# PROCEEDINGS OF THE 25th ANNUAL WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

**Victoria, British Columbia**
**September 1977**

# Proceedings of the 25th Annual Western International Forest Disease Work Conference

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**Compiled by:**

Proceedings of the Twenty-Fifth Western International Forest Disease Work Conference
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# FOREWORD

The Twenty-Fifth Annual meeting of the Western International Forest Disease Work Conference met in Victoria, British Columbia, the site of the founding meeting. One hundred and two pathologists participated. It was especially gratifying to the executive to see so many of the "founding fathers" show up.

The Conference was opened Tuesday morning, October 18, by chairman Graham and was welcomed by Bill Young, Assistant Chief Forester (Resource Management), Britich Columbia Forest Service. Mr. C. P. Brett, Productivity Coordinator, British Columbia Forest Service, presented the keynote address, "Forest Diseases As A Part of the Forest Ecosystem".

The officers for the "25th" were:

Don Graham, Chairman
John Laut, Secretary-Treasurer
Earl Nelson, Program Chairman
Local Arrangements, Bill Bloomberg

Our thanks, especially, to the local arrangements committee for creating the proper atmosphere for the conference.

NOTICE

We regret to report that Dr. Stuart R. Andrews passed away in Fort Collins, Colorado, on May 25, 1978. Stuie retired as Project Leader in Forest Disease Research at the Rocky Mountain Station in 1971. He was a charter member of WIFDWIC and a very active member. He is survived by his wife Helen, a daughter, Jenné, of Minneapolis, Minnesota, and a son, Stuart, of Estes Park, Colorado. A Memoriam will be included in next year's proceedings.

# CHAIRMAN'S REMARKS

Welcome everyone and for those of you who previously have not attended this work conference we extend a special welcome. This is the 25th meeting and a quarter of a century of WIFDWC. Certainly, it is appropriate that the 25th meeting is being held in the same place as where this work conference originated in November 1953. Also, perhaps it is appropriate that your chairman for this year attended the first meeting as one of the 33 delegates and had at least a tiny part in getting the conference off to a fine start. At least I think it is nice.

Of interest is that eight of the 25 meetings have been held here in Canada; Victoria in 1953, 1962, 1972, and 1977, Vancouver in 1958, Banff in 1961, Kelowna in 1965, and Harrison Hot Springs in 1970.

There are two significant events I would like to mention; one has happened and the other is forthcoming. First, a history of Forest Disease Research in the Western United States and British Columbia by Thomas S. "Buck" Buchanan has been published. Second, a Symposium: Dwarf Mistletoe control through forest management, is being organized. It will be April 11-13, 1978 in Berkeley, California.

The agenda looks about right in time. However, it is easy to get bogged down so I suggest that moderators be tough so as to allow for meaningful discussion.

Finally, I hope I can make the 50th meeting in the year 2002 and that it will be held here in Victoria.

# FOREST MANAGEMENT IN BRITISH COLUMBIA WITH PARTICULAR REFERENCE TO THE PROVINCE'S FOREST DISEASE PROBLEMS

Bill Young

## INTRODUCTION

I appreciated the opportunity in being invited to participate in the Western International Forest Disease Work Conference.

In discussing the program with Bill Bloomberg, the Local Arrangements Chairman, he identified the three main concerns of this conference:

- the impacts of disease management on the forest ecosystem,
- the communication of research results to the 'user' community,
- the role of disease research in intensive forest management.

This morning I would like particularly to say a few words on the third of your three concerns - the role of disease research in intensive forest management. Even to be more specific, the intensive forestry practices concerned with the regenerating and tending of the province's new forests. In so doing, I certainly don't wish to infer that the other two concerns are not of importance.

Before addressing some comments to this more specific subject of the role of disease research in intensive forest management and at the risk of boring some who have heard me say this before, I would like to spend a few minutes for the benefit of the 'out-of-province' guests to emphasize the importance of 'forestry' to the Province of British Columbia.

First, I must say that it is a regrettable fact that the importance of British Columbia's forest resource and the magnitude and complexities of the pertinent programs involved are not fully appreciated by British Columbians. For example, a relatively few people in this province appreciate that:

1) British Columbia has the great diversity of climatic, topographic and 'forestry' conditions in Canada.

2) British Columbia is the home of Canada's most important and diverse fishery resource - a resource that is directly affected by its forests and its forest harvesting programs. For example, the Fraser River is known as the most important salmon river in the world.

3) Canada's export of forest products make a greater net contribution to the nation's balance of payments than the combined exports of agricultural and mineral products and that almost fifty percent of the timber harvested in Canada is cut in British Columbia.

4) Approximately seventy percent of the lumber manufactured in Canada is manufactured in British Columbia.

The intent of these introductory remarks is simply to attempt to put into perspective that British Columbia is one of the world's major forest areas whose forests provide the major social and economic well-being of its citizens. Further, British Columbia is a province with attributes that attract people with the result that we have a rapidly increasing population that primarily depends on our forests for its social and economic well-being.

It is obvious that with British Columbia's major dependency on its forests we must maintain this province's 'golden goose' in a healthy state if we are to continue to collect our golden eggs in future years. How can this be done? Not by feeding the 'golden goose' a diet of chicken feed but through major investments in the forest estate. It is here that the interaction of forest disease research is not only desirable but essential. In this country, as most of you appreciate, the responsibility for forest disease research is that of the Government of Canada. In the past few years, British Columbia has made massive investments in intensive forestry programs and I am sure that you can appreciate the serious concern that is voiced when we hear of Government of Canada 'zero budgets' and program restrictions and the fear that this may result in program curtailment in forest disease research.

It is obvious that, as the old growth forest becomes more scarce and more expensive to harvest in certain parts of the province, increased priority must be given to the intensive management of our future forests on the higher forest sites. Nowhere is this more apparent than on British Columbia's lower coast.

With this change in emphasis, however, new problems arise. Problems in economics, harvesting equipment, marketing, environmental, and, most important to you - forest diseases. Probably the greatest threat to our future forests of the Lower Mainland is root rots which are causing a major concern in our second growth forests. Gordon Wallis and others from the Canadian Forestry Service have been working on this problem and through publications, field seminars, and personal contact have made commendable strides in making field foresters aware of the problem. This awareness has been reflected in the direction of juvenile spacing programs and salvage logging trials. However, the problem isn't going to go away and is an example of the essential need for forest disease reasearch and, equally important, the communication of this research to the 'user' community as rapidly as possible. In short, if this province is to maintain a viable forest industry in the future, it is essential that we intensively manage our high site forest lands for increased quality and quantity of wood. To believe that this may not be achieved because of an insurmountable root rot problem is just too dark a picture to consider.

I apologize for dwelling too long on the intensive forestry issue on the lower coast but it is an issue dear to my heart. Of course, I don't want to minimize forest disease research and extension work that must be done on a host of other critical problem areas including:

Lodgepole pine mistletoe

Douglad fir mistletoe

White pine blister rust

and the like.

In summary, I would like to welcome the out-of-province visitors to British Columbia. At a time when spruce budworm and mountain pine beetle seem to be getting most of the publicity, I hope that I have confirmed in your minds the position of the B.C. Forest Service on the essential importance of forest disease research and the equally important priority of quickly communicating results. While not as spectacular to the general public as a spruce budworm or mountain pine beetle infestation, the importance of forest disease research to British Columbia's future forests cannot be over-estimated.

KEYNOTE ADDRESS TO WESTERN INTERNATIONAL

FOREST DISEASE WORK CONFERENCE

## FOREST DISEASES AS A PART OF THE FOREST ECOSYSTEM

Paul Brett, Productivity Coordinator
British Columbia Forest Service

Mr. Chairman, forest pathologists, fellow foresters and guests.

Thank you for the introduction and thank you also for the honor and privilege of presenting the keynote address at your 25th Western International Forest Disease Work Conference. I have been impressed for some time with the productivity of your membership and with the manner in which you maintain effective communications on an individual basis and as a group. The large and important body of literature produced by North American forest pathologists, accumulated in a region where, in general, somewhat extensive forest management priorities have prevailed for a long time, is testimony to your dedication and perserverance. I will have more to say about this later.

Today I have been asked to keep in mind the central theme of your deliberations, namely "Forest Diseases as a Part of the Forest Ecosystem". At the same time, I have been asked to give a few opinions on why and how forest managers need to be concerned about forest diseases and further, some of the responsibilities of the forest pathologist in acquiring needed information and knowledge, and transferring such products to the users.

First, however, I would like to develop some perspective against which you can judge my subsequent comments. In doilg so, you will undoubtedly hear a tune similar to the one played by Bill Young in his welcoming remarks.

Canada is a forestry nation, no other single resource contributes as much to the Canadian economy. British Columbia is responsible for nearly one half this economic activity. Within the Province, forestry and the forest industry are by far the major generators of economic and social benefits. As such the forest products trade is fairly described as the "engine of growth and prosperity" in the Provincial economy.

In the minds of many local folk, this is because there is no other concentration of coniferous timber anywhere in the world with a potential equal to that of British Columbia. Furthermore, the Province has other important attributes such as good ports, abundant water supply and relatively cheap energy, low population, highly skilled labor force, stable political system and homogenous land ownership.

In recent years, however, the competitiveness of the British Columbia Forest Industry in world markets has been steadily declining - mostly as a result of decreases in products quality accompanied by substantial increases in production costs. Also, the forest resource upon which this activity is based is changing. Old growth is giving way to young growth and current levels of extensive or low cost management are not likely to bring forth the full potential of this new forest in the future.

The foregoing comments, I hope, emphasize the vital importance to the Provincial economy of maintaining a healthy, competitive forest industry. I hope also that the crucial need of this industry for continuing wood supplies of high quality and at reasonable cost is seen clearly. In my opinion, the first mentioned need is a major Provincial objective whereas the second is the major objective of the Provincial Forestry Service.

Now, why forest management within an ecological framework? Forest pathologists, I ask you. What are the alternatives? As our old growth stocks diminish we are in effect becoming managers of a young-growth forest. In this new, largely man-created forest, the effectiveness of our silvicultural program will be a key factor in providing a basis for continuance of vigorous and competitive forest economies. This is so because even with improvements in utilization technology, future levels of continuing wood supply are directly related to our skills in harnessing and productive capacity of the forest land base.

"Harnessing the productive capacity of the forest land base". I am repeating this phrase not only to emphasize its importance as a major strategy to achieve future wood supply goals but also to convey to you the message that such a strategy implies long term management obligations--in other words, responsible resource stewardship.

In this context, responsible silviculture can be described as applied forest ecology since it is forest ecosystems, not forest stands or trees that we must manage if we expect to make an informed impact on the productivity of our forests. Only in this manner can wood production be kept in a continuing harmony with all of the factors bearing on productivity, i.e. ecological limitations and the integrated resource management opportunities which our land base presents to us.

The foundation of silvicultural practices therefore, is knowledge of forest ecosystems and their dynamics. Further, long term efforts to improve this knowledge base, if they are to be efficient and successful, will depend largely on our ability to organize accumulated knowledge and experience on our ecosystem basis.

The first step which is being taken to implement a program based on the foregoing principles concerns the identification of forest ecosystems within a practical framework, i.e. a biogeoclimatic classification, that can be understood and applied by field practitioners with little formalized training in ecology. In British Columbia, programs to identify and describe forest ecosystems for interpretive purposes are well under way in five of our six Forest Districts. To date this work has enabled the production and use of tree species selection guides for reforestation planting prescriptions in three of these Districts, and has spurred the development of other silvicultural prescriptions for mechanical site preparation and burning. This work is the natural outcome of years of scientific research, testing and demonstration particularly by Dr. Krajina and his students.

As suggested above, the B.C. Forest Service is making progress in this regard but it is only a beginning in the successful implementation and steady improvement of sound silvicultural practices in the Province. In the long run, our ability to organize accumulated experience and knowledge on an ecosystem basis is mandatory because it confers and accumulates management expertise that is fundamental to systematically and efficiently improving our ability to manage forest ecosystems.

In this manner it has to be clear that forest diseases, for example, should be regarded not as aberrations that periodically confuse and disillusion foresters. Rather they have to be regarded for what they are and treated as such, i.e. an integral component of the total assemblage of living organisms together with their total non-living environment that make up the forest ecosystem. This is the lesson for managers, pathologists, researchers etc., alike. Therefore, just as the forest manager must become aware and cognizant of all of the factors bearing on the attainment of his objectives so must "ecosystem component specialists" such as the forest pathologists, for example. Thus, it is self evident that the work of forest disease specialists, cannot be carried out successfully in isolation.

In my view, the foregoing argument and my own experience suggest two major needs relative to your field of interest. First, unravelling and explaining the role and significance of forest diseases in an ecosystem context demands a much higher degree of collaboration between yourselves and other ecosystem component specialists. More long term realistic disciplinary studies based on controlled, specific, and deliberated interventions into forest ecosystems are overdue. The best local example of such a study is the Shawnigan project, sponsored by the Canadian Forestry Service. This project is aimed at explaining the effects of fertilization and thinning in a Douglas-fir-Gaultheria shallon - Mahonia nervosa forest ecosystem type within the Coastal Douglas-fir wetter biogeoclimatic sub-zone. In the study, the forest pathologist and entomologist are working hand in hand with the tree physiologist, the pedologist, the micro-biologist, silviculturalist, mensurationist etc. Further, and while the study embraces some pretty "heavy" in-depth research, the forest manager is also involved and committed to it. As might be expected, the work has already had an impact on at least local operations and has a bright future provided that the C.F.S. doesn't inadvertently smother the "baby" with Federal "zero" budgets!

A second concern of yours, I would suggest, is to avoid the omphaloskepsis so frequently induced in specialists in the past, by forest managers who were too busy to listen or talk to you. The old ball game is over and a new one is just beginning. You can't help him by contemplating your own navel. His new function will be to develop and improve his performance as a forest ecosystem manager in order to produce wood and other forest products. Accordingly he will be looking at and choosing from a whole array of alternatives to meet this very basic objective. You can "bank on it" that he will not dwell on what he sees as tangential approaches or "no show" options.

A case in point is early stocking control. Of course, he is going to do it. And of course he may be incurring horrible risks. But you can see, I hope, that the "don't do it" option isn't very helpful; and neither is the "do it, but at an unacceptable cost" alterna-ive. Surely, what is required (after someone gets more serious about defining the risk much clearer) are more and better alternatives. For example, how about the old "self destructing species" but using the least rust-resistant white pine strains in an admixture, or off site species, or dwarf alder and so on. The point is, the forest manager is assuming a large and complex task. He will therefore need the assistance of a team of specialists, all of whom can identify strongly with this task and can work positively and imaginatively within and beyond their respective disciplines in an open and constructive manner.

Finally, I would like to speak directly to the issue of getting knowledge to the user. From what I have said previously, I think you should have a pretty good hint as to my feelings in this regard. However, to summarize, in B.C. the objective should be to improve and intensify forestry practices:

1. to levels which are consistent with the future wood supply needs of a healthy, competitive forest industry,

2. in the public interest of securing full efficient use of the forest resource base, and

3. within the bounds of good resource stewardship.

The forest ecosystem manager is a key person in the attainment of this objective and he sould be the one who "calls the shots". At the same time he needs a great deal of help to do his job effectively and efficiently. There must therefore be a continuum from himself and his operations, on through support, research development and monitoring staff and all the way to support research groupd; and there must be a strong 2-way exchange of information, advice and committment.

It is my habit to liken this situation to an irrigation system which is sufficiently important and complex to require continuing effort to improve its performance and to repair breakdowns. The manager of the works is equivalent to the forester. The fact that water is coming out the other end of the pipe is not a reasonable measure of his performance whereas how much water, when, of what quality, and at what cost, are. In the normal course of oeprations and under a logical, systematic form of management, all sorts of problems and opportunities will arise, i.e. leaks, contamination, and how about some larger pipe? Each will be priorized in terms of the basic objectives of the operation and each will be attacked in order of their priority. Some problems will be solved and some opportunities will be realized at operational levels. Some will require innovativeness and therefore a testing phase. Still others will require something altogether new - knowledge or tools, which once produced, must be tested and perhaps refined, before being put into use. Using the manager of works at one end and the research at the other end as an example, neither party will be very effective in their respective roles if they do not appreciate where the other guy fits into the system and what each can and must do to make it operate in a satisfactory manner. Therefore, if on one hand there are forest managers around who do not know what research is, its value, and how to use it effectively in an integrated manner in order to do their jobs well, then I suggest that they take up basket weaving. On the other hand, most researchers would do well to think through the very real benefits of tuning in to the real problems, needs and opportunities as expressed by those who have the clear responsibility not only for identifying them but doing something about it.

So I say with respect to transferring knowledge into use - "What problem?" So long as everyone knows and does their duty, that information that is required will be produced and will be used, just as a matter of course.

To conclude, in British Columbia, as in many other parts of this continent we are rapidly entering a new era - one in which a very extensive brand of forestry aimed at removal of an old growth natural forest is being replaced by management concerned with the establishment and tending of a new forest tailored to meet long term needs of the whole community. This transition will not be achieved overnight. Nor will it be achieved without large infusions of knowledge and experience on how to do this job effectively and efficiently. It is in the latter area that many years of research and development (often carried on without much support or interest from forest managers) finally is going to start paying off. In other words, ladies and gentlemen, from your point of view, we are entering a golden age in the sense that many of your contributions, past, present and future will be seen to be relevant and not just "nice" things to do - when there are spare dollars in the kitty.

Thank you very much for your kind attention. My best wishes for a successful work conference.

Panel: Regulatory Functions of Diseases in Forest Ecosystems

J.R. Parmeter, Moderator

Introduction - J. R. Parmeter

Owing to a propensity to commit to writing ideas substantiated by about the same amount of evidence generally deemed sufficient for two-o-clock-in-the-morning, smoke-filled-motel-room, who-can-talk-the-loudest WIFDWC discussions, I find myself chairing a panel on the functions of diseases in natural ecosystems. Such a discussion would be largely out of place at any pathology meeting other than WIFDWC, since for practical purposes only forest pathologists deal with what might be considered "natural" ecosystems. This involvement with somewhat natural ecosystems (setting aside for the moment the facts that most of our forests have been logged at least onec, that fire has been excluded for many decades, that deliberate changes have been wrought by foresters through planting and various silvicultural manipulations, and that congressional committees have compacted many of our soils) puts forest pathologists in a unique position to contemplate the workings of nature, and perhaps even to utilize them.

Other plant pathologists, dealing with highly artificial systems, generally have viewed diseases as enemies, perversities of nature, or instruments of the devil to be attacked with anything from poison to prayer. From the perspective of forest pathology, I'd like to suggest that diseases are integral, perhaps essential regulators of forest ecosystems; that they perform several important functions, and that by understanding these functions and the feedback mechanisms that moderate them, we can go a long way towards cooperating with, rather than fighting with, the system.

Presently (I can't bear to say "at this point in time") we lack hard data, but by combining a few extrapolations from the hallowed principles of plant pathology, a smattering of knowledge about the behavior of pathogens, a scattering of observations by forest pathologists, and a few shot glasses of deduction, we can recognize some likely functions of pathogens in forests and the feedbacks that regulate disease activity. Among these are: 1) adjustment of live biomass to the carrying capacity of the site, 2) promotion of stability through diversification of communities, 3) restriction of species to adequate site and range, and 4) promotion of generation "turnover".

The first three suggested functions will be discussed by my able colleagues, who, having been given only the vaguest of notions about what to discuss, will develop their topics in whatever fashion pleases them. The fourth topic I'd like to discuss briefly here as a modest introduction.

# RELATIONSHIPS OF TREE DISEASES AND STAND DENSITY

Ed F. Wicker

Density relates to the number of plants/unit area at a given time. It directly influences the technical properties of the wood produced and the quality and quantity of forest products harvested. Competition from neighbors directly influences both vitality and vigor of individual plants. Density is readily altered by both abiotic and biotic factors, including man. For these reasons, regulation of stand density is an important function of silviculture. The fundamental objective is to concentrate growth on the superior stems in the stand. A brief examination of the natural development of a stand, unregulated by man, will enhance one's appreciation of the effects of density on individual and stand development.

In general, the stand begins with many thousans individuals/hectare (ha). These individuals may be of a single taxon or they may be different taxa forming a mixture. In any event, they are immediately affected by the actions and interactions of numerous fluctuating environmental factors. Each of these factors affect the plant simultaneously. Their effects on the plant are modified by one another. The composite of their actions and interactions is known as the environmental complex. The environment is highly heterogeneous, even more so than most can conceive. Thus, the ecologic amplitude of plants is expansive but not unlimited. The plant has definite tolerance limits for each of these factors. When variations in any single factor or combination of factors exceeds the tolerance limits of the plant, the plant will lose its competitive position. Its vigor and vitality will decline. If this decline is unabated, the plant will die. The existence and intensity of interrelationships between individuals is determined by density. Such relationships may be beneficial, neutral, or detrimental. A most critical relationship between individuals is competition. Within certain spatial limits, plants compete with one another for the available matter and energy necessary for growth. A plant's capacity to compete with its neighbors is inherently prescribed by its genetic constitution. This competitive capacity is modified by the environment. The effects of competition on height growth is a critical factor in the development of a forest stand. As the less competitive individuals are crowded more and more by more vigorous neighbors, they begin to decline and gradually become mortality statistics unless the competition is removed. However, for some individuals, the process is nonreversible once initiated. Thus, as a stand of trees develops there is a continual reduction in numbers of individuals over time. This reduction in numbers results from the rigors of the selective effects of the environmental complex. The resulting stand is the product of a multiplicity of interactions encompassing the total heterogeneity of environment and ecologic amplitude of the taxa represented. Thus, the stand influences the environment and the environment influences the stand. The two are inseparable.

The natural process of stand development is often viewed as a steady and progressive natural selection of the fittest. Unfortunately, those individuals selected as the fittest via natural selection may not be compatible with the desires of the land manager. It is within this context that the bases for the practice of silviculture spawn.

Diseases are a major factor altering stand density. In this capacity, they are regarded by some foresters as "natural accidents," a viewpoint not shared by the author. Diseases are an integral phase of all plant ecosystems. They constantly and continuously influence the patterns of change, development, and dynamic equilibrium of the ecosystem. Simultaneously, every adpect of their behavioral patterns are conditioned by the functional activities of the ecosystem. Their significance to mankind is based mainly on land use. Invariably, it is those diseases that reduce stand density that attract the major share of man's attention.

Some diseased are nonselective in their actions of altering stand density. Others reflect varying degrees of selectivity based upon species, age, crown class, foliage retention, etc. In either case, the action of disease in altering stand density is largely incompatible with man's desires and objectives for managing the forest. The conspicuous disadvantages of the unplanned and mainly unpredictable nature of their actions masks any insidious advantages. To date, we have been about as accurate at predicting disease behavior as we have at predicting the behavior of wildfires in wilderness areas. Why? As a starter, one might ponder our dearth of knowledge in recognizing, identifying, and explaining the ecological role of diseases in development of vegetation, particularly, in forest habitats.

Indirectly, by altering stand density, diseases exert some profound effects upon land use and management decisions. The rate of density alteration is as variable as the patterns of alteration. This variability becomes very evident when one compares enphytotic with epiphytotic disease conditions or diseases caused by exotic with indigenous agents. This variability is reflected in the floristic composition, succession physiognomy, structure, and distribution of vegetation throughout the sere, finding its ultimate manifestation in productivity.

In 1937, Ralph C. Hawley wrote that the average forester today fails to appreciate how threatening a factor disease may be in the production of forest crops and how necessary for success it will be to adjust management practice to minimize their effects. With a few exceptions, his comments are equally applicable in 1977. Only time has changed. How long must we wait?

# FOREST DISEASES AS DETERMINANTS OF STAND COMPOSITION AND FOREST SUCCESSION

Earl E. Nelson

Spurr and Barnes (1964) in their text, Forest Ecology, state that under specific conditions of site--using site in its broadest sense to include geographic location, climate, soil, and topographic position--a series of stages of plant succession can be deduced which begins with the colonization of that site and proceeds to a stage typically characterized by tolerant and long-lived organisms that constitute a more or less balanced and relatively permanent community.

The forest is never stable but remains a dynamic community in the later successional stages, just as it is in the earlier stages. Secondary succession follows a disturbance and disrupts rather than destroys an existing community.

Less eloquently said, the forest, however changing it may be, is a product of its total environment. The orderly progression of plant succession is many times characterized by a certain amount of disorder. Although rarely considered by most ecologists, disorder is frequently caused by less obvious elements of the ecosystem, forest tree pathogens.

What stand changes occur in the presence of forest disease? Again, Spurr and Barnes concede that major compositional changes may occur when new species are introduced into the ecosystem or when disease or insects eliminate species. If one has not seen for himself, one can readily imagine the magnitude of upheaval when diseases such as chestnut blight, Dutch elm disease, or oakwilt invade the eastern hardwood forest. Closer to home, the introduction of white pine blister rust and Port-Orford-cedar root rot into the native forest habitat has provided an expensive and perhaps unheeded lesson in ecology.

Introduced diseases of such virulence cause drastic changes in the ecosystem. Though we must attempt to solve problems caused by introduced diseases, chances of success are greater with those diseases which have their place in the forest ecosystem. Through careful study and wise management, they can be dealt with effectively.

In general, diseases which are host-specific may perform a thinning function in stands where that species is a minor stand component or decimate stands composed primarily of that species. Small holes made in the canopy encourage climax species, and large gaps encourage seral species.

Under some conditions, pathogens having wide host ranges may act similar to host-specific pathogens since tree species in mixed stands vary in their resistance. Where conditions for disease development are less than ideal, those species most resistant will increase in dominance in the residual stand. Again, where destruction in the residual stand is substantial, seral species may be encouraged in the understory; where disturbance is minor, climax species may be encouraged.

One apparently native fungus causing increased concern in the West is *Verticicladiella wagenerii*, the cause of black stain in conifers. Much has been learned about this fungus since its discovery in 1938 on ponderosa pine in Lassen County, California. Stand type seems to be the most important determinant of where *V. wagenerii* infections are likely to be found. In the Southwest, most infection centers occur in pure, overstocked, even-age stands of ponderosa pine between 40 and 80 years old. Many of the infection centers are in low-lying areas. Where the disease occurs in mixed stands, it is uncommon for more than one species to be infected, thus true fir in pine-fir transitions are spared as are western hemlock in Douglas-fir-western hemlock stands in the Pacific Northwest. Incidence of infection appears to be increasing in second-growth stands, especially in monocultures (Goheed 1971).

Other more or less host-specific pathogens, such as dwarf mistletoes, may act similarly. In mixed stands, dwarf mistletoe may play an important role in accelerating stand succession. If more seral species are infected as lodgepole pine in a pine-fir-spruce association or as ponderosa pine in a pine-fir association, climax vegetation is reached at an earlier point in time. Dwarf mistletoe infection in climax vegetation, especially if stand purity is high, may debilitate the climax species to such a degree that seral species will invade the area.

I would like to focus a bit on three pathogens which are not so host-specific--pathogens which, once invading a site, can persist on that site for a long period, even in the absence of a living host. I think we are all well acquainted with them and their potential for destruction. I am referring to *Armillaria mellea, Fomes annosus,* and *Phellinus weirii*.

Many statements I have made or will make are rather general. You may know of situations where the reverse is closer to the truth. There are many factors which affect stand development, diseases being only one. In the final analysis each site is unique and must be judged separately.

## *Armillaria mellea*

*Armillaria mellea* is perhaps the most widespread, most studied, earliest known, most omniverous, and least understood forest pathogen we deal with. It is frequently billed as a "pathogen of opportunity" being ubiquitous, lying in wait for some accident of nature or activity of man to send it rampant.

Partial cutting, drought, insect activity, disease outbreaks, all may trigger an eruption. Evidence indicates that the fungus is always secondary to some other factor which predisposes the tree to disease. The site, the choice of species, the method of regeneration, the type of thinning, defoliation, and suppression may all have such an influence (Huntly, Cafley, and Jorgensen 1961). Stumps are often closely associated with damage. Balsam woolly aphid damage has led to *A. mellea* attacks in Newfoundland (Hudak and Wells 1974), and mechanical defoliation of trees to stimulate feeding of insects reduced their resistance to attack.

One might imagine, then, that a diversity of species in a stand would reduce chances of a general weakening of stand resistance brought about by a host-specific insect or disease, or possibly environmental events such as snowbreak or fire damage.

Once *A. mellea* centers appear, how does stand composition affect progress of the disease and how does this pathogen affect the resulting composition of the stand? It seems that outbreaks such as that occurring in Washington, southeast of Mt. Adams, occur in transition forest types--in this particular case between forest types of ponderosa pine and Douglas-fir. The result here appears to be a change in forest type from one predominantly pine to one predominantly fir (Shaw et al., 1976).

*Armillaria mellea* often causes damage in the mixed conifer types of the intermountain region.[1/] Where the *Thuja plicata/Pachistima myrsinites* association is climax in eastern Washington and northern Idaho, we find mixed stands of Douglas-fir, grand fir, lodgepole pine, western white pine, and western larch preceding the climax type. When *A. mellea* progresses beyond killing isolated trees and creates a root rot center (either alone or in combination with other root diseases), Douglas-fir and grand fir are killed more frequently than are the other species, although they too may be attacked. When openings are small, succession may be accelerated towards climax. Large openings tend to favor reproduction of Douglas-fir and grand fir--a situation which delays natural succession and results in perpetuation of the disease.

Management practices such as mechanical disturbance of soil in areas where *A. mellea* is active can encourage the development of more pioneering species such as western larch and lodgepole pine. The dominance of these more "resistant" species on a site will tend to reduce future root rot damage, resulting in greater wood production.

### *Fomes annosus*

*Fomes annosus* has gained the respect of forest pathologists in its dual roles of killer and butt-rotter of conifers in western North America and other temperate coniferous forests around the world. In Yosemite National Park, *Fomes annosus* is killing ponderosa pine, incense-cedar and some white fir on sites which are dominated by oak-grass associations before the exclusion of fire.[2/] Now conifer stands in the presence of *F. annosus* are reverting back to black oak. To the south, a similar situation exists with stands of Jeffrey pine, ponderosa pine, incense-cedar, and white fir reverting to black and live oak. Pine is readily killed while butt-rotted incense-cedar and white fir are frequently windthrown to open

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1/ Personal communication, Dr. Ed Wicker, Intermountain Forest and Range Experiment Station, Forestry Sciences Laboratory, Moscow, Idaho.

2/ Personal communication, Dr. Richard Smith, Regional Office, USDA Forest Service, San Francisco, CA.

up extensive areas. Current management recommendations (seemingly in tune with nature) are to hasten the reversion to oak stands by planting oak seedlings on infested sites.

In the productive western hemlock belt of western Oregon, Washington and B.C., *F. annosus* is a frequent cause of butt rot.[3/] Trees are not often killed, and holes in these stands--when they do occur at all--are quickly filled by suppressed, understory hemlock and cedar. In the absence of fire, *Fomes annosus* is perpetuated. Considerable volume may be lost to cull, but little change occurs in forest succession. Recommendations for reforesting such areas to reduce further losses appear to be lacking.

## *Phellinus weirii*

*Phellinus weirii* (laminated root rot) in the nearly pure Douglas-fir forests of the Pacific Northwest causes openings in stands which eventuall6 fill in with shade-tolerant species such as western hemlock and western red-cedar--a not so orderly step perhaps but a definite step toward the climax forest of the region. Though neither species is immune to laminated root rot, the resulting mixed forest seems to have a higher degree of resistance to the disease, resulting in less mortality and sometimes slower rates of spread than in pure Douglas-fir. On more difficult sites or where damage is unusually severe, sites may revert to brush for long periods.

