the Prairies with the onset of summer. Chinooks along the Rockies and foothills country produce a rise in temperature, occasionally 30 to 40°F within an hour and terminate by the arrival of strong cold artic winds. A drop in temperature from +40°F to -30°F is not uncommon. In some winters, artic winds push the chinook with sudden rises of 20°F well to the south and east of the normal chinook belt into the Plains area.

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[1]Northern Forest Research Centre, Edmonton, Alberta.

Bark and Wood Structure of Canker

Bark Structure

In radial sections of initial canker, damaged parenchymata in the cambium, cortex and phloem become physically disorganized by crushing, collapse and honeycombing. Disintegration of cellular contents results in inter- and intracellular occlusions with gummy resin and pitch, respectively, in poplar and pine. On the living side of the stem adjacent to the canker, new periderm and phloem tend to unfold the edge of current sapwood resulting in a raised ridge-like band.

Radial sections of scabby bark in 2-year-old poplar and 3-year-old pine show essentially the same sequences of necrosis in the cortex and phloem. Discoloration in poplar scabby bark is yellowish brown and that of pine a reddish or purplish brown as described by Mullick (1972). Below the upper scabby bark of poplar, a second periderm forms in the phloem and cortex with exfoliation of the original. In pine small but not the large patches of scabby bark flake off after a second periderm is formed. In large patches, phloem rays proliferate to develop horizontal resin canals that coalesce into a single pitch pocket. Periderm sequences in later years consist of the same number of cork cell layers or several times more than the original one. Accompanying them are wedges of rejuvenation tissue contributed by the phloem ray and cortex. As new excrescences develop unevenly, they tend to push necrotic phloem layers into oblique alignment. In older wood, enlargement of the lesion in area and thickness of scabby bark follows each freeze-killing of the phloem alternating with sequences of periderm enclosing lens-like laminations. Longitudinal fissures characterize poplar scabby bark and pitch pockets characterize pine scabby bark which often is raised along one side.

The cambium ray initials at the interface of the phloem and xylem bordering the canker proliferate to produce ray excrescences consisting of isodiametric parenchymatous cells that result in a thick layer of occlusion tissues intergrading laterally with normal phloem. Sieve elements and cambial initials are absent. Ray parenchyma, retaining their normal orientation throughout the excrescence are less conspicuous and shorter than the normal cells. Diagonal sequences of periderm often develop in this tissue.

Wood Structure

Frost ring is the first to form in sapwood of stems with scabby bark but it may be absent if the bark and sapwood are killed outright in young trees. The first tissues to be formed have their origin in the xylem ray of the summerwood which proliferate in the springwood to form aggregate, multiseriate and uniseriate rays in poplar and ray excrescences in pine. Callosed reticulate wall thickenings are common in parenchyma of the former and in reticulate tracheids of the latter. All cells tend to

retain isodiametric form of ray initials and frequently they are angular and globose. Interspersed among them are cells of cambial origin, all of which become dominant as soon as the cambium is reestablished. Tracheids frequently have fine to broad bands of spiral thickenings and are variously bent, forked, attenuated at opices or one end angular and blunt or rounded and clavate. Vessels of poplar also stand out because of their lateral proliferations, forking and scalariform and reticulate pitting. Presence of attenuated border pits and callose distinguishes these conducting elements from normal ones.

Another extreme variation of wood structure occurs at the margins of the canker where ray cells develop weaker isodiametric tissues similar to the ones occurring in the phloem. Reestablishment of the cambium at the frost ring and at the margin of the canker shows a wide range of development and maturation in the sequences of multiple growth layers. As in the frost ring, alignment of tissues becomes quite complex, involving some overlapping, twisting and turning of the elements and resulting in interlocking grain of the wood. Observations show that even after four months, reorientation of the elements does not occur. Ray proliferation diminishes somewhat but it continues to dominate the multiple growth layer. Spiral tracheids are numerous except for the gelatinous fibers.

Process of Development of Canker

Phloem and xylem are most vulnerable to freeze-killing during the developmental and maturation cycles. Development of the phloem in April exposes this tissue at bud and needle traces to frost injury earlier by 4 to 6 weeks than that of the xylem which begins to develop in May. Similarly, phloem and xylem are vulnerable during the autumn transition because their late maturation coincides with the killing frost; the most common loci are leaf and bud traces. Damage to the bark may occur during the winter months when very warm day temperature is succeeded by cold night temperature.

Bark and sapwood in current shoots show no visible difference in susceptibility to freeze-killing, particularly if wood and buds are immature and leaves are green as in poplar. In older wood, sapwood is less susceptible to killing as long as it is nourished and protected by undamaged bark. Once the storage capacity of the bark is reduced, the phloem and xylem no longer are able to rejuvenate readily at the margin of the canker. In decreasing order of sensitivity to frost-killing, the tissues are phloem rays, cortex, cambial region rays, pith, and phloem and xylem parenchyma in the cambial region. Frost-killing has the greatest impact on tissues most active in storage and rejuvenation occurring in the zone between the cortex and the phloem. The impact of the damage on subsequent development of new phloem and xylem is, therefore, in inverse proportion.

Initiation of canker starts with phloem discoloration and sequences of periderm separating dead tissues from living ones. The resultant raised lesion of bark becomes scabby and very much laminated. In pine it may flake off in the first year but it soon becomes resin-soaked and unable to separate readily. A pitch pocket develops with the enlargement and fusion of horizontal resin canals. New resin canals from proliferation of phloem ray cells provide a continuous flow into the pitch pocket. When pitch flow becomes profuse, the scabby bark lifts to one side. In poplar, scabby bark remains intact for several weeks before it ruptures and allows some of the water soluble gummy resins to drain from the impregnated dead tissues. Cracks develop in the wood below if the cambium and parenchyma may have been killed. Phloem ray excrescences become prominent along the edge of the canker resulting in terracing of scabby bark in poplar.

Once an ungulate segment of wood becomes exposed to and impregnated with pitch and gummy resin from the bark, it discolors in an arc, the width of the canker. But pitch impregnated wood does not weather and cross-check as does poplar wood impregnated with gummy resins.

Discussion and Summary

Decreasing order of susceptibility of rejuvenating tissues has been from that of the most actively proliferating cortex parenchyma and phloem rays to the proliferating xylem ray. These tissues have been found to be poorly developed and differentiated. However, tissues developed by the reestablished cambium have also been found to be defective and poorly differentiated, resulting particularly in weaker fibers, smaller vessels, and in a tendency toward spiral tracheids and reticulate and scalariform vessel elements. Long after the reestablishment of the cambium, ray initials continued to play an increased role in the development of vascular tissues. They were observed as massive excrescences in the phloem and as aggregates of multiseriate and defused cells in the xylem.

Thus, winter injury has had two types of impact on living tissues: necrosis of storage parenchyma and the inability of the cambium to survive. Ultimately, reestablishment has resulted in insufficient development and maturation of vascular occlusion tissues. The storage and vascular tissues have always been interdependent. In view of the evidence, the ability of the host to survive the impact has depended on growth factors first and on species and clones second.

This report has been compiled from personal research notes and previous publications (Zalasky, 1970, 1972). Some of the useful Canadian references for weather records and reports are Ashwell (1971), Canada Department of Transport (1965-1971), and Kendrew and Currie (1955). For readings on frost ring, the

American authors Rhoads (1923), Harris (1934), and Glock *et al.* (1960) are highly recommended. For original work on scabby bark, German author, Joachim (1957 and 1963) would be the starting point.

Application of Results

Low temperature effects are of two kinds, complete disorganization and necrosis of developing and maturing parenchymata and the change in the pattern of development of specialized differentiated cells. The foregoing information has great significance in hardening off of seedlings, in all forms of amenity plantings and establishment of trees, in performance tests for winter survival, and in the use of pulp.

1. In hardening off of seedlings, the method presently in use in high risk areas may in fact lead to defects in seedlings by suppression of the terminal bud resulting in forking and weak stem form. A combination of low temperature and freezing water spray is of questionable value in preparing seedlings for growth under field conditions. Retardation of plant development during the normal growth cycle may in fact lead to more damage later. Lateral buds usually break in July and new shoots developing in August become vulnerable to autumn freeze-killing. This leads to a question — is hardening off by low temperature necessary or can it be dispensed with entirely if seedlings were planted or set out after the danger of frost? The advantage of the latter is that plants put on additional growth sufficient to nourish new buds and store food before the frost season starts.

2. In tree establishment, low temperature damage to the stem in the form of branch or leader dieback and canker leads to deformation of the crown and stem in young and pole-sized trees. It results in shortened life span of trees used in recreational amenity plantings. On the other hand, these trees have the advantage of the broad crown being more amenable for use as shade. In performance tests for survival under winter conditions, current shoots and sapwood in general endure better when the growth cycle occurs well in advance of autumn freeze-killing.

3. Growth factors readily affect rejuvenation. Soil fertility often accounts for patchy growth and failure of survival of weaker plants regardless of species or clone.

4. In harvesting of trees for pulp, the high risk areas can be readily mapped from the existing damaged stands. A high per cent of short fibers in pulp often requires mixing longer fiber obtained from more valuable species as spruce. It also adds to the cost of filtering and marketing cheaper fiber separately. "Schlereid-like" cells are an obsession in paper making because they will not absorb ink, thus leaving white spots on dense paper. They also have window-like openings on all sides. In light weight paper, their inclusion leads to a weakness of mottling characteristic or "light spots" in an area that should be uniformly opaque.

Literature Cited

Ashwell, I. 1971. Warm blast across the snow covered prairie. Geographical Magazine 43:858-863.

Canada Department of Transport. 1965-1971. Monthly records. Meteorological observations in Canada. Meteorological Branch, Toronto, Ontario.

Glock, W. S., Studhalter, R. A., & Agerter, S. R. 1960. Classification and multiplicity of growth layers in the branches of trees. The Smithsonian Institute, Washington, The Lord Baltimore Press, Inc., Baltimore, Maryland. p. 294.

Harris, H. H. 1934. Frost ring formation in some winter-injured deciduous trees and shrubs. Amer. J. Bot. 21:485-498.