Extensive stands of nearly pure mountain hemlock at elevations near 5,000 feet in the Oregon Cascade Range are aggressively attacked by *Phellinus weirii*. Here, where hemlock is the climax vegetation, the disease causes a reversion to mixed conifer stands. The effects of the disease on stand composition have been studied in two areas near the Cascade crest. In root rot centers, western white pine and lodgepole pine accounted for about 50 percent of all surviving trees even though these species represent only about 5 percent of the composition of the uninfected surrounding stand. True firs (mostly Pacific silver fir), comprised 40 to 45 percent of the survivors in the infection centers compared to 8-17 percent of trees in the uninfected adjacent stands. Mountain hemlock represented about 5 percent of those trees surviving in infection centers whereas it comprised up to 90 percent of all trees in the surrounding stand.

In general, seedlings invading the root rot centers followed a similar pattern. Pines, true firs, and mountain hemlock all invaded infection centers. Pines and true firs comprise a much greater proportion of within-site vegetation than in the surrounding forest although the fir tends to lose its relative dominance in time.

[3/] Personal communication, Dr. Charles Driver, College of Forest Resources, University of Washington, Seattle, WA.

Huge, complex stands dominated by lodgepole pine exist interspersed in the dominant cover of mountain hemlock. One can speculate that this is nature's answer to restoring order to the succession of species in the high Cascades. Foresters can heed this lesson and reforest root rot centers with species such as pine to increase timber productivity.

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# REGULATION OF SITE SELECTION

James W. Byler

I suspect that we would all agree that site frequently limits the survival, growth and reproduction of trees. The expressions "poor site", "unstable site" and "problem site" are much used in forestry, although the reasons for poor tree growth and survival are not well understood. We pathologists would probably agree that a substantial part of the site problem is a disease problem. The forester is apt to believe that a substantial part of the disease problem is a site problem. But, both orientations express a common point, i.e., there is a relationship between particular diseases and particular sites.

I plan to show slides of a few examples of California forest tree diseases that are most damaging on particular sites and made a pitch for obtaining site-related information on tree diseases that can be used in forest management.

A number of diseases are most damaging on low, dry sites in California. One of these is annosus root disease (*Fomes annosus*) of ponderosa and Jeffrey pines. The disease is very prevalent on low rainfall sites on the east side of the Sierra Nevadas, where one-half or more of the cut stumps in a timber sale may eventually become infection centers. On the west side of the Sierra Nevada range, pine mortality occurs predominantly on the dryer, low elevation pine sites, and less frequently in the mixed conifer. The disease is also prevalent in southern California forests, again on hot, dry pine sites. Apparently there is a relationship between site and the annosus distribution patterns, but we don't know the reasons for the pattern. And, perhaps more importantly, we lack sufficiently precise indicators, of the high hazard sites where borax stump treatment should be required.

Canker diseases also appear to be most prevalent on marginal, dry sites. *Dermea* canker (*Dermea pseudotsugae*) of Douglas-fir was discovered in several northern California plantations and natural stands a few years ago. The infested natural stands have been mainly on low sites. We don't know why the disease occurs in plantations or whether some plantation sites are more hazardous than others.

*Cytospora* canker (*Cytospira abietis*) is considered to be a minor disease problem on true firs in California, although it is common on branches infected with dwarf mistletoe. Occasionally the disease is severe on trees uninfected by dwarf mistletoe. These damaging infestations appear to occur in frost pockets and on dry, east side sites.

Dwarf mistletoes attack thrifty as well as slow-growing trees. Perhaps individual dwarf mistletoe plants grow best on a vigorous host. Nevertheless, the most damaging dwarf mistletoe infestations appear to occur on the lower sites. The trees on the low sites grow in height more slowly perhaps allowing the parasite to move upward and occupy a greater proportion of the tree crown. If dwarf mistletoes are really less damaging on high sites than on low ones, perhaps the land manager has the options of thinning moderately infested stands on good sites, allowing the trees to make rapid height growth so that the infested proportion of the crown becomes successively less. This option may not be feasible on low sites.

So far, I have been talking mainly about diseases found on poor, low or dry sites - mainly, I expect, because of the effect of the site on the host. There is another class of diseases that are most damaging on good sites - primarily here because of a direct effect on the pathogen.

White pine blister rust (*Cronartium ribicola*) is a good example of this. In much of the Sierra Nevada range, blister rust is a minor problem on sugar pine - its principle tree host in California. But it can be locally severe - usually in stream bottoms, around lakes and in other moist locations. Ninety percent or more of the young sugar pines may be infected in such locations. We know rust incidence and damage is related to site but we cannot reliably predict sites on which the problem will or will not occur.

I have presented only a few of many possible examples of diseases that are more damaging in dry sites and those favored by moist sites. Now I would like to make my pitch. I believe we need more research and survey information on the interrelationships between disease damage and site.

Many forest disease problems are not amendable to suppression or control in the usual agricultural sense of the word. But if we keep in mind that there are some very good site-related reasons for many (and perhaps most) of our disease problems there may be some obvious and efficient ways to prevent or minimize damage.

The forest manager is already managing his stands to avoid disease problems, at least to some extent. He knows that the white fir understory is not growing in the lodgepole pine flat, and he will not rely on it for regeneration, even though he does not recognize that the cause of the problem is *Cytospora* canker.

When selecting a stand improvement or regeneration method for a given site, the forester intergrates information on growth and survival of the tree species, appropriate stocking densities, site index, soil moisture and fertility, climate and microclimate, economic feasibility, etc. He is also in the position to consider the effects his treatments have on the level of disease damage if we provide him with the appropriate information.

1. Can we predict the effects of his cutting on the incidence of annosus root disease of his site? If so, this information can be used to determine whether borax stump treatment is necessary and cost beneficial.

2. Can we define the sites where cankers will be damaging on given host species? If so, his regeneration methods can favor other tree species.

3. How does site index affect the level of growth loss and mortality caused by dwarf mistletoe? Are there good sites where dwarf mistletoe suppression is not necessary or cost-beneficial, and other sites where it is essential in order to obtain a harvest?

4. Can we define, with reliability, the sites on which blister rust will not be a problem, and sites on which it will prevent regeneration with susceptible species. Can we do this before the area is planted?

Frequently, in California at least, there are a number of suitable stand treatment options. If we can provide forest managers with some reliable predictions about the affects that his treatment may have on the level of disease damage, he can expect to accomplish a great deal of disease prevention at little or no additional cost above that already budgeted for the cultural treatment.

# DISEASE AND GENERATION TIME

J. R. Parmeter

As a general rule, those species that rapidly turn over generations are best able to evolve and adapt to changing environmental conditions. Many terrestrial plants possess innate mechanisms to insure that individuals die with regularity, thus promoting rapid adjustment and radiation of the gene pool. Large woody perennials do not appear to have innate death mechanisms. Barring encounter with some lethal extrinsic factor, trees appear well suited to live indefinitely. We have all observed suppressed trees of great age, "pygmy" forests, attractive bonzai trees, or wizzened cliff-dwelling pines. When nutrients or water become limiting, such trees retrench with extremely slow growth, but they stay alive.

I'd like to suggest here that diseases and insects are valuable to the development of most forest communities because they provide the means to remove trees that otherwise would continue to compete with and prevent good growth of the better-adapted trees. But even when dominant trees have survived to produce a well-spaced, mature forest, these must die in order to allow continued "fine tuning" of the species to the environment.

Forest ecologists have long recognized that each tree species has its age limit, and forest pathologists have demonstrated repeatedly that as trees age they are increasingly attacked by pathogens, mainly decays. It appears likely that it is an array of diseases and insects that set the upper age limits of tree species, thereby determining in large part the generation time of the species.

It is perhaps coincidental but worth noting that among species of the venerable gymnosperms, ginko, sequoia, redwood, and dawn redwood represent relict species that once occupied extensive ranges but are now greatly restricted. These are among the most insect and disease resistant species of forest trees. It is not inconceivable that these species have become so disease resistant and therefore so long-lived that they have been unable to adapt and to compete with their shorter-lived associates. If we follow this speculation to its extreme, we might find that too much resistant leads down the path to extinction. This view is of course the opposite of our logical assumption that resistant species should be more successful than their disease-ridden associates. Perhaps, for a species, health may be hazardous.

Panel: INTENSIVE FOREST MANAGEMENT AS INFLUENCED BY FOREST DISEASES

C. Driver, Moderator

# DWARF MISTLETOE AND WESTERN HEMLOCK MANAGEMENT

K. W. Russell

"How should dwarf mistletoe control be integrated with western hemlock silviculture?"

"Why consider dwarf mistletoe control?" Losses in Washington and Oregon from this parasite (all species) alone amount to nearly one billion board feet per year in both growth loss and mortality (2).

Certain harvesting techniques used in western hemlock may actually intensify dwarf mistletoe incidence. Dwarf mistletoe control is effective. It is another method to increase yield and should rank with precommercial thinning or fertilization in importance.

## THE PARASITE

New and Simplified Classification. The taxonomy of *Arceuthobium* (dwarf mistletoe) has recently been revised by Hawksworth into a logical and uncluttered system (4). Under the old system, a few mistletoe species were named for several hosts with a *form* designation for preferred host.

The new system assigns the host species name to the dwarf mistletoe species name. The old name for hemlock dwarf mistletoe, *Arceuthobium campylopodum* form *tsugensis,* becomes simply *Arceuthobium tsugense.*

Other dwarf mistletoes are renamed similarly.

Range. *A. tsugense* is found throughout coastal hemlock forests of Alaska, British Columbia, Washington, Oregon and parts of coastal and Interior California. It extends to the crest on the west slopes of the Cascades in Oregon and Washington.

The plants are found from Haines, Alaska to central California ranging in elevation from sea level in the north to 8100 feet in the central Sierra Navada of California. Although an original find and collection by Weir exists, the presence of *A. tsugense* has not been reconfirmed in the interior part of the hemlock range in Idaho (4). For practical forest management purposes it does not exist.

Hosts. Western and mountain hemlocks *Tsuga mertensiana* are the principle hosts. Other conifers are attacked when in association. *A. tsugense* will be found on *Abies lasicocarpa, A. amabilis, A. grandis, A. procera, Pinus contorta* (shore pine) and *P. monticola.* In higher elevations in

Washington *Abies amabilis* is a common associated species with western hemlock and often becomes infected by *A. tsugense* instead of *A. abietinum*, the true fir dwarf mistletoe (4). On Orcas Island in Washington and along south coastal British Columbia *A. tsugense* infects *Pinus contorta* (shore pine) and *P. monticola*.

## BIOLOGICAL FACTORS

There are a number of factors and characteristics that affect the development of *A. tsugense* in a stand. These play an important role in developing and understanding control principles.

Role of fire. Significant. Little or no dwarf mistletoe will be found in stands that burned completely. Occasional infection centers may start from birds or rodents carrying seeds in on their coats. Squirrels and birds also feed on the seeds.

Pattern of infection. The infection throughout a stand is not uniform unless the stand is decadent old growth. The spread pattern of the seeds results in a patchy infection. Unlike fungus spores, dwarf mistletoe seeds travel a limited distance except when carried by birds or small animals.

Life cycle. Production of mature fruit occurs four years following seed dispersal. This is up to two years shorter than other dwarf mistletoes (10).

Rate of spread. Spread is most rapid from infected overstory trees to understory. Dwarf mistletoe seeds could immediately infect areas 30 to 50 feet away from each source when overstory is present.

Spread through uniform height, even aged stands is much slower, usually less than two feet per year (4). Open stands may have spread rates up to 1.5 times faster due to greater light and more vigorous plants (1).

Vertical spread without an overstory seed source proceeds upwards in the crown at a rate of two feet per year and slightly faster in open stands (5).

Seed dispersal. A single western hemlock overstory tree is capable of dispersing seeds over about 6000 square feet (9). This means that FEWER THAN 10 WELL DISPERSED INFECTED TREES PER ACRE COULD POTENTIALLY INFECT ALL NEW OR EXISTING REGENERATION.

Density of stand-light requirements. As stands become heavily infected they also become more dense. This lack of light tends to suppress *A. tsugense* seed production. Only the endophytic system functions. Dwarf mistletoe plants that have not seeded for many years produce heavy seed crops when exposed to sun following thinning or clearcutting.

Target size and type. Tree size has some bearing on its ability to become infected. A small three to five year old seedling simply does not have sufficient surface area to easily become infected. Deep snow in the Washington Cascades apparently helps keep most trees under six feet tall from becoming infected. The snow may detach seed as it settles during melting (8,11).

Thick, carpet-like stands of uniform height hemlock regeneration under deteriorating infected overstory may not be as susceptable to dwarf mistletoe. The dense foliage does not allow good dwarf mistletoe seed penetration to suitable host bark epidermis. Light intensity is too low for good seed germination. The dense carpet of foliage retains those seeds that do germinate and they die because the radicle and holdfast do not contact bark tissue.

As soon as the hemlock regeneration begins to express itself as individual tree crowns with tops and sides, it offers a better target for dwarf mistletoe seed. The seed is more effectively transported to young bark tissue.

Typical dwarf mistletoe development and intensification in western hemlock is greatest following a catastrophe. High grade logging and blowdown are good examples. Frequently, early loggers selected out the more valuable Douglas-fir and left the then worthless hemlock.

## CONTROL

*A. tsugense* is controlled silviculturally by cutting or killing infected host trees. Every management plan for western hemlock should stress dwarf mistletoe control. All control actions can be done using present day silvicultural systems and forest practices requiring slight modification with little change in cost.

DWARF MISTLETOE IN WESTERN HEMLOCK IS THE EASIEST FOREST PEST ANYWHERE TO CONTROL. SUCCESS CAN BE NEARLY 100% IF DONE CORRECTLY.

RECOGNITION IS THE KEY TO SUCCESSFUL CONTROL.

Clearcutting. Under most circumstances, western hemlock is harvested and regenerated by clearcutting. This silvisultural method provides the best opportunity to control the dwarf mistletoe. The modification for disease-free regeneration rising from infected stands is simple: all hemlock residuals must be cut or destroyed.

When units are burned for slash reduction and planting preparation, all residual stems are normally destroyed. When units will not be burned, stems may be removed either during initial falling or afterwards by a special crew. A special "whip and muletail" falling team may work well because it offers year-round employment for one or two persons working on 1000 to 2000 acres of clearcuts per year. Many loggers feel it is "not their job" to cut the small stems and labor difficulties arise when they are asked to remove them.

Herbicides could also be used in a variety of ways to kill infected residuals. It is best to instruct crews to destroy all western hemlock residuals when infection is heavy. Latent infections that have not yet produced aerial plants may be missed. New infections also are not easily detected.

A typical infected residual sapling left in the clearcut will be a hazard to future regeneration. Under the old growth stand this small infected tree with latent dwarf mistletoe seed potential presented little hazard to neighboring regeneration. Soon after logging, under full sunlight, the dwarf mistletoe endophytic system begins to produce aerial shoots and seed and the suppressed sapling shows good growth and even produced cones. Rising regeneration is then showered with dwarf mistletoe seed. This tree cannot remain in the clearcut longer than five years before it damages the new regeneration.

Standard high lead shows usually destroy much infected advance regeneraiton. Modern skyline, balloon or helicopter shows often do not. Under certain conditions, the forester desires to leave the advance regeneration because it buys him extra time on the next rotation. Special care must be taken to assure that the residuals are dwarf mistletoe free.

The only way to assure a dwarf mistletoe free stand under the above conditions is to encourage another conifer. Many skyline or balloon systems in Washington are located in mid to high elevation areas where Pacific silver fir is the most common associate. In this case, all infected hemlock must be cut and the silver fir left. New hemlock regeneration will probably fill in the openings. The occasional infected silver fir will not be harmful to the overall stand. It can become infected with *A. tsugense,* but not commonly.

All infected western hemlock must be removed within five years.

Junk stands. Frequently the forester encounters mid elevation stands in western Washington that were high graded during the 1930's and 40's. The best Douglas-fir, true firs and perhaps a small amount of western hemlock were removed. The remaining stand was a mish-mash of species and size classes. It became a dwarf mistletoe haven because of ideal light conditions and soon all hemlock was thoroughly infected.

Forty years later these stands are a mess. They present a management headache. Cull is high, growth is poor because of dwarf mistletoe and age class spread is even greater.

Three things can be done to improve volume production in these stands: (1) Leave it alone until the youngest or best quality age class group becomes merchantable, then clearcut; (2) Harvest now, cutting all ols growth, all western hemlock down to six feet and leave the silver fir and occasional Douglas-fir advanced regeneration, then harvest again at a date when the residuals become merchantable; (3) Clearcut now and start over, making sure that all hemlock is killed. An important factor to remember is that in areas of high balcam woolley aphid infestation special precautions must be taken. Silver fir then becomes a less desirable species.

Any of the three alternatives can be used, depending on an economic analysis for best return. The point is that the forester knows he will eventually control the dwarf mistletoe. Such stands must be evaluated individually for best results because no blanket rule is adequate.

Shelterwood. This silvicultural system is a proven alternative on certain sites for successfully regenerating western hemlock (12). Presence of dwarf mistletoe in the overstory warrants special concern to prevent regeneration from becoming infected. When dwarf mistletoe is severe, clearcutting is advised. When dwarf mistletoe is light or moderate, shelterwooding is satisfactory provided all overstory is removed within five years.

Regeneration that forms a thick carpet of uniform height does not become as easily infected as taller regeneration of uneven height. Since well stocked regeneration may be expected in shelterwoods, this is an advantage. Dwarf mistletoe infection in the interim five years would be very low.

Cutting unit layout. Natural or man-made barriers must be used to prevent reinvasion of hemlock regeneration by dwarf mistletoe. Streams, lakes, natural stand openings, resistant conifers such as Douglas-fir or true fir, hardwood stands, roads and power line rights-of-way are useful barriers. Ridge tops are not good barriers because winds can carry dwarf mistletoe seed over the top. Valley bottoms are better (1).

Large clearcut units over 200 acres help reduce the ratio of perimeter to area and rate of reinvasion (1). Reinvasion from clearcut boundaries may be minimized by careful management planning. Adjoining infected units could be cut after the first is harvested but within the five year limit. This conflicts with current trends of smaller clearcuts and must be dealt with accordingly.

Another alternative is to create a barrier for dwarf mistletoe resistant conifers. Douglas-fir could be planted in 100 to 200 foot wide strips around the clearcut boundary. Western hemlock regeneration invading the barrier could be removed during precommercial thinning.

Precommercial thinning. It is best not to precommercial thin dwarf mistletoe infected stands unless they are less than eight or ten years old. At that age or less, most of the infection could be arrested by thinning. As the young stands approach 15 years, the dwarf mistletoe intensifies rapidly. Harvest date is too distant and the disease will intensify too much to provide good volume production through the rotation.

Infected residuals in young stands are often slightly taller than the rest of the stand. These easily detectable disease centers should be removed at the same time spacing is done. Small clearcuts will result which could be planted provided brush is not too severe. These small openings are better than having infection centers spread to non-diseased parts of the stand.

Thinning crews must be carefully trained or their thinning activity will only intensify the dwarf mistletoe. At best, control will not be complete. The disease will not be eradicated but can be reduced to an acceptable low level. Such stands should be entered into permanent recording systems as needing dwarf mistletoe clean-u½ at liquidation.

Intermediate thinning. When dense western hemlock stands are thinned, the increased light provides stimulus for dwarf mistletoe seed production. Commercial thinning of light to moderately infected stands is not recommended at early ages (20-25 years) for this reason. Growth loss would probably be significant (up to one half or more) by the time such stands reach rotation age (50 years ±).

When final harvest is less than 15 years away, light thinning is acceptable because the dwarf mistletoe impact would not be as severe during that time span.

Intermediate thinnings should not create much change in lighting conditions whenever dwarf mistletoe is encountered. Maintaining crown closure allows infected branches to self-prune and the disease intensification may decline slightly (1).

Heavily infected stands should not be thinned at all. These stands must be considered for early pathological rotation. Thinning activity in such stands would only stimulate regeneration which would become infected. It is far better for future crops to hold these stands for early harvest and clean up the dwarf mistletoe by a clean clearcut.

Pruning. Not recommended in forestry operations. Pruning is desirable in campgrounds or picnic areas where dwarf mistletoe infected western hemlock is present (7). Coastal recreation sites are frequently located under hemlock of various sizes. Heavily infected crowns produce dwarf mistletoe brooms that may weigh up to 200 lbs. or more. These can severely damage a camper or could fatally injure persons sleeping in a tent. Landowners are legally responsible for safety certification of their recreation sites. This includes insepction and removal of hazardous limbs, dwarf mistletoe brooms and seriously decayed trees.

Pruning heavy brooms in these stands is a good practice. It is best done with a cherry picker lift and air or otherwise powered pruning saws. Crown closure should be maintained to prevent stimulus of dwarf mistletoe seed production.

## CONDENSED CONTROL PRINCIPLES

Dwarf mistletoe control in western hemlock should rank equally with other volume producing management activities such as fertilization and thinning.

Consider control at stand liquidation time.

Insist on clean clearcuts. Remove all infected residuals, especially in skyline, balloon or other types of aerial logging.

Carefully analyze infected "junk stands" and follow alternatives that provide the best return.

Use fire, mechanical or chemical methods to remove unwanted trees.

Precommercially thin lightly infected stands that are younger than ten years old. Train crews carefully so that their thinning does not favor the dwarf mistletoe. Stay away from heavy infection in young stands. Place them on an early harvest rotation.

Thin lightly infected commercial sized stands only to the degree that light composition within the stand does not change materially. This prevents dwarf mistletoe seed production.

Do not thin heavily infected commercial sized stands.

Dwarf mistletoe control is part of good forest management. Don't forget to look back to see how it's going!

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# *PHELLINUS WEIRII* AND INTENSIVE MANAGEMENT WORKSHOPS AS AN AID IN REACHING THE PRACTICING FORESTER

G.W. Wallis

For those interested in undertaking intensive management in stands undergoing losses caused by *Phellinus weirii* root rot, guides can be found in the publications by Hadfield and Johnson (1976) (Laminated root rot. A guide for reducing and preventing losses in Oregon and Washington forests. U.S. Forest Service, Pacific Northwest Region) and Wallis (1976) *(Phellinus (Poria) weirii* root rot. Detection and management proposals in Douglas-fir stands. Environment Canada, Forestry Tech. Rept. 12.) These are essentially the summation of many years of work by a number of workers interested in this disease.

Rather than detailing the specific recommendations presented in these publications, I feel the group as a whole may find it of more interest if I outlined my reactions and thoughts derived from a series of root rot workshops Dr. Morrison and I conducted recently. My remarks, of course, apply to B.C., none, some, or all of which may be pertinent across the line.

During the past year, we presented 21 workshops throughout the province in an attempt to alert practicing foresters to the problems they will be required to face when applying intensive management operations to stands undergoing root rot losses. We included the three root rot fungi *Phellinus weirii, Fomes annosus* and *Armillaria mellea* but I will confine any examples I use here to the former.

First, by intensive management, I mean the regulated growth of a stand from seedling stage, be it natural or planted, through to maturity. This may cover a period of 40 to 100+ years, depending on growing site, tree species, end product, etc.

In the event that you should tend to be overly critical from some of my remarks, I should brief you on the state of the art here in B.C. Dependence on second-growth stands to supply some of the demands for wood is a relatively very recent occurrence; most production still comes from the over-mature stands. Second-growth stands now being cut have undergone very little if any management; their early life occurred when intensive management was a figment of the imagination. Also, because of the newness of the game and the long-term nature of the crop, much of the knowledge required to undertake intelligent intensive management is lacking. In addition to these shortfalls, the forester is faced with applying high cost operations to a relatively low net return crop. Foresters are now just starting to get some of the support they require from the upper echelons of government and industry to undertake intensive management operations.

As forest pathologists, we must keep these limitations clearly in mind when insisting that realistic intensive management operations cannot be attempted without an input for diseases. This is most assuredly true for root rots.

What did the workshops tell us? Having been through this exercise, I feel confident in saying that very few of us really have a clear comprehension of the impact of diseases in the thinking and planning of foresters. Although I have spent a fair proportion of my time in the field over the years, I was frequently unprepared for what we encountered relative to both a lack of familiarity and knowledge of diseases. A goodly number of foresters and allied workers were toatlly unfamiliar with the existence of root rots. When their attention was directed to stands containing a high level of mortality, they appeared to accept this as normal for the ecosystem concerned, without questioning the cause. This was particularly true in the Interior where intensive management is still a little way in the future. However, many foresters, even among those who were aware of root rots, had given little thought to the consequences of diseases in their intensive management plans. They already had, or were preparing to, undertake costly intensive management operation such as planting and spacing, overlooking the obvious presence of disease.

Who is to blame? Obviously some of the blame must lie at the feet of the foresters themselves. Some of them appear to fly blindfolded, acting first and crying afterwards. Some of the problem, I feel, must lie with our forestry schools in failing to stimulate an interest in diseases and in driving home the consequences of diseases in stand development. In this regard, I would stress that during and following the workshops, when the root rot problems were adequately demonstrated, most showed a sincere interest in trying to cope with the problems even though our remedial treatments were vague, complex and costly. Finally, most of the blame must lie on my own shoulders. I had convinced myself before starting the workshops that most foresters had an interest in major diseases, had access to the literature and had been harped at enough that they would have a grasp of the basic problem but might like some discussion on the more confusing aspects of control. As already indicated, I recognized this was an entirely wrong assumption early in the planning of the workshops.

Some of the problem may lie with the complexities and costs of manipulating stands to reduce root rot. However, in stating these, I feel we are groping for excuses. Much of the activities of root rots is hidden below ground, consequently, unless the damage is very heavy the losses may not be spectacular enough to excite an interest. Remedial action can be costly and complex, tending to discourage managers. For example, removal of infected old-growth stumps may cost upward of 50 dollars each; land clearing can run 200 to 500 dollars an acre; control by replacing susceptible species can be messy and in the long run may be negated by natural fill-in of susceptible species.

Even though these control procedures may not sit well with many foresters, there is much to be gained by them having a working knowledge of diseases, particularly their potential for build-up of losses during the life of a stand. Having in mind that planting costs can run in excess of 100 dollars an acre and that precommercial thinning can equal or in some cases, double this, knowing when and when not to expend these funds in particular stands can be a considerable benefit.

In summation, I am not happy by what I saw and learned during the root rot workshops of some forestry activities but am heartened by the results. I should point out, and, as you will see on the field trip, my remarks do not pertain only to root rots.

I am convinced that diseases, not insects, will create the major problems to be faced in stands undergoing intensive management. Because of the sneaky nature of most of our major diseases, the problem of selling them to the forester is going to be much more difficult than selling spectacular insect outbreaks. However, the savings to be gained are extremely large and well worth an extended effort.

I have a gut feeling that it is time forestry schools took a hard, in-depth look at the pathology they are giving practicing foresters. Are these prople leaving school with an appreciation of the potential of diseases and with an interest in doing something about it? I don't think so.

We undoubtedly need go-betweens in provincial and industrial agencies to interpret scientific findings for the practitioner. However, until that day comes, you can make your tasks much more meaningful by informing foresters of your work to a point where they bug hell out of you. There is probably no better way of doing this, disseminating your information and correcting misconceptions, than by a series of well prepared field discussion groups.

# *FOMES ANNOSUS*
# IN SECOND-GROWTH STANDS

Duncan Morrison

Can we afford to ignore *Fomes annosus* when managing second-growth stands? Although the wording may vary, this question is frequently asked of research and extension workers by those respondible for managing second-growth forests. Experience in the southeastern states, Britain and elsewhere has shown the potnetial of *Fomes annosus* to cause losses in intensively managed forests. As the intensity of management in our second-growth increases, so does the importance of answering this question.

In spite of warnings given by those with experience in other regions, the threat posed by *Fomes annosus* is being ignored by many who are engaged in second-growth management. If the experience of other regions is any indication, the consequences of this could be significant in the present and future rotations.

There has been much fence-sitting regarding recommendation to control *F. annosus* in the region. This stems from a lack of information on the biology and damage caused by the fungus and a reluctance to recommend control measures, such as stump treatment, that may make management operations uneconomical. However, in the west, the occurrence of *Fomes annosus* has been reported for about 40 years and the fungus has been researched intensively for 15 years. There is sufficient information on which to base a decision regarding the threat posed by *F. annosus* and the necessity to prescribe control measures. Let's briefly review this information.

## Distribution and Hosts

*Fomes annosus* is found from Alaska to California and from the Pacific through several mountain ranges. The fungus has been recorded on most native conifer and hardwood species (Ehrlich, 1939; Englerth 1942; Foster 1960; Olson 1941).

## Occurrence in old-growth and second-growth stands.

In old-growth stands *F. annosus* causes butt rot or mortality depending on the tree species. The fungus may remain viable in old-growth stumps for at least 60 years (Morrison, unpublished). These stumps and those infected by spores following harvest are the sources of inoculum for infection of second-growth stands. In coastal B.C., they appear to be equally important as inoculum sources. Spread is by mycelial transfer at points of root contact. Trees younger than 15 to 20 years and *Pinus* spp may be killed whereas trees older than 20 years are butt rotted.

Second-growth Douglas-fir and hemlock trees with butt rot have not exhibited compartmentalization of decay like that described by Shigo

(1975) for *Pinus resinosa*. The probable reason is that killing of cambium at the root collar, which apparently triggers a host response, has not been observed.

The incidence of *Fomes annosus* in stands where killing does not occur is difficult to measure because trees with butt rot do not show symptoms. Infection levels must be estimated by examining stumps following thinning and/or boring selected trees. Using these methods, Driver and Wood (1968) found 0 to 57% (average of 5 stands 17%) of stems sampled in young hemlock stands had butt rot and Morrison and Johnson (in press) recorded 5 centers/ha containing 1 to 3 trees in a 25 year-old Douglas-fir plantation and 12 centers/ha containing 1 to 6 trees in a 45 year-old hemlock stand.

Occurrence following Spacing and Commercial Thinning.

Spacing (precommercial thinning) operations create approximately 5000 to 9000 stumps per ha. In Washington and B.C., the incidence of *F. annosus* in stumps from spaced stands ranged from 0 to 90% depending on location, time of year, tree species, etc. (Russell et al. 1973, Driver and Wood 1968 and Morrison and Johnson unpublished). In coastal B.C. colonization rates of 50 to 80% three to six months after cutting declined to 0 to 10% five years after cutting (Morrison and Johnson, in press). However, if only one percent of spacing stumps become colonized stands will be thoroughly infested. Further work is required to determine the longevity of *F. annosus* in spacing stumps and their effectiveness as a source of inoculum.

In a study of spore infection and spread of *F. annosus* in hemlock and Douglas-fir stumps following commercial thinning, Wallis and Reynolds (1970) reported that 18% of stumps were colonized; of 113 stumps excavated, 65 had colonized roots in contact with living roots of adjacent trees and decay was present in 33 of these. These results and excavation of natural infection centers demonstrate that spore infection and spread to contacting residuals will occur in hemlock, Douglas-fir and other coastal species.

In commercial thinning operations some scarring of residuals is inevitable regardless of the precautions taken. Wounds on the roots and lower bole of hemlock greater than 9 $dm^2$ in area have a 50% chance of being colonized by *F. annosus* (Wallis and Morrison 1975). Not only is volume lost but these trees also become potential infection centers.

Recommendations.

What should our recommendations be concerning *F. annosus* in second-growth management? Based on the above information, we recommend the following in coastal B.C.

Hazard rating of sites after removal of the old-growth. Although treatment of old-growth stumps would probably reduce the incidence of *F. annosus* in the next rotation, it is not practicable, at present.

Stumps in spacings should be treated. Until the importance of spacing stumps as sources of inoculum is understood. Stump treatment is cheap insurance. Compare the cost of stump treatment with that for site rehabilitation by stump removal.

All stumps in commercial thinnings must be treated. Severely scarred trees should be removed.

By the end of the present rotation (40 to 50 years hence), the importance of *Fomes annosus* in intensive management should be well known. We cannot afford to wait that long before prescribing control measures; the evidence suggests that a buildup of *F. annosus* in managed stands can occur in this region, as it has in others. We have an opportunity to keep *F. annosus* at a level that will not adversely affect management - let's take it.

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# *ARMILLARIA MELLEA* AND EASTSIDE PINE MANAGEMENT

Gregory M. Filip

Root disease caused by *Armillaria (Armillariella) mellea* causes substantial losses in Oregon and Washington forests, at times attaining epidemic proportions (1,7). On the "westside" (all land west of the Cascade Mountains), most damage occurs in young plantations with offiste of weakened trees established where numerous infected stumps of the former overstory occur. Mortality by *A. mellea* also occurs in mature trees that are weakened, suppressed, or infected with other root pathogens. Damage in "eastside" stands, especially in pine-true fir associations, is more spectacular than in westside stands, occasionally occurring as numerous disease centers containing dead and dying timber killed by *A. mellea*. As much as 25 percent mortality has been recorded in a 500 acre mature stand in southern Oregon (1). Such land may remain out of production indefinitely. Several methods of disease management have been tested in the Pacific Northwest. The following discussion will focus primarily on eastside stands where damage is most substantial.

## I. Chemicals

Chemical application in root diseased forests may be intended to 1) protect healthy trees from infection, 2) eradicate the pathogen from infected trees, or 3) remove the fungus from dead trees and stumps which act as inoculum sources. Currently there are no chemical protectants or eradicants that are effective on living trees, although many have been tested (unpublished). Several fumigants (chloropicrin, Vorlex, Vapam, methyl bormide, and carbon disulfide) have been tested and are effective in eradicating *A. mellea* from small diameter ponderosa pine stumps (3). Further testing is needed to ascertain the practicality and effectiveness of chemical control on a large scale. Environmental restrictuons may also pose a problem.

## II. Thinning

Cutting of immature stands to stimulate growth of residual trees is termed thinning. Since *A. mellea* is generally considered a pathogen of weak or suppressed trees, thinning infected stands should reduce infection of residual trees. One Oregon study in a small diameter (3-7 in.) ponderosa pine stand infected with *A. mellea* shows less mortality in thinned plots as compared to unthinned plots after eight years (4). Additional thinning studies are underway in larger diameter ponderosa pine (L. Roth, personal communication). More of such studies are needed in other tree species.

## III. Fertilizing

The main purpose of fertilizer application is to increase tree vigor by providing a proper nutrient regime. Fertilizer application to

*A. mellea* infected stands should therefore prevent healthy trees from becoming infected and infected trees from dying, since the fungus is normally considered a pathogen of weak or stressed trees. At present, there are no data to support this theory although studies are underway (L. Roth, personal communication). Preliminary observation of Douglas-fir plantations on the Olympic peninsula, Washington, shows no significant differences in root rot mortality between fertilized and unfertilized plantations, although applications of urea were fairly recent. In British Columbia, urea and nitrate fertilizers failed to inhibit root rot caused by *Phellinus weirii* in young Douglas-fir stands (9).

IV. Disease Resistance

Resistance to Armillaria root rot may be a function of tree species or tree age. All commercial conifers have some degree of susceptibility to infection. Ponderosa pine and true fir appear to be most susceptible especially when growing in association. In southern Oregon, incense cedar was found to be more disease resistant than other conifers in the same vicinity.(2).

Resistance may increase or appear to be lost as a tree matures. In southern Washington, disease resistance in ponderosa pine appeared to increase with tree maturation (6). In southern Oregon, however, mortality increased with tree age in mixed stands of white fir and ponderosa pine (1). Increase or decrease of resistance with tree age may be correlated with site and should therefore be used as a management alternative on a stand by stand basis.

Method of plantation establishment also has a profound effect on disease incidence. Exotic species have been found to be more susceptible to *A. mellea* than native species (8). The benefits gained by the use of resistant species may therefore be hegated if the species are not endemic. Infection has also been demonstrated to be highest in plantations which have been established by bare root stock vs. those which have been established in container or direct seeding (8).

V. Stump Removal

Damage caused by Armillaria root rot whether in young plantations or in mature natural stands is correlated with the presence of numerous infected stumps of the former overstory (1,5,7,8). The fungus spreads from these large infected stumps to the understory through root and/or rhizomorph contact. Infection by spores is negligible. Removal of infected stumps prior to stand establishment eliminates the major inoculum sources from the site and thus may reduce damage to a tolerable level.

Studies are underway in southern Washington that test stump removal of dead, dying, and highly susceptible ponderosa pine as a possible method of disease control combined with a thinning operation (5). Stump and stem removal of infected trees will 1) salvage trees that may be usable, 2) create root-free barriers that l-mit enlargement of disease centers, 3) destroy inoculum and eliminate fungal food bases, and 4) create a quality seed bed. Stump and stem removal of living but highly susceptible trees based on previously established guidelines will, in addition, essentially be a thinning operation.

Disease management is always an additional cost to the forest manager. Its price in many cases may exceed the economic return of a disease-free, or more realistically, a mortality-free crop. In some cases "doing nothing" may be the only viable alternative especially on sites of low economical value. Other values such as recreation, wildlife, or watershed must also be considered before any form of disease management can be practiced. Control measures may have to be combined to be effective. Each site should be thoroughly evaluated and the problem vigorously investigated in order to prescribe a management scheme which will be effective, economical, and environmentally acceptable.

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# THINNING SECOND-GROWTH STANDS

Paul E. Aho

An 18 percent decline in softwood sawtimber production is expected for the Pacific Coast region from 1970 to 2000 (Anon. 1973). Unless productivity can be markedly increased by intensified forest management and improved utilization the allowable cut from national forest lands are expected to drop after the year 2000.

Commercial thinning of second-growth stands of coniferous species to increase forest productivity has been used increasingly in the Pacific Northwest. Most commercial thinnings are in second-growth western hemlock, Douglas-fir, Sitka spruce, and ponderosa pine stands. Not surprisingly, most of what we know about the impact of decay associated with thinning wounds is from studies made in western hemlock, Douglas-fir, and Sitka spruce.

The major positive benefits of thinning are increased growth of residual trees and recovery of volume that would not survive until a single cut harvest is made. Negative effects of thinning, which may reduce or completely offset the gains, include soil compaction, windthrow, and decay and growth losses associated with wounds and sunscald. My discussion will concentrate on the effects of wounding.

Entering second-growth stands with logging equipment can result in wounds to many of the residual trees. The amount of damage depends largely upon stand density, slope gradient, time of year, type of logging equipment, tree species, and perhaps most importantly, the skill and care taken by logging operators. Damage is usually most severe on steep slopes, in dense stands, in spring and early summer, when using tractor instead of high lead or horse skidding, in stands of thin barked species, and when done by unskilled or careless logging operators.

There are four sources or possible causes of volume losses related to thinning wounds in second-growth trees. The main causes of volume loss are: 1) decay caused by hymenomycetous fungi which invade wounds, and 2) decay caused by root and butt rots which invade wounds or stumps of cut trees and then spread through root contacts to neighboring trees. *Fomitopsis annosa* (Fr.) Karst. is the most important fungus causing the second type of volume loss. Duncan Morrison has already discussed loss to *F. annosa* in second-growth stands.

Little information is available on the other two sources of volume loss from thinning wounds. Losses may occur: 3) when severely wounded residual trees do not respond to thinning, and 4) when wounds reactivate dormant *Echinodontium tinctorium* Ell. and Ev. infections in hemlock and true fir species.

## Decay Losses Caused by Humenomycetous Fungi

There are many factors or conditions which may influence incidence and extent of decay associated with wounds. Some of the more important are: tree species; size, condition, or type of wound or its position in relation to the ground; and various environmental conditions.

Tree species with non-resinous woods, such as true firs and hemlock are, in general, infected by decay fungi more easily than species with resinous wood, such as Douglas-fir and ponserosa pine. This does not always hold, however, since some species, like spruce, with resin ducts in wood are very susceptible to infection by deacy fungi when wounded.

Incidence of infection and decay extent increase with increasing wound size. Season when skidding is done may affect wound size. In spring and early summer when bark is loose, wounds are more easily made and they tend to be larger.

Condition and thpe of wound are very important. Deep, gouged wounds are more frequently infected than shallow, smooth wounds. Position in relation to the ground is perhaps more important. Wounds occurring above 4.5 feet are less often infected by decay fungi than are wounds between ground line and 4.5 feet and in some species the wood behind the injury may only be stained. Root wounds nearly always become infected and decay seems to progress more rapidly than decay associated with other types of wounds. This has been attributed to increased moisture below or at the ground line.

Skidding affects the type and position of wounds made on residual trees. Nearly the same percentage of injuries are caused by tractor (28%) and high lead (26%) skidding (Aulerich et al. 1974). Tractor skidding, however, causes more wounds below the height of 1 foot on the stem than does high lead thinning (58 vs. 33%). Most damage caused by tractors occurs where infection by decay fungi is most likely.

Other environmental conditions, such as rainfall, slope aspect, topographic position, and elevation probably influence the degree to which thinning wounds are infected by decay fungi, but information on these factors is scant and often contradictory.

## Loss of Potential Growth

There is conflicting evidence that severely wounded trees do not respond to thinning as well or as rapidly as unwounded or less severely damaged trees. Potential growth loss in wounded hardwoods only occurs when trees are nearly girdled by injuries (Jemison 1944).

Two studies of growth losses related to injuries in Douglas-firs have been made in the Pacific Northwest (Shea 1961; 1967). The first study, though inconclusive, found evidence that diameter growth of injured

Douglas-firs was adversely affected (Shea 1961). In the second study, diameter increment of Douglas-firs 60 to 100 years old was not significantly affected by man-made root and butt wounds (Shea 1967). The author, however, concluded that diameter measurements at d.b.h. may have been influenced by hose response to the injuries.

In Finland, severely damaged residual spruce (*Picea abies* (L.) Karst.) did not respond to release from thinning as much as less severely wounded and unwounded trees (Isomäki and Kallio 1974). Radial growth was reduced 50 percent by deep wounds and cut roots and height growth was reduced 40 percent by root collar damage.

We are currently studying decay and growth losses associated with wounds in thinned second-growth Douglas-fir stands in western Oregon and Washington. Cubic- and boare-foot decay losses associated with wounds of all ages on 102 trees from 19 stands were 0.6 and 2.0 percent, respectively. These losses are similar to those reported by others (Hunt and Krueger 1962; Shea 1961; Worthington 1961).

We do not have firm data at this time on growth losses associated with wounds. Preliminary indications are that severe wounds do influence growth response of trees to thinning. Surprisingly, wound length appears to have a stronger effect than scar area, scar width, or scar width as a percentage of tree circumference at the point of injury. Growth losses associated with severe wounds may be more serious than decay losses in thinned second-growth Douglas-fir stands.

Loss from Reactivation of Dormant *Echinodontium tinctorium* Infections

Most forest pathologists have concluded that true heartrot fungi, including *E. tinctorium* which caused so much damage in old-growth forests, will not be a major problem in second-growth managed stands. Wounds in thinned second-growth hemlock and true fir stands have taken on added significance since the mode of infection and subsequent decay development by *E. tinctorium* has been worked out. The primary infection courts for this fungus in western hemlock are adaxial twigs less than 2mm in size on living branches (Etheridge et al. 1972). Suppression slows healing of the small twig traces allowing infection to take place. Our studies in eastern Oregon and Washington indicate that the Indian paint fungus and other decay fungi can infect grand fir in a similar manner (Aho and Hutchins 1977). When the original infection site heals and conditions become unfavoragle for continued growth of the fungus, it may go into a dormant stage for 50 or more years (Etheridge and Craig 1976).

It appears that death of infected branches or other injuries reactivate the dormant infections (Etheridge and Craig 1976). We've found that patch-killing by bark beetles apparently reactivates infections by the Indian paint fungus in suppressed grand firs. Dormant *E. tinctorium* infections may also have been reactivated when grand fir tops were killed by tussock moth defoliation.

Forest managers in Oregon and Washington are beginning to thin true fir stands which have been suppressed and subjected to possible infection by *E. tinctorium*. We have examined four such thinned white fir stands in the Fremont National Forest. Our data have not been analyzed yet, however, more than 50 percent of the residual trees had one or more wounds and some of the trees did have incipient Indian paint fungus infections. Thinning previously suppressed hemlock and true fir stands may result in unacceptable decay losses at rotation age if a high percentage of wounds on residual trees are invaded by decay fungi or if wounds reactivate dormant *E. tinctorium* infections.

## Procedures to Minimize Losses

Much damage done to residual trees during thinning operations is unnecessary. A number of steps can be taken to reduce injuries to leave trees including convincing the logging operator that by using common sense, demage can be held to a minimum. We've examined many stands. The amount of damage varies immensely and is probably related to the care taken by the logging operator.

Most damage in thinned stands is along the edges of skid trails. To minimize damage, lay out skid trails in advance of logging. Make them in a stream drainage-like pattern without sharp turns and take advantage of natural openings in the stand. Leave buffer trees or cull logs along the edges of skid trails to protect residual trees. Remove the buffer trees at the end of the thinning operation.

Try not to thin stands, or use extreme care, in the spring or early summer. Bark is easily rubbed off at this time of year. To reduce sunscald damage, do not thin young stands of thin-barked species, such as hemlock and true firs, too heavily. A high percentage of sunscald wounds become infected by decay fungi.

Protect stumps of susceptible species from infection by spores of *F. annosa*. This should be done as soon as possible after felling. Borax, applied generously over the stump surface as a dry powder or in an aqueous solution, is the recommended treatment (Wallis and Morrison 1975).

There are no chemical or biological methods for protecting wounds on forest trees from infection by decay fungi. Currently used wound dressings do little to protect injuries from decay fungi. The best control is to prevent or at least hold wounds to a minimum during thinning operations.

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Panel: Knowledge Utilization in Western Forest Pathology

R.Z. Callaham, Moderator

MODERATOR'S REMARKS

The purpose of this panel discussion is to give you an new framework for thinking about utilization of available knowledge in forest pathology. Considerable scientific investigation of knowledge utilization has been carried out during the past 20 years. Some underlying principles and models have emerged from this effort. My discussion of these should provide a general background for thinking about the many and diverse ways in which knowledge utilization occurs.

Basic to all knowledge utilization systems is adequacy of access to scientific and technical information. Modern scientific and technical information systems are a far cry from those that many of you became familiar with during your years in educational institutions. We have brought a leading information specialist from the University of Washington to tell you something about modern scientific and technical information systems.

Forest pathologists turn to bibliographic data bases for answers to their questions. These data bases lead you to what is known about certain subjects, diseases, or problems. Here to tell you about available and needed data bases is an information specialist who has had the unique experience of compiling data base, FIREBASE, for your colleagues in another area of forest protection. One outcome of his presentation will be a compilation and ranking of the data bases used by you as forest pathologists. Then we will turn to some of your colleagues in forest pathology to explain and illustrate some successful models for knowledge utilization in forest pathology. They will help you to analyze some of the reasons for successes and failures in knowledge utilization in your field.

# KNOWLEDGE UTILIZAITON, WHAT'S IT ALL ABOUT

Robert Z. Callaham

Knowledge utilization, called technology transfer in the 1960's has been subject to increasing scientific inquiry in recent years. Investigators have identified some of the processes, and models for achieving knowledge utilization. My purpose today is to give you quickly an overview of knowledge utilization. I have borrowed heavily from Glazer's (1977) "Putting Knowledge to Use: A Distillation of the Literature Regarding Knowledge Transfer and Change."

Knowledge utilization is both a field of study and a process. As a field of study it has lead to new insights into the processes, and has helped to identify factors that contributed to successes or failures in knowledge utilization. It has resulted in generating new and improved principles and strategies for knowledge utilization. As a process knowledge utilization creates a climate conducive to change.

A continuing goal of most programs is to utilize available knowledge; now having knowledge utilization results in: (1) unrealized benefits; (2) excessive costs; (3) time lags in applications; (4) under utilization of lands and resources.

Stages in the cycle of knowledge utilization are several. The usual place to start is with an identified need. Diagnoses of the problems then follows. Alternatives for change or improvement are postulated. Deciding on the alternatives to be followed leads to actions to cause a desired change. Finally, evaluation aims at determining whether desired changes have been accomplished. This often leads then through subsequent cycles by identifying new or different needs, diagnoses, alternatives, decisions, actions, evaluations, et seq.

Some barriers to achieving knowledge utilization result from:

1. Inter-personal
   a. Credibility
   b. Value perception
   c. Self-image and status

2. Organizational
   a. Distribution of power
   b. Bureaucratic structure
   c. Size, affluence, and capacity
   d. Occupational specialization
   e. Inertia

3. Diversity of information needs of
   a. Researchers
   b. Academicians
   c. Administrators
   d. Practitioners

4. Information explosion causing
    a. Overabundance of information
    b. Lack of awareness of current and past information
    c. Difficulty in selecting most relevant information
    d. Errors in selectivity

All knowledge utilization processes and models have common elements. First, they require access to an availability of scientific and technical information. Second, they require access to numeric and other "hard" data. Third, they require interpretation, analysis, summarization, and re-packaging of information for application to particular problems. Fourth, they require, in order to facilitate the flow of information, a variety of communication systems, such as seminars, symposia, workshops, meetings, facsimile transmission, etc. Fifth, they require implanting information via training, teaching, and demonstrations. Sixth, they require the identification and exploitation of experts and consultants in whose hands and minds needed knowledge and methodology resides.

## Knowledge Utilization Models

Knowledge utilization takes place in many diverse ways, but students of these processes have generally agreed that six models are most common:

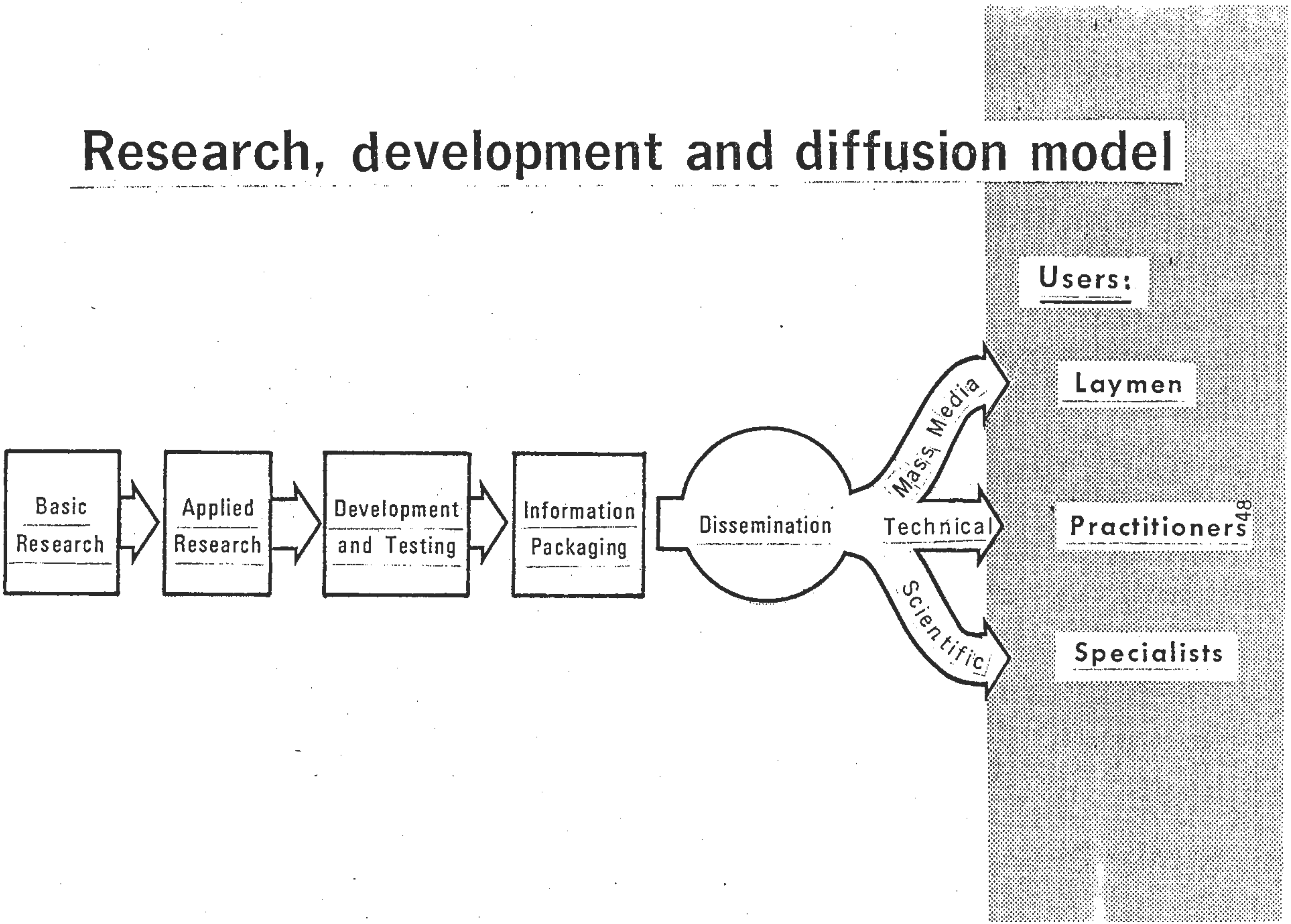
1. Research, development, and diffusion model
2. Social-interaction and diffusion model
3. Problem-solving model
4. Planned-change model
5. Action-research model
6. Problem-solving dialogue or linkage model

Borrowing heavily from other authors, I have prepared a series of sketches and tables depicting these models, their characteristics and problems in application.

## Change Agent Activities Emphasized in the Five Models

| Model | Consulting | Training | Research and Development |
|---|---|---|---|
| Research, development, and diffusion | Yes (External data sources) | No | No, but possible |
| Social interaction and diffusion | Yes (External data sources) | No, but possible | Possibly, but not integral to the model |
| Problem solving | Yes (Internal data sources) | Yes | Probably, but limited and not integral to the model |
| Planned change | Yes | Yes | Yes, but implicit and limited |
| Action research | Yes | Yes | Yes |
| | - Link knowledge sources to users<br>- Diagnose needs of user system<br>- Recommend uses for knowledge | - Teach knowledge retrieval methods<br>- Teach use of knowledge in planning for change<br>- Teach new skills for implementing and evaluating change | - Help user evaluate effects of using knowledge<br>- Evaluate total process of change<br>- Feedback knowledge obtained to R&D community |

# Research, development and diffusion model



# RESEARCH, DEVELOPMENT AND DIFFUSION MODEL
(HAVELOCK, ET AL 1969)

## ASSUMPTIONS

A. SCIENTISTS GENERATE NEW KNOWLEDGE (DATA) NEEDED BY USERS

B. USERS PASSIVE CONSUMERS AND ONLY ACCEPT KNOWLEDGE PRESENTED IN "RIGHT WAY"

C. RATIONAL SEQUENCE OF COORDINATED ACTIVITIES

D. CAN REACH MASS AUDIENCES

## PROBLEMS

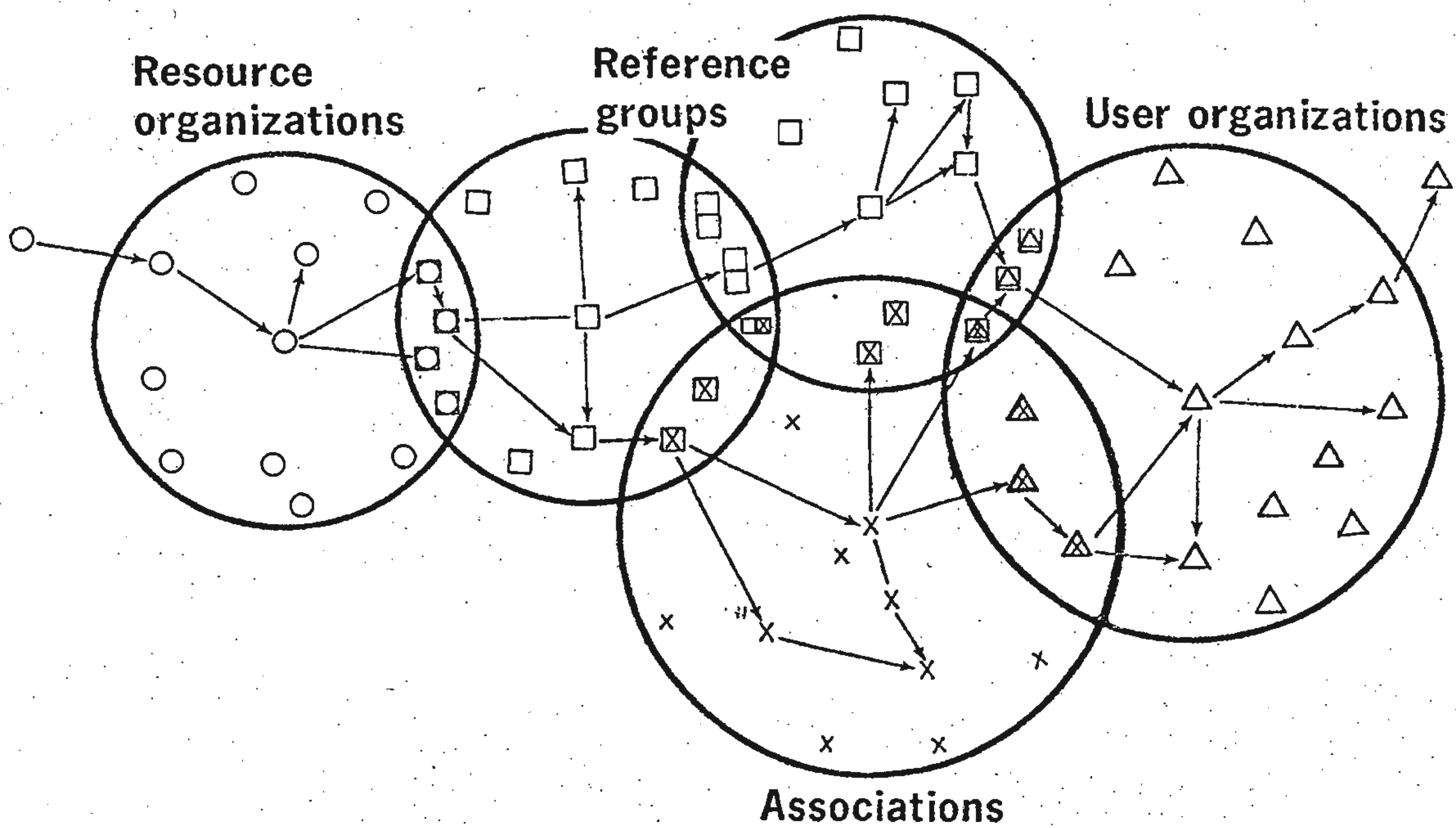
A. OVER RATIONAL

B. OVER IDEALIZED

C. EXCESSIVELY ORIENTED TO RESEARCH

D. MAJOR ASPECTS OF COMMUNICATION AND CHANGE PROCESS ARE IGNORED

# Social-interaction, and diffusion model



## SOCIAL INTERACTION AND DIFFUSION MODEL
(LIONBERGER, MENZEL, KATZ, ETC. 1950'S)

**ASSUMPTIONS**

A. KNOWLEDGE (DATA) EXISTS

B. DATA GENERATED BY OTHERS NOT BY USERS

C. USERS PASSIVE AND ONLY ACCEPT KNOWLEDGE FROM CERTAIN PEOPLE

D. NATURAL DATA FLOW VIA PERSONAL INFLUENCE OF OPINION LEADERS AND GATEKEEPERS

E. CHANGE AGENT CAN USE THIS FLOW

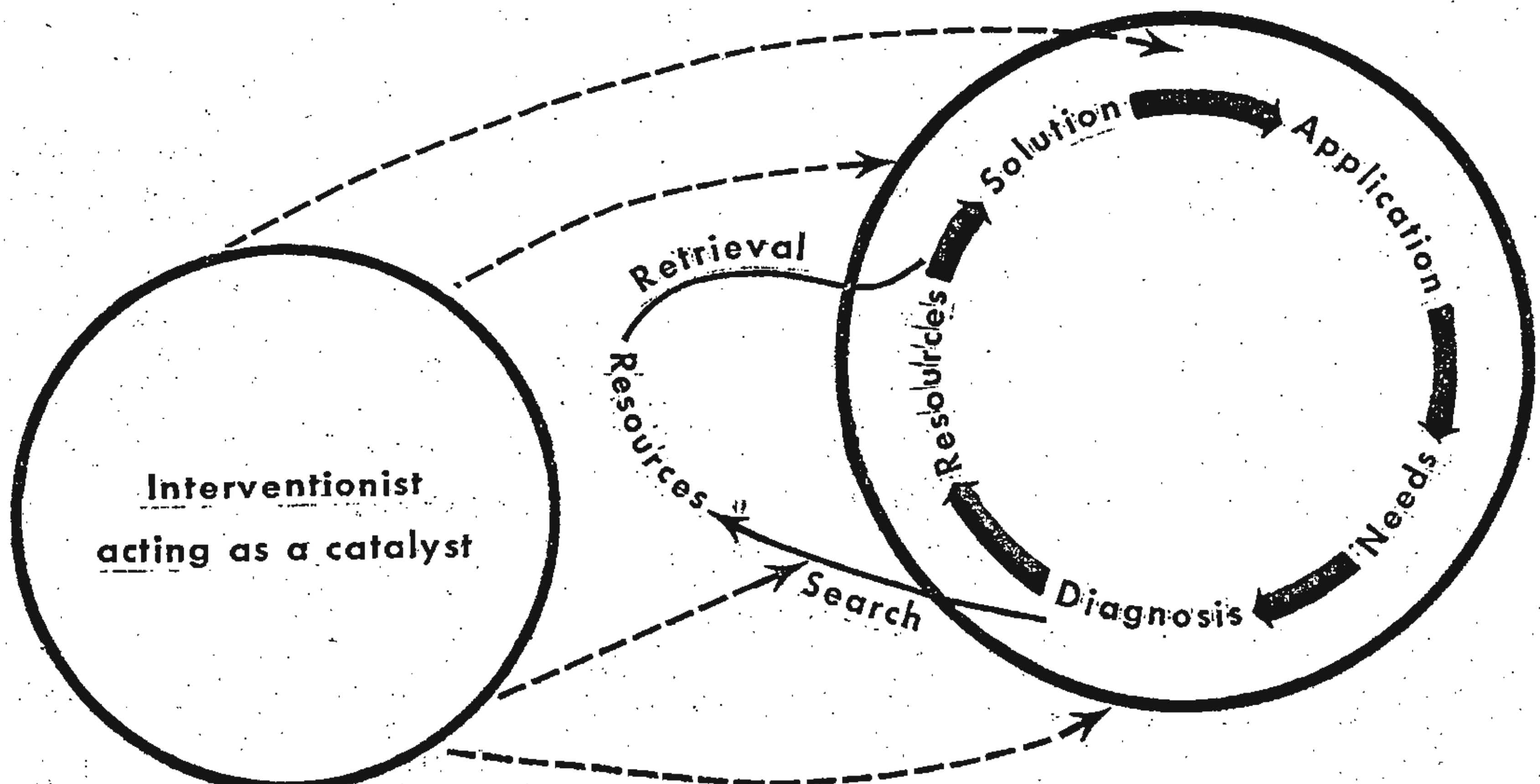
F. PROCESS NATURALLY LEADS TO ACTIVE USE