Joachim, H. F. 1957. Uber Frostschaden an der Gatterng *Populus*. Arch. Forstwesen. 6:601-678.

Joachim, H. F. 1963. Bark diseases of poplar. *In* Holtzzer-storung durch Pilze. Akadamie Verlag, Berlin. p. 17-23.

Kendrew, W. G., & B. W. Currie. 1955. The climate of central Canada. Manitoba, Saskatchewan and the Districts of Mackenzie and Keewatim. Queen's Printer, Ottawa. p. 194.

Mullick, D. B. 1971. Natural pigment differences distinguished first and sequent periderms of conifers through a cryofixation and chemical techniques. Can. J. Bot. 49:1703-1711.

Rhoads, A. S. 1923. The formation and pathological anatomy of frost rings in conifers injured by late frosts. USDA Bull. No. 1131:1-16.

Zalasky, H. 1970. Disease problems of poplar in western interior of Canada. Canadian Forestry Serv., Department of Fisheries and Forestry, Information Rept. A-X-39.

Zalasky, H. 1972. Problems in spruce relating to soil, climate and recreational land use in the Bragg Creek area, Alberta. Northern Forest Research Centre, Internal Rept. NOR-10.

TRUNK INJECTION OF BENOMYL IN *ULMUS AMERICANA*

Ronald A. Morrow[1], Nagayoshi Oshima[1], and John G. Laut[2]

One hundred thirty-seven mature American elms (*Ulmus americana* L.) were treated with 5000 ppm solubilized benomyl to test its effectiveness as a controlling measure for Dutch elm disease. Twenty-five trees with positively diagnosed infection were treated to examine its therapeutic possibilities. These trees displayed less than 25% visual crown symptoms. The remaining 112 trees were treated as a possible preventive measure.

Trunk injection was accomplished through the use of an increment borer, 60 ml syringe and a common rubber stopper. At each injection point an increment boring from one-half to one inch deep was taken. The core was removed, and the benomyl solution was injected by applying pressure to the syringe. A seal between the increment borer and the syringe was provided by placing the needle of the syringe through a rubber stopper. One 60 ml injection was made for each inch of trunk diameter.

This method of injection proved to be fast and simple while still complying to the needs of the researcher.

[1]Botany and Plant Pathology Department, Colorado State University, Fort Collins, Colorado.
[2]Colorado State Forest Service, Fort Collins, Colorado.

PROJECTS

NEW OR MODIFIED AND COMPLETED OR TERMINATED*

UNIVERSITIES

- ✓ University of Arizona
- ✓ University of British Columbia
- ✓ University of California
- ✓ Colorado State University
- ✓ University of Hawaii
- — Oregon State University
- — University of Wyoming

STATE FORESTRY DEPARTMENTS

- — Colorado State Forestry Department
- — Oregon State Forestry Department

CANADIAN FORESTRY SERVICE

- ✓ Pacific Forest Research Centre - Victoria
- ✓ Northern Forest Research Centre - Edmonton
- ✓ Western Forest Products Laboratory - Vancouver

U.S. FOREST SERVICE

- ✓ Region 1
- — Region 2
- ✓ Region 3
- ✓ Region 4
- — Region 5
- ✓ Region 6
- ✓ Intermountain Forest and Range Experiment Station
- — Pacific Northwest Forest and Range Experiment Station
- ✓ Pacific Southwest Forest and Range Experiment Station
- ✓ Rocky Mountain Forest and Range Experiment Station

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* ✓ indicates report, see following. — indicates no change or no report.

UNIVERSITY OF ARIZONA

New or Modified Projects:

Sparassis radicata and root rot of conifers in southern Arizona.—Kenneth J. Martin.

Poria carnegiea and decay of saguaro cactus in Arizona.—J. Page Lindsey.

Synoptic key to fungi causing decay in spruces in North America.—K. J. Martin & R. L. Gilbertson.

Completed or Terminated Projects:

69-J-1. Manual for identification of Basidiomycetes causing decay of ponderosa pine in the Southwest.—R. L. Gilbertson. A manuscript covering 230 species has been submitted to the University of Arizona press.

UNIVERSITY OF BRITISH COLUMBIA

New or Modified Projects:

Characterization and development of heartwood stain in *Populus trichocarpa*.—A. A. Gokhele.

Completed or Terminated Projects:

Rate of upward advance and intensification of water and hemlock mistletoe. To be published in Can. J. Forestry Res.

UNIVERSITY OF CALIFORNIA

New or Modified Projects:

Effects of smoke on forest disease fungi.—J. R. Parmeter.

Studies of the host range and control of canker stain *(Ceratocystis fimbriata* f. *plantani)* of plane tree.—A. H. McCain.

COLORADO STATE UNIVERSITY

Completed or Terminated Projects:

Effects of dwarf mistletoe on the wood properties of lodgepole pine.—Douglas D. Piirto, M.S. Thesis. 78 p. Being prepared for publication in the Forest Products Journal.

Resin disease of dwarf mistletoe of lodgepole pine.—Walter R. Mark, Ph.D. Dissertation. 96 p. Being prepared for publication in Phytopathology

UNIVERSITY OF HAWAII

(See Pacific Southwest Forest and Range Experiment Station)

CANADIAN FORESTRY SERVICE - PACIFIC FOREST RESEARCH CENTRE - VICTORIA

New or Modified Projects:

Armillaria mellea root rot: importance and biology.—D. J. Morrison. Objectives: To assess the importance of root disease caused by *A. mellea* in plantations and young stands of the major commercial species of British Columbia. To assess the suitability of stumps of some native trees to act as a food base for *A. mellea*. To examine host resistance and isolate pathogenicity.

Feasibility of immunizing seedlings against root-disease fungi with *Ascocoryne sarcoides*.—D. E. Etheridge.

G-stem diseases-stains and decays. 65-G-1. Factors influencing resistance of lodgepole pine to attack by the bark beetle-blue stain fungi complex; pathological aspects.—H. S. Whitney. Modify in 1972 as follows: Project moved from Northern Forest Research Centre, Edmonton, Alberta, to Pacific Forest Research Centre. Project forms part of an integrated cross disciplinary study having as the objective finding ways and means of reducing forest resource losses caused by bark beetles. The role of microorganisms in the attack on conifers by bark beetles is the general area of research. Currently, microorganisms associated with bark beetles attacking spruce and the effects of spruce diseases on bark beetle outbreaks is being emphasized.

CANADIAN FORESTRY SERVICE - NORTHERN FORESTRY RESEARCH CENTRE - EDMONTON

New or Modified Projects:

Epidemiology of dwarf mistletoe *(A. americanum)* on jack pine [*Pinus divaricata* (neé *P. banksiana*)].—John Muir.

CANADIAN FORESTRY SERVICE - WESTERN FOREST PRODUCTS LABORATORY - VANCOUVER

New or Modified Projects:

72-J-. Decay and shock resistance of western red cedar transmission poles in service.—J. W. Roff.

71-J- . Analysis of aspen chip deterioration during outside storage.—Roger S. Smith.

72-J- . Utilization of decayed wood in pulp manufacture.—J. W. Roff.

72-J- . Degradation and preservative treatments of western red cedar shingles and shakes.—A. J. Cserjesi & Roger S. Smith.

Completed or Terminated Projects:

60-J-1. Relation of wood-inhabiting fungi to preservatives.—J. W. Roff & A. J. Cserjesi. Now included in 66-J-2.

66-J-1. Effectiveness of Boron diffusion treatment vs. advance of heart rots in stored unseasoned lumber.—J. W. Roff.

68-J-3. Establishment of threshold concentrations of fungicides for lumber.—J. W. Roff.

U.S. FOREST SERVICE - REGION 1

New or Modified Projects:

Survey for distribution of cankers caused by *Tubercularia ulmea* on Russian olive and Siberian elm in North Dakota shelterbelt plantings.—Oscar J. Dooling.

Survey of SO_2 damage to forest vegetation near ore smelters at Anaconda, Montana, and Wallace/Kellogg, Idaho.—Clinton E. Carlson.

Identification, distribution and intensity of root rots in western Montana and northern Idaho.—Ralph E. Williams.

U.S. FOREST SERVICE - REGION 3

New or Modified Projects:

In June 1972 we initiated a three-year screening study in cooperation with the University of Arizona, Tucson, to develop:

1. A ranking of selected native southwestern forest trees and plants as to their SO_2 susceptibility.

2. Record symptoms of acute SO_2 injury to these plants.

Results of this study will increase the efficiency and reliability of detection and evaluation surveys of SO_2-caused injury to southwestern forest vegetation. In the southwest

SO_2 results primarily from smelting and electrical power generating activity.

U.S. FOREST SERVICE - REGION 4

Completed or Terminated Projects:

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

Collection of stand data in dwarf mistletoe infected lodgepole pine (L_{pp}). These data will be tested against the Simulated Yield Study in L_{pp} developed by Hawksworth for R-2. If results show that R-4 L_{pp} is similar to R-Z L_{pp}, then results of the R-2 Rocky Mountain Station Study will be utilized in R-4 forest management.

U.S. FOREST SERVICE - REGION 6

New or Modified Projects:

Determination of *Poria weirii* impacts on forest resources in west side Douglas-fir stands.

Completed or Terminated Projects:

66-H-10 and 67-A-2.

Pruning dwarf mistletoe brooms from old-growth ponderosa pine.

INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION

New or Modified Projects:

Diseases of browse shrubs: preliminary assessment.—R. G. Krebill.

Investigation of natural inactivation of white pine blister rust cankers in Europe.—E. F. Wicker. Objective: To observe, record, collect and isolate those fungi and bacteria which have had an opportunity for one or more centuries to develop an ecological association with rust cankers.

The ramification of bark tissues of *Pinus monticola* Dougl. by *Cronartium ribicola* J. C. Fischer.—B. L. Welch & N. E. Martin. Objective: To determine how *C. ribicola* spreads within the bark tissues of *P. monticola*.

Completed or Terminated Projects:

53-I-1. Progress of pole blight in white pine stands treated to eradicate the disease.—C. D. Leaphart.