**PROBLEMS**

A. TARGETS FOR CHANGE ARE INDIVIDUALS NOT SOCIAL SYSTEMS

B. USER PASSIVE, NOT ACTIVE IN DISSEMINATION AND USE

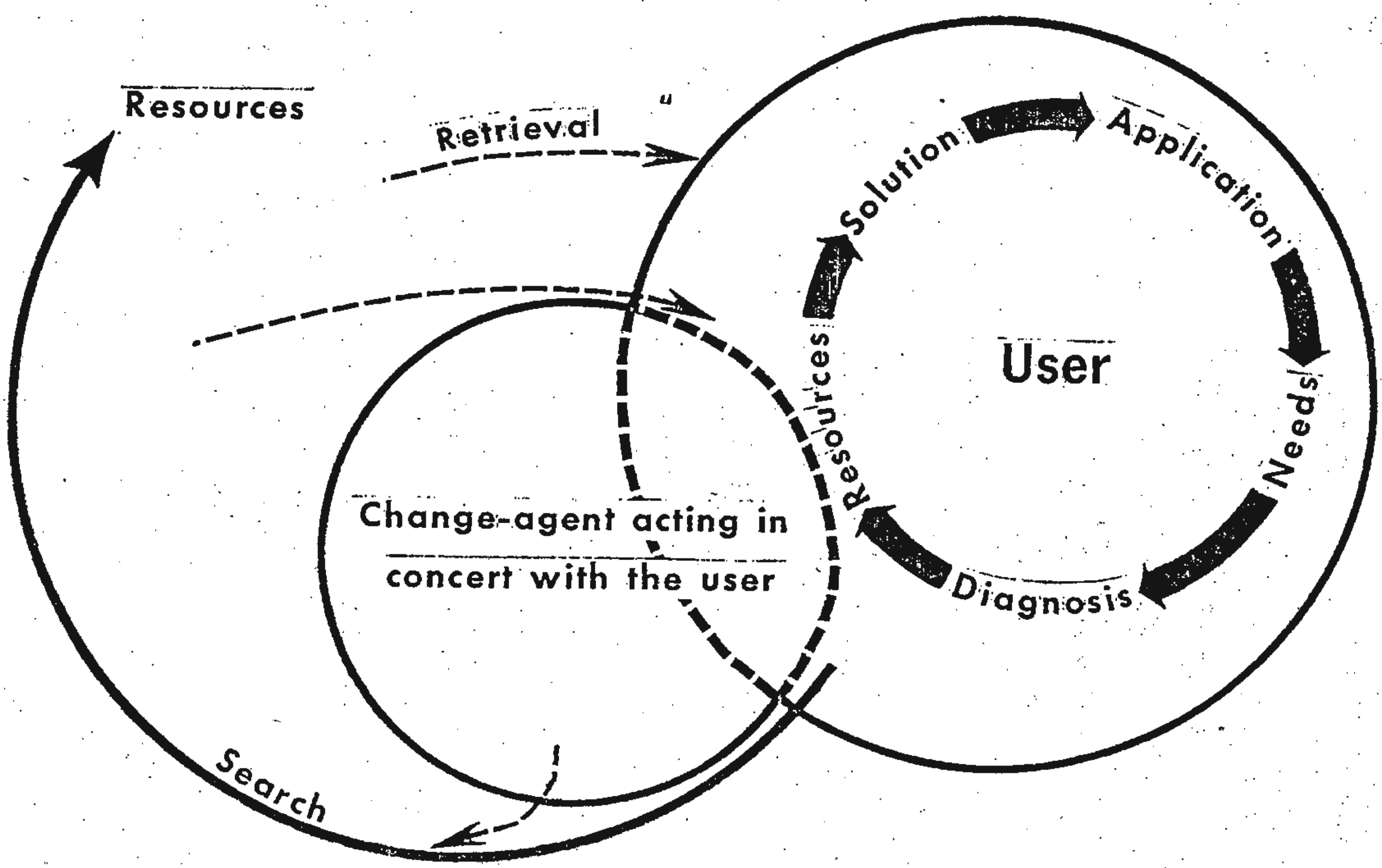
# Problem-solving model



## PROBLEM SOLVING MODEL
(ARGYRIS, 1970)

| ASSUMPTIONS | PROBLEMS |
|---|---|
| A. SOME KNOWLEDGE (DATA) EXISTS IN USER SYSTEM | A. LITTLE EVIDENCE FOR ASSUMPTIONS ABOUT WAYS INFORMATION IS GENERATED, SHARED, AND USED |
| B. KNOWLEDGE (DATA) NOT GENERATED ADEQUATELY, NOT DISSEMINATED APPROPRIATELY, AND NOT USED EFFECTIVELY | B. PUTS HEAVY STRAIN ON USER |
| C. PROBLEMS DUE TO BLOCKAGE OR LACK OF LINKAGE IN COMMUNICATIONS WITHIN USER SYSTEM | C. MINIMIZES ROLE OF OUTSIDE RESOURCES |
| D. INTERVENTIONIST (NOT A CHANGE AGENT) CATALYZES CHANGE OF USER SYSTEM IN MAJOR, BASIC WAYS TOWARD SELF-SUFFICIENCY | D. DOES NOT PROVIDE FOR MASS DIFFUSION AND UTILIZATION |

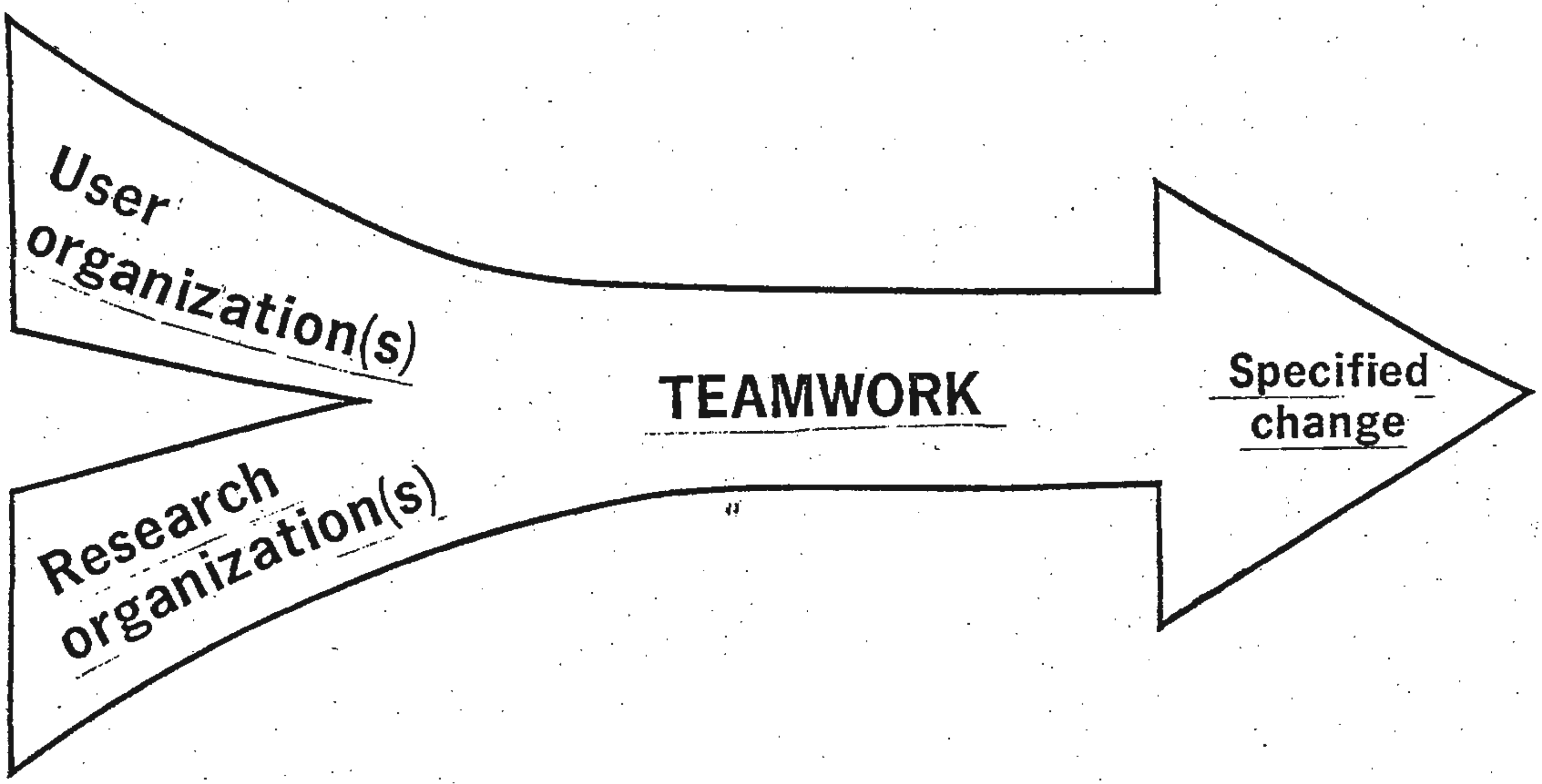
# Planned-change model



## PLANNED CHANGE MODEL
(LIPPITT, WATSON, & WESTLEY 1958)

| ASSUMPTIONS | PROBLEMS |
| --- | --- |
| A. KNOWLEDGE (DATA) EXISTS IN USER SYSTEM OR CAN BE PROVIDED FROM OUTSIDE BY CHANGE AGENT | A. GOAL, TO INTERNALIZE PLANNED CHANGE, IS NOT OPERATIONALLY SPECIFIED |
| B. KNOWLEDGE (DATA) MUST BE DIRECTLY TRANSLATABLE INTO ACTION STEPS | B. EMPHASIS IS ON SOLVING SPECIFIC PROBLEMS |
| C. MECHANISMS AND COMMITMENTS CAN BE DEVELOPED TO STABILIZE CHANGES MADE | C. DOES NOT PROVIDE FOR MASS DIFFUSION AND UTILIZATION |

## Action-research model



# ACTION RESEARCH MODEL
(LEWIN 1947, LIPPITT ET AL 1958)

ASSUMPTIONS

A. KNOWLEDGE (DATA) DOES NOT EXIST IN USER SYSTEM

B. CONTINUOUS PROCESS OF RESEARCH AND ACTION ARE INEXTRICABLY LINKED

C. RESEARCH IS AN ACTION INTERVENTION IN USER SYSTEM FOR DIAGNOSING PROBLEMS, PLANNING, IMPLEMENTING CHANGES, AND EVALUATING EFFECTS

D. USER LEARNS WITH RESEARCHER/CHANGE AGENT AND APPLIES KNOWLEDGE GENERATED TO REAL SPECIFIC PROBLEMS

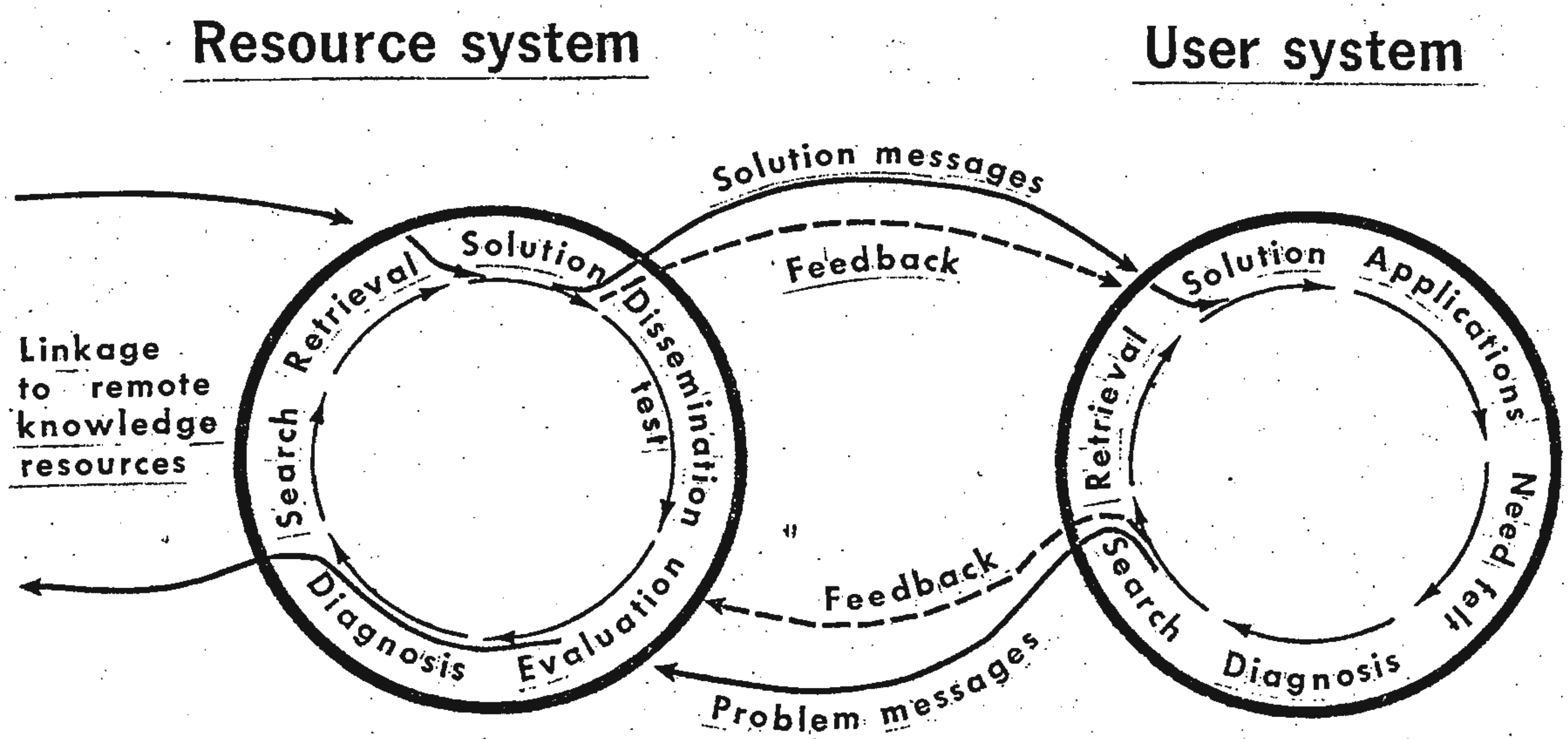
PROBLEMS

A. RESEARCHER AND CHANGE AGENTS HAVE MULTIPLE, CONFLICTING ROLES AS SCIENTIST, TEACHER, LINKER, AND EVALUATOR

B. REQUIRES CONSIDERABLE COMMITMENT AND EFFORT BY USER - PERHAPS MORE THAN WILL OR CAN BE GIVEN

C. FOCUS IS ON PROCESS OF CHANGE NOT ON THE CHANGE NEEDED

# Problem-solving or linkage model



## PROBLEM-SOLVING DIALOGUE OR LINKAGE MODEL

| CHARACTERISTICS | PROBLEM |
|---|---|
| 1. PRODUCES RECIPROCAL RELATIONSHIP BETWEEN CHANGE-AGENT AND RESEARCHER | 1. REQUIRES FREE-FLOW COMMUNICATIONS THROUGHOUT THE SYSTEM, WHICH MAY BE DIFFICULT TO ACHIEVE |
| 2. PRODUCES AN UNDERSTANDING OF USER'S NEED, SEARCH ACTIVITY AND SOLUTION-APPLICATION PROCEDURE | |

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# MODERN SCIENTIFIC AND TECHNICAL INFORMATION SERVICES FOR FOREST PATHOLOGY

Barbara B. Gordon

My first contact with forestry was as an undergraduate at the University of Michigan when I briefly worked for the eminent forest entomologist, Samuel Graham. Between typing stints I was allowed to patch up the wildlife teaching specimens. But, judiciously, I thought it time to leave when I ended up with several surplus birds' heads and no corresponding bodies. Little did I know that later I would be deeply involved in forestry. This time around, however, I'm not so uneasy about mismatched items because sleuthing them is what a librarian's life is all about.

However, in order to explore the topic of modern scientific and technical information services for forest pathology, I would first like to discuss what these services may be and from what sort of library or information service. Then, as the example I know best of this type of service, I would like to tell you about PACFORNET: what it is, what it does, and whom it serves. I shall try not to leave any stray bodies about.

In forest pathology as in other disciplines knowing how to find information is a necessity. Information is central to success and he who has the best quality information will have the competitive edge. Yet traditionally scientists and researchers have not viewed information finding as a skill, although it's quite unreasonable to expect them to develop the particular kinds of skills that librarians develop in information searching. Using the principle of least effort in information searching and rather than an uphill struggle of coping with libraries, one may settle for lower quality, incomplete, or less reliable information. This has been shown even with scientists and researchers whose jobs depend on the quality of information and the quality of work they produce.[1] Traditional libraries are funded and operated on the assumption that a user can find things for himself. Special services libraries have developed to bridge these information gaps. I'll tell you now what a special-services library is and what it does. In the trade we shorten this name to "special libraries".

A special library or information service dealing with the sciences customarily maintains a regular systematic alerting operation. This is usually a list of new acquisitions and may be manually or computer-produced. It may consist of selected books, periodical articles, pamphlets, reports, patents if applicable, and other unique items, all issuing from a multitude of publishing bodies.

In order to function effectively the library staff must be knowledgeable in the multidisciplinary sciences involved as well as in the practices and techniques of library science. The identifying feature of a special library is that it involves participation by the librarian in the seeking and organizing of information for special purposes.[2] A special library's main purpose is to secure, assemble, and make available all the information that relates in any way to a specific subject. Information is acquired and organized for special purposes, and is not only located in normal standard publications but also in the less obvious and ephemeral publications such as elusive government research reports and project reports. Thus unique files are cumulated for the specific benefit of the organization or clients they are designed to serve.[4]

Of equal importance is the ability to communicate effectively whatever may be needed from the assembled files. A special library has an obligation to produce information which may not even be in published form but which can be detected only by knowing how and where to direct discreet inquiry. Sometimes this may mean tracking down an author through three later jobs to wring a loan of his last copy of a paper. In the most effective services even future requirements are anticipated by alert observation of organizational developments so that information is ready when it is needed.[3]

Procedures for organizing information are usually derived from standard methods developed for nonspecialized libraries to suit the requirements of a particular situation. For example, in a special library for forestry this means we may use one or more of the following Dewey Decimal, Library of Congress, Universal Decimal or Oxford Decimal Classifications, or even a variety of subject methods including indexing. As a result of the expanding technologies of the World War II years, the scientific literature has increased since in volume at such a rate that improvements over conventional methods of coping with this quantity have been sought. Traditional methods of filing and indexing are too slow to be satisfactory when large numbers of items must be handled. So we've turned to new systems employing automation and computers for library-related purposes. These, however, are only more sophisticated methods for doing the same things that can be done on a lesser scale by means of the compiling and indexing methods generally used in any scientivic/technical special library.[4]

As a recapitulation I have been describing the unique functions of special libraries which provide modern scientific and technical information services. I have briefly touched upon the uniqueness of the subject matter, its detailed availability, its current alerting service obligation, and general acceptance of new methods for filing and indexing. And the involvement of the librarian through both subject-matter-knowledge and in its organization.

Now I would like to flesh out those skinny bones by using a live specimen for example. I would like to tell you about PACFORNET--which is alive and well and living on the Pacific Coast, to paraphrase Jacques Brel.

PACFORNET is a special services operation conducted by a network of libraries and it not only includes all the points just discussed but also some unique features. It was designed for foresters. And forest pathologists are included in that broad term, even though it is not for their exclusive benefit.

I'm going to tell you of the background of PACFORNET and its current program and services, what it is and how it operates. Then I'll list a few of the benefits to the foresters in the region, and several examples specifically relating to forest pathologists. And lastly, future directions of PACFORNET where it will serve as the prototype and example for other forestry information service networks.

PACFORNET is an acronym derived from the title 'Pacific Coast Forestry Information Network.' This network started life under another name, CALFORNET, which grew out of the library of the U.S.F.S. Pacific Southwest Experiment Station in Berkeley. Documents were sent to both researchers at the Station and foresters in the field as they requested them from a widely distributed current awareness list titled the MONTHLY ALERT. This method of alerting is a typical, widely practiced special library operation. But this was carried further. Through discussions and negotiations with the California State Library, document request channels were worked out for non-Forest Service people to request the announced items via the county libraries with the California State Library serving as the next resource link and the P.S.W. Station Library as the final back-up in the request chain. This chain was called the California Forestry Network or CALFORNET.

In 1975 after the Pacific Northwest Experiment Station in Portland had closed down its own library and bought into CALFORNET service, the MONTHLY ALERT was sent to U.S.F.S. personnel in Washington, Oregon, and Alaska with document delivery supplied by the University of Washington as a contractor.

The network name was changed from CALFORNET to the Pacific Coast Forest Research Information Network or PACFORNET. Thus two service centers were established with PACFORNET-North serving the northern states and PACFORNET-South still serving Hawaii, the Trust Territories, and California.

PACFORNET-North on funds contributed equally by the PNW Station and Region 6 serves Washington, Oregon, and Alaska. PACFORNET-North's experimental phase contract was for $19,000; we have now completed two and one half years of service and our contract for fiscal year-1978 - effective 1 October - was for $130,000. The total budget for PACFORNET was $315,617 for the past year. This compares favorably with budgets for library services at other Forest Service units. The estimated annual cost of PACFORNET per user in fiscal year-1978 will be about $70.14, or less than one day's pay ($80.28).[6]

PACFORNET is a library-based information network serving U.S.F.S. foresters and wildland managers; at this point we are not extending any service to industry, the private sector, nor beyond the Pacific coast of the U.S.A. There are expansion plans, however, but as it currently exists, all PACFORNET users get this current awareness service called the MONTHLY ALERT. The contents are a selective repackaging of recently received literature relevant to Pacific coast forestry. In addition to monographs, monographic serials, reports, symposia, etc., an occasional important journal article is included. There are also selected environmental impact statements, theses, processed publications and documents on legislation and hearings. Each issue averages about 180 items and is indexed. There are both a subject and a species index.

The ALERTs cumulate into the PACFORNET database, maintained on a FAMULUS program at the PSW Station's library in Berkeley.[5] The MONTHLY ALERT is coupled with document delivery. Forest Service users return each ALERT cover to their service center (meaning PACFORNET North or South), listing the items they want to see by number. Retention copies are sent whenever possible and otherwise loaned on a queue basis. Much of each month's material has been gathered together prior to the publication of the ALERT.

Four levels of service are provided to Forest Service requestors who write or call in their requests. MONTHLY ALERT response is the first level. The second level is what we call direct or regular requests - meaning document delivery or loan of literature originating outside the MONTHLY ALERT. In other words, the request of any citation needed from any other reference source. Level three is reference and referral services and level four is literature search services, including on-line searching of computerized bibliographic data bases. This is increasing substantially as users learn of the availability and utility of this service. There were 688 searches made in fiscal year-1976 and they are estimated to number 850 in fiscal year-1977.[6]

As forest pathologists I thought you might be interested in hearing the subjects of a few pertinent on-line searches performed at PACFORNET-North in the last few months. They are:

- Diseases of specific species
- Mycorrhyzae of Picea spp.
- Mistletoe
- Forest pathology and seasonal growth
- Sirococcus strobilinus
- Fomes annosus on Tsuga heterophylla
- Foliar rusts
- Forest disease
- Phytopathology - evolution
- Phytopathology - seasonal growth

Special libraries have long been known for their interlibrary cooperation, and PACFORNET is a prime example of this cooperation or networking. Here we have a library of the U.S.F.S. cooperating with an academic library to provide service to foresters. But we also go further afield to fill requests. If the requested materials are not in the Forest Resources Library nor elsewhere in the collections of the University of Washington Libraries, we may turn to the Pacific Northwest Bibliographic Center. There are several such bibliographic centers over the U.S.A.

PNBC, as we abbreviate it, is a switching center for library requests to be filled by the appropriate library in the six-state region. PNBC has no collection of its own but is housed within the University of Washington Library and maintains a four million card file representing each cataloged book in libraries of the region. The Pacific Northwest Bibliographic Center is funded by the states and certain other agencies in the Pacific Northwest to provide better library service to the citizens.

As the news of PACFORNET services filters through the U.S. Forest Service, the number of requests climb. The flow of technical literature to users in the field and at Stations increased from 34,117 documents delivered in fiscal year-1976 to an estimate for fiscal year-1977 of 49,128 - an increase of 69.5 percent. This amounts to nearly 200 documents per working day.[6] This is a total of both PACFORNET service centers; we know that on our busy days we may handle four bags of mail in PACFORNET North alone.

PACFORNET has just had an evaluation of its services, and it was found very much alive and doing very well. An executive review was carried out by a team composed of Deputy Regional Foresters, Directors, and Assistant Directors of Stations and Areas, plus others from the Missoula Equipment Technical Service Center, National Agricultural Library, and the Bureau of Land Management's Western Technical Service Center. Team members visited Stations, Regional Offices, and National Forests to talk to users. The team's conclusions were that:

1. PACFORNET is a needed technical information service not provided by any other government agency.

2. Pluses are PACFORNET's value in technology transfer, wide acceptance and use, cost-effectiveness, adn improving work being done.

3. Negative findings identified problem areas related to information about services, training-to-use services, restricted coverage of subject matter, and limits on services.

The Executive Review Team made four recommendations:

1. Expand PACFORNET to WESTFORNET. Included in the analysis should be: needs for staffing, potentials for contracting, estimated costs, location(s) of WESTFORNET service centers, likely cooperators, and potentials for financing by multiple users.

2. Broaden the user group to include cooperators (which means industry), and insofar as possible, extend full services to cooperator users outside of the Forest Service.

3. PACFORNET should work together to correct problems and negative findings and to explore ways for non-Forest Service users to pay for services received: no free lunch.

4. Develop training packages for PACFORNET which may readily be adapted to WESTFORNET.[6]

So those of you not in PACFORNET may soon have reason to be excited about expanded PACFORNET-like services. I am looking forward to the 1978 birth and development of WESTFORNET which will include PACFORNET and go into the inter-mountain and Rocky Mountain regions. In the northeast and southeast areas of the country similar forestry networks are in various developmental stages. And there is world-wide interest in subject networks. Both the FAO and the IUFRO have recommended establishment of a uniform and readily accessible international system for storage and retrieval of research information,[8] with one of the prime emphases on forestry.[7] However, no international monetary support for forestry networks has been forthcoming. If a forestry information network is to be, it has to grow from the grass roots upward. No country and no national agency has stepped forward to fund this, and there is no likelihood of any big money on the horizon.

I hope you share my excitement in the growth of one forestry network - PACFORNET. I hope you will find it increasingly useful to you both generally and in your specialty as forest pathologists. Who knows how and where this may all develop, but you can bet we'll be delivering documents however and wherever it goes.

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8. International Union of Forestry Research Organizations. IUFRO World Congress, 16th, Oslo, Norway, 1976. Congress Recommendations, IUFRO World Congress, p. 2.

# SCIENTIFIC AND TECHNICAL DATA BASES RELATED TO FOREST PATHOLOGY

Alan R. Taylor

## INTRODUCTION

The computer is part of the problem! Rather, the way we've used computers is part of the problem. Why? Because . . .'I've got a data base, you've got a data base, lots of God's chilluns got data bases,' and most of them are incompatible, not readily accessible; and they are not standardized in the kinds of bibliographic information they offer.

I'll be talking about bibliographic data bases for the next 10 minutes. We'll perform a quick survey of your use of computerized data bases, then introduce a proposed network-compatible data base for forest disease and insect literature.

## SURVEY OF COMPUTERIZED BIBLIOGRAPHIC DATA BASE USAGE 1/

Your Knowledge Utilization Panel would like to know the extent of your use of computer-assisted literature data bases.

1. Have you requested or performed one or more computerized literature searches pertaining to your work during the past 12 months? (Please circle one):

   YES (18) NO (11)

2. If you circled "YES" above, please indicate below the approximate number of times that computerized literature searches were performed for you (or by you) during the past 12 months (Circle one):

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 or more |
|---|---|---|---|---|---|---|---|---|---|
| (4) | (6) | (3) | (2) | (1) | (0) | (0) | (0) | (0) | (2) |

3. Listed below are several data bases and systems that contain, in part, citations or data of interest to forest pathologists and entomologists. Some are available commercially, and others are maintained and made available by individuals or government agencies. The list is by no means complete.

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1/ This is a summary of the 29 questionnaires returned to the author following his presentation on October 19. The questions are reproduced here. The number of responses for each question is enclosed in parentheses.

Please place a "√" by those that you have utilized in the past 12 months (it doesn't matter whether you performed the searches yourself or had someone else do them in your behalf):

(7) AGRICOLA (CAIN) (Agricultural on-Line Access)
(0) AIDS (Abstract Information Digest Service)
(5) BIOSIS PREVIEWS
(0) BOREAL NORTHERN TITLES
(7) CAB SYSTEM (Commonwealth Agricultural Bureaux System)(Includes items from Biblio. of Systematic Mycology, Forestry Abstracts, Index of Fungi, Review of Plant Pathology, and 16 other journals)
(1) CACon (Chemical Abstracts condensates)
(1) CAN/OLE (Canadian On-Line Enquiry)
(0) CDI (Comprehensive Dissertation Index)
(3) CRIS (Current Research Information System)
(0) CRONARTIUM RIBICOLA LIBRARY
(1) ENV (Environment)
(2) FIDS (Forest Insects and Disease Survey)
(0) FIRE ECOLOGY CITATIONS FILE
(0) FOREST ENTOMOLOGY
(0) FOREST INSECTICIDES
(0) BYPSY MOTH
(0) IVC (Insect Virus Catalog)
(10) MISTLETOE LITERATURE OF THE WORLD
(2) NTIS (Government Reports)
(4) PACFORNET Data Base (Pacific Coast Forest Research Information Network)
(2) POLLUTION ABSTRACTS
(4) PSW STA PUB (Pacific Southwest Forest & Range Experiment Station publications list)
(0) SPRUCE BUDWORM
(3) SSIE (Smithsonian Science Information Exchange)
(0) TOXLINE (Toxicology Information On-Line)

The summary shows that 18 of the 29 respondents had employed computerized data bases one or more times during the past year (question #1). Eight of these respondents had requested or performed such computerized literature searches three or more times in that period (question #2). Responses to the final question indicate that MISTLETOE LITERATURE OF THE WORLD, AGRICOLA, and CAB SYSTEM were the most frequently used data bases during the past year.

We asked the audience to list on the survey form any additional data bases, whether computerized or manual card files, that might be helpful to forest pathologists. The two items that we were able to verify are shown below. Both are manual card files:

1. BIBLIOGRAPHY OF DUTCH ELM DISEASE (about 2,000 items)
   Contact: John G. Laut, Colorado Forest Service, Colorado State University, Fort Collins, CO 80523

2. ARMILLARIA ROOT ROT (about 2,000 items)
   Contact: C.G. Shaw, Forestry Sciences Laboratory, P.O. Box 909, Juneau, AK 99803.

A DATA BASE FOR FOREST INSECT AND DISEASE LITERATURE?

The above survey demonstrates that the literature pertinent to your needs is scattered among many data bases throughout the world. Some of them are readily available to you. Many are not. Most of them do not list unpublished reports and few of them provide abstracts in printout form. Most are young; that is, they were begun within the past 3-7 years and carry only the references published from their start-up year forward.

The Technical Information Office (TIO) of USDA Forest Service has proposed that forest pathologists and entomologists pool their fiscal and information resources and construct a data base for disease and insect literature.[2] Such a data base would become one of a family of compatible, forestry-related data bases whose development is being coordinated by TIO. This family of data bases, all having similar input requirements and printout formats, is called the RENEWABLE RESOURCES TECHNICAL INFORMATION SYSTEM (RRTIS) (Callaham 1976). Several RRTIS data bases are currently under construction. For a description of one that is operational, see Taylor (1977).

The general TIO approach has been to help potential users set up a steering committee and to coordinate development of the computer file. The committee would determine target user groups, sources of funding, decide on the scope of the data base, and direct the collection and conversion of existing personal data bases to get the new data base started. Sharing and consolidation of existing personal data bases is the essence of this approach.