58-I-1. Dendroclimatology of western white pine in the Inland Empire region.—C. D. Leaphart.

66-H-1. Feasibility of establishing white pine tissue explants and/or subcultures infected with *C. ribicola* in axenic culture.—A. E. Harvey.

66-H-9. Biological control of western white pine blister rust.—R. E. Williams & E. F. Wicker.

PACIFIC SOUTHWEST FOREST & RANGE EXPERIMENT STATION

New or Modified Projects:

The pathology of Ohia decline in Hawaii.—R. V. Bega. Studies are underway by the PSWF&RES, the Hawaii State Division of Forestry, and the University of Hawaii to determine the cause of widespread and serious deterioration and dieback of Ohia *(Metrosideros collina)* and Koa *(Acacia koa)* forests in Hawaii.

The overall broad objectives of the coordinated research effort are:

1. Determine the present location, extent, and rate of spread of tree death and decline and determine its subsequent effects on the composition of the forests.

2. Determine the nature and causes of the decline and death of Ohia-Koa trees and identify the factors contributing to the apparent recent acceleration of this decline.

3. Develop, if feasible, control measures which will arrest or retard the decline of these forests.

Species susceptibility to mechanical failures on recreation sites — replacement of hazardous species.—L. A. Paine.

Chronic effect of photochemical oxidant air pollution on the composition of the ponderosa pine-sugar pine-fir forest cover type.—P. R. Miller.

Completed or Terminated Projects:

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

ROCKY MOUNTAIN FOREST & RANGE EXPERIMENT STATION

New or Modified Projects:

Simulation of the effects of dwarf mistletoe on yields in uneven-aged ponderosa pine stands in Colorado.—F. G. Hawksworth, T. E. Hinds, & C. A. Myers.

Stand evaluation of past spruce beetle infestations.—J. M. Schmid & T. E. Hinds.

Pollination ecology of three species of dwarf mistletoe in northern Colorado.—R. Penfield, R. E. Stevens, & F. G. Hawksworth.

Completed or Terminated Projects:

62-D-1. Diseases of marginal ponderosa pine, pinyon, and juniper.—J. W. Riffle.

67-E-1. Foliage diseases of conifers in the southwest.—P. C. Lightle.

62-7-10. Silvicultural control of ponderosa pine dwarf mistletoe.—from P. C. Lightle to F. G. Hawksworth.

67-G-1. Causes of cull in the mixed conifer stands of the southwest.—P. C. Lightle.

DWARF MISTLETOE COMMITTEE REPORT

Robert F. Scharpf[1]
Chairman

MISTLETOE RESEARCH AND DEVELOPMENT ACTIVITIES

Taxonomy, Hosts and Distribution

Arceuthobium cyanocarpum was found in the Copper Mountains near Jarbridge, Nevada, on *Pinus albicaulis*. This is the first report for this host from Nevada and the only third known area of this mistletoe in Nevada.—F. G. Hawksworth, W. R. Mark, T. E. Hinds, U.S.F.S., Fort Collins, Colorado.

Arceuthobium guatemalense, a parasite of *Pinus ayacahuite* previously known only from Guatemala, was found in Oaxaca, Mexico. This is the first record of it from Mexico.—R. S. Peterson, St. John's College, Santa Fe, New Mexico.

The isolated Navaho Mountain in southern Utah was examined for dwarf mistletoes and three species were found: *Arceuthobium douglasii* on *Pseudotsuga menziesii*, *A. vaginatum cryptopodum* on *Pinus ponderosa*, *A. divaricatum* on *Pinus edulis*.—F. G. Hawksworth & P. C. Lightle, U.S.F.S. Fort Collins, and Bob Loomis, Southwest Region, U.S.F.S.

In our monograph on *Arceuthobium* (USDA Agriculture Handbook 401) we discussed the northern and southern segregates of *Arceuthobium globosum*. Recent studies in Mexico suggest that the southern population occurs at least as far north as Mexico City. It now appears that the southern form (characterized by large greenish shoots, large, late-maturing fruits, and consistent witches' broom formation) and the northern population (characterized by small yellow shoots, small, early-maturing fruits, and lack of witches' brooms) should probably be considered as distinct species.—F. G. Hawksworth, R. F. Scharpf, & D. M. Knutson, U.S.F.S.

Though some further advice is needed from experts in mistletoe and wood anatomy, it appears that we have picked up an infection of hemlock mistletoe on coastal Douglas-fir near Horne Lake, Vancouver Island. There were no shoots on the swelling, but dwarf mistletoe endophytic system was indicated in the sections examined microscopically. The host seems to have walled off the endophytic strands with a continuous periderm. Sinkers are absent from the outside four or five wood rings, but prominent in older rings.—R. B. Smith, Victoria.

Physiology and Anatomy

Frost damage to dwarf mistletoe berries by early fall freeze

[1]Pacific Southwest Forest and Range Experiment Station, Berkeley.

was observed previously (Tunnock *et al.*, 1965; Smith, 1970). In a controlled environment approximating the overnight temperature drop to various degrees of frost, it was found that lodgepole pine dwarf mistletoe berries were ruptured within an hour after exposure to 24°F. Temperatures above 26°F did not cause any damage although the berries were exposed to these freezing temperatures for up to 6 hours. This may explain why the northern distribution of lodgepole pine dwarf mistletoe in British Columbia follows so closely the August 15 early frost line.—J. A. Baranyay, Victoria.

The effect of water stress on the respiration of ponderosa pine and lodgepole pine and their respective dwarf mistletoes, *A. vaginatum* and *A. americanum*, was studied. Oxygen consumption by segments of needles and dwarf mistletoe stems placed in various percent solutions of polyethylene glycol and water for 25 minutes was determined by using a platinum cathode. The ten polyethylene solutions had osmotic potentials ranging from 1.5 bars to 48 bars. Respiration was greatest for the segments of lodgepole pine and its parasite and ponderosa pine at 7 bars, whereas the rate of *A. vaginatum* decreased steadily with stress. The mistletoes respired at rates 2-1/2 to 4 times their hosts. Also, at all but the lowest level of stress, the differences between the rates of the host and parasite were greater for lodgepole pine and *A. americanum* being 1-1/2 times the average difference for the other pair. Osmotic potential differences (the mistletoes having greater potentials) are also greater with the lodgepole pine-*A. americanum* pair. *A. vaginatum* and ponderosa pine showed an average difference of 4 bars whereas the former pair reached an average of 7 bars. Also, with few exceptions as 24 bars host osmotic potential is approached. It seemed that the balance was no longer in favor of *A. vaginatum* whereas *A. americanum* maintained a potential gradient favorable to the parasite up to 30 bars (host osmotic pressure).—J. T. Fisher & C. P. P. Reid, Colorado State University.

Work on the dwarf mistletoe centers in three areas, as follows: (1) study of the aerial epidermis of *A. douglasii* and *A. tsugense;* (2) investigation of the anatomical relationships between host vascular tissues and *A. tsugense* sinker cells that are involved in the translocation of nutrients from host to parasite; and (3) qualitative and quantitative analysis of the chlorophylls and carotenoids in certain species of *Arceuthobium* (and *Phoradendron*) and the correlation of the data with anatomical observations. The first study employs scanning and transmission electron microscopy, and light microscopy. The second study involves transmission electron microscopy, light microscopy and tracer work. The third study involves transmission electron microscopy, light microscopy, and photospectrometry.—C. Calvin, C. Alosi, & P. Barnhart, Portland State University, Portland, Oregon.

Life Cycle Studies

Studies on pollination and pollen dispersal of *Arceuthobium*

americanum, *A. vaginatum* subsp. *cryptopodum*, and *A. cyanocarpum* were conducted in northern Colorado. Several hundred insects collected on pistillate and staminate flowers are now being identified and analyzed for pollen. Wind dispersal is quite common and pollen was found over 200 feet away from the closest staminate plant in all three species.—R. Penfield, U.S. Forest Service, Fort Collins.

A paper entitled "Factors affecting dispersal of dwarf mistletoe seeds from an overstory western hemlock tree" will appear in the February, 1973, issue of *Northwest Science*.

It is now 10 years since I planted 60 hemlock trees around an isolated dwarf mistletoe infected hemlock. They now average 8.5 feet in height. Of the 50 originals still alive, 47 have at least one infection. Three trees in the outside circle, 33 feet from the source tree, remain free of infection. The maximum number of infections on a single tree is 168 on one planted 9 feet from the source. The total number of infections on the small trees is 1,137, an average of 24 per infected tree. Several trees are considerably deformed as a result of infection. In 1971, infections on the planted trees produced about 32,000 seed. A fuller description of the results is given in a handout which will be distributed to those attending the 1972 WIFDWC field trip to Cowichan Lake.—R. B. Smith, Victoria.

Population buildup from 1958 inoculations of dwarf mistletoe on red firs in the Southern Cascades was over 20-fold in 12 years. By contrast, increase over a comparable period in the central Sierra Nevada was less than one-fold. In addition, the incubation period in the Cascades was generally 2 years, whereas 3 years was usual in the Sierra. Abundant fruiting occurred 5 years after inoculation in the Cascades, but did not occur until 7 years in the Sierra. These observations suggest that mistletoe populations of a given species may behave quite differently in different areas and that some caution is warranted in extrapolating from data in different areas.—J. R. Parmeter, Jr., University of California, Berkeley, and R. F. Scharpf, Pacific Southwest Forest and Range Experiment Station.

Observations from inoculations of red and white fir in the central Sierra Nevada suggest that infection and buildup may be related to elevation at which the host is growing. Greatest infection occurred at the lower elevational limits of the host, moderate infection in the mid-range, and little infection at the upper elevations.—R. F. Scharpf & J. R. Parmeter.

Previous studies showed that understory red fir reproduction reached 3-4 feet in height before infection by dwarf mistletoe began to occur. Studies this summer showed that vigorous open growing seedlings remain substantially mistletoe-free until they reach 6-8 feet in height.—F. F. Scharpf, Pacific Southwest Forest and Range Experiment Station.

Initiating field studies on Douglas-fir dwarf mistletoe with initial emphasis on inoculum potential (overwinter survival of seeds and establishment rates) and the rate of disease development within individual trees and in stands.—D. M. Knutson, Pacific Northwest Forest and Range Experiment Station.

Host-Parasite Relations

With Jim Barrett. 1959-1965 comparison of tree (height, diameter, volume, crown length, density, vigor, number branches) and dwarf mistletoe characteristic (number branches infected, number branch infections, number infection in top 1/2 of crown) to answer the question, "Which combination of characters in 1959 would allow the most accurate prediction of 1965 conditions? For example, is rapid increase of number of branch infections in the top one-half of crown related to crown density?—D. M. Knutson.

Effects on Host

Manuscripts submitted: (1) Dwarfmistletoe reduces root growth of ponderosa pine seedlings. *Forestry Sci.* (2) Life Cycle Studies. III. Year-round production of dwarf mistletoe infected seedlings. *Forestry Sci.*—D. M. Knutson.

Administrative studies on impact of dwarf mistletoe on released red firs in California have been completed this year. Data from five National Forests in California are currently being analyzed and final results should be obtained by the end of the year. Preliminary results confirm those of last year. Non-infected, lightly infected, and moderately infected trees show little difference in growth rate. Some reduction in height and diameter growth was found in heavily infected trees. However, the differences in growth before and after release were far greater than growth differences associated with dwarf mistletoe alone. Permanent plots were established on each forest to follow changes in growth, mistletoe populations, and tree mortality.—R. F. Scharpf, Pacific Southwest Forest and Range Experiment Station, and Neil MacGregor, Region 5, U.S. Forest Service, San Francisco.

Methods for simulating yields in even-aged, dwarf mistletoe infected ponderosa pine stands were published by Myers, Hawksworth, and Lightle (U.S. Forest Serv. Res. Paper RM-87, 16 p., 1972). Studies which we hope will yield similar information for uneven-aged stands were begun in ponderosa pine in Colorado. Fourteen plots with over 3000 trees were established in 1972. Analyses will be made this winter and field work will continue next summer.—F. G. Hawksworth, T. E. Hinds, & W. R. Mark, Fort Collins.

"The effects of dwarf mistletoe on the wood properties of lodgepole pine." A study funded by McIntire-Stennis to investigate the effects of dwarf mistletoe (*Arceuthobium americanum* Nutt. ex. Engelm.) on the wood properties of Rocky Mountain lodgepole pine (*Pinus contorta* Dougl.) was completed in December, 1971.

Three comparisons were made using a one-way analysis of variance as the test of significance. The three comparisons were: (1) between wood from non-infected trees (control) and infected wood from infected trees; (2) between wood from non-infected trees (control) and non-infected wood from infected trees; (3) between infected wood and non-infected wood from infected trees.

The results indicated:

1. A decline in modulus of elasticity, modulus of rupture and work to proportional limit in both infected and non-infected wood from infected trees.

2. A higher specific gravity of the infected wood.

3. A higher percentage of alcohol-benzene extractives in the infected wood.

4. An increase in longitudinal shrinkage in both infected and non-infected wood from the same tree.

5. A higher percentage of latewood in control wood.

6. No significant difference in growth ring width between infected and control wood.

7. A narrow growth ring in the non-infected regions of an infected tree.

8. A decrease in tracheid length in both infected and non-infected wood from the same tree.

9. An increase in microfibril angle in both infected and non-infected wood from the same tree.

This was the first study to show that both infected and non-infected wood from infected trees is inferior to wood from non-infected trees in strength and longitudinal shrinkage characteristics.—D. D. Piirto, Forest Products Laboratory, Berkeley.

Two similar stands of Douglas-fir, one healthy and the other infested, were compared. The healthy stand produced 1.5 times the board foot volume in one-half the time. By predicting the volume of the healthy stand at age 120 (the age of the infested stand), the healthy stand will produce 3.7 times the volume of the infested stand. Publication: Haglund, S. A., & O. J. Dooling. 1972. Observations on the impact of dwarf mistletoe on Douglas-fir in western Montana. USDA Forest Serv., Northern Region, Insect and Disease Rept., 6 p.—O. J. Dooling, Division of State & Private Forestry, Missoula, Montana.

Ecology

The work on host specificity is being continued. The infection process of both *Arceuthobium campylopodum* and *A. tsugense* is being studied on hosts and non-hosts. Additionally, we have initiated a study of the distribution of *Arceuthobium douglasii*

on the west slope of the Cascades. We are looking at sites in Mt. Hood, Willamette and Umpqua National Forests. One site of infection in Mt. Hood National Forest has been examined in some detail and is composed of several isolated patches of infection. An understanding of population dynamics in these west slope infections is being sought. An investigation of the impact which birds may have on dwarf mistletoe seed dispersal has just begun.—R. O. Tinnin, Portland State University.

Trials initiated in the fall of 1970 to determine the rates of survival of dwarf mistletoe seeds in various bioclimatic zones in British Columbia (see 1971 report) were repeated in the fall of 1971. Again, *A. douglasii* seeds failed to survive the winter at the 130-mile site in the Cariboo which is well north of the present range of Douglas-fir dwarf mistletoe. In contrast, 11 and 13 percent of the seeds of the same species planted in two more southern bioclimatic zones had visible radicles when checked in May, 1972. *A. americanum* seeds again germinated very well (90%) on Vancouver Island where the species does not occur naturally. Possibly because of the severe winter, germination of *A. americanum* seeds was only 3 percent in the 130-mile area which is well within the natural range of this species.—R. B. Smith, Victoria.

Control - Chemical

Tests of several chemicals to control *Arceuthobium vaginatum* subsp. *cryptopodum* on ponderosa pine were conducted near Estes Park, Colorado, in the summer of 1972. Chemicals tested include Asulam (Chipman), Racuza (Veliscol), Probe (Veliscol), Mon 2/39 (Monsanto), Princep 80 W (Geigy), Attrex (Atrazine) (Geigy), Sumitol (Geigy), Trifluran (Treflan) (Lilly), and Kuron (Dow). Sprays and trunk injections were tried. No results to date.—A. Moinat, 1816 - 13th Street, Greeley, Colorado 80631.

Final results of the chemical tests to control dwarf mistletoe on the Bandolier National Monument, New Mexico, have been analyzed. Various analogues of 245, TB proved to be no more effective in controlling the parasite than the carrier (No. 2 fuel oil) alone.—P. C. Lightle, Rocky Mountain Station, Fort Collins, & E. Lampi, National Park Service.

Control - Biological

The larvae of *Lycaenopsis cinerea* Edwards, common blue butterfly, were found feeding heavily on lodgepole pine dwarf mistletoe aerial plants in four widespread locations in the interior of British Columbia. The population seemed to be the highest in the Alexis Lake area where approximately 30 percent of the infected regeneration checked supported feeding larvae.—J. A. Baranyay, Victoria.

Three field study sites have been established to evaluate *Callophrys johnsoni* as a bio-control agent of hemlock dwarf mistletoe. I'm taking life table data on the number of eggs laid, and larval and adult survival as well as getting estimates of amounts of mistletoe tissue destroyed. Damage to the mistletoe varies from none (Coast Range) to severe (Crater Lake area). Other data include the influence of height of dwarf mistletoe in the tree, amount of shade or sun, and position within the crown on larval activity.—D. McCorkle, Oregon College of Education, Monmouth, Oregon.

A new disease syndrome (termed resin disease) of *Arceuthobium americanum* on lodgepole pine is reported in Colorado, Idaho, Montana, Utah, and Wyoming. The disease is of the canker type and effectively eliminates shoots from established dwarf mistletoe plants. In one area in Colorado 100 percent of the dwarf mistletoe plants were diseased, and two-thirds of the aerial shoots were eliminated from over 50 percent of the plants. Isolations from naturally infected resin disease cankers yielded 11 fungi. *Alternaria alternata* was recovered in 44.0 percent of the isolations and *Aureobasidium pullulans* in 32.0 percent of the isolations. *A. alternata* proved to be the most successful inoculum, yielding up to 80 percent resin disease establishment; it was followed closely by *A. pullulans*. *Cladosporium herbarum* and *Epicoccum nigrum* caused symptoms only when associated with *Alternaria* or *Aureobasidium*. Resin disease fulfills several of the criteria established for successful biological control agents, and studies to determine its applicability should be undertaken. Resin disease has been shown to be induced by several weakly parasitic fungi which induce a host response periderm. An abnormal response periderm was found in all naturally and artificially infected resin disease cankers examined and is the mechanism by which dwarf mistletoe shoots are killed. The response periderm prevents the shoots from obtaining needed water and carbohydrate supplies and is similar to that formed after an injury to the bark. This similarity suggests that the formation of the periderm is a non-specific result of stimuli from pine cells wounded or killed by the resin disease fungi.—W. R. Mark, F. G. Hawksworth, N. Oshima, Colorado State University, U.S. Forest Service.

The fungus *Nectria flammea* was found parasitizing two scale insects, *Hemiberlesia rapax* and *Aspidiotus nerii*, which were parasitizing a dwarf mistletoe, *Arceuthobium hondurense*, in Honduras.—F. G. Hawksworth, Rocky Mountain Station, and E. Wicker, Intermountain Station.

Control - Silvicultural

Established (April 1972) a small (50 trees) field test of Russian pruning (pruning from the top) of dwarf mistletoe infected ponderosa pine saplings and poles. Tree survival and development of new, mistletoe-free crown are the criteria of success. Annual tree growth and mistletoe development will be compared for pruned and control trees.—D. M. Knutson, Pacific Northwest Forest and Range Experiment Station.

Testing the effect of three levels of urea (0, 150, 300 lbs n/acre) on the aerial shoot growth and on tree growth of outplanted infected and uninfected ponderosa pine seedlings.—D. M. Knutson, Pacific Northwest Forest and Range Experiment Station.

Control was conducted on approximately 8,500 acres in conjunction with normal timber sales and site rehabilitation activities.—O. J. Dooling, Division of State & Private Forestry, Missoula, Montana.