DISADVANTAGES

Some disadvantages inherent in such a plan are:

1. Start-up costs and maintenance costs are considerable. (Start-up costs have been estimated at about $200,000 for a new data base under RRTIS.[3]

2. Such a data base could not be expected to be allinclusive of the world's forest disease and insect literature; therefore, the new data base would not be a total substitute for existing data bases, e.g., those listed on the questionnaire above.

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[2]R.G. Krebill 1975. "Tree disease abstracts: Intredis II," (sample issue). USDA Forest Service, Forest Insect and Disease Research, Washington, D.C. 92p.

[3]R.Z. Callaham. Personal communication, November 19, 1977.

3. Heavy and continuing commitment is required of the steering committee during the developmental phase.

ADVANTAGES

On the other hand, the approach suggested by TIO has the positive effect of building toward a network of compatible data bases instead of compounding the difficulties that attend the present day proliferation of small, incompatible ones. Other advantages to the users include:

1. Single source access--you know who to call, where to go, to get access to the file.

2. The file can be made to include references to unpublished reports and older items if the steering committee so directs.

3. The file can include abstracts or digests, or could list only bibliographic citations, depending upon the user group needs.

CONCLUSION

I'm not suggesting that you rush to adopt the TIO approach. But I am suggesting that you look closely at your own individual information retrieval capabilities with a critical eye to improving them through a modern systems approach.

Thank you.

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# INFORMATION ANALYSIS, APPLICATIONS AND PILOT PROJECTS

D. Drummond

Information analysis represents the flow of information from a source to an ultimate user with intermediate evaluation which may include repackaging or condensing information to make it more usable.

In the past, the most effective means of information transfer has been through personal contact. These contacts usually are restricted to small groups of individuals located within a restricted geographical area, and working on similar problems. Contacts that occur outside these small groups are accidental and sporadic.

One alternative to personal contact is the traditional literature system. However, there are substantial time delays in processing information through this system. It requires that participants show initiative in the placing of information into the literature system, as well as retrieving it from the system, evaluating it relative to needs, and utilizing it. Within large scientific disciplines, such as medicine, researchers and practitioners may not even consult the same publishing medium, although this is not likely to occur in plant pathology. Unfortunately, researchers and practitioners sometimes each feel that the other is responsible for initiating action that will result in the ultimate utilization of research data. This however is a rare attitude. Usually a real concern is expressed that new or proven knowledge reach the user in the most usable format. The Dwarf Mistletoe Symposium next April, aimed specifically at the timber manager, is a good example.

Figure 1 is a simplistic schematic representing two general populations, the research population and the user population. A transition zone is depicted between the two populations through which information must be processed prior to its utilization. Individual members of the two populations have other priorities that restrict their activities within this transition zone. Some barriers and bridges to the movement of information through this zone are also listed in the schematic. These are not intended to be all-inclusive, but are illustrative of the problems that are often encountered. The greatest barrier to moving the information across this zone, however, is not necessarily the participants. The successful implementation of research is often dependent upon the results satisfying rather pragmatic constraints placed on them within the transition zone. These often are economic or logistic in nature. There are also constraints dictated by political, organizational and psychological sources.

Bridges to the movement of information through the transition zone include funding, coordination groups, joint projects, literature retrieval systems, data bases, management support and pilot projects. The Methods Application Group, U.S.F.S., represents a coordination group that was formed primarily to function within this transition zone, the idea being that if funds and personnel were available to help bridge this gap, the participants may be less reluctant to initiate contacts that, in the past, would have required substantial commitment of time and money.

Such groups also function in expanding the effectiveness of personal contact by extending the scope of personal contacts beyond their normal limits.

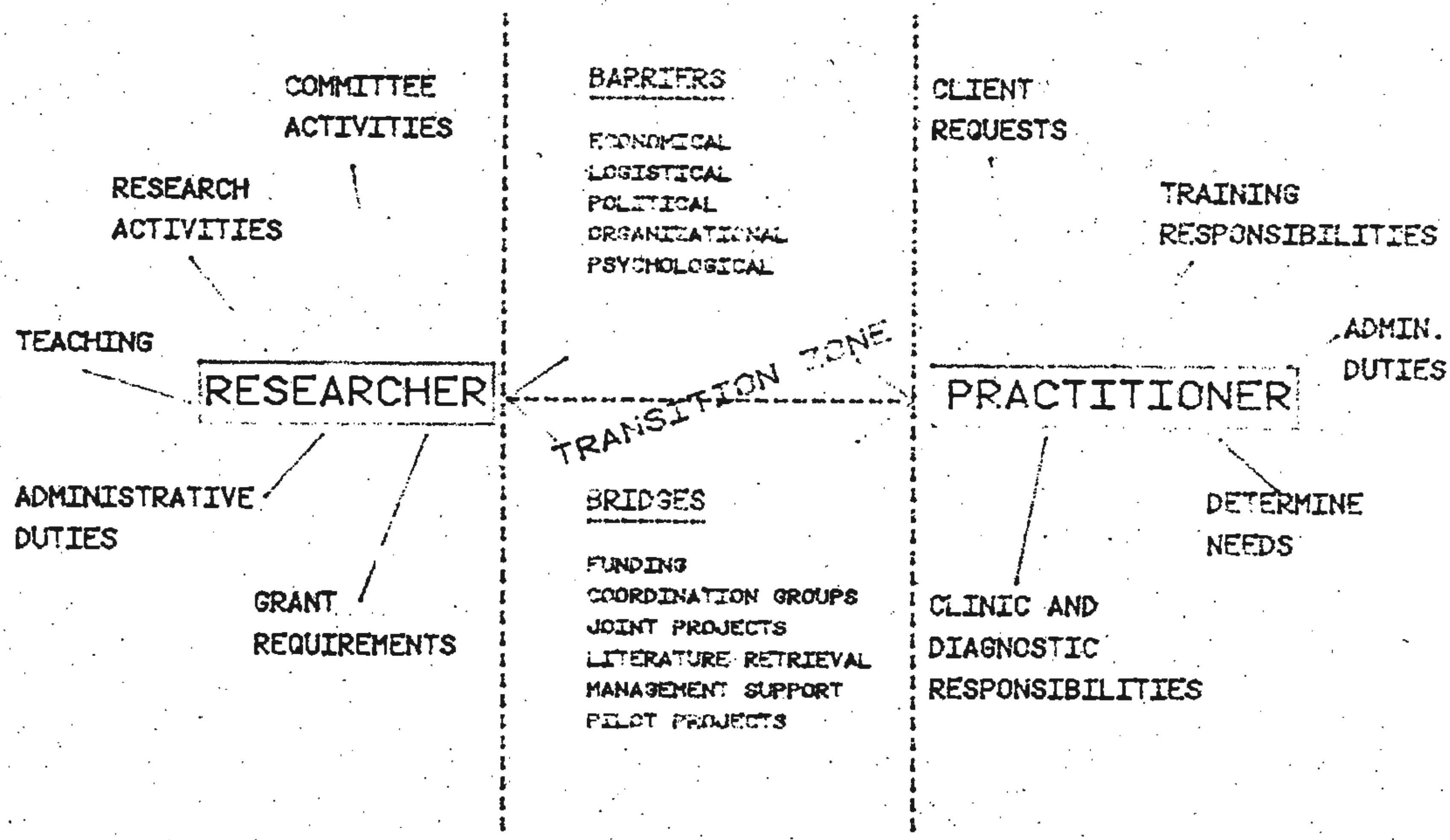
The following examples of involvement by our group illustrate the activities of a coordination group. We have presented training sessions on aircraft calibration and characterization to help project managers determine how well an aircraft spray system is performing during spray application. We have published an instruction manual that outlines aircraft calibration and characterization procedures. This illustrates both the evaluation and repackaging concept of information analysis. A Spray Deposition Assessment publication is in print now and illustrates how research results are repackaged for the user in a way he can easily use.

MAG also maintains specialized data processing systems designed by research and provides training in their use. For example, we presently maintain a computer system that analyzes spray deposit data that can be accessed by field units. The Douglas-fir Tussock Moth Model will also be housed at MAG when it is completed and validated. We are presently involved in an attempt to standardize spruce budworm egg mass sampling procedures in hopes that egg mass sampling results can be made comparable westwide. We are also coordinating the production of a Survey Methods Manual. This represents an attempt to make a variety of survey methods available at a moment's notice to individuals when they are faced with surveying a new pest problem within their area. It will be published in a looseleaf format in hopes that inhibitions to revising it are minimized and it can be updated as often as needed. Contacts with industry and agencies that may have promising support systems, such as aircraft guidance systems or remote sensing systems, are maintained.

The pilot project is of particular importance in bridging the transition zone. This is often where systems developed through research must bear fruit, i.e., the final test, before it can actually become an operational procedure. MAG has taken part in coordinating such aspects as project location, personnel, and has helped in data processing and reporting. Our involvement in pilot projects to date has been in the testing of aerially-applied pesticides. We also have loss assessment pilot projects on the mountain pine beetle and the dwarf mistletoes.

The success of this kind of service group is contingent upon the group being visible to both the research and user communities and that both communities show a wi-lingness to involve the group in meeting their objectives. If this does not occur then, instead of one transition zone we have two.

FIGURE 1:


COMMITTEE ACTIVITIES
RESEARCH ACTIVITIES
TEACHING
RESEARCHER
ADMINISTRATIVE DUTIES
GRANT REQUIREMENTS
BARRIERS
ECONOMICAL
LOGISTICAL
POLITICAL
ORGANIZATIONAL
PSYCHOLOGICAL
TRANSITION ZONE
BRIDGES
FUNDING
COORDINATION GROUPS
JOINT PROJECTS
LITERATURE RETRIEVAL
MANAGEMENT SUPPORT
PILOT PROJECTS
CLIENT REQUESTS
TRAINING RESPONSIBILITIES
ADMIN. DUTIES
PRACTITIONER
DETERMINE NEEDS
CLINIC AND DIAGNOSTIC RESPONSIBILITIES

# RESISTANCE TO WHITE PINE BLISTER RUST
# THE ACTION RESEARCH MODEL EXEMPLIFIED

Geral I. McDonald

The program to develop blister rust resistant white pine was started in 1950. This effort, as originally conceived, consisted of a cooperative arrangement between two administrative units of the U.S. Forest Service that was designed to meet a specific objective. Both the scientific and user portion of the program were placed under the leadership of a single administrator. The objective of this first phase of the white pine resistance program was met by 1970. From 1970 on the objectives of the program and the character of the user group changed creating the second phase.

In order to understand why the resistance program has been used as an example of successful knowledge transfer, we must first look at a few traits of the innovation or technology being transferred or placed into use. A list (table 1) of these traits that seemed very relevant to me is known as the CORRECT list (Glaser, 1976).

Disease resistance had a high degree of credibility. The idea of resistance had been around for about 40 years even in 1950. The only feature to be proven was that genetics and resistance could be applied to trees. Resistance is easily observed and, therefore, easily demonstrated. Resistance was a very relevant solution to a persistent problem of great concern. Resistance to blister rust could be shown to possess a very significant cost-benefit advantage over competing technologies. Resistance was easy to apply--one had only to plant resistant seedlings. Resistance was very compatible with ongoing management techniques. Resistance had a high degree of trialability as trials were inexpensive and did not require an irreversible commitment.

As you can see the resistance program had nearly everything going for it from its inception. Anyone of the six models of knowledge transfer would probably have worked. But, the model that could most assure success, the action-research model, was inadvertently selected. Inadvertently in the sense that the six models had not been defined in 1950.

My interpretation of how the action research model worked in this case (Figure 1) is as follows. The most important characteristic of this model is that both research and user functions are included under one administrator. Published literature is combined with new evidence created by application of the scientific method by competnet scientists. The information generated is then put into action by the same scientists. Peer review and journal publication simply function to establish scientific credentials and thereby credibility. This model worked because the objective was very specific and the users of the information very limited in number.

Upon the production of resistant planting stock a whole series of new objectives arose. Many users became involved. Several different organization units had to be dealt with. These changed objectives and user groups created the need for a new knowledge transfer model. Again one of the six models was inadvertently used (Fig. 2).

I believe the current rust resistance program is organized along the lines of the problem-solving dialogue of linkage model. This model is much more complex and flexible than the action-research model. As shown in (Fig. 2) the current program makes use of demonstration areas, demonstration methodologies (systems modeling), and cooperative studies with users to transfer solutions and record needs. The double lines indicate the powerful nature of these three devices in transferring information both ways. The double-arrowed line between "consultations and seminars" and "users systems" indicates a small amount of two-way information flow. The solid single arrowed line between "user reports" and "user systems" denotes the effective one-way nature of such reports. The user reports are written by the information generators (scientists) for direct consumption by the users (for an example see Hoff and McDonald, 1976). The dashed line and single arrow indicate the weak and one-way nature of journal publications in information transfer to the user. I believe that journal publication serves only to establish scientific credentials and to stimulate the creativity of information generators. Without journal publication, including peer review, the whole operation would cease to function. This organization contains enough flexibility that completely new objectives can be smoothly incorporated and old objectives maintained or dropped according to current needs. For example, the white pine blister rust program has expanded to include studies directed toward resistance to Douglas-fir needle cast, western spruce budworm, and larch casebearer. The future undoubtedly holds more changes but for the present the problem-solving dialogue or linkage model fits our needs.

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Table 1. The CORRECT List of Change Factors

Glaser 1976

C redibility - stemming from the soundness of evidence for the innovation's value or from its espousal by highly respected persons or institutions.

O bservability - the opportunity for potential users to see a demonstration of the innovation or its results in operational practice.

R elevance - to coping with a persistent or bothersome problem of concern to many or to influential people.

R elative advantage - cost-benefit or other advantage over existing practices; the conviction that improvement will more than offset additional effort which may be required to adopt or adapt the change.

E ase in understanding and installation - as contrasted with difficulty of putting into operation or transplanting from another setting.

C ompatibility - with potential user's values, norms, procedures, and facilities.

T rialability, divisibility, or reversibility - which permits a pilot tryout one step at a time and does not call for an irreversible commitment.

Phase I

The Action Research Model

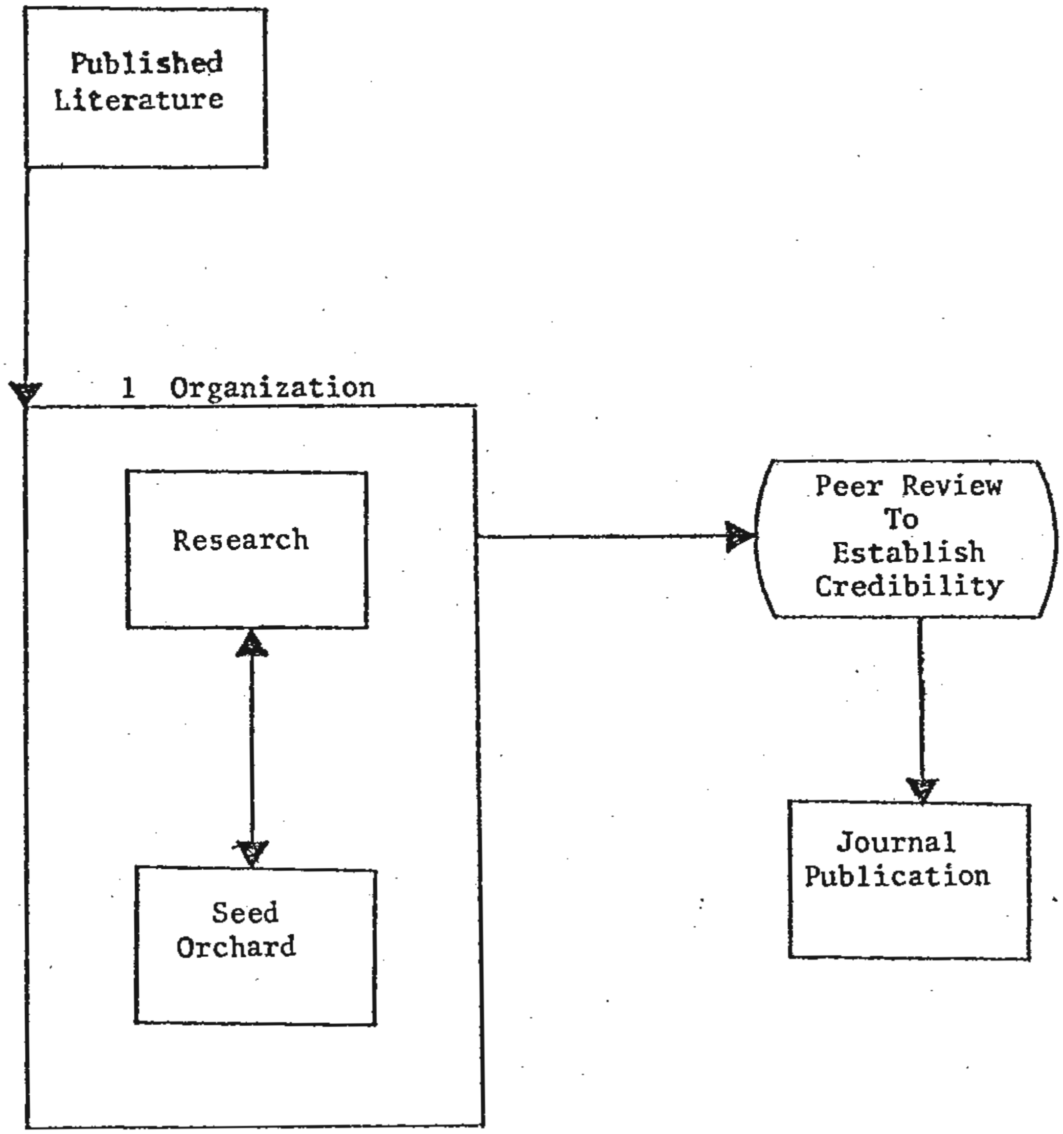


Figure 1. Flow diagram of Resistant Western White program information transfer for period 1950 to 1970

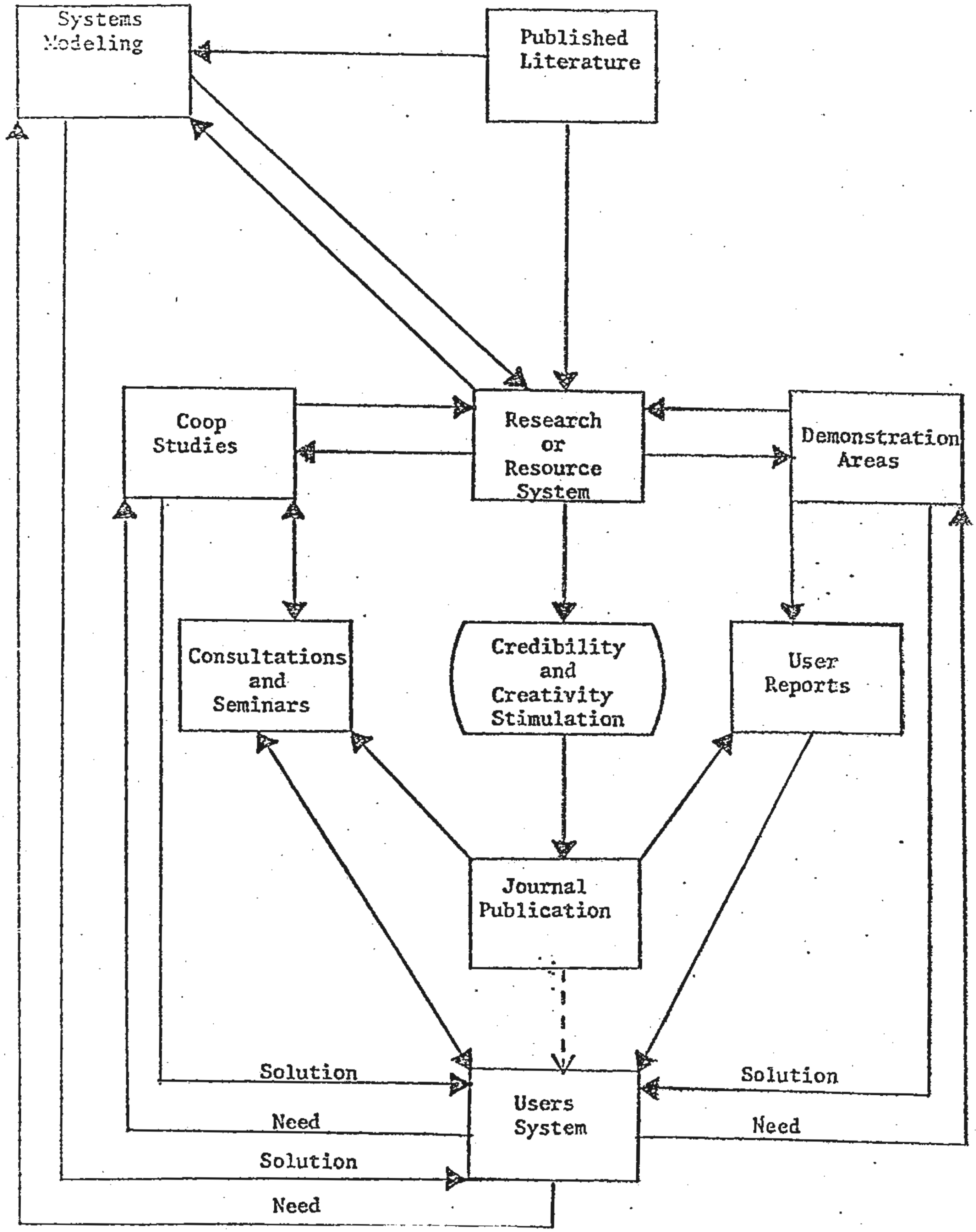


Figure 2. Flow diagram of resistant-western-white-pine program information transfer for the period 1970 to present

# THE LINKER BETWEEN RESEARCHERS AND PRACTITIONERS
## BRITISH COLUMBIA'S SITUATION

D. H. Owen

Efficient utilization of knowledge presents a problem in resource management common to many areas of the world. A major step towards its solution obviously is the establishment of adequate communication links between those who provide the knowledge and those who use it.

Today I would like to deal first in general with the matter of communication links, and then outline briefly some of the work done towards establishing these links within the profession of forestry in British Columbia.

A wide variety of authorities in various disciplines are of the general opinion that the void between researchers and practitioners is increasing rather than decreasing. This results from the increasing amount of research conducted and the escalating volume of material produced by scientists combined with the growing pressure on practitioners to solve diverse and complex problems.

The practitioner is unaware of much pertinent research. He is faced with little time to digest much of the material disseminated or to assess its efficacy. In many instances, there is a lack of organizational structure to implement many of the research findings.

In a paper presented to the 7th World Forestry Congress, Professor J.H.G. Smith of the University of B.C.'s Faculty of Forestry, expressed the opinion that much of the success in communication depends on early recognition of what is of potential operational interest. Much information, he said, was of concern only to a few specialists. This problem was compounded by the fact that foresters' interests and needs change very rapidly.

He found that there seems to be almost universal agreement among field foresters that the information they need is seldom available in an understandable form when problems arise. "Furthermore," he said, "it is widely agreed among field foresters that research results should be given in concise form with suggestions for possible action."

At this point I would like to add that, in my opinion, solving the problem of knowledge communication in forest management must be taken beyond linking the work of the researcher and practitioner into the public domain. This is imperative in British Columbia with its growing public participation in resource management decision-making. Only with an informed public can we hope to take rational, effective management action which enjoys general support.

To obtain maximum efficiency, the objective of the knowledge communication link should be to ensure the best interaction performance by making both the researcher and practitioner aware of the applicability and importance of each others work to the solution of problems, and also to ensure that there is understanding of the magnitude of the problems and the necessity and degree of urgency of their solution.

Perhaps the most important single requirement of successful communication identified by various authorities is for a continued feedback and information system, including such elements as: periodic team meetings, organizational meetings to sense needs, problems and opportunities, meetings between interdepartmental units of the organization, renewal conferences, performance reviews, and periodic visits from outside consultants.

Personal contact is an important ingredient. Too often we find the researcher and the practitioner have different goals. The practitioner is "mission-oriented", while the researcher tends to be "discipline-oriented". The practitioner tends to focus on decisions, the researcher on contributions to knowledge.

The mutual understanding created by an adequate communication link can draw the work of the researcher and practitioner together to reach a common goal.

Vital to this accomplishment is the work of the linking agent. He may be part of the knowledge-producing system or the knowledge-using system. Or he may be part of both systems. In any event, as one authority expresses it, "he is the catalyst of change, and a potentially powerful linking force in the continuous effort to put knowledge to practical and innovative use".

Good communication should result in the needs and problems of the practitioner being presented in researchable form, and the work of the researcher being directed towards solving problems that have clear implications for practice. Accomplishment of this is one of the primary functions of the linking agent.

Finally, where they affect public concern in resource management, pertinent positive results of this collaboration should be communicated to the public through the various media.

Now I would like to turn to some of the efforts in British Columbia towards improved knowledge communication links in the field of forestry.

Particularly for the benefit of our non-Canadian visitors, a brief review of the organizational structure of research responsibility may be of interest since it contributes significantly to this problem of knowledge utilization.

The federal Ministry of Fisheries and Environment, of which the Canada Forestry Service is part, is responsible for conducting much of the research in forest diseases and insects. However, the Canada Forestry Service is not responsible for the management of the forest resource. This obligation rests with the provincial Ministry of Forests.

In addition, a considerable amount of research is undertaken by the forestry faculties of the universities, company foresters, and the B.C. Forest Service Research Division.

The problems of coordinating the research effort, establishing priorities, disseminating the findings and implementing the results were recognized early in the 1970's, and the B.C. Forest Research Board was born as a result.

This is a three-tiered agency made up of the Board itself, under the chairmanship of the Forest Service, and of the working committee and technical subcommittees. All three levels are represented by the B.C. Forest Service, the federal Forestry Service, university and industry.

Formation of the Board was looked upon as a major step towards overcoming the difficulties experienced in the past in establishing research priorities and coordinating the effort. Unfortunately, the early enthusiasm has waned because the expectations for it have not been fulfilled. The Board is floundering due to lack of funding and serious direction.

As the provincial agency responsible for forest land management in B.C., it is logical for the provincial Forest Service to assume the role of linking agent between the researcher providing the knowledge and the practitioner applying it in the field.

The primary responsibility for being conversant with the requirements of both the researchers and the practitioners must rest with the Research Division. However, this does not exclude the other Divisions, particularly those of Forest Protection and Reforestation, from assisting in the role of linking agent.

Some examples of fields in which the communication gaps are being filled are:

1. Site preparation, where workshops, field demonstrations, and handbooks are utilized to implement research findings;

2. An ecological classification and interpretation program, where tree species selection guidelines have been prepared in four Forest Districts, and field workshops are being conducted;

3. A tree improvement program, where seed orchard development by industry and the Forest Service is utilizing the technology as fast as the Research Division can produce it as a result of training programs and collaboration, and

4. Physiological research on nursery stock, where results are put into practice via production scale experiments and training programs such as quality control monitoring sessions.

One of the most recent and realistic steps taken in development of an overall communication link between the researchers and the practitioners has been the establishment of District Research Advisory Committees.

These committees were established on the premise that the real measure of success in a forest research program is the degree to which results end up in improved forest practices. If research is to achieve a high degree of success, research efforts must be directed to solve problems and explore opportunities which are of considerable importance to practical forestry. Obviously it is of great benefit to research if the Forest District staffs are involved in identifying these problems.

If these requirements are met, we have provided many of the essential ingredients to successful interaction between research and practical application.

The liaison function of the regional research officer is stressed, both at problem identification and implementation stages. The active participation of District staffs in research matters is encouraged. A strong link is being forged.

Two underlying objectives are paramount:

First is the generation of District participation in identifying problems requiring research and establishing their priorities; in operationally applying research results, and in collaborating in the research, probably through the provision of students, vehicles, accomodation, and so on.

Second, and equally important, is ensuring that research is directed toward the solution of the most critical problems facing the District.

While this process is largely District-oriented, headquarters can probably be expected to be involved in all stages of the process. However, its main input will be concentrated on other aspects of the communication link, including:

1. Helping to ensure that other partners in land management and in research are given opportunities to analyze a particular problem and make recommendations.

2. Helping to identify alternative approaches to problem solutions, and

3. Helping to provide support funds and expertise from a variety of sources.

In closing, and at the risk of some repetition, I would like to make a round-up of some recent examples of workshops and/or field demonstrations which have brought researchers and practitioners together to exchange ideas and discuss research and findings. They will give you some idea of the range and direction of our efforts towards establishing functional and objective links in knowledge communication.

The examples that come to mind cover the following problems affecting our forest management activities:

1. Mistletoe
2. Root rot
3. Mountain pine beetle
4. Streambank management
5. Forest hydrology
6. Site preparation
7. Tree improvement
8. Ecological classification and interpretation, and
9. Quality control monitoring of nursery stock.

Obviously, we still have a long way to go to close all the gaps where communication links are needed, but I feel we have made a good start in the right direction. With positive and constructive participants, aided by an adequate and knowledgeable linking agent, I am positive we can reach the goal.

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# IS THERE ANYBODY OUT THERE? WATCH YOUR LANGUAGE!

John G. Laut

Who does research talk to? Who listens and what do they hear? They hear according to what they want to hear or according to their own perception of their own problems.

As an example of how various audiences interpret the same material in different ways the Western Regional Working Conference of the National Program of Research for Forests and Associated Rangelands (NPRF) recently published the results of their July 1971 meeting. This Conference examined and prioritized the research problems of western forestry. The problem statements had been written by task forces of the various research disciplines. The ranking of all the problem statements was done in Subject Area Working groups by two separate groups - Participants and Delegates.

The Protection Working Group had 11 Delegates, basically administrators, and represented:

- State Forestry Organizations - 4
- BLM - 4
- National Park Service - 1
- University (wildlife) - 1
- Private woodland owner - 1

NOTE: The absence of USFS and Research representation (Dick Parmeter was Secretary to the Working Group).

The Participants to the Protection Group included 16 people distributed as follows:

- USFS - NFS - 4
- USFS - Research - 1 (Callaham)
- State Forestry - 1
- State Ag. Experiment Station - 1
- Pest Action Groups, etc. - 2
- University - 3
- Forest Industry - 1
- SAF - 2
- Environmentalists - 1

Both audiences were basically similar although the Participants perhaps had closer relations to the field while Delegates tended to be heavy on the Administrator type.

These groups examined and ranked, 579 problem statements in 19 subject areas. The subject areas were rated in importance as shown in Table 1.

These two groups, with only slight diversity in background and present responsibilities produced only slightly different priorities for the broad subject areas.

However, when asked to rank the 579 individual problems, as expressed in 1 sentence statements written, for the most part, by scientists, wide divergence in the 2 prioritized lists developed. Based on the number of problems that were ranked in the top 100 the subject area rankings are shown in Table 2.

Note now that 11 of the 19 are ranked significantly different, where only 4 were different on the earlier list.

Why the difference? Language and multiplicity of choice were the only difference between the listings (no difference in what was given to each group however).

Let's examine one more level before I get into my main thesis. The rankings of individual problems, regardless of area, indicates extreme divergence between the 2 groups. If the 100 top-priority problems only 1 was ranked in the same spot by both delegate and participant groups: "Emphasize policy goal specifications and data requirements before data collection" was number 1 on both lists. From that point on there is very little correlation. Some examples are:

Participant rank 2 was ranked 102 by delegates.

Delegate rank 2 was ranked lower than 100 by participants.

Delegate rank 20 was ranked 87 by participants.

Participant rank 20 was ranked 48 by delegates.

Participant rank 50 was ranked lower than 100 by delegates.

Delegate rank 50 was ranked lower than 100 by participants.