A pruning study established in 1966 in dwarf mistletoe-infected lodgepole pine was evaluated in 1971 and 1972. The study was designed to determine the feasibility of pruning dwarf mistletoe-infected trees. Even after a reasonably thorough pruning that involved removing the highest visibly infected branch plus two additional whorls of branches, 51%, or over half of the pruned trees, were infected. The incidence of infected trees did not appear to be directly related to any particular pruning height.—D. Brown, Region 2, U.S. Forest Service, Denver.

A study to determine the importance of bole infections in ponderosa pine was begun in Colorado. Preliminary results of examination of over 600 bole infections confirm that infectivity is inversely related to bole diameter at point of infection. Trees with bole infections over 6 inches in diameter (at the point of infection) produce very few seeds and are an insignificant threat to surrounding trees and need not be reason for sacrificing the trees.—F. G. Hawksworth, W. R. Mark, & T. E. Hinds, Rocky Mountain Station, Fort Collins.

A manuscript on the dwarf mistletoe control project at Grand Canyon National Park has been completed and is being processed as a Station Research Paper. This program by the National Park Service to control the parasite was begun in one area in 1949. This was the first large-scale attempt to control dwarf mistletoe in a recreational forest. This 2000-plus acre area has been sanitized at approximately 5-year intervals since the initial treatment. The report describes the control effort and compares the treated and untreated portions after 20 years. The results indicate that the original goal of the project — to reduce the level of dwarf mistletoe and protect the ponderosa pine forest — has been achieved. Recommendations for dwarf mistletoe control in recreational forests, based on knowledge gained from this project, are summarized.— P. C. Lightly & F. G. Hawksworth, Rocky Mountain Station, Fort Collins.

Surveys

A road reconnaissance survey was conducted in the lodgepole pine stands of the Cariboo Forest District. Of the 697.5 road miles of lodgepole pine type sampled, 28.3% were through healthy stands, 40.7% lightly, 20.4% moderately, and 10.6% severely dwarf mistletoe infected stands. The data from a line plot sampling, which followed, are being presently processed.— J. A. Baranyay, Victoria.

Arceuthobium laricis was collected several times on *Picea engelmanii* in British Columbia during the past. This year it was found in such intensity at Glacier Creek, Lardeau Ranger District, that was not experienced before. In an 8 chain long sample strip all the 35 Engelmann spruce trees were heavily infected and 8 were found dead from heavy dwarf mistletoe infection. It seemed that a broom developed from each branch infection and stem swelling similar to that caused by larch mistletoe on larch was also found.

The stand is a 110 year old mixed stand consisting of 35% western hemlock, 20% red cedar, 15% Douglas-fir, 15% lodgepole pine, 10% Engelmann spruce and 5% western larch. Most of the western larch has already fallen out of the stand but lodgepole pine heavily infected by the larch mistletoe also provided a continuous source of inoculum. Engelmann spruce is in the co-dominant crown class about 10 feet below the dominant western larch and lodgepole pine.

The severe infection of Engelmann spruce at Glacier Creek can be explained by the peculiar stand and disease conditions but it also suggests a higher relative susceptibility of this host to larch mistletoe than was observed before.—J. A. Baranyay & E. V. Morris, Victoria.

Systematic sampling schemes for dwarf mistletoe in western hemlock are unworkable. A survey in the forms area of northwest Washington (Olympic Peninsula) demonstrated that the scattered and patchy distribution patterns of the mistletoe cannot be surveyed by normal methods. We found that roadside or elevated vantage points above old clearcuts gave more information than 2 hours crashing through brush. This survey revealed that dwarf mistletoe was adequately controlled on state clearcuts. Smooth silhouettes of young trees meant no mistletoe problems while raggedy silhouettes with overstory remaining had mistletoe.—K. Russell, Department of Natural Resources, Olympia.

Miscellaneous

Nectria canker of dwarf mistletoe seedlings of western hemlock.—A. Funk, R. B. Smith, & J. A. Baranyay, Victoria.

Light affects penetration and infection of pines by dwarf mistletoe. *Phytopathology* (in press).—R. F. Scharpf, Pacific Southwest Forest & Range Experiment Station.

The Hawksworth Mistletoe Index has finally been adapted to the FAMULUS literature retrieval system. Only minor editing of the citations needs to be done. We are now in the process of writing up a "user's manual" to facilitate information retrieval. Until that time, however, limited retrieval requests will be proceesed by the Pacific Southwest Forest and Range Experiment Station.—R. F. Scharpf & F. W. Hawksworth, Pacific Southwest Forest and Range Experiment Station, and Rocky Mountain Station, respectively.

The effects of dwarf mistletoe on the wood properties of lodgepole pine. M.S. Thesis, Colorado State University, Forst Collins, Colorado, 78 p.—D. D. Piirto, Forest Products Laboratory, Berkeley.

COMMITTEE ON FOREST DISEASE RECREATION HAZARD

Peter Gaidula[1]
Chairman

It is with pleasure that I present the report of this Committee. Dr. Lee A. Paine of the Pacific Southwest Forest and Range Experiment Station gave up the Committee chairmanship and in May 1972 I was appointed to that post.

As a newcomer to this organization, allow me to outline briefly my past and present activities. I am a graduate Forester and a member of the Society of American Foresters. Since 1956 I have been with the California Department of Parks and Recreation, and since 1968 have worked out of their Sacramento headquarters with the Resource Management and Protection Division. My areas of staff responsibility include the Statewide Tree Hazard Control Program, Fire Protection, Forest Insect and Disease Control, Soil Erosion and Visitor Impact on the Environment.

Tree Failure Studies

The tree failure studies under Dr. Paine continue on much the same basis as in the past. Analysis of failure reports being received from all regions including Hawaii and Alaska continue to show a reduction in the accident rates. At the outset of the study, over 40% of the failures were causing property losses, bodily injury or fatalities; while presently this figure is about 10%. It appears that the Tree Hazard Research Program is resulting in a greater awareness of existing tree hazards on recreation sites by recreation site managers and administrators who appear to be following through with control programs.

Studies by Lee Paine are in progress on more detailed damage potential tables with more accurate and specific data for a larger number of genera than were previously available. These tables are used in the field for hazard evaluation. Other studies are underway at the Experiment Station in regard to the effects of its program on accident rates resulting from tree failures and on the types of hazard reduced in relation to the classes of failure which occurred on the same sites.

Summaries of the data are available upon request to the Station, some free of charge. The Station will try to service requests without charge for a printer listing of tree failure reports submitted from organizations cooperating in the study. Also, various computer tables can be supplied for which there will be a charge for computer processing time. Other types of analyses, special tables and studies can be requested by contacting Lee Paine at the Experiment

[1]California Department of Parks and Recreation, Sacramento.

Station in Berkeley.

A major change in the tree failure studies is planned for the year 1973. This involves the inclusion of urban recreation sites, a step which was taken following requests from county and city agencies. It is possible that their problems will prove to be somewhat different from those in the more extensive forested recreation areas with which the Station has been working. Lee Paine has indicated that it may well be that, on further study, tree hazard problems of the city and county sites will turn out to be more serious even though limited to a much smaller total area. The need for more attention at the county level to tree hazards in recreation areas under their jurisdiction was dramatically emphasized in our part of California recently when, in a county recreation area on August 15, 1972, a dead pine fell into a family camping group, killing two persons and seriously injuring three others. My visit to the site indicated that this was definitely a preventable accident. Further inquiry revealed that there was no hazard control program.

Publications

Periodic inspections usually indicate that a fair percentage of all trees within forested recreation sites contain some kind of hazard. Last year Committee Chairman Paine reported the publication of his paper entitled "Accident Hazard Evaluation and Control Decisions on Forested Recreation Sites." This paper is an aid to the recreation site manager in arriving at a consistent evaluation of tree hazards on his site. This system of evaluation provides the manager with the damage potential in dollars for each hazard evaluated. Having obtained these evaluations, he is faced with the questions: On what trees should I spend my money for hazard control? Should the level of control (that is, the acceptable level of loss to property and recreationists) be set at $50 or should it be $100? Just what should the standard for tree hazard control be? Some possible answers will be obtained in a forthcoming research paper by Lee Paine entitled "Administrative Goals and Safety Standards for Hazard Control on Forested Recreation Sites." This publication is now in press and should be available before the end of this year.

Future Activities

In my discussions with the past Chairman, Lee Paine, he expressed the desirability of broadening and strengthening the usefulness of this Committee. Ways to bring this about were discussed at the meeting of this Committee held the evening of September 26 here in Victoria. (See report of meeting which follows.)

This Committee would welcome your ideas for improving and expanding the usefulness of the Committee.

WORKSHOP AND MEETING

The Committee on Forest Disease Recreation Hazards held a combined workshop and business meeting on September 26, 1972, at 7:00 PM, at which Chairman Peter Gaidula presided. Mr. Wayne Howe, Assistant Director of Operations, Pacific North Region of the National Park Service, Seattle, Washington, invited to attend, discussed the Park Service handling of their tree hazard program. Mike Srago of Region 5, U.S. Forest Service, San Francisco, and Dave Graham of Region 6, Portland, Oregon, outlined their regional programs for control of tree hazards.

Others in attendance were:

National Park Service

Eslie Lampi, Santa Fe, New Mexico

U.S. Forest Service

Jim Hadfield, Portland, Oregon
Dave Johnson, Portland, Oregon
John F. Wear, Portland, Oregon
Al Tegethoff, Ogden, Utah
Robert C. Loomis, Albuquerque, New Mexico
Peter P. Laird, Ashville, North Carolina
Robert D. Wolfe, Pineville, Louisiana
George L. Downing, Denver, Colorado

Pacific Forest Research Center

Gordon W. Wallis, Victoria, B.C.

Past-chairman, Lee Paine, before passing the Chairmanship onto the new Chairman, expressed the desirability of broadening and strengthening the usefulness of this Committee. One of the ways he suggested to accomplish this would be to extend participation in Committee activities to include administrators, recreation site managers and even safety officers of the various agencies involved in forest recreation. Their participation could be helpful in overcoming the frequently voiced problem of getting research results into field application. Other suggested ways of strengthening the activities of the Committee include the use of invited speakers to the workshops and participation of Committee members in future WIFDWC panel discussions.

The training of personnel in tree hazard detection, evaluation, and control was discussed. It was apparent from the discussion that there is a need for some training aids to carry out the training. The production of a film for this purpose was felt to be very desirable; however, its financing and production would be major obstacles to overcome. The idea was dropped from further consideration at this time. The group felt that a basic necessity for carrying out a training program is an outline showing subject matter to be covered. Mike Srago was asked to work up such an outline in collaboration with Al Tegethoff.

The group discussed the role the Committee might play in compiling and disseminating available information on the subject of tree hazards to public agencies administering recreation sites. There appears to be a need for such information, particularly at the county level, as evidenced by the recent catastrophe that occurred in central California recently at a county-operated campground. (See Annual Report preceding.) It was decided that the size of the task might become too great if we tried to reach the numerous county agencies. Therefore, the group agreed that, in order to keep the project within a scope capable of accomplishment, the Committee would attempt to reach mainly federal and state agencies. Dave Graham was asked to compile a literature list on the subject of tree hazards. It was the general consensus of the group that distribution of this list could best be handled by the respective regional offices of the Forest Service.

The Committee next discussed the idea of requesting a place on next year's Conference program for discussion of forest disease recreation hazards. It was agreed that the Committee chairman would recommend to the chairman of next year's Conference that this subject be placed on the 1973 program. Following the meeting, Chairman Gaidula contacted Interim Conference Chairman, Bob Gilbertson and Ed Wicker, newly-elected 1973 Conference Chairman, to convey this recommendation to them.

INTERCONFERENCE COMMITTEE ON JOINT MEETING WITH FOREST ENTOMOLOGISTS

H. Stuart Whitney[1]

Terms of Reference

As a result of a motion passed by the 1972 WFIWC, we were instructed by the executives of both Conferences (WFIWC and WIFDWC) to examine possibilities of a joint meeting: What? Why? How? When? Where? — and to report to the 20th WIFDWC and the 24th WFIWC.

Methods

Through meetings, phone calls, letters and ad hoc conversations, gather data on current, recently completed, planned, and potential interdisciplinary activities. Analyse and report recommendations.

Analyses, Deliberations, etc.

1. In addition to the abundant subject material for a joint program, the proposed joint conference would provide an unusual opportunity to examine interdisciplinary problems and identify any that should be taken up.

2. The venture would only be worth the disruption for a truly joint, at least 75%, meeting because most other methods of exchanging ideas can be handled under existing conference formats.

3. Previous attempts have failed because of insufficient preparation.

4. This should be a one-shot effort with no commitment for any permanent changes in either conference.

5. Present commitments of the conferences and of resource people regarding future meeting sites and programs must be considered. WFIWC is committed to Tucson for 1973 and to the Salt Lake City area for 1974. Canadian Phytopathologists and American Phytopathologists are meeting jointly in Vancouver in August 1974. This could diminish (compete for travel funds, people, and program material) the 1974 WIFDWC.

Recommendation

This Committee recommends that the 20th WIFDWC make a decision

[1]Pacific Forest Research Centre, Victoria, British Columbia.

for or against a joint meeting with WFIWC on the basis of the material presented herein and, if in favor, make a positive motion to be carried out by this Committee to the 1973 WFIWC with proposals for possible meeting site, times and program suggestions.

AIR POLLUTION COMMITTEE

Paul R. Miller[1]
Chairman

AIR POLLUTION INJURY TO FOREST VEGETATION IN THE WESTERN UNITED STATES AND CANADA

During the summer of 1972, a two-page questionnaire was sent to 34 forest pathologists and other scientists concerned with air pollution injury in forested areas of the West. More than 80% of the questionnaires were returned. Information for each separate site of injury was taken from the questionnaire and all of the available information including location, source, and kind of pollutant(s), extent of injury, species most affected, outlook for the future, present research or survey activities and list of published reports, among other items was transferred to a summary page.

A total of 78 pollutant sources were reported of which five were shut down, 67 were presently active, and six were anticipated in the near future. Considering the active and anticipated sources, there were 34 sources of sulfur dioxide mainly from copper smelters, 14 sources of hydrogen fluoride principally from aluminum reduction plants, and 14 urban sources of photochemical oxidants. The most serious damage at present includes that to the mixed conifer forest caused by oxidants in several parts of California and fluoride damage in the Pacific Northwest and Northern Rocky Mountain states. Sulfur dioxide sources are scattered throughout the three western Canadian provinces and nine western states where the questionnaire was received, but mainly only chronic injury was reported or suspected.

This questionnaire has also identified our lack of factual information about air pollutant damage to western forests. A follow-up questionnaire in a few years will allow us to develop a better inventory of damage utilizing the original report as a format so that the same questions will be asked again.

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[1]Air Pollution Research Center, University of California, Riverside, California 92507.

FIELD TRIPS REPORT

Approximately 20 members and friends toured the Pacific Forest Research Centre in Victoria where they heard presentations by Joe Baranyay on methodology in survey and impact studies, Dave Etheridge on biological control of root disease, Jack Sutherland on nematodes in forest nurseries and Wolf Ziller on the mycological herbarium. The tour ended in the new computer center with a discussion of the services being provided for forest pathology.

Forty-eight members and guests participated in the field trip to Nitinat Valley and Cowichan Lake, Vancouver Island. The first stop was at a hemlock dwarf mistletoe seed trapping and infection demonstration area. Dick Smith explained that the plot was established in 1963 by clearing away all trees except one 35-foot infected residual and then planting 60 small hemlock in 10 rows radiating from the source tree. Supplementary data on the magnitude and pattern of seed dispersal was obtained by trapping seeds for five years (1964-68). The source tree was cut down in 1969. The planted hemlocks now average 8.5 feet in height and contain 1,137 infections, 168 on one tree. Multiple leaders caused by stem infections have already deformed several of the small trees. With over 30,000 dwarf mistletoe fruit produced in each of 1971 and 1972, internal reinfection is proceeding rapidly. An early frost destroyed many of the fruit in 1970, and it appeared that a few days prior to the field trip, another early frost had caused many of the fruit to split.

The group next visited a six year old Douglas-fir plantation where 10-15% of the trees were affected with dieback, stem cankering and bushy top. Al Funk outlined his observations on the associations he had found between *Phomopsis lokoyae* and *Xenomeris abietis* with the dieback. Many stem cankers had resulted from infection of bark miner galleries by species of *Pragmopora* and *Tympanis*. *Dermea pseudotsugae* was also associated with stem cankers. The cause of "bushy tops" was not determined. At the final stop of the afternoon, the group inspected a 70 year old Douglas-fir stand showing severe damage as a result of *Poria weirii* root rot. Gordon Wallis and Duncan Morrison presented their thoughts on mode of development of the disease and control by means of stump extraction, alternate species of trees, fertilizer application and destruction of the fungus in stumps with pulping extractives.

INTERIM PROGRAM REPORT

Robert L. Gilbertson[1]
Chairman

I. The following topics for discussion have been suggested by various members:

A. Diseases of browse plants on western forest lands.
B. Intensified efforts for development of economically feasible control methods for forest tree diseases.
C. Urban tree pathology in western North America and the education of specialists in diseases of ornamental and shade trees.
D. Monitoring of environmental damage due to atmospheric pollutants.

1. Review of work being done currently in the southwest in monitoring damage due to SO_2, fluorine, and photochemical pollutants.
2. Effect of air pollutants on cryptograms (fungi, algae, lichens) that stabilize soil surfaces in arid regions in the southwest.

E. Impact of native pine blister rusts in western North America and particularly limb rust if meeting in southern Rocky Mountain region.
F. Diseases of southwestern hardwoods in areas of high value for watershed protection and recreational uses.
G. Canker diseases of aspen in western North America.
H. Pathology of ponderosa pine in the southwest (if meeting is in southern Colorado as suggested).
I. Extension functions in forest pathology.
J. Detection of hidden defects in standing timber, logs, and lumber and estimation of their extent.
K. Foliage diseases of southwestern (or western) conifers and their impact on forest management plans.
L. Phorodendron species and their significance in pathology of southwestern trees.
M. Workshop type session on procedures for collecting, preserving and identifying wood-rotting fungi.
N. Demonstration workshop on methods of collection, preparation, and identification of conifer needle cast fungi.
O. Panel on teaching of forest pathology to discuss course organization, texts, field trips, and field problems, auto-tutorial techniques, audio-visual aids, etc.
P. Role of forest pathology in ecosystems research.
Q Panel discussion on tree hazards in recreational areas, including research, detection, evaluation, training of personnel in detection and control of such hazards,

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[1]Department of Plant Pathology, University of Arizona, Tucson 85721.

control programs of various agencies, costs, accident rates, etc.

R. Case studies on forest products decay problems.

II. Suggestions on organization and carrying out of meetings.

A. Schedule time for committee meetings during the day. These should not be squeezed in at night or lunch hours.

B. Schedule time for invited or special papers. Don't expect to fit them in during slack periods of regular program. This year there was very little time to do this and still allow discussion.

C. Consider scheduling business meeting at some time other than the last day when interest has waned and half of the members have gone.

D. Consider scheduling fewer paper-type presentations to allow more discussion time. Many members feel that this free discussion is the most valuable aspect of our meetings and that time limitations have curtailed this.

E. If panels cover regional problems, consider field trip in second day and inside programs on third and fourth days to discuss problems seen.

F. If possible, check on the possibility of distracting noise in the area of the meetings to avoid this nuisance.

PUBLICATIONS

BARANYAY, J. A. 1972. Silvicultural control of dwarf mistletoe in young lodgepole pine stands in Alberta and British Columbia. Pac. For. Res. Centre, Can. For. Serv., Victoria, B.C., Int. Rept. BC-29.

BARANYAY, J. A. 1972. Introduction to forest disease problems. Pac. For. Res. Centre, Can. For. Serv., Victoria, B.C., Pest Leaflet 54.