Without belaboring the point, two problem statements are germane to this discussion. Problem statement #327 "Incorporating new and existing research information into practical pest management programs," was ranked 4th and statement number 621, "Methods of transferring research results to diverse environments and management conditions" was ranked 7th - by the Delegates. Score one for Technology Transfer!? Wait a moment - the Participants ranked them 52 and 167 respectively!

Technology transfer is recognized as a legitimate need? By whom? Yes, there is someone out there to listen and yes - you had better watch your language or they won't hear what you thought you said.

To make one more reference to NPRF the Work Group for Protection gave the problem cited above, "Incorporating new and existing research information into practical pest management programs," the highest ranking of all the problems listed for insect, disease, and fire research. The mandate is clear - our research results need to be translated into healthier forests on the ground.

The problem is clear - the potential user hears what he expects to hear - not necessarily what you said.

What now? Yes, someone is out there listening! What they hear depends on the languages used for the intercourse. Jargon - my dictionary says it is "the technical or specialized vocabulary or phraseology used among themselves by the members of a particular profession, sect or similarly restricted group" but this is listed as the third definition. Before you nod your heads in wise agreement realize that the first definition is "confused, unintelligible speech; gibberish!"

Unfortunately the scientific research worker (knowledge producer) belongs to sect apart from the practicing forester (knowledge user). Each has its own jargon and intercourse between jargons results in unintelligible gibberish. Productive developments are stillborn.

Speaking of jargon - before today I considered myself as one of those who simply tried to explain research results to practicing foresters or even to landowners in order to grow healthy forests. Now - if you look at your program, you know that I am a linker in the transfer of technology. I didn't know I was even joining a new profession. I am not sure I want to pay that price. So - depending on the current language I and people with similar jobs can be called a linker. What is that? Research says why don't they use my neat discoveries and have healthy forests. The field says why don't they give me answers to my problems instead of wasting time on that research stuff. Does that sound familiar - or only half of it? Well the linker is the guy in the middle that hears both. The linker recognizes that neither side is hearing and tries to correct that situation any way he can.

How to break down these communication barriers? Many agencies, in fact most, have created special offices or units for this purpose. They go by various titles from the now out-moded public-relations, liaison, information and education and now technology transfer. From where I stand most of these efforts suffer from the same problem - staffed by communication experts or professionals they soon develop a jargon of their own aimed at their perceived public. Seldom is that public the professional field forester and the jargon is seldom that of either of the two groups with whom we are concerned. Do not misunderstand - many of these efforts are first rate and highly worthwhile. They meet their own objectives. My point is that too frequently the problem being discussed here requires different objectives that the interposition of a third jargon cannot meet.

Watch your language! With apologies to the Canadian Civil Servants here today - not many of us, researchers or foresters, are even bilingual, never mind multilingual to a degree where two-way communication can occur. When faces with a foreign language problem what do you do? You may ignore it and go on about your business wondering when that so and so will ever learn English. You might seek a translator and get one who comprehends both but can only speak a third. Ideally you will find a translator who can communicate in both.

At the risk of falling into the trap I baited earlier I see my job as a translator. I don't know if I do a good job or not but I try to prevent that stillborn gibberish. A linker in the transfer of technology? Maybe but really nothing but a procurer who tries to ensure fruitful intercourse between two groups of people who have certain inherent differences but who desperately need each other and are separated by their jargon.

Models of communication techniques, knowledge utilization, computer acronyms are fine but I wouldn't want my forester to marry one (even under the equal opportunity regulations). The best model I know of, the most effective tool that we have is to get Frank Hawksworth and a working forester leaning up against the same mistletoe infected tree; get Gordie Wallis and a field forester digging at the roots of the same tree. That's communication. They might not read Forest Science or Phytopathology but they can understand talk from a man with dirty hands.

Let's go back to NPRF again. One group (delegates) rated technology transfer in I&D as the highest priority within I&D and approximately 7th in overall forest research problems. I submit that this subject, Technology Transfer is not a forest pathology or entomology research problem. It is a problem for pathology researchers. Equally it is a problem of the research user. Technology transfer may be a responsibility of a research person but it is not that person's primary responsibility. That is to produce knowledge. Forestry, in the United States at least, has many people whose job presumably is the transfer of that knowledge. The USFS Regional or Area Forest Insect and Disease Management units should have initial primary responsibility - internally and externally through their charged state and private activities. State forestry organizations and extension services are next in line.

For a field forester to cry "I can't understand the research results" is unfortunate but understandable. For him to make that complaint to the researcher is unforgivable and generally unproductive. He should know where to go to obtain the necessary translation.

Those translators or technology transfer specialists, or linkers or procurers (or many other names that might come to mind) are most often hiding somewhere doing other things - often producing more duplicate data or other jargons and thereby creating more confusion and conflict.

We don't need more research on technology transfer. We need people assigned and directed to that area who are committed to a partnership between the research producer and the user.

TABLE 1

| Participant Importance Rating | Subject Area | Delegate Importance Rating |
|---|---|---|
| 1 | -Multi Resource Inventory and Appraisal | 2 |
| 9 | -Alternative Uses of Land | 9 |
| 5 | -Multiple Use Potential and Evaluation | 6 |
| 2 | -Biology, Culture and Management of Forests and Timber Related Crops | 3 |
| 15 | -Genetics and Breeding | 15 |
| * 6 | -Timber Production Economics | 12 |
| **10 | -Insect Control | 11 |
| **13 | -Disease | 14 |
| **18 | -Fire | 17 |
| * 14 | -Harvesting and Engineering Systems | 10 |
| 17 | -Properties, Processing and Protection of Wood | 19 |
| 16 | -Economics and Marketing of Wood Products | 16 |
| * 4 | -Watershed Protection and Management | * 1 |
| 7 | -Soil, Plant, Water and Nutrient Relationships | 8 |
| 8 | -Alleviation of Soil Water and Air Pollution | 7 |
| * 11 | -Range Resource Management | 5 |
| 3 | -Wildlife and Fish Habitat | 4 |
| 12 | -Outdoor Recreation | 13 |
| 19 | -Rural and Urban Environmental Enhancement | 18 |

*Subject areas that differed by two or more in the rating.

**Of special interest - Disease is considered low importance but have sympathy for our friends in fire research. Insect research is only slightly higher than disease research.

TABLE 2

| Participant Importance Rating | Subject Area | Delegate Importance Rating |
|---|---|---|
| 2 | -Appraisal | 1 |
| 1 | -Biology | *4 |
| 4 | -Wildlife | *7 |
| 7 | -Watersheds | *2 |
| 5 | -Evaluation | 5 |
| 3 | -Economics | *8 |
| 6 | -Soils | *0 |
| 7 | -Pollution | *9 |
| 4 | -Alternate Uses | *9 |
| 5 | -Insects | *3 |
| 8 | -Range | *5 |
| 6 | -Recreation | 6 |
| 4 | -Disease | *7 |
| 0 | -Harvesting | *8 |
| 0 | -Genetics | 0 |
| 0 | -Marketing | 0 |
| 0 | -Processing | 0 |
| 0 | -Fire | 0 |
| 0 | -Environmental Values | 0 |

*Areas that differ by more than two rank positions

# Panel: Computer Programming as a Tool for Disease Management

W. J. Bloomberg, Moderator

## INTRODUCTION, W. J. Bloomberg

I think it is fair to say that the computer has come of age in biological research. The naive claims that computers would solve all problems have been replaced by a more realistic view that they are just another tool, albeit powerful, at the researcher's disposal. With specific reference to forest pathology, computers have increased by a magnitude our capabilities in the following applications:

1. Statistical analyses. Our acquisition and analysis of data is no longer rigidly bound by the limitations of desk and hand calculators. We can explore interesting relationships at will.

2. Data banks. Voluminous data, painstakingly gathered over long periods can be organized for instant retrieval and analysis rather than allowed to molder in files because of the interminable job of compiling it by hand.

3. Surveys. Survey methodology and analysis can be developed rapidly and flexibly through the computer. Preliminary testing of sampling plans by computer simulation can replace some of the costly and time-consuming field trials.

4. Models. Modelling is a-tracting great attention in forest pathology because it offers the opportunity of integrating into a single solution the many and varied factors that enter into forest pathology problems. Because of this interest, I would like to expand some ideas about models.

### Model Types

Models may be of the conceptual (hypothetical) type, used for research planning and education, or empirical, used for research evaluation and research application. Research planning models are appropriate for new projects or project proposals, evaluation models for "middle-aged" projects, and application models for "mature", or sometimes "overmature" projects. The role of models in new projects is to identify critical relationships and to order research task priorities. Model development will typically require 1-2 years. In middle-aged projects, sufficient data has been collected to construct a framework model in order to ascertain what further research needs to be done. Suggested development period for such models is 3-5 years. Mature projects are characterized by large data and experience resources enabling fairly complete models to be built and applied. Completion period for such models would be 2-3 years.

## Model Complexity

Complexity, or resolution, of a forest disease model should be determined forest management needs. High resolution models are characterized by small reporting units, e.g. a single tree, or a part of a tree, short reporting periods, e.g. 1-30 days, usually a maximum of one year, detailed parameters, many mechanisms resolved and a narrow interface with the forest management context. Examples of high resolution models are Strand's dwarf mistletoe model and Bloomberg's nursery disease model. Low resolution models have large reporting units e.g. a stand or watershed, long reporting periods e.g. 5-10 years, broad parameters, relatively few mechanisms resolved and a broad interface with the forest management context. An example is Meyers et al's LPMIST. Medium resolution models have both high and low resolution features e.g. Myers et al's SWYLD2. One disease problem may be usefully modelled at two or more resolution levels providing the models are complementary.

## Future of Forest Disease Modelling

It is safe to predict that modelling will become progressively incorporated into forest disease research as have statistical analysis and other numerical methods. Probably, models will become more modular, structured, and available to researchers through cookbooks and canned programs. Like other major scientific tools, modelling will modify research orientation e.g. by priorizing research on critical relationships rather than on classical factorial experiments.

# SIMULATION YIELD PROGRAMS: A TOOL FOR THE FOREST LAND MANAGER IN DEVELOPING SILVICULTURAL TREATMENTS FOR LODGEPOLE PINE STANDS AFFECTED BY DWARF MISTLETOE AND COMANDRA BLISTER RUST

David W. Johnson

## Scope of the Problem in the Rocky Mountain Region

Dwarf Mistletoe, *Arceuthobium americanum* Nutt. ex. Engelm., and comandra blister rust, *Cronartium comandrae* Pk., are two of the most important disease problems in lodgepole pine stands in the Rocky Mountain Region. Lodgepole pine dwarf mistletoe has infested an estimated 50 percent of all the commercial lodgepole pine forest in the Region. The disease is most damaging in partial cut stands where dwarf mistletoe was disregarded when harvesting stands. Infected residual trees have provided for additional spread and intensification of the disease. Heavily infested stands have about half the volume and twice the mortality rate of non-infested stands on comparable sites. A comparison of estimated acreages infested by size classes for the Bighorn, Shoshone and Medicine Bow National Forests is shown in Table 1. This provides some scope to the problem in this Region. The major impacts of the disease are growth loss and mortality.

Comandra blister rust has also been observed throughout much of the lodgepole pine t-pe in the Region, especially in stands over 80 years old. The exact distribution of the disease is unknown. Data from sample plots established by Peterson (1962) and Krebill (1965) in the Bighorn and Shoshone National Forests, indicates that approximately 25 percent of living and dead lodgepole were infected with rust.

Current disease impact consists primarily of spike tops, growth loss and mortality in pole- to sawtimber-size trees. Data collected by Brown (1977) from 49 temporary plots established in the Bighorn, Medicine Bow and Shoshone National Forests in 1975 and 1976, show a considerable range of rust incidence (Table 2). These plots did not necessarily represent the average condition of lodgepole pine stands in these Forests, but a range of stand conditions in sampled rust infected stands.

The greatest concentration of rust incidence and damage to lodgepole pine in the Region has been observed along the northside of the Upper Wind River Drainage in the Shoshone National Forest in western Wyoming. The dilema now facing the land manager, particularly for the Wind River District, is what to do with rust infested stands.

TABLE 1 ESTIMATES OF COMMERCIAL ACREAGES OF LODGEPOLE PINE INFESTED WITH DWARF MISTLETOE. R-2.

| NATIONAL FOREST | SIZE CLASS | TOTAL ACRES | % INFESTED WITH DWARF MISTLETOE |
|---|---|---|---|
| BIGHORN | Sawtimber | 136,000 | 40 |
| | Pole | 113,000 | 16 |
| | Seedling - sapling | 51,000 | 10 |
| SHOSHONE | Sawtimber | 74,000 | 58 |
| | Pole | 84,000 | 24 |
| | Seedling - sapling | 1/ | 1/ |
| MEDICINE BOW | Sawtimber | 209,000 | 76 |
| | Pole | 95,000 | 55 |
| | Seedling - sapling | 64,000 | 37 |

1/ Figures not available.

TABLE 2 SUMMARY OF 49 COMANDRA RUST STUDY PLOTS IN WYOMING: [1]

| SIZE CLASS | DIAMETER RANGE | CRR | DMR |
|---|---|---|---|
| Seedling - Sapling | 1.4 - 4.9 | 0.2 - 1.4 | 0 - 4.9 |
| Pole | 5.0 - 8.9 | 0.1 - 3.1 | 0 - 5.3 |
| Sawtimber | 9.1 - 13.1 | 0.4 - 2.1 | 0 - 4.4 |

1/ Range in values given for plots in various size classes.

Management Opportunities

Even though practical methods of control for comandra rust are not available, damage can be reduced. Low incidence of the rust, particularly in dense stands results in a light thinning. Timber cutting should be conducted first in the more heavily infested stands where in some cases stand removal and replacement may be the only option. The inventory of heavily damaged stands should be converted as rapidly as possible to productive stands. More management opportunities are available for light to moderately infected stands. In the case of intermediate cuts or thinnings as many trees as possible with stem cankers and spike tops should be removed without reducing the stands below recommended basal areas. In any case the most heavily infected or seriously damaged trees should be removed first.

Dwarf mistletoe, in contrast to the current rust problem, continues to intensify in infested stands and therefore must be handled differently. Dwarf mistletoe control is practiced widely in the Region. Recently published silvicultural guidelines offer the land manager a range of control alternatives (Dooling and Brown 1976).

The land manager now has a tool available in the recently developed simulation yield programs to aid him in making management decisions for stands under consideration. These programs produce a printout of a management scheme including intermediate cuts and final harvest showing yield projections, based on current stand conditions. The projections can be varied by altering the input data to achieve different management objectives. The land manager then selects the scheme that best fits his management goals and restraints for a particular stand. The newest program, RMYLD, is a composite of what were separate programs for ponderosa pine, lodgepole pine and Engelmann spruce - subalpine fir (Edminster 1978). The lodgepole pine subroutine of RMYLD has been modified to include the effects of dwarf mistletoe and will be modified for the effects of comandra rust on lodgepole pine yield. The program should be available sometime in 1978.

The user of RMYLD must indicate, in the required data inputs, the tree species and for lodgepole pine the presence or absence of dwarf mistletoe and comandra rust. The disease input values are average estimates of the incidence and intensity of each disease for the stand. These estimates are obtained from individual tree ratings using a numerical rating scheme for each disease. These schemes, called dwarf mistletoe rating (DMR) (Hawksworth 1978) and comandra rust rating (CRR) (Brown 1977) are explained in Figures 1 and 2.

The two rating schemes are intended for pole size and larger trees. Trees can be rated and values recorded during stand examinations or surveys (Johnson and Minnemeyer 1977). Yield projections for infected stands are then used to evaluate treatment feasibility and priorities.

INSTRUCTIONS

STEP 1. Divide live crown into thirds.

STEP 2. Rate each third separately. Each third should be given a rating of 0, 1 or 2 as described below:

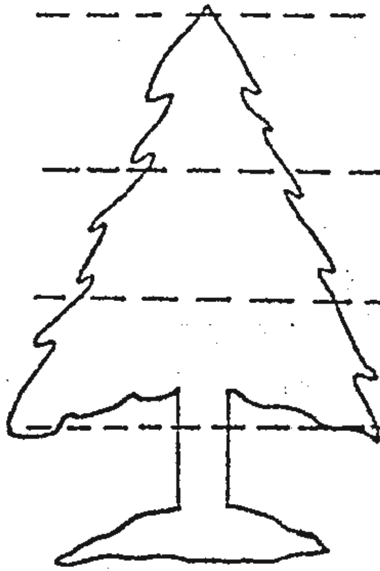
0 No visible infections

1 Light infection (½ or less of total number of branches in the third infected.)

2 Heavy infection (more than ½ of total number of branches in the third infected).

STEP 3. Finally, add ratings of thirds to obtain rating for total tree.

EXAMPLE



If this third has no visible infections, its' rating is 0

If this third is lightly infected, its' rating is 1

If this third is heavily infected, its' rating is 2

The tree in this example will receive a total rating of 3

RATING SCALE: 0 - 6

FIGURE 2 Comandra Rust Rating (CRR) System

INSTRUCTIONS

STEP 1. Divide crown (live & dead portions) into thirds

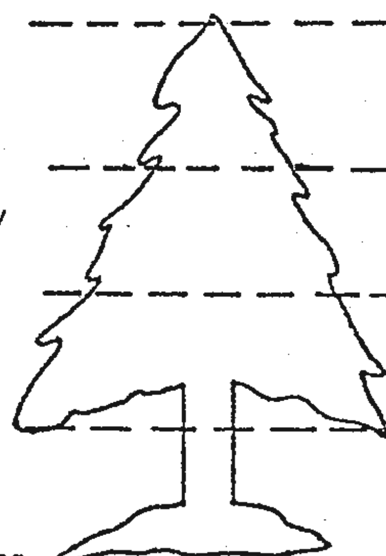
STEP 2. Rate each third separately using only the most serious canker in any third according to the following values:

| crown third | non-girdling stem canker | girdling stem canker |
|---|---|---|
| upper | 1 | 2 |
| middle | 2 | 4 |
| lower | 4 | 8 |

When more than one girdling canker occurs on a tree, rate only the lowest one. Cankers located below the live crown are rated the same as the lower third.

STEP 3. Total the ratings for the entire tree.

EXAMPLE



If this third has no visible infection; its' rating is 0

If this third has a girdling stem canker its' rating is 4

If this third has a non-girdling stem canker, its' rating is 4

The tree in this example will receive a total rating of 8

RATING SCALE: 0 - 8

Similar rating schemes could be developed for other major insect and disease pests. These would provide valuable tools for land managers in assessing damage.

One important difference between dwarf mistletoe and comandra rust in these stands at the present time is that the former continues to intensify over time through new infections whereas the latter does not, to our knowledge. One feature then not automatically included in the projection of yield for rust infected stands is the prediction and projected effect of new infections. The user of the modified RMYLD program then must indicate the occurrence of new infections if and when they occur in order to determine their effect on yield. The yield projections, in each case, show how management practices can minimize impact by slowing disease intensification in the case of dwarf mistletoe and slowing stand deterioration in the case of comandra rust.

When applying a management option from RMYLD to an actual stand where tree cutting is anticipated, the leave trees should be carefully selected. A list of criteria for leave tree selection, in decreasing order of desirability, is shown in Figure 3. Obviously the most desirable leave trees are those that are disease-free or only lightly infected. If it is necessary to leave infected trees to maintain adequate stocking select those less seriously damaged from rust, instead of dwarf mistletoe infected trees.

## Future Needs

Yield projections from RMYLD need to be verified for rust infected stands. Advantage could be taken of proposed thinning projects in an infected area and make measurements before and after treatment.

Additional information is needed on growth dynamics of the rust within individual tree crowns. The current program includes volume reduction in the existing dead, spike tops. The program will account for spread of the rust down the trunk and also for non-girdling cankers that become lethal. Volume loss resulting from the deat top will then be subtracted from total tree volume. Effects of the rust on tree height and stem diameter needs further investigation.

In stands affected by both diseases, the rate of deterioration may be greater than stands affected by only one of the diseases. Additional field work is needed to study the interaction and possible synergistic effects of these diseases.

FIGURE 3 SUGGESTED CRITERIA FOR LEAVE TREE SELECTION IN COMANDRA RUST AND DWARF MISTLETOE INFESTED LODGEPOLE PINE STANDS

| TREE CONDITION | LEAVE TREE PREFERENCE |
| --- | --- |
| 1. Apparently disease free | Most desirable |
| 2. DMR of 2 or less (no rust) | ↑ |
| 3. Non-girdling rust canker - CRR of 2 or less (no mistletoe)<br>a. $<$ ½ around circumference<br>b. $>$ ½ around circumference | |
| 4. Girdling stem canker - CRR of 4 or less (no mistletoe)<br>a. upper 3rd<br>b. middle 3rd | |
| 5. Spike top - CRR of 4 or less (no mistletoe)<br>a. $>$ ½ live crown<br>b. $<$ ½ live crown | |
| 6. Cankers in lower 3rd or less than 10' of live crown remaining | |
| 7. Multiple stem cankers | ↓ |
| 8. Any rust and DM combination | Least desirable |

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# YIELD SIMULATIONS IN DWARF MISTLETOE-INFESTED STANDS

F. G. Hawksworth

Yield simulation techniques can be very useful to forest managers and I think that greater emphasis on their development will be evident in the near future. For today, I'd like to discuss these topics.

I. Comparison of various t-pes of simulation approaches.

II. Operational yield simulation models for mistletoe-infested stands.

III. Application of mistletoe-yield models.

IV. Where we go from here.

## I. Comparison of Various Types of Simulation Approaches

Two principal lines of investigation relation to forest pests are underway: (1) analyses that emphasize pest population and spread and, (2) analyses that emphasize effects of pests on host populations. Both types of effort are underway in both forest pathology and forest entomology in the West. A recent symposium on modeling for pest management provides a good up-to-date summary of the subject (Tummala, Haynes and Croft, 1976).

### 1. Analyses that emphasize pest populations

For these types of analyses, quantitative information is obtained on various factors of the life cycle of the pest organism and its association with its host. Numerous studies using the life table technique have been conducted for forest insects. Harcourt (1969) presents a good review of the development and use of life tables in the study of insect populations. Some notable examples of this technique for forest pests include:

Mountain pine beetle (*Dendroctonus ponderosae)* Knight 1959, Cole 1974.

Needle miner (*Recurvaria starki*) Stark 1952.

Spruce budworm (*Choristoneura fumiferana*) Morris 1955.

Pine sawflies (*Neodiprion fulviceps*) Dahlsten 1967.

Dwarf mistletoes (*Arceuthobium americanum* and *A. vaginatum*) Hawksworth 1965.

Another excellent example in forest pathology is the recent study by Strand and Roth (1976) on a simulation model for spread and intensification of western dwarf mistletoe in thinned stands of ponderosa pine saplings. This model estimates misteltoe intensity in evenly spaced trees of uniform height. Because of these limitations, the model is presently of limited utility, but the development of this model is a milestone in forest pathology as it presents one of the first successful simulations of a forest disease organism. Recently Dixon (1977) has developed a spread model for ponderosa pine dwarf mistletoe in the Southwest and the Rocky Mountains. Much work is presently underway to qualify mountain pine beetle - lodgepole pine interactions (Amman 1976, Anderson et al. 1976, Berryman 1976, Cole 1974, Cole et al 1976).

Berryman (1974, 1976) recently published excellent papers on the efforts to construct a general productivity model for bark beetles. This work dealt mostly with *Scolytus ventrales* on *Abies* but includes comparative studies of other bark beetles. Research to date has given a preliminary model of bark beetle productivity within infested trees. The eventual synthesis of a general population model will require information on insect migration from trees to newly attacked trees, but such data are not yet available. As Berryman (1974) notes, practical application of population models to pest management problems must await integration of productivity and migration submodels.

In theory these would be the most logical types of analyses as they involve detailed studies of the parasite and host. In practice, however, because of the extreme complexity of the parasite-host-environment interactions, none of these models have yet been developed to the state where they can be effectively used to simulate effects of the parasite on host populations.

2. Analyses that emphasize effects of the pest on host populations.

For these types of analyses, quantitative information is developed on the effects of the pest organism on growth and mortality of the host populations. This still involves comprehensive knowledge of the pest organism (as in the previous types) but emphasis is on quantitative effects of the pest on diameter growth, height growth, and mortality, and how fast the pest spreads and intensified in relation to various stand parameters (d.b.h., density, age, site, etc.).

A major modeling effort of this type is underway with the tussock moth (Bergstrom 1977). This model, which should be operational in 1978, consists of three principal submodels - a stand prognosis model, a stand outbreak model and a socioeconomic model.

## II. Operational Yield Simulation Models for Mistletoe-Infested Stands

For dwarf mistletoe studies, two general approaches can be used for this type of studies, depending primarily on the types of stands being investigated. For even-aged or two-storied stands of a single species, parameters based on stand averages are useful. This is the method that we have used for lodgepole pine and ponderosa pine (Myers et al. 1971, Myers et al. 1976). However, data based on stand averages are not adequate to describe stands of uneven age structures or of mixed species. For these, much more complicated techniques are involved which include projection based on individual trees or tree classes. Because stand models are so complex, none of them are yet operational, even for non-diseased stands. The model that seems to be closest to reality is that by Stage (1973, 1975) for mixed conifers in the Inland Empire. Ed Wicker is working with Al Stage in developing dwarf mistletoe loss data that will be incorporated into the growth model when it becomes operational.

Since our programs for dwarf-mistletoe infested stands are the only ones operational to date, I'll discuss them in some detail. Our first attempt was to develop yield simulation for even-aged lodgepole pine stands in the central Rocky Mountains - LPMIST (Myers et al. 1971). We then developed a similar model for even-aged ponderosa pine in the Southwest - SWYLD (Myers et al. 1972). The latter was then expanded to include two-storied as well as even-aged stands - SWYLD (Myers et al. 1976, Fletcher 1976, Edminster and Hawksworth 1976). These models have now been incorporated into a single model for several Rocky Mountain conifers - RMYIELD which will be published soon by the Rocky Mountain Station (Edminster 1978).

I think that an important point in developing yield simulations for stands is that the forest pathologist should not attempt to "go it alone". Day-to-day cooperation with forest mensurationists, modelers, and silviculturists is essential. In our case, mensurationists had been constructing yield simulation for "healthy" stands for some time before we got into the act. It was thus relatively simple to adjust various effects due to disease; for example, to quantify how mistletoe affects height growth, diameter growth, and mortality in relation to stand factors previously used to quantify growth in healthy stands (e.g., site index, density, d.b.h., tree age, etc.).

## III. Application of Mistletoe-Yield Models

Use of these yield simulation procedures is relatively simple and the kind of information needed is generally of the type that is normally acquired in forest surveys or inventories:

1. Site index.
2. Number of stems per acre.
3. Average d.b.h.
4. Average stand age.
5. Mistletoe situation (percent of trees infected, average mistletoe rating, or percent of the stand infested).
6. The forest manager's plans for the area, including t-pe of product (maximum cubic foot vs. board foot production), thinning levels, thinning frequency, rotation age.

If the two-aged situation is being analyzed, data for items 1-5 are needed for each story.

The following brief example will explain how the system can be applied. I've only chosen an extremely simple case here as Jim Walters will discuss some actual cases later.

An example will show how these techniques might be applied to a lodgepole pine stand 50 years old that is heavily infected by dwarf mistletoe, (stand average DMR = 4.0 on site 50). Let us compare the expected yields if:

1. Nothing is done to the stand, or
2. The stand is salvaged now and a new, healthy stand is regenerated.

Figure 1 shows the expected merchantable cubic foot yields under the two alternatives. If nothing is done to the stand, the present 1,000 cubic feet per acre will increase to about 1,600 cubic feet per acre in about 30 years, and then decline as mortality due to mistletoe takes its toll. On the other hand, if the present stand is salvaged and a new stand regenerated, there will be a progressive increase in volume. The yields in the new stand will surpass those from the untreated stand after about 50 years. After 100 years, yields in the new stand will be about 4,500 cubic feet per acre, or six times that in the untreated stand, even though it is 50 years younger.

These simple examples are based on just two options for this stand. We could make the same type of analyses for cubic foot or board foot yields for many other combinations of thinning levels, thinning frequencies, and rotation ages. Also, by use of the system, infected and uninfected stands can be compared to determine the potential growth rates of the site and to help the forest manager to decide where thinning or pest control funds might be spent most efficiently.

## IV. Summary and Where Do We Go From Here

Operational programs have been developed for mistletoe-infested even aged lodgepole pine stands in the Rocky Mountain - LPMIST. The program is being used in the Rocky Mountain Region (Colorado and Wyoming) to evaluate the benefits of all proposed thinnings whether mistletoe is present in the stand or not. Also utility of the program is being evaluated for lodgepole pine stands in the Northern Rockies and in the Intermountain Region and in Central British Columbia. The similar program for infested ponderosa pine stands - SWYLD-2, which can handle two-storied as well as even-aged stands, is used throughout the Southwest where more than 200 stands totalling 35,000 acres have been analyzed by the U.S. Forest Service and the Forestry Office of the Bureau of Indian Affairs. Also the Colorado State Forest Service has made extensive use of the SWYLD-2 in their development of forest management plans for private land owners.

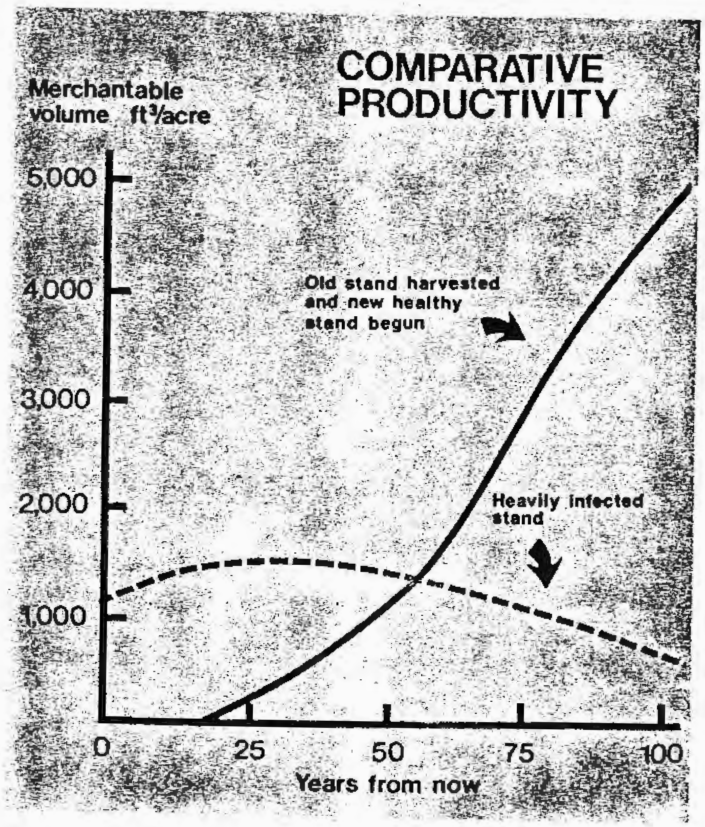


Figure 1. Comparative merchantable yields expected in (1) a heavily infested 50-year old lodgepole pine stand and (2) if the stand was harvested and a new healthy stand begun.

I think the knowledge is now available to extend yield simulation techniques to other pests. Dave Johnson will discuss an extension of these techniques to lodgepole pine stands affected by comandra blister rust. And, judging by our experience with the mistletoe simulation programs, I'd say that not only would they be useful, but more importantly, they would be used.

Yield simulations will doubtless become more accurate as more sophisticated techniques and more actual loss data become available.