BARANYAY, J. A. 1972. Dwarf mistletoes in British Columbia. Pac. For. Res. Centre, Can. For. Serv., Victoria, B.C., Pest Leaflet 44. (In press.)

BARANYAY, J. A., F. G. HAWKSWORTH, & R. B. SMITH. 1971. Glossary of dwarf mistletoe terms. Pac. For. Res. Centre, Can. For. Serv., Victoria, B.C., B.C.P.-2-71. 42 p.

BARANYAY, J. A., & R. B. SMITH. 1972. Dwarf mistletoe in British Columbia and recommendations for their control. Pac. For. Res. Centre, Can. For. Serv., Victoria, B.C., Info. Rept. BC-X-72. (In press.)

BARANYAY, J. A., & W. G. ZILLER. 1972. Broom rusts of conifers in British Columbia. Pac. For. Res. Centre, Can. For. Serv., Victoria, B.C., Pest Leaflet 48. (In press.)

BARANYAY, J. A., & W. G. ZILLER. 1972. Spruce cone rusts in British Columbia. Pac. For. Res. Centre, Can. For. Serv., Victoria, B.C., Pest Leaflet 50.

BARTON, G. M., & R. S. SMITH. 1971. Brown stain in kiln-dried *Abies amabilis* lumber. Bi-Monthly Res. Notes 27:21-23.

BLOOMBERG, W. J. 1971. Diseases of Douglas-fir seedlings caused by *Fusarium oxysporum*. Phytopathology 61:467-470.

BLOOMBERG, W. J., & W. LOCK. 1972. Strain differences in *Fusarium oxysporum* causing diseases of Douglas-fir seedlings. Phytopathology 62:481-485.

BLOOMBERG, W. J., & J. R. SUTHERLAND. 1971. Phenology and fungus-nematode relations of corky root disease of Douglas-fir. Ann. Appl. Biol. 69:265-276.

BYLER, J. W., & F. W. COBB, JR. 1972. The occurrence and pathogenicity of *Nectria fuckeliana* on dwarf mistletoe in California. Can. J. Bot. 50:1172.

BYLER, J. W., F. W. COBB, JR., & J. R. PARMETER, JR. 1972. Effects of secondary fungi on the epidemiology of western gall rust. Can. J. Bot. 50:1061-1066.

BYLER, J. W., F. W. COBB, JR., & J. R. PARMETER, JR. 1972. Occurrence and significance of fungi inhabiting galls caused by *Peridermium harknessii*. Can. J. Bot. 50:1275-1282.

CANFIELD, E. R., & R. L. GILBERTSON. 1971. Notes on the genus *Albatrellus* in Arizona. Mycologia 63:964-971.

COBB, FIELDS W., JR., EUGENE ZAVARIN, & JOHN BERGOT. 1972. Effect of air pollution on the volatile oil from leaves of *Pinus ponderosa*. Phytochemistry 11:1815-1818.

CSERJESI, A. J., & E. L. JOHNSON. 1972. Methylation of pentachlorophenol by *Trichoderma virgatum*. Can. J. Microbiol. 18:45-49.

CSERJESI, A. J., J. W. ROFF, & W. G. WARREN. 1971. Quality control of lumber fungicidal treatment: estimating number of samples. Mat. Res. & Stand. 11:29-32.

CZABATOR, F. J., J. M. STALEY, & G. A. SNOW. 1971. Extensive southern pine needle blight during 1970-71 and associated fungi. Plant Dis. Reptr. 55:764-766.

ETHERIDGE, D. E., H. M. CRAIG, & S. H. FARRIS. 1972. Infection of western hemlock by the Indian paint fungus via living branches. Environment Canada, For. Serv., Bi-Monthly Res. Notes 28:3-4.

EVANS, LANCE S., & P. R. MILLER. 1972. Ozone damage to ponderosa pine: a histological and histochemical appraisal. Amer. J. Bot. 59:297-304.

EVANS, LANCE S., & P. R. MILLER. 1972. Comparative needle anatomy and relative ozone sensitivity of four pine species. Can. J. Bot. 50:1067-1071.

FELIX, L. S., B. UHRENHOLDT, & J. R. PARMETER, JR. 1971. Association of *Scolytus ventralis* (Coleoptera: Scolytidae) and *Phoradendron bolleanum* subspecies *pauciform* on *Abies concolor*. Can. Entomol. 103:1697-1703.

FRANKIE, G. W., & J. R. PARMETER, JR. 1972. A preliminary study of the relationship between *Coryneum cardinale* (Fungi Imperfecti) and *Laspeyresia cupressana* (Lepidoptera: Tortricidae). Plant Dis. Reptr. 56:992-994.

FUNK, A. 1972. Sirococcus shoot blight of western hemlock in British Columbia and Alaska. Plant Dis. Reptr. 56:645-647.

FUNK, A., & A. C. MOLNAR. 1972. *Kabatina thujae* on yellow cedar in British Columbia nurseries. Environment Canada, For. Serv., Bi-Monthly Res. Notes 28:16-17.

FUNK, A., & A. K. PARKER. 1972. A canker of western flowering dogwood caused by *Sclerophoma ambigua* n. sp. Can. J. Bot. 50: 1623-1625.

FUNK, A., & B. C. SUTTON. 1972. A disease of conifer buds in western Canada associated with *Dichomera gemmicola* n. sp. Can. J. Bot. 50:1513-1518.

GILBERTSON, R. L. 1971. Phylogenetic relationships of Hymenomycetes with resupinate, hydnaceous basidiocarps, p. 275-307. *In* Evolution in the Higher Basidiomycetes. Univ. of Tenn. Press, Knoxville.

HARVEY, A. E., & J. L. GRASHAM. 1971. Production of the nutritional requirements for growth of *Cronartium ribicola* by a nonhost species. Can. J. Bot. 49:1517-1519.

HAWKSWORTH, F. G. 1972. Biological control of the mistletoes, p. 83-92. *In* Biological Control of Forest Diseases. XV Congr. of the I.U.F.R.O., Can. For. Serv.

HAWKSWORTH, F. G., & D. WIENS. 1972. Biology and classification of dwarf mistletoes *(Arceuthobium)*. USDA Agric. Handbook 401. 234 p.

HELMS, J. A., F. W. COBB, JR., & H. S. WHITNEY. 1971. Effect of infection by *Verticladiella wagenerii* on the physiology of *Pinus ponderosa*. Phytopathology 61:920-925.

HERRING, Jon L. 1972. A new species of *Neoborella* from dwarf mistletoe in Colorado (Hemiptera: Miridae). Proc. Entomol. Soc. Wash. 74:9-10.

HINDS, T. E. 1972. Ceratocystis canker of aspen. Phytopathology 62:213-220.

HINDS, T. E. 1972. Insect transmission of *Ceratocystis* species associated with aspen. Phytopathology 62:221-225.

HINDS, T. E., & PAUL E. BUFFAM. 1971. Blue stain in Engelmann spruce trap trees treated with cacodylic acid. USDA For. Serv. Res. Note RM-201. 4 p.

HINDS, T. E., & R. W. DAVIDSON. 1972. *Ceratocystis* species associated with aspen ambrosia beetle. Mycologia 64:405-409.

HUNT, R. S., & F. W. COBB, JR. 1971. Selective medium for the isolation of wood-rotting basidiomycetes. Can. J. Bot. 49:2064-2065.

HUNT, R. S., J. R. PARMETER, JR., & F. W. COBB, JR. 1971. A stump treatment technique for biological control of forest root pathogens. Plant Dis. Reptr. 55:659-662.

KREBILL, R. G. 1970. Autoecious gall rusts of pines in southern Michigan and New York. Plant Dis. Reptr. 54:853-855.

KREBILL, R. G. 1971. Effect of low temperature on germination of teliospores of *Cronartium ribicola*. Phytopathology 61:899 (Abstr.).

KREBILL, R. G. 1972. Germination of basidiospores of *Cronartium comandrae* on rocks and vegetation. Phytopathology 62:389-390.

KREBILL, R. G. 1972. Preliminary annotated list of diseases of shrubs on western game ranges. USDA For. Serv. Res. Note INT-156. 8 p.

KREBILL, R. G. 1972 *Pucciniastrum goeppertianum* in *Abies lasiocarpa* in the Rocky Mountain states. Amer. Midland Naturalist 87:570-576.

KREBILL, R. G., & D. L. NELSON. 1970. Nuclei of Jeffrey pine limb rust Peridermia. Mycologia 62:996-1002.

KREBILL, R. G., & Y. HIRATSUKA. 1972. Nuclear condition and possible life cycle of *Peridermium ephedrae*. Southwestern Naturalist 16:432-433.

LEAPHART, C. D., & M. W. FOILES. 1972. Effects of removing pole-blighted western white pine trees on growth and development of a mixed conifer stand. USDA For. Serv. Res. Note INT-161. 6 p.

LEAPHART, C. D., R. D. HUNGERFORD, & H. E. JOHNSON. 1972. Stem deformities in young trees caused by snowpack and its movement. USDA For. Serv. Res. Note INT-159. 10 p.

LOMBARD, F. F., R. W. DAVIDSON, & R. L. GILBERTSON. 1972. Studies of two species of *Phellinus* in western North America. Mycopathol. et Mycol. Appl. 46:351-365.

McCAIN, A. H., & R. S. SMITH, JR. 1972. Quantitative assay of *Macrophomina phaseoli* from soil. Phytopathology 62:1098.

MARTIN, N. E. 1972. Influence of blister rust on inorganic solute concentrations in western white pine. Phytopathology 62:226-229.

MILLER, PAUL R., M. N. McCUTCHAN, & B. C. RYAN. 1972. Influence of climate and topography on oxidant concentrations causing injury to conifers. Southern Calif. Proc., VI Symp. For. Experts on Fume Damage, Essen, Germany, 1970.

MILLER, PAUL R., & A. A. MILLECAN. 1971. Extent of oxidant air pollution damage to some pines and other conifers in California. Plant Dis. Reptr. 55:555-559.

MYERS, C. A., F. G. HAWKSWORTH, & P. C. LIGHTLE. 1972. Stimulating yields of southwestern ponderosa pine stands, including effects of dwarf mistletoe. USDA For. Serv. Res. Paper RM-87. 16 p.

NEUHAUSER, K. S., & R. L. GILBERTSON. 1971. Some aspects of bipolar heterothallism in *Fomes cajanderi* Karst. Mycologia 63:722-735.

PAINE, LEE A. 1972. Administrative goals and safety standards for hazard control on forested recreation sites. (In press.)

PARMETER, J. R., JR., & F. W. COBB, JR. 1972. Long-term impingement of aerobiology systems on plant production systems. *In* Beninghoff, W. S. & R. L. Edmunds [eds.], US/IBP Aerobiology Program Handbook, No. 2, Univ. Mich. 158 p.

PARMETER, J. R., JR., & ROBERT F. SCHARPF. 1972. Spread of dwarf mistletoe from discrete seed sources into young stands of ponderosa and Jeffrey pines. USDA For. Serv. Res. Note PSW-269. 5 p.

PETERSON, ROGER S. 1972. *Coleosporium crowellii* (Uredinales). Plant Dis. Reptr. 56:474-475.

RICKMAN, J. T., A. E. HARVEY, & C. S. SHAW. 1972. SOLAR: An on-line information retrieval system for plant pathology. Wash. Agr. Exp. Sta. Bulletin 758. 8 p.

ROFF, J. W., & J. KRZYZEWSKI. 1972. In-service assessment of load capacity, decay and retreatment of utility poles. Info. Rept. OP-X-45, Can. For. Serv. 11 p.

SMITH, R. B. 1972. Relative susceptibility of coastal and interior western hemlock to hemlock dwarf mistletoe *(Arceuthobium tsugense)*. Environment Canada, For. Serv., Bi-Monthly Res. Notes 28:17-18.

SMITH, R. B. 1972. Relation of topography and vegetation to the occurrence of Douglas-fir dwarf mistletoe at its northern limits in British Columbia. Ecology (in press).

SMITH, R. B. 1973. Factors affecting dispersal of dwarf mistletoe seeds from an overstory western hemlock tree. Northwest Sci. (in press).

SMITH, R. B., & E. F. WASS. 1972. Douglas-fir, a new host for hemlock dwarf mistletoe. Environment Canada, For. Serv. Bi-Monthly Res. Notes 28:15.

SMITH, R. B., & E. F. WASS. 1972. Infection of amabilis fir by larch dwarf mistletoe. Environment Canada, For. Serv. Bi-Monthly Res. Notes 28:17.

SMITH, R. S. 1970. Responsibilities and risks involved in the use of wood protecting chemicals. Occ. Health Rev., Can. Dept. Health & Welfare 21:1-6.

SMITH, R. S. 1972. Maintenance of fungal cultures in pre-sterilized disposable, screw-cap plastic tubes. Mycologia 63:1218-1221.

SMITH, R. S., & J. V. HATTON. 1971. Economic feasibility of chemical protection for outside chip storage. TAPPI 54:1638-1640.

SMITH, R. S., & A. OFOSU-ASIEDU. 1972. Distribution of thermophilic and thermo-tolerant fungi in spruce-pine chip pile. Can. J. For. Res. 2 :16-26.

SMITH, R. S., & C. V. SHARMAN. 1971. Effect of gamma radiation and ethylene oxide sterilization of wood on its subsequent decay by four wood-destroying fungi. Wood & Fiber 2:356-362.

SMITH, RICHARD S., JR. 1972. Needle casts of high-altitude white pines in California. Plant Dis. Reptr. 56:102-103.

SMITH, RICHARD S., JR., A. H. McCAIN, M. SRAGO, R. KROHN, & D. PERRY. 1972. Control of Sirococcus tip blight of Jeffrey pine seedlings. Plant Dis. Reptr. 56 :241-242.

SPOTTS, R. A., J. ALTMAN, & J. M. STALEY. 1972. Soil salinity related to ponderosa pine tipburn. Phytopathology 62:705-708.

STALEY, J. M., & H. H. BYNUM. 1972. A new *Lophodermella* on *Pinus ponderosa* and *P. attenuata*. Mycologia 64:722-726.

SWANN, G. W., & J. W. ROFF. 1972. Lab test suggests anti-stain dip effective on frozen wood. Can. For. Ind., May, 35-39.

SUTHERLAND, J. R., & D. A. ROSS. 1971. Temperature effects of survival of *Xiphinema bakeri* in fallow soil. J. Nematol. 3:276-279.

WHITNEY, H. S. 1971. Association of *Dendroctonus ponderosae* Hopk. (Coleoptera: Scolytidae) with blue stain fungi and yeasts during brood development. Can. Entomol. 103:1495-1503.

WHITNEY, H. S., & R. A. BLAUEL. 1972. Ascospore dispersion in *Ceratocystis* spp. and *Europhium clavigerum* in conifer resin. Mycologia 64:410-414.

WHITNEY, H. S., & F. W. COBB, JR. 1972. Nonstaining fungi associated with the bark beetle *Dendroctonus brevicomis* (Coleoptera: Scolytidae) on *Pinus ponderosa*. Can. J. Bot. (in press).

WIENS, DELBERT, & MARY DEDECKER. 1972. Rare natural hybridization in *Phoradendron* (Viscaceae). Madroño 21:395-402.

WILLIAMS, WAYNE T., FREIDA FORTIER, & JOHN OSBORN. 1972. Distribution of three species of dwarf mistletoe on their principal pine hosts in the Colorado front range. Plant Dis. Reptr. 56: 223-227.

ZAVARIN, EUGENE, FIELDS W. COBB, JR., JOHN BERGOT, & HOLLIS W. BARBER. 1971. Variation of the *Pinus ponderosa* needle oil with season and needle age. Phytochemistry 10:3107-3114.

ZILLER, W. G. 1972. Lophodermium needle cast of pines in nurseries and plantations. Can. For. Serv., Victoria, B.C., Pest Leaflet 52.

BUSINESS MEETING

September 29, 1972

Committee Reports

1. Dwarf Mistletoe. Report was distributed to members and will also appear in the proceedings. Ed Wicker, new chairman replacing Bob Scharpf.

2. Forest Disease Recreation Hazard. Peter Gaidula, new chairman replacing Lee Paine.

3. Air Pollution. Report will be mailed out separately; Paul Miller, chairman.

4. Interim Program. Chairman Bob Gilbertson submitted his report which will appear in the proceedings.

5. Disease Control. Committee dissolved by reason of lack of membership participation.

Minutes

Minutes of previous meeting accepted as they appear in the 19th Proceedings with a correction on page 99, New Business, B. The number on the list should have been 200 instead of 20.

Secretary-Treasurer's Report

The attached financial statement was presented.

Old Business

The status of the 18th Proceedings which have not been available was discussed. Don Graham will look into the matter.

Jack Roff commented on the importance to the Conference of reports of new techniques and project reports.

New Business

Keith Shea reported on 1973 meetings that could conflict with the 21st WIFDWC. September 5-12, 1973, International Congress of Plant Pathology in Minnesota.

The distribution of the Proceedings was discussed. It was agreed that the publication list could be made available to non-WIFDWC members but the Proceedings are for members and participants only.

Joint Conference. The report of the InterConference Committee on the possibility of a joint meeting of WIFDWC and WFIWC, H. S. Whitney, Chairman, had been made available to the members. After some discussion the membership voted to meet with WFIWC. It was also decided that we should inform WFIWC that we would like to meet with them some time from September 1974 to March 1975.

Meeting Site for 1973. It was unanimous that we meet in Colorado. The dates of the meeting were discussed but no decision was made.

Air Pollution Committee. Deferred action until report is made available (Alex Molnar).

Election of Officers

Ed Wicker was elected Chairman. Robert Loomis was elected Secretary-Treasurer.

Commendation

The Local Arrangements Committee under the chairmanship of Duncan Morrison was thanked for the fine arrangements. The Program Committee chaired by Larry Weir was also thanked. Members also found the field trips worthwhile and interesting.

FINANCIAL STATEMENT - 1972

Bank balance February 17, 1972		$195.90
Less bank service charges		5.95
Balance September 25, 1972		$189.95 ($U.S.)
Income:		
Registration		
regular - 73*	$572.10 ($Canad.)	
honorary - 5	--	
student - 2	--	
Banquet tickets		
122 @ 4.50	549.00	
	$1,121.10 ($Canad.)	
Expenses:		
Meeting Rooms	$ 80.00	
Banquet	779.00	
Bus	130.00	
Lunches	74.63	
Coffee	57.50	
Miscellaneous	8.44	
	$1,129.57 ($Canad.)	
Balance, October 1, 1972		$180.45 ($U.S.)†

*Registration: 41 - $8.50 U.S., 32 - $8.00 Canadian.

†Discrepancy due to conversion from Canadian to U.S. dollars.

SOCIAL ACHIEVEMENT AWARD WINNERS

For the record, as suggested by the membership, the following list of social achievement award winners was prepared by Gordon Wallis:

Conference	Location	Winner
5	Salem	Stuie Andrews
6	Vancouver	Stuie Andrews
7	Pullman	Don Leaphart
8	Centralia	Keith Shea
9	Banff	Phil Thomas
10	Victoria	Toby Childs
11	Jackson	Alex Molnar
12	Berkeley	Reed Miller
13	Kelowna	Art Parker
14	Bend	C. Gardner Shaw
15	Santa Fe	Larry Weir
16	Coeur d'Alene	Bob Scharpf
17	Olympia	Dick Parmeter
18	Harrison	Jim Kimmey
19	Medford	Ed Wicker
20	Victoria	Vivian Muir

HONORARY LIFE MEMBERS

Warren V. Benedict
Thomas S. Buchanan
Toby W. Childs
Lowell J. Farmer
John R. Hansbrough
Homer J. Hartman
Dwight Hester
Benton Howard
James W. Kimmey
James L. Mielke
Douglas Reed Miller
Virgil D. Moss
Clarence R. Quick
William G. Solheim
Conrad P. Wessela
Ernest Wright

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---

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†Attended Twentieth Conference.

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