A beauty of computer techniques is that it is a simple matter to insert a new card when a better equation becomes available, and the programs can be, and are being, continually updated. In order to test the reliability of the predications, a series of permanent plots in both lodgepole pine (in Colorado) and ponderosa pine (in Arizona and Colorado) have been established in healthy and mistletoe-infected stands. Periodic growth measurements from these plots will be used to refine growth and disease effects equations as needed. As of now, it seems that our loss data is pretty close to the actual situation, at least some people think we are over-estimating losses and some think that we are underestimating them, so perhaps we are in the right ballpark.

One admitted weakness of our simulations is that they are based on growth in healthy stands adjusted for effects of the parasite. Ideally, it would have been better to develop separate equations for diseased stands, but the great amount of field work needed precluded our going that route initially. Eventually, I see the day when it will be possible to incorporate "pathogen" models, such as Mary Ann Strand's, with "growth effects" models for yield simulations of progressively more accuracy and usefulness.

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# COMPUTER APPLICATIONS TO *PHELLINUS* ROOT ROT RESEARCH

W. J. Bloomberg

In this paper, I would like to amplify some allusions I made in my opening remarks to the role of computer programming with specific reference to *Phellinus* root rot research.

## Data Banks

At PFRC we have assembled records on over 20,000 trees, covering an examination period up to 40 years, documenting the development of *Phellinus* root rot. The records, obtained from several sources, have been reduced to a common format, and stored on magnetic tape. Retrieval and analysis programs have been written to allow immediate inspection of any record, and to carry out standard summarization and statistical analyses on any subsets of the records. The objective is to predict *Phellinus* impact using an analytical approach. Some examples shown here are changes in causes of mortality in a Douglas-fir plantation between ages 17 and 22 years, d.b.h. distribution of healthy and root rot trees in an 18 year old plantation and development of root rot symptoms in a plantation over an 8 year period.

## Survey Methodology

Survey methods for estimating *Phellinus* root rot centers in stands were developed by testing the ruggedness of sampling designs on simulated field situations including a wide range of center sizes, shapes, orientations and distributions. Designs which passed the tests of accuracy and precision were subjected to field testing. Data analysis and survey reporting have been computerized.

## Disease Modelling

The purpose of modelling *Phellinus* root rot is to take a dynamic approach to impact prediction and to test management strategies. The *Phellinus* research falls into the middle-aged category and has produced much data on inoculum sources, infection and root destruction, some data on disease spread and limited data on growth impact. Sufficient data is available for the construction of a framework model comprising stand creation, primary inoculum distribution, root distribution, contact probability, fungus spread, root destruction and impact. The model is of medium resolution, with the individual tree as the reporting unit, and 5 years as the reporting period. Interfacing with management contexts is through site preparation, planting, spacing and thinning.

The modelling approach indicated the following areas for further data collection: correlation of root destruction and growth reduction, root distribution and distribution of primary inoculum (old stumps). Several impact indicators have been examined, the most promising being height growth related to diameter, or height:diameter ratio. Amount of root decayed correlated best with this indicator. Root distribution has been examined by hydraulically-excavating root systems. The alternatives of describing the root systems as a canopy, or as a collection of individual roots are being examined. A correlation has been observed between ring width and the decay of individual roots.

# APPLICATION OF THE SIMULATED YIELD PROGRAM SWYLD2 IN THE SOUTHWEST

J. W. Walters

## I. Current Status of the SWYLD2 Program in the Southwest - Arizona and New Mexico

The simulated yield program SWYLD2 (Myers et al. 1976; Edminster and Hawksworth 1976) is currently being used in Region 3 to aid land managers in quantifying timber volume losses caused by southwestern dwarf mistletoe (*Arceuthobium vaginatum* subsp. *cryptopodum*). Quantification of mistletoe-caused volume loss often provides justification for intensive management of infested stands. The SWYLD2 program is also useful in ascertaining that dwarf mistletoe is a problem in a particular stand. A less frequent use for the simulated yield program involves application in recreation areas where dwarf mistletoe is present. Simulating growth and mortality of infected trees aids the recreational land manager in determining the time frame associated with deterioration of the forest canopy. Thus, alternative management schemes can be devised before the problem develops into an undesirable situation.

A start on implementing the SWYLD2 program in Region 3 was initiated in 1975. Since that time, over 35,000 acres of mistletoe-infested ponderosa pine have been surveyed for input in the SWYLD2 program. Surveys have been completed on 18 Ranger Districts and 1 Indian Reservation. Over the past 3 years, our survey procedure for collecting data to input in SWYLD2 has been refined and modified. Due to numerous modifications in 1975 and 1976 surveys, only the current procedure will be discussed at this time. In 1977, the following basic procedure was used for data collection:

Sample points were located on a 10x10-chain grid throughout the survey area. Fixed and variable radius plots (B.A.F.) were established at each sample point. The sample consisted of all live trees 4.5 feet tall to 5.9 inches d.b.h. on the fixed plot and live tally trees 6.0 inches d.b.h. and larger on the B.A.F. plot. Presence or absence of dwarf mistletoe and d.b.h. were recorded for all sample trees. A sketch map of plot locations was made during the survey for later use in showing dwarf mistletoe distribution. A specified number of age and height measurements was taken to estimate site index. Age and height measurements were also taken from a specified number of codominant or dominant trees in each story of the stand. These measurements represent average story age and height. Data were recorded on forms specifically designed for rapid transfer of information into a computer summary program.

Field data were then processed through the SWSUMMARY computer program. This program was designed to accomodate data from the previously outlined survey. SWSUMMARY prepares stand summary tables and calculates SWYLD2 stand condition variables from survey data. The program also summarizes age and height information for three sets of selected trees. These selected trees represent (1) maximum site potential of the stand, (2) average age and height of overstory dominant and codominant trees, and (3) average age and height of understory "dominant" and "codominant" trees. The summary tables are useful in determining SWYLD2 management options, and theprogram lists SWYLD2 stand condition variables.

Input in SWSUMMARY is entered conversationally and by use of a mass-storage file. The file is built prior to running the program. SWSUMMARY may also be run on a batch mode with keypunched data cards. Utilizing results of SWSUMMARY, SWYLD2 input variables are developed and simulations are made. From the simulations, a management plan, emphasizing control of dwarf mistletoe, can be developed and implemented.

A cost analysis was made for the eight survey areas completed in 1977. Cost estimates are based on a field crew of two forestry technicians (i.e., $4/hr.) working 40 hours per week. Average cost, including travel time from Ranger District office to survey area, was 30¢ per acre. Pure survey cost, excluding travel to the survey area, averaged 23¢ per acre. In 1978, we anticipate reducing the grid interval from 10x10 chains to a closer spacing, dependent on size of the survey area. A closer plot interval will be used in smaller stands. The reduction will cause survey cost to increase. However, we estimate that even at a 4-chain interval, survey cost will not exceed 75¢ per acre. The range in survey cost from 23¢ to 75¢ per acre appears reasonable for use of an intensive forest management tool.

## II. Problem Areas in the SWYLD2 Implementation Program

During the implementation of SWYLD2 in Region 3, we have encountered various problem areas. A brief synopsis of the major difficulties follows.

### A. Survey and Data Collection Area

1. The SWYLD2 program is suitable for use in stands composed of at least 90 percent ponderosa pine. Other commercial species (i.e., white fir, Douglas-fir, and southwestern white pine) may account for the remaining 10 percent of the stand. Using this guideline, variation in growth and volume predictions is considered minimal in most stands. Also, bias in estimating dwarf mistletoe levels is relatively minor.

The basic problem rests in stands where non-commercial species are prevalent. Gambel oak and various juniper species often occur in combination with ponderosa pine. The effect of these trees on ponderosa pine can be significant due to competition. Since growth and mortality equations are not currently available for these species, they cannot be incorporated into the SWYLD2 program. In addition, the physical structure of these species precludes them from any similarity to ponderosa pine in volume production. At present, stands with substantial amounts of basal area (10-20%) in non-commercial species are essentially avoided when survey areas are selected. Since these types of stands are very common in the Southwest, this appears to be a poor alternative.

2. A second problem in this area invólves definition of an even-aged versus a two-storied stand. By definition, an even-aged stand is composed of trees exhibiting a unimofal diameter distribution. A two-storied stand then has a bimodal distribution. In the Southwest, two-storied stands are managed under a management age class system. This system results in selection of two or more age classes or diameter groups to be featured in management. In relating this system to the SWYLD2 program, an arbitrary decision often results in division of the stand into overstory and understory. For example, overstory may be defined as all trees 9.0 inches d.b.h. and larger, with understory being all trees less than 9.0 inches d.b.h. Thus, the true bimodal diameter distribution may not be reflected in input for SWYLD2. Our surveys indicated that the magnitude of this problem varies from stand to stand. Preliminary examination of proposed survey areas aids in eliminating stands with highly variable diameter distributions. Since the SWYLD2 program deals with stand averages, some diversity can be tolerated.

B. Data Processing Area

Essentially, all recognized problems in this area have been or are currently being resolved. The only facet which resulted in some difficulty involved a lack of computer training at the Ranger District level. This difficulty is being resolved through Regional and individual Ranger District training sessions.

C. Yield Table Interpretation Area

Interpretation of simulated yield tables continually causes some difficulty. New users must undergo persistent use and familiarization with SWYLD2 until a full understanding is gained. Caution must be exercised in applying results of one simulation to other areas in the vicinity. Our evaluations indicate that small changes in certain SWYLD2 stand condition variables can result in drastic differences in overall yields and management alternatives.

D. Economic Area

1. The primary problem in this area involves where funding should be obtained for use of the SWYLD2 program, particularly field data collection at the Ranger District level. Since much of the information collected is of silvisultural value, both Forest Insect and Disease Management and Timber Management may have responsibility. Our simulations indicate that when dwarf mistletoe is present in any quantity, there is potential for a substantial problem to develop if the stand is not properly treated.

2. From this initial difficulty stem problems of adequate staffing, allocation of time for data collection, etc.

E. Overall Use Area

1. Duplication of effort may occur in stands where a compartment examination (silvicultural examination) has been completed. The data collection systems and the type of data gathered are not similar when comparing compartment examination with the SWYLD2 survey. Potential does exist for modification of the compartment examination procedure. Resurvey of only areas where dwarf mistletoe has been noted in a compartment examination may reduce duplication of effort. Both alternatives are being tested at the present time.

2. Management constraints for other disciplines, such as fire control, recreation, and wildlife, are continually becoming more important. These constraints often result in silvicultural treatment of mistletoe-infested stands, such that simulation is not accurate or reliable. Thus, discrepancies between ground truth and simulated yield tables occur. We have attempted to modify SWYLD2 for accommodation of such constraints. Modification will continue in the future.

## III. Summary

As with any new management tool, problem areas develop and must be resolved for continued implementation of the SWYLD2 program. This program is currently providing Southwestern resource managers new opportunities to examine various management alternatives in dwarf mistletoe-infested stands. In addition, the SWYLD2 program has enabled resource managers to quantify volume losses caused by dwarf mistletoe. Thus, land managers can better evaluate the benefits and consequences of controlling dwarf mistletoe. Continued use and development of this management tool will result in improved treatment of the dwarf mistletoe problem.

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# DWARF MISTLETOE IMPACT

Dave Drummond

My name and face are new to many of you and I would like to thank you for the opportunity to introduce both myself and the Methods Application Group (attached to the FI&DM Washington Office Staff), located in Davis, California. Personnel with the Group have very broad backgrounds and include a Survey Entomologist (David Grimble) from Syracuse, New York; a Survey Pathologist (myself) from Penn State via Ontario, Canada; a Remote Sensing Specialist (Bill Klein) from Ogden; an Aerial Applications Specialist (Jack Barry) from Dugway Proving Grounds; a Biometrician (Bob Young) from the Statistical Reporting Service in Sacramento; and a new Mathematical Statistician (John Wong) who just joined us from the Department of Defense, San Francisco. Bill Ciesla (former Staff Director in Region 1) heads up the unit.

Among the activities that we have been assigned is the task of assessing volume loss over large areas. To test the feasibility of such volume loss surveys, we have chosen two pests, (1) the Mountain Pine Beetle and (2) the Dwarf Mistletoes. To help guide these activities, we asked several people to join in loss assessment working groups. From this point I will only discuss the dwarf mistletoe volume loss survey.

Oscar Dooling, Jim Hadfield, Frank Hawksworth, Dave Johnson, Bob Scharpf, Dick SMith, Al Tegethoff and Jim Walters all consented to help guide this project. Mike Cole, a Research Silviculturist with the Intermountain Research Station dealing with Lodgepole pine ecosystems, is also a member of the working group.

It was decided during our initial meeting to evaluate existing data as potential sources of a loss estimate and to do this on three National Forests during the first year if possible. The Medicine Bow in Wyoming, the Prescott in Arizona and the Deschutes in Oregon were chosen. The objectives were (1) to use available timber inventory data to generate volume loss estimates and (2)to use other incidence data available for each forest to compare to the timber inventory estimate.

Medicine Bow data have a dwarf mistletoe assessment for each plot tree. Frank Hawksworth's road and plot survey completed in the mid-50's was also available for comparison. In addition we decided to conduct another road and plot survey as a tool for use where inventory records were unavailable or where mistletoe information was absent. Variable plots were established in conjunction with the road survey to determine how closely we could estimate volume. On the Prescott, timber inventory individual tree records have been consulted and these data are presently being summarized. There is also a dwarf mistletoe survey available for the Prescott which can be compared to the timber inventory summary. For the above two forests, we are using the Rocky Mountain Yield Simulation Program (RMYLD), a tool to generate loss estimates for both infested and uninfested stands.

A yield simulator for the Deschutes was thought to be near completion. Unfortunately this simulator is not available; however, we are utilizing timber inventory data without the simulator to estimate volume loss. In addition, the FI&DM office in Portland is transferring growth information from original field data forms that was collected for approximately one-third of the plot trees.

## Preliminary Results for the Medicine Bow

Table 1 compares incidence data acquired from several sources. It showed that 47% of the Stage I timber inventory plots contain one or more mistletoe infected trees. If converted to acreage represented by those plots, 55% of the Medicine Bow acreage contain mistletoe infected trees. The road survey conducted in 1977 revealed that 60.5% of the miles traversed were adjacent to mistletoe infested stands (survey involved only one side of the road). 60% of the plots established in conjunction with the road survey contained mistletoe infected trees.

A volume comparison of estimates of total volume per acre is shown at the bottom of Table 1. The Stage I (timber inventory) average volume is 2302 cubic feet per acre. The 1977 road survey estimate is 2213 cubic feet per acre. These population means are not statistically different. The results shown in Table 1 suggest that (1) all data sources produced similar estimates of dwarf mistletoe incidence; and (2) the plot portion of the road survey and the Stage I timber inventory produced comparable estimates of average total cubic feet volume per acre.

The RMYLD simulation model on file at the Fort Collins Computer Center was used to estimate volume. Volume differences attributable to dwarf mistletoe were acquired by entering existing parameters for all plots into the RMYLD program. The RMYLD program then provided an estimated ten-year volume increment for each plot. Subsequent to the initial run, data from all plots containing infected trees were reentered, now assuming no mistletoe infection. The volume difference between the two runs of the simulator for each plot was attributed to the influence of dwarf mistletoe on growth. Volume differences for each plot, derived in this fashion, were then stratified by dwarf mistletoe rating, weighted and multiplied by the acres represented by that level of infestation.

Tables 2 and 3 depict summaries for the plots established during the road survey and the data acquired from the timber inventory Stage I files respectively. The ten-year growth loss estimate from the road survey data was greater than 40 million cubic feet (Table 2), while the same ten-year estimate using Stage I timber inventory data resulted in only 1.6 million cubic feet volume loss.

These preliminary data reveal that while timber inventory crews are able to recognize the presence of dwarf mistletoe on inventory plots, they significantly underestimate the intensity of infection. This is illustrated by the fact that the acreage represented by dwarf mistletoe ratings of 3.1 or greater was 34% for the 1977 road survey plot data while, according to the timber inventory data, only 3% of the acreage represented average dwarf mistletoe ratings greater than 3.1.

TABLE 1:

DWARF MISTLETOE INCIDENCE IN THE LODGEPOLE PINE TYPE ON THE MEDICINE BOW NATIONAL FOREST

| SOURCE | PARAMETER | VALUE |
|---|---|---|
| T.I. STAGE I | % PLOTS—MISTLETOE | 47.0 |
| T.I. STAGE I | % ACRES—MISTLETOE | 55.0 |
| ROAD SURVEY | % MILES—MISTLETOE | 60.5 |
| ROAD SURVEY | % PLOTS—MISTLETOE | 60.0 |
| HAWKSWORTH'S SURVEY | % PLOTS—MISTLETOE | 59.0 |

PER ACRE VOLUME ESTIMATES

| | |
|---|---|
| T.I. STAGE I | 2302.6 CU. FT. |
| ROAD SURVEY PLOTS | 2213.3 CU. FT. |

TABLE 2:

TEN YEAR CU. FT. VOLUME LOSS ESTIMATE DERIVED FROM THE 1977 ROAD SURVEY PLOT DATA FOR THE MEDICINE BOW NATIONAL FOREST USING THE RMYLD SIMULATED YIELD PROGRAM

| AVE. DMR | WEIGHTED DIFFERENCE PER ACRE | ACRES | CUBIC FOOT VOL. LOSS |
|---|---|---|---|
| 0 | 0 | 182,407 | 0 |
| 0.1-1.0 | 0 | 38,587 | 0 |
| 1.1-2.0 | 4.00 | 17,539 | 70,156 |
| 2.1-3.0 | 53.30 | 10,523 | 560,875 |
| 3.1-4.0 | 191.20 | 45,601 | 8,718,911 |
| 4.1-5.0 | 482.83 | 59,632 | 28,792,118 |
| 5.1-6.0 | 92.20 | 21,046 | 1,940,441 |
| TOTALS | | 375,335 | 40,082,501 |

ANNUAL LOSS EQUAL TOTAL DIVIDED BY 10

TABLE 3:

TEN YEAR CU. FT. VOLUME LOSS ESTIMATE DERIVED FROM THE MEDICINE BOW NATIONAL FOREST TIMBER INVENTORY USING THE RMYLD SIMULATED YIELD PROGRAM

| AVE. DMR | WEIGHTED DIFFERENCE PER ACRE | ACRES | CUBIC FOOT VOL. LOSS |
|---|---|---|---|
| 0 | 0 | 158,420 | 0 |
| 0.1-1.0 | 0 | 137,690 | 0 |
| 1.1-2.0 | 5.65 | 36,778 | 207,796 |
| 2.1-3.0 | 62.90 | 11,583 | 728,571 |
| 3.1-4.0 | 120.00 | 4,148 | 497,760 |
| 4.1-5.0 | 4.00 | 4,470 | 178,800 |
| TOTALS | | 353,089 | 1,613,000 |

ANNUAL LOSS EQUAL TOTAL DIVIDED BY 10

# USE OF AERIAL PHOTOGRAPHS TO LOCATE *FOMES ANNOSUS* CENTERS IN A PINE FOREST

Robert E. Wood and Michael J. Schuft

A number of people, many of them in this audience, have used aerial photos to aid in identifying and locating root rots; certainly the concept is not new. In fact, one of the panels presented at WIFDWC in 1975 used aerial and ground photos to illustrate the appearance of mortality centers caused by various pathogens. The conditions under which the California Region of the U.S. Forest Service conducted a biological evaluation and the reasons for doing it are unique. Rather than discuss the feasibility of the method, which has been reviewed elsewhere, I would like to tell you how we did it, and spend some time discussing the problems we encountered.

The California Region was asked by personnel of the Cleveland National Forest near San Diego to provide them with information on tree mortality at Laguna Mountain such as how much, where, what species and stands, and from what causes. In addition, they wanted to know the locations of all root rot centers on the mountain in order to better plan recreational development.

I shall digress here and explain that Laguna Mountain is a plateau located 40 miles East of San Diego, is about 6000 feet high, and is the place where residents of San Diego go in order to see trees, rocks and snow. It receives very heavy visitor use in both summer and winter, about 1,532,600 visitor days per year. Divide the visitor use days by the acres of timber in public ownership, about 7100 acres, and you have 216 visitor days per acre per year. It must be obvious that the timber on the mountain is a valuable resource. As far as recreational developments, there are four campgrounds, two institutional camps, two picnic areas and about 200 summer homes, all on public lands. The mountain is well roaded, allowing use of almost all of the forested area.

Local foresters felt that before planning any additional developments or modifying existing ones, they should know where they could expect pest problems, and how much land they actually had available for development. A previous survey had located areas impacted by dwarf mistletoe but did not map *Fomes annosus* problem areas.

## Methods

Using a Forest Service aircraft and a Zeiss RMK-2 camera with a 9"x9" format and a 8¼" lens, we photographed the entire 7100 acres using medium speed ekctachrome color transparency film at a scale of 1:5000, and Aerocolor negative film at a scale of 1.10,000. The color transparancies were interpreted for all current mortality and for areas having a combination of signatures indicating *F. annosus*. All centers thought to be caused by *F. annosus* were transferred to the 1:10,000 prints which were then covered with a transparent film to preserve the delineation, and assembled into an atlas which can be used in the office or taken into the field. A ground check of 125 recently dead tree groups was made to adjust the photo estimate of mortality, to determine the pests associated with the dead trees, and to collect data on dead trees, stands and sites. In addition, 152 of the centers attributed to *F. annosus* were examined to determine if the fungus was in fact causing the mortality. An informal ground check was conducted while interpretation was going on; the photo-interpreter spent part of each day in the field checking his accuracy.

Results

We found approximately 2100 dead tree groups on the mountain; the mortality rate was 0 6/trees/acre. There were five important pests contributing to the mortality; the California flatheaded borer, *Melanophila californica,* contributed to about 61% of the mortality, dwarf mistletoe, *Arceuthobium campylopodum*, contributed to about 61%, *F. annosus* contributed to about 48%, *Elytroderma deformans* about 7%, and *Armillaria mellea* about 5%. These pests usually occurred as complexes; often three were involved in the same mortality group. We will be providing the local foresters with additional information indicating problem stand classes, basal areas, and the like.

We identified 1383 *F. annosus* centers on the mountain, about one center for every five acres of forest type, including hardwoods. The formal ground check of 152 centers showed that 80% of the centers attributed to *F. annosus* were actually caused by fungus or by *A. mellea*. In addition, 67 centers interpreted as not being caused by *F. annosus* were checked; 13% were found to have *F. annosus* present. In brief, we were right 80% of the time when we said *F. annosus* was present in a mortality group, and right 87% of the time when we said it was not present.

Photo Signatures

Photo signatures were discussed at length at the 1975 WIFDWC meeting; however, I would like to review the range of root rot indicators which we used. They are:

1) Old stumps,
2) Newer stumps,
3) Staubs (broken off snags),
4) White snags (older)
5) Black snags (newer)
6) Current mortality (Sorrel), and
7) Thin-crowned or fading trees.

We said arbitrarily that to be considered an *F. annosus* center, there must be at least three of the above signatures present, or if there are just two, they must be numerous or obvious. Also, the signatures must be spacially related in a way that would indicate the spread of *F. annosus* from one to another. For instance, a snag located 100 feet from current mortality, with no signatures in between, was not considered evidence of the presence of the root rot. One of the limitations we discovered is that most trees which die are cut down and often removed, either because of hazard, for firewood, or as an insect control measure. Therefore, a center which might, if left alone, contain a range of signatures, in fact often consisted of a number of stujps, cut as near the ground as possible. Obviously, there is not much, in this situation, that can be used to indicate continuing mortality, which, after all, is the best indicator of *F. annosus* that can be seen on aerial photos.

## Problems

In hopes that it might help anyone who decides to do a similar survey, I would like to indicate some of the problems we encountered. First, we photographed in early April, before hardwoods leafed out. Although we were sometimes able to see dead conifers under the leafless oaks, those same oaks, if conical in shape and single stemmed, looked much like dead conifers. Some of them were interpreted as such and all of them had to be closely examined, thus increasing interpretation time. The photographs should have been taken in June, after the oaks were leafed out.

Second, the scale of interpreted photographs, 1:5000, was at the upper limit for imaging many of the stumps, which are generally less than 24 inches in diameter and which are often cut almost flush with the ground. Using a scale of 1:4000 or even 1:2000, as have been done in other evaluations, while it overcomes this problem, also results in a large number of photos with increased costs and time involved in keepong track of them. I think the solution to this problem lies in evaluating the objectives of each evaluation, the biological conditions, and of course the financial limitations.

## Slides

Illustrations consisted of enlargements of aerial photographs at various scales and ground photographs illustrating the following conditions:

1. Typical small center (three enlargements) showing staubs, snags and current mortality. This is an ideal, but not often observed, range of signatures.

2. Typical small center (three enlargements) with stumps, current mortality, and a thin-crowned tree. Again, an ideal range of signatures not often observed.

3. Coalescing centers (one enlargement). Judged to be three adjacent centers, two containing a range of signatures, the third only two snags. In fact, there were only two *F. annosus* centers. If the established rules had been followed, the third would not have been considered a center and an error would not have been made.

4. Small center (three enlargements) with a large number of stumps and one sorrel tree. Although there were only two signatures, one of them was very abundant. Ground inspection confirmed the presence of *F. annosus*.

5. Coalescing centers (one enlargement) with poor signatures. Many staubs, stumps, sorrel and thin-crowned trees, but with green crowns interspersed. Actually five different centers, but were considered to be a single one for management purposes.

6. Large centers (one enlargement) with long distances between signatures. Three pests, flatheaded borer, dwarf mistletoe and *F. annosus* were present, probably accounting for the accelerated mortality rate.

7. Small center (two enlargements) which was missed becasue onlv stumps could be seen on the photos. Two black snags were hidden by shadow.

8. Large center (one enlargement) containing stumps, black snags, and current mortality. This center, probably the largest encountered, was missed because the distances between the signatures was considered too great to allow the spread of *F. annosus*.

# FUNGISTATIC EFFECTS OF SMOKE: A PROGRESS REPORT

Devon Zagory

Investigations into the fungicidal and fungistatic effects of smoke are in progress at U.C. Berkeley. Much of the effort is devoted to quantification of smoke and its' effects. Barley straw is used as fuel in the experimental work. At present two quantification techniques are used.

1. Glass slides are used as surfaces for smoke deposition and then placed in a densichron to measure the decrease in optical transmission.

2. Petri plates containing one of several media are exposed to smoke and then innoculated with a plug of *Rhizoctonia solani* as a bioassay organism. Linear growth rate appears to be inversely proportional to smoke deposition.

Fewer powdery mildew colonies developed on three week old barley plants that had been exposed to smoke than on those which had not been exposed. Phytotoxicity occurred with four or more minutes of smoke.

*Colletotrichum trifolii* failed to develop on alfalfa plants that had been sprayed with dilute commercial liquid smoke product. Plants sprayed only with water developed numerous lesions.

Dilute commercial liquid smoke product reduced field soil populations of Pythium ultimum to near zero.

Pilot tests have been initiated to investigate the effects of forest fire smoke on forest pathogens. Results are tentative as this was a poor year for controlled burning in California.

Results with agricultural pathogens indicate that smoke is a potent and potentially useful fungistatic agent and suggest that its' effects may be of importance in a forest situation.

# POTENTIAL CONTROL OF *PORIA WEIRII* AND *FOMES ANNOSUS* ROOT ROTS WITH SEWAGE SLUDGE

Robert L. Edmonds and David Chavez

*Phellinus (Poria) weirii* causes a destructive root rot of Douglas-fir (*Pseudotsuga menziesii*). The fungus can survive more than 50 years in infected roots and stumps, infecting roots of a new tree generation as they contact the old residue. Similar behavior is exhibited by *Fomes annosus* in western hemlock (*Tsuga heterophylla*) stands. Together these two pathogens constitute a major continuing threat to forest stands in Western Washington.

Survival of *P. weirii* decreases in nitrogen amended soils (Nelson, 1970), as a result of an alteration of the microbial population in the soil and increased competition against *P. weirii*. However, applications of up to 700 kg/ha of urea are needed before effects are noticable. This is a higher rate of application than is commercially normal.

Sewage sludge has traditionally been disposed of in lakes, rivers or oceans. This is now deemed to be environmentally unsound and sludge is now increasingly being applied on land. With the application of dewatered sewage sludge (20-40% solids) to forest soils, the possibility exists that this nutrient-rich substance could increase forest growth and control root pathogens because of large additions of nitrogen in particular. Sludge also could contain other constituents which may be directly toxic to these pathogens.

The specific objective of this study is to determine if sewage sludge applied to clearcuts or existing forest stands can indeed be used to reduce incidence of *P. weirii* and *F. annosus*.

Preliminary culture tests were conducted with the two pathogens, *P. weirii* and *F. annosus*, and a saprophyte (*Trichoderma* sp.) on various sludge and control medias (fresh sludge agar, 1-year-aged sludge agar, 3-year-sludge agar, 2% malt agar and soil extract agar). In addition, a wood cube burial experiment involving *P. weirii* was conducted with naturally infected Douglas-fir wood buried under fresh sludge and sludge aged in the field for one year.

Wood cubes (3" x 3" x 3") were buried just beneath sludge at depths of 3", 12" and 24" at the Charles Lathrop Pack Experimental Forest near Eatonville, Washington. Survival of *P. weirii* was monitored after 14, 30 and 90 days using wood chip isolations. Sewage sludge from the city of Seattle's West Point plant was utilized.

Inhibition of growth of *P. weirii* on the various sludge medias occurred. Growth was also slower on soil extract agar in comparison to malt agar. *Fomes annosus* growth was also inhibited by fresh sludge agar but growth was little affected on aged sludge agar. Growth of *Trichoderma* sp. was only slightly affected by the sludge treated agars. This sludge would appear to contain some substances which are directly toxic to *P. weirii* in particular and which could be capable of leaching into the vicinity of roots in which the pathogen is growing.

Results from the buried block experiments are as yet inconclusive, although there appears to be slightly poorer survival of *P. weirii* in blocks under sludge in comparison to the control treatment. Perhaps in the short time period involved one would not expect to see dramatic control. The next stage in this study is to apply sludge to existing forests known to have *P. weirii* or *F. annosus* and monitor the progress of these diseases over a long time period.

## REFERENCES

Nelson, E. E. 1970. Effects of nitrogen fertilizer on survival of *Poria weirii* and populations of soil fungi and aerobic actinomycetes. Northwest Sci., 44:102-106.

# A LOOK AT SOME FOREST DISEASE PROBLEMS IN NEW ZEALAND AND AUSTRALIA

C. G. (Terry) Shaw III

With the aid of numerous kodochrome slides some current forest disease problems in New Zealand and Australia were illustrated and discussed. Observations on these disease problems were made during the last 3 years while I was a Research Forest Pathologist with the Forest Research Institute (NZFS), Roturua, New Zealand. The Australian material was obtained through a months official visit to Australia under a joint New Zealand-Australia Forestry exchange scheme. Subsequent correspondence with several forest pathologists in Australia (including Dare Edwards, N.S.W.; Geoff Marks, Victoria; and Glen Kile in Tasmania) supplemented my brief experiences there. Short comments are given below on a few of the problems discussed. No references are cited, but further information on any of the topics along with the names and addresses of researchers working on the various diseases may be obtained by contacting me.

## New Zealand

The basis of present New Zealand forestry lies in approximately 1,000,000 hectares of State and privately-owned exotic, mainly coniferous forests. *Pinus radiata* is the most important species occupying some 85 percent of the planted area. Thus, a large proportion of the research efforts have dealt with this species.

*Dothistroma* needle blight, caused by *Dothistroma pini*, was first recorded in 1962. Since this time, it has spread throughout the pine forests in the North Island and South Island, except the provinces of Southland and Cantervury. On *P. radiata* the disease can cause a marked reduction in growth if not controlled after defoliation levels reach 25 percent of the normally live, unsuppressed foliage. In the Central North Island where large tracts of pine have been planted, effective control on *P. radiata* has been achieved through aerial application of copper fungicides. All forest areas are annually inspected and those showing infection levels exceeding 25 percent defoliation are recommended for treatment. Three sprayings, most effectively applied in November and December, are normally required before age 15 when *P. radiata* develops a natural resistance to the disease. This year some 80,000 hectares of land will be treated at a cost of roughly $8.00/ hectare. Some other species (*P. ponderosa*) do not develop this resistance with age and some older, heavily infected stands show minimal growth. Cutting is being accelerated in these stands and replanting is mainly with *P. radiata*. The presence of the disease has, thus, intensified the near monoculture of *P. radiata*.

Some stands of *P. radiata* on the west coast of the S. island (a generally cool, humid environment with frequent fog) have not responded well to the traditional treatment and, in some instances, resistance has not developed by age 15. For this reason, along with environmental concerns, further expansion of pine plantations in these areas may be reconsidered. Studies are now in progress on the mechanisms of resistance with age, periods of field infection, control effectiveness, and possible interactions with other diseases.

Douglas-fir is the second most important exotic conifer in New Zealand, occupying some 50,000 hectares. Over the last several years, the growth rate of semimature stands in the North Island has shown a decline. This decline appears to correspond with the spread of the needle cast fungus *Phaeoryptopus gaumannii*, which has been accompanied or followed by an increase in leaf defoliating insects. While it has been difficult to establish how much of the decline in growth is actually due to *P. gaumannii*, it alone can reduce seedling growth and research continues on the effects and control of the disease as well as development of adequate silvicultural regimes for Douglas-fir.

This presentation notes the first occurrence of the Black Stain Root Disease, caused by *Verticicladiella* spp., on *P. strobus* in New Zealand. Reports of *Verticicladiella* on conifers outside North America are rare and further studies on the New Zealand occurrences are in progress. The fungus has been isolated from dying *P. strobus* at two locations; results of pathogenicity tests on *P. strobus* and *P. radiata* are not yet available. *P. strobus* accounts for only a small portion of the exotic softwoods, but the wood has a high social value. It is the most desirable species for wood chopping contests, a sport with an enthusiastic following.

*Diplodia pinea* is generally considered a wound pathogen on trees weakened by some climatic or edaphic factor or suffering from mechanical injury. However, recent studies have shown that the fungus can be a primary pathogen on young, unhardened shoots of *P. radiata* that may result in the development of multiple-leadered trees of little value. In one heavily diseased stand, only 6 percent of the trees met acceptable pulpmill standards because of repeated leader dieback from *D. pinea*. Cases of such severe infection are uncommon and generally localized. In most stands, leader dieback from *D. pinea* is only occasionally seen and presently of little significance. The fungus is common on frost-damaged *P. radiata* seedlings and may cause mortality by entering branch whorls after pruning of green branches. The latter disease is called Diplodia Whorl Canker and is generally not a cause of significant mortality. The fungus also causes some sapstain in pine timber.

While studies on the deterioration of blowdown have been conducted, the problem is avoided as much as possible by quick utilization of downed material. As certain insects are not acceptable in export logs, some fumigation is conducted. The potential problem is real as a recent single storm on the S. Island leveled some 2 million cubic meters of pine.

Poplar leaf rust was first detected in New Zealand in the autumn of 1973, (probably blowing over from Australia where the disease had only arrived in 1972) and spread rapidly throughout the country. Both the European (*Melampsora larici-populina*) and North American (*M. medusae*) rusts were found initially, but now only *M. larici-populina* is common. Poplars are frequently used for soil stabilization and shelterbelts. Heavy rust infection greatly curtails root growth and, thus, reduces their effectiveness in hillside stabilization. There is no impact from the rust on the alternate, coniferous hosts, primarily larch. Selected clones of rust-resistant poplars are being propogated to release for planting. Unfortunately, some recent clonal introductions also included the previously nonrecorded poplar leaf spot organism, *Marssonina* spp.

*Armillaria* root rot, caused by at least two different species of *Armillariella*, is a major problem on sites freshly cleared of indigenous forest and planted with pines. One third of the planted stems may be killed, largely in groups around residual stumps, within 5 years of planting. The level of mortality varies with the composition of the former cover. Older, heavily-infected trees are prone to windthrow and suffer a significant reduction in growth. *P. radiata* heavily infected with both *Armillaria* root rot and *Dothistroma* needle blight may suffer a growth reduction greater than the additive effect of the two diseases alone. A recent financial analysis suggested that the disease increased the plantation growing costs by 37 to 43 percent. Control by inoculum reduction through root and stump removal appears theoretically justified if costs do not exceed 140-170 $/ha. On terrain where heavy machinery can operate, present control costs are within these limits.

Several of the native tree species suffer from various declines and diebacks. These often involve a complex of factors including certain pathogens, browsing animals, insects, and climatic factors.

Rust diseases on conifers indigenous to the Southern Hemisphere are rare in comparison to the rich rust flora of the Northern Hemisphere. Recently, the first rust on a member of the Podocarpaceae, a major family of Southern Hemisphere conifers, was found in an isolated location on the central North Island. The rust spermagonia fit into a new type recently described by Hiratuska.

Eucalypts are being planted on an increasing area to supply high-quality hardwood lumber and an exotic source of hardwood chips to replace the limited supply of suitable native hardwoods. A leaf blotch caused by *Mycosphaerella nubilosa* is troublesome on some species growing on certain sites. This disease, and others that are potentially damaging to eucalypts (i.e. *Phytophthora cinnamomi*) and insect pests are being closely monitored as the planting of eucalypts expands.

The following topics were mentioned during the discussion, but are not elaborated on here: Mycorrhizae research; herbicide damage; *Phomopsis* canker; soil nutrient deficiencies; graft incompatibilities in seed orchards; *Uromycladium* galls on *Acacia*, and dodder.

## Australia

Natural forests of Australia are dominated by some 500 species of Eucalypt hardwoods. The forest areas are mainly limited to coastal regions and Tasmania; sites with adequate annual rainfall. In some areas pine plantations, principally *P. radiata* except in Queensland where pines from the southern U.S.A. are favored, have been established. Some of these plantings are on sites that are marginal for good tree growth.

Eucalypts in various locations suffer from an array of diebacks and declines, many of unknown causes, to which the Australians have assigned some delightful names (i.e., Gully dieback, Regrowth dieback, Jarrah dieback, Ourimbah dieback, and High Altitude dieback). Only those diebacks I personally observed will be mentioned.

High altitude dieback has killed semimature and overmature *Eucalyptus delegatensis* in all canopy classes on some 4,000 hectares at elevations above 800 meters in northeastern Tasmania. While the cause is really unknown, the dieback may be a natural feature of succession towards a climax forest dominated by *Northofagus cunninghamii*. Regular burning to control understory development appears to maintain health.

Regrowth dieback affects some 16,000 hectares of choice *E. regnans* and *E. obliqua* in southern Tasmania. In regrowth stands aged between 30 and 120 years, dying trees are scattered among apparently healthy ones or in patches with no descrete boundaries. As yet no causal agent has been identified.

*Phytophthora cinnamomi* is undoubtedly the most destructive forest pathogen in Australia. It is the cause of several Eucalypt forest declines as well as damage to pine plantations and nurseries. In some cases, the disease is as politically volatile as it is biologically active.

In Western Australia, *P. cinnamomi* is the primary cause of Jarrah dieback--a disease that has affected several hundred species of native flora over some 200,000 hectares. It is generally accepted that *P. cinnamomi* was introduced into Western Australia, probably in the 1920's, and has since been widely dispersed, primarily by logging activity and earthmoving equipment. The problem is made even more complex by the unique nature of the Jarrah forest and its several overlapping and somewhat incompatible values--timber, a unique array of wildflowers (many susceptible to the disease) that are renowned for their beauty, watershed for the environs of Perth and rich deposits of bauxite. To limit further spread of the disease restricted entry into and from diseased areas is being strictly enforced.

Recent studies have indicated that the present practice of low intensity fuel reduction burns may favor an understory (*Banksia grandis*) that is highly susceptible to the disease and helps maintain a mivroenvironment favorable to disease. Contrarily, high intensity burning will not kill off the eucalypts and may favor development of a legume understory (*Acacia pulchella*) which is not only less susceptible to the disease, but may also inhibit its development in the eucalypts.

In East Gippsland, South Gippsland, and the Brisbane Ranges of Victoria, introduced *P. cinnamomi* is the primary cause of extensive eucalypt diebacks. Disease incidence and spread appear similar to Jarrah dieback; causing major changes in the structure of the ecosystem. The disease became a recent issue in the Victorian Parliament when a motion of "no confidence" in the Minister for Forests was introduced principally because of his handling of the situation. While politicians, foresters, pathologists, conservation organizations, timber and paper companies continue to ballyhoo, the disease steadily advances. The strict quarantine procedures implemented in Western Australia are not presently practiced in Victoria and may not be possible. A stroke of the pen recently relieved the Victorian Forestry Commission of the bulk of the problem as some 100,000 hectares of severely diseased areas were transferred to the National Parks Service. These lands formerly yielded excellent ducalypt timber and were easily accessible. Research in Victoria has also indicated that certain *Acacia* species may be antagonistic to *P. cinnimomi*.

In Queensland and New South Wales, *P. cinnimomi* has been isolated from dying native vegetation. While most disease outbreaks appear to result from introduction of the fungus, it is still unsettled if it is indigenous to parts of Queensland. In the past, this topic stirred often heated debates among Australian pathologists. A near 1:1 ratio of A1 and A2 mating types of the fungus in Queensland and New Guinea and the rarity of A1 in other parts of the world is presented as evidence that Queensland and New Guinea may be the center of origin for this species.

*P. cinnimomi* has also caused heavy losses in several pine nurseries in Queensland. Outplanting of infected seedlings has resulted in some mortality and disease spread in the field. Badly-infected nurseries were closed and in others strict sanitary measures for the movement of machinery, equipment and seedlings were implemented and extensive soil fumigation was initiated.

Queensland has several important agricultural crops (i.e., avacado and pineapple) that can be severely affected by *P. cinnamomi*. Often these crops are grown near pine plantations. Irrigation waters passing through the crops may carry the fungus to the forest.

*Dothistroma* needle blight was first detected in Australia in 1975 on *P. radiata* at Barrington Tops State Forest, New South Wales. To date, the disease has been detected at nine sites in New South Wales and three in the Australian Capital Territory. All infected areas in N.S.W. are being aerially sprayed with cuperous oxide. In general, the situation appears far less serious than in New Zealand. Weather conditions and less continuity of susceptible pine species may be important limiting factors. The *D. pini* infections I observed on *P. radiata* in the A.C.T. did not readily develop the characteristic red bands on the needles as it does in New Zealand and the disease was confined to specific spots described as extremely moist, boron-deficient soaks. Infection intensity on heavily-diseased trees suggested that the disease had probably been present for 3 or 4 years prior to detection.

Various forms (species?) of the root pathogen *Armillaria* are associated with crown deterioration in a wide range of eucalypts. In some instances, disease development followed thinning and selective logging. The most severe and extensive damage associated with *Armillaria* is in the eucalypt forests around Creswick in Victoria. Control studies through inoculum reduction by root and stump removal are now being initiated. In this situation, rhizomorphs are rare and root contacts are important for local disease spread.

The root rot caused by *Phellinus noxius* has been recorded in plantations of hoop pine (*Araucaria cunninghamii*) in coastal and subcoastal areas of eastern Queensland. The root rot is similar in many ways to the North American *Phellinus weirii*, killing trees in expanding infection centers often oriented on large, residual stumps. Losses, in general, have not been high and machine clearing of land before planting has reduced them further.

# KINKY DISEASE OF PINE

R. S. Hunt

The name "Kinky disease" has been used to describe the symptoms of an unknown disease of pine in British Columbia. Part of this syndrome consists of chlorotic, twisted and/or stunted foliage. Occasionally shoot twisting is associated with these symptoms. Between the needles under the needle sheath, brown necrotic tissue can frequently be observed, especially in the autumn. At this time high populations of a plant feeding mite, *Trisetacus campnodus* Keifer & Saunders, are found at this location. This mite is hyaline to white, 100 to 150 μ long and is usually sedentary.

Occasionally no other symptoms are observed, but frequently dieback occurs and new buds develop, resulting in bushy, short, chlorotic trees. The opportunistic, secondary imperfect fungus, *Sclerophoma pithyophila,* is commonly found fruiting on necrotic foliage and shoots.

It is now believed that Kinky disease is caused by an initial attack by *Trisetacus campnodus* and a secondary attack by *Sclerophoma pithyophila*. Similar symptoms may be produced by aphids feeding in the needle sheath area, but these are readily observed and only attack an occasional branch. Magnesium deficiency likewise produces similar symptoms, but this deficiency is easily rectified with applications of magnesium sulphate. However, Kinky disease trees are not adversely low in magnesium, nor do applications of magnesium sulphate ameliorate the tree's condition.

Preliminary observations suggest that *Trisetacus campnodus* has shore pine as a native host, while lodgepole pine is a new host. *Trisetacus campnodus* and Kinky disease on shore pine appear to be merely curiosities, but interior lodgepole pine planted on the coast is readily attacked *Trisetacus campnodus* and Kinky disease becomes a major debilitating disease.

Interior lodgepole pine planting stock has been grown in coastal nurseries and planted back in native habitats in the Interior. It is possible that the mite could spread from native shore pine to lodgepole pine in nurseries and then from the outplanted seedlings to native lodgepole pine stands.

Three major areas in the Interior have plantations stocked with coastal grown seedlings, which are believed to have been severely infected with *Trisetacus campnodus*. Examination of these areas, approximately 5 years after outplanting, revealed high populations of the mite and typical symptoms only in one area. To date there has been no observed spread to native lodgepole pine stands.

# OZONE INJURY TO PINES IN THE SOUTHERN SIERRA NEVADA

Richard S. Smith
Detlev R. Vogler

At the 1975 Monterey meeting of WIFDWC, Region 5 described the results of a survey of ozone injury to ponderosa and Jeffrey pines in a portion of the southern Sierra Nevada. Speculation concerning future adverse impacts resulting from this air pollution problem were based on the assumptions that: 1) ozone injury to pines was increasing each year as evidenced by established trend plots, and 2) the conditions observed and described on the front ridge between the Kings and Kaweah Rivers were representative of the whole southern Sierra Nevada.

Since this report the Forest Insect and Disease Management Staff of Region 5 has continued its efforts to evaluate this air pollution problem. These efforts have included: 1) the continued yearly evaluation of ozone injury on the original plus newly established ozone injury trend plots, 2) seasonlong (April through October) monitoring of ozone levels at selected forest sites in the southern Sierra Nevada (1 site in 1976, 3 in 1977, and 4 planned for 1978); and 3) complete survey of all national forest lands in the San Joaquin Air Basin (Sierra and Sequoia National Forests) for ozone injury to ponderosa and Jeffrey pines. The results of these evaluations are as follows:

## Ozone Injury Trend Plots

The original ozone injury trend plots have been evaluated at the end of each se-son for the past four years. Newer plots have been evaluated for 2 to 3 years. There have been no statistically significant changes in the average plot readings from one year to the next and hence no trends of either increasing or decreasing injury are evident. One must conclude that ozone injury to ponderosa and Jeffrey pine in the areas evaluated has occurred at about the same level each year for the last four years. The average injury scores for these plots range between slight to very slight according to Miller's rating system. But there were individual trees (0-8% of the trees/plot) which were severely affected and in which some reduction in growth was probable.

## Ozone Monitoring

In 1975, we had no season-long ozone dosage information for a forested site in the southern Sierra Nevada. In 1976, we established an ozone monitoring station at Whitaker's Forest (elevation 5400') some 50 miles due east of and downwind from Fresno. This site is in the front range of the Sierra Nevada, roughly in the center of the area described in our 1975 report. The 1976 data from the Whitaker's monitoring confirmed the presence of ozone in sufficient seasonal dosage to account for the symptoms observed on ponderosa and Jeffrey pines in this general area. The seasonal dose was approximately 1/5 to 1/4 of the dosage recorded in the highest ozone areas of the San Bernardino Mountains. The highest maximum hourly average for 1976 was 14 pphm. The Federal Standard of 8 pphm was exceeded on more than 1/2 the days from mid-July through September.

In 1977, additional monitoring stations were established at Park Ridge Lookout (elevation 7500'), two miles north of Whitaker's, and at Mountain Home State Forest (elevation 5900') thirty five miles south of the Whitaker's Station. The 1977 seasonal dosage at Whitaker's was higher than the 1976 dosage. The Park Ridge and Mountain Home dosages follow a pattern similar to Whitaker's but with lower peaks; hence they have a lower seasonal dosage.

In a summary of the 1976 ozone monitoring for the San Joaquin Air Basin the California Air Resources Board showed that the highest ozone concentrations were occurring downwind from the urban centers and the highest seasonal dosages were found 30 to 60 miles downwind in the foothills and mountains of the Sierra Nevada. In 1976, the Whitaker's Forest monitoring station had the second highest average daily maximum concentration and the second highest seasonal dosages above 5 pphm. The highest recorded average and dosage was from Clingings Junction in the foothills between Fresno and Whitaker's Forest.

## Ozone Injury Survey

Late this summer we started a forest-wide ozone injury survey in the Sierra and Sequoia National Forests. In this survey ponderosa and Jeffrey pine stands between 4,000 and 8,000' in elevation on preselected sites were assayed for ozone injury. Although the survey is still in progress and yet incomplete, sufficient information has been collected to show that there are large areas of these forests where ozone injury is absent or so low as to be inconsequential.

## Conclusions

With this new information we cannot accept the assumptions put forth in 1975 that 1) ozone injury is increasing and 2) that it is common over the whole southern Sierras. Instead it is our conclusion that the severity of the injury has remained relatively static for the last four years and that it is limited in distribution, most likely to the front range and major drainages of these mountains.

# ACTIVE PROJECTS

## A. Forest Disease Surveys--General

57-A-1 Forest dieseas sampling studies (G.W. Wallis).

58-A-1 Taxonomic and biological studies of Ascomycetes and Fungi Inperfecti (A. Funk).

71-A-1 *Dermea pseudotsugae* survey (M. Srago).

71-A-2 Aerial photography and root disease surveys (F.W. Cobb, J. Byler, J. Caylor).

71-A-3 Impact evaluation of white pine blister rust (J. Byler, N. MacGregor).

71-A-4 Appraisal of damage caused by forest pests in B.C. (G. A. VanSickle).

71-A-t Detection and reporting, forest insect and disease survey (D.A. Ross). (Formerly 68-A-1).

71-A-10 Development of a continuous nursery disease survey (W.J. Bloomberg).

71-A-7 Disease sampling in Douglas-fir plantations (G.W. Wallis).

71-A-8 Monitoring nursery systems (L.W. Carlson).

71-A-9 Forest insect and disease survey in the Prairie Provinces, Yukon and Northwest Territories (W.G.H. Ives, R.A. Blauel, Y. Hiratsuka, and H.R. Wong).

72-A-1 Survey of $SO_2$ damage to forest vegetation near ore smelters at Anaconda, Montana, and Wallace/Kellog, Idaho (C.E. Carlson).

73-A-1 Developing survey methods for diseases in the nursery (K.W. Russell).

73-A-2 *Rhizina undulata* detection survey in northwest Washington - initial survey and permanent impact transects (K.W. Russell).

73-A-3 Pest damage inventory (J. Byler and D. Hart).

73-A-4 Forest Disease: diagnostic and taxonomic services and research (R.S. Hunt).

74-A-1 Disease (and insect) detection surveys in Colorado forests (J.G. Laut and M.E. Schomaker).

74-A-2 *Verticladiella* in Douglas-fir in Oregon (E.N. Hansen).

74-A-3 Comparative survey designs for evaluating net impact of root diseases on the northern Idaho Panhandle National Forest. (R.E. Williams and C.D. Leaphart - 143).

77-A-1 Evaluation of the extent and cause of tree mortality on the San Bernardino National Forest (Byler, Cobb, and Ed Wood).

77-A-2 An illustrated guide to forest diseases of conifers in the Southwest (J. Walters).

B. Non-infectious Diseases

66-B-1 Susceptibility of western conifers to air pollution (R.V. Bega).

68-B-1 Detection of chronic photochemical oxidant injury to conifers by remote sensing (P.R. Miller, R.V. Bega, and R. Heller).

68-B-2 Physiological impact on ponderosa pine growing under natural conditions of chronic exposure to oxidant air pollution (P.R. Miller).

71-B-1 Influence of the forest canopy on total oxidant concentrations (P.R. Miller).

71-B-2 The effect of atmospheric effluents on the forest (R. Blauel, D. Hocking, and S.S. Malhotra).

72-B-1 Effects of smoke on forest disease fungi (J.R. Parmeter).

72-B-2 Chronic effect of photochemical oxidant air pollution on the composition of the ponderosa pine-sugar pine-fir forest cover type (P.R. Miller).

77-B-1 Evaluation of deicing salt damage to roadside trees (J. Walters).

C. Cone, Seed, and Seedling Diseases

53-C-1 Forest nursery diseases (W.J. Bloomberg).

68-C-1 Nematodes in forest nurseries (J.R. Sutherland).

71-C-1 Occurrence of endophytic fungi in conifer seedlings (W.J. Bloomberg).

73-C-1 Composting for organic matter additives at the nursery (K.W. Russell).

73-C-2 Pathology of forest seedlings in storage (J.C. Jopkins).

76-C-1 Diseases of seeds and cones. PC-14-246 (J. Sutherland).

76-C-2 Simulation of forest nursery diseases. PC-40-157 (W. Bloomberg)

77-C-1 Nursery disease problems at the Albuquerque Tree Nursery (E. Sharon, J. Walters).

77-C-2 Soil Fumigation for production of hardwood nursery stock: Effects on seedling growth, mycorrhizae, Root-pathogenic fungi, and nematodes. (J.W. Riffle).

D. Root and Soil Diseases or Relationships

64-D-1 The host range of *Armillaria mellea* on subtropical species (E. Trujillo and R.V. Bega).

65-D-1 Inter-relationships between root-pathogenic fungi, especially *Fomes annosus,* and bark beetle infestations in coniferous forests (F.W. Cobb, Jr., J.R. Parmeter, Jr., R.W. Stark, D.L. Wood, and E. Zavarin).

66-D-1 Investigations on the occurrence and control of *Fomes annosus* butt- and root-rot of intensively managed stands (C.H. Driver).

66-D-2 Studies on the cytology and genetics of *Fomes annosus* (C.H. Driver).

66-D-3 Studies on the effects of site treatments (slash burning, fertilization, mechanical soil disturbance, etc.) on limiting the abilities of *Poria weirii* to infect the regenerating stand (C.H. Driver).

66-D-4 Field trials to test effects of thinning on spread and intensification of Armillaria root rot in young ponderosa pine (D. Johnson).

69-D-1 Taxonomy of hypogenous mycorrhizal fungi (J.M. Trappe).

69-D-2 Stump infection by basidiospores of *Poria weirii* (E.E. Nelson).

69-D-3 Relative species susceptibility to *Poria weirii* infection (E.E. Nelson).

71-D-1 The biology and control of *Armillaria* in ponderosa pine (L.F. Roth).

71-D-2 *Poria weirii* root rot: Biology and control (G.W. Wallis, D.J. Morrison). (Formerly 53-D-3).

71-D-3 *Fomes annosus* root and butt rot: Biology and control (G.W. Wallis, D.J. Morrison). (Formerly 65-D-2).

72-D-1 Determination of *Poria weirii* impacts on forest resources in west-side Douglas-fir stands. (J. Hadfield?).

72-D-2 *Armillaria mellea* root rot: importance and biology (D.J. Morrison).

72-D-3 Identification, distribution and intensity of root rots in western Montana and northern Idaho (R.E. Williams). Formerly 67-D-5).

73-D-1 Testing native conifer plantings for resistance to *Poria weirii* (K.W. Russell).

73-D-2 Testing red alder plantings to reduce *Poria weirii* development (K.W. Russell).

73-D-3 *Alnus rubra* as a biological control agent for *Phellinus weirii* (E. Hansen, E. Nelson, and J. Trappe).

73-D-4 Taxonomy and distribution of the endomycorrhizal fungi of the family Endogonaceae (J. M. Trappe).

73-D-5 *Fomes annosus* evaluation (M. Srago).

74-D-1 Distribution and epidemiology of *Verticicladiella wagenerii* on pinon pine in Colorado (L.B. Helberg).

74-D-2 The role of ectotrophic mycelium in the initiation of *Phellinius (Porius) weirii* infections (E.M. Hansen).

74-D-3 Survival infectivity of *P. weirii* in Douglas-fir stumps (E.M. Hansen).

74-D-4 Changes in severity of *P. weirii*resulting from forest management (E.M. Hansen).

74-D-5 Cytology and sexuality of *P. weirii* (E.M. Hansen).

74-D-6 Silvicultural prescriptions for management of stands affected by root diseases (C.D. Leaphart - 142).

76-D-1 An evaluation of *Verticicladiella* in Oregon. (E. Hansen).

76-D-2 Potential of several species of *Phytophthora* for damage to coniferous forests and forest nurseries. (E. Hansen, L. Roth).

76-D-3 A special color infra-red flight will be flown over *Armillaria* infection centers near Mt. Adams in southcentral Washington. The unique part of the flight is that specifications call for a high cloud cover. The resulting shadowless photography gives better resolution of ground surface and reduces shadows which conceal root rot killed trees. (K. Russell).

76-D-4 Simulation of root rot impact in second-growth coastal Douglas-fir stands (PC-40-276) (W. Bloomberg, G. Wallis).

76-D-5 Fertilization and root disruption to control laminated root rot of Douglas-fir. (Thies, Nelson).

76-D-6 Effect of surface-applied and incorporated chipped slash, with and without supplemental nitrogen, on soil microflora and survival of *Phellinus (Poria) weirii* in buried wood cubes. (Nelson).

76-D-7 Effect of N, P and K on survival of *Phellinus weirii* in buried wood (Nelson).

76-D-8 Evaluation of the rate of spread of black stain root disease, *Verticicladiella wagnerii*, in plantations. (D. Goheen).

76-D-9 Evaluation of tree species susceptibility to laminated root rot in eastern Oregon and Washington (G. Filip).

77-D-1 Characterization of zone lines formed on artificial media and in wood by *Phellinus weirii* (C.Y. Li).

77-D-2 Light and temperature induced sporophore formation of *Phellinus weirii* (C.Y. Li).

77-D-3 Effect of lipids on colonization of wood disks by *Fomes annosus* (C.Y. Li).

77-D-4 Soil bacterial populations antagonistic to *Phellinus weirii* in 40-year-old pure alder and pure conifer stands of coastal Oregon (C.Y. Li).

77-D-5 Characterization of a bacterium antagonistic to *Phellinus weirii*, *Armillaria mellea* and *Fomes annosus*. (Anita S. Hutchins).

77-D-6 Identification of site factors associated with *Poria* root disease and rating stands for probability of damage in northern Idaho. (Ralph E. Williams).

77-D-7 Identification of chemical and physical characteristics of minaloosa soils which are highly correlated with high indidence of *Poria* root disease in northern Idaho. (Ralph E. Williams).

77-D-8 Dynamics of *Poria* root disease centers in northern Idaho (Ralph E. Williams).

77-D-9 Airborne spore density of *Fomes annosus* in selected sites in western Montana. (Ralph E. Williams).

E. Foliage Diseases

68-E-1 Needle diseases of conifers (J.M. Staley).

71-E-1 *Elytroderma deformans* - Mortality and growth impact on Jeffrey pines (R.F. Scharpf and R.V. Bega).

74-E-1 Biology of *Gymnosporangium fuscum* in B.C. (B.J. van der Kamp).

76-E-1 Initial observations have been completed on a suspected needle disease (unk) of grand fir which concerns Christmas tree growers. During the summer, 1977, several fungicides will be applied to test for control. (K. Russell).

76-E-2 Evaluation of the growth impact of *Rhabdocline pseudotsugae* on sapling Douglas-firs in western Oregon. (D. Goheen)

76-E-3 Evaluation of the growth impact of *Lophodermella concolor* on sapling lodgepole pines in central Oregon. (R. Harvey)

77-E-1 *Dothistroma pini* resistance in ponderosa pine (G.W. Peterson).

77-E-2 Inheritance of resistance to *Dothistroma pini* in Austrian pine. (Joint with RWU 1501). (G.W. Peterson & D.F. Van Haverbeke).

77-E-3 Investigations of fungus foliar pathogens of *Juniperus* spp. (Andrea Ostrofsky and G.W. Peterson).

77-E-4 Resistance to *Phomopsis juniperovora* in geographic sources of *Juniperus virginiana* and *J. scopulorum* (G.W. Peterson).

F. Stem Diseases Malformations, Witches-brooms, Dwarf mistletoe, etc.

61-F-1 Eradication and thinning studies for dwarf mistletoe control in infected stands in western larch, Douglas-fir and lodgepole pine (E.F. Wicker).

62-F-1 Field cultures with dwarf mistletoe (F.G. Hawksworth and T.E. Hinds).

62-F-2 Ecology of lodgepole pine dwarf mistletoe (F.G. Hawksworth).

62-F-3 Ecology of ponderosa pine dwarf mistletoe (F.G. Hawksworth).

62-F-4 Silvicultural control of ponderosa pine ,dwarf mistletoe (F.G. Hawksworth).

73-F-1 Spread and intensification of dwarf mistletoe in ponderosa and Jeffrey pines in California (R.F. Scharpf, and J.R. Parmeter, Jr.)

63-F-2 Epidemiology of dwarf mistletoes on firs in California (F.R. Scharpf).

64-F-1 Development and pathogenicity of *Hypoxylon fuscum* on northwestern species of alder (*Alnus*) (J.D. Rogers).

65-F-1 The effect of dwarf mistletoe on growth of western hemlock (K.W. Russell).

68-F-1 Silvicultural control of dwarf mistletoe in young lodgepole pine stands (G.A. Van Sickle).

68-F-2 Silvicultural control of lodgepole pine dwarf mistletoe (Dave Johnson, F.G. Hawksworth and T.E. Hinds).

68-F-3 *In vitro* culture of Arceuthobium spp. (E.F. Wicker).

68-F-4 Spread and intensification of dwarf mistletoe in young uni-storied stands of western larch, Douglas fir and lodgepole pine with controlled stocking (E.F. Wicker and C.D. Leaphart).

71-F-1 Growth impact, associated mortality, and spread and intensification of dwarf mistletoe in stands of Douglas-fir, lodgepole pine, and western larch (O.J. Dooling and E.F. Wicker).

71-F-2 Dwarf mistletoe control in rural and suburban residential developments (J.G. Laut).

72-F-1 Simulation of the effects of dwarf mistletoe in ponderosa pine and lodgepole pine stands (F.G. Hawksworth, T.E. Hinds, and C.B. Edminster).

73-F-1 Dwarf mistletoe evaluation in campgrounds (N. MacGregor).

73-F-2 Impact of dwarf mistletoe on Douglas-fir (D.M. Knutson).

73-F-3 Biology of Douglas-fir dwarf mistletoe (D. M. Knutson).

73-F-4 Effects of dwarf mistletoe on yields in ponderosa pine in the Pacific Northwest (J.L. Stewart).

73-F-5 Dwarf mistletoe on hemlock (J.L. Stewart).

74-F-1 Efficacy of induced resin-disease for control of dwarf mistletoes in high value stands (J.G. Laut).

74-F-2 Growth of the endophytic system in *Arceuthobium* (E.F. Wicker, N.E. Martin - 146).

74-F-3 Chemical composition of the mucilaginous covering of dwarf mistletoe seeds (E.F. Wicker - 144).

74-F-4 Tree growth reduction caused by dwarf mistletoe infection (E.F. Wicker, N.E. Martin, J.Y. Woo - 147).

75-F-1 Biology and epidemiology of dwarf mistletoes of Arizona white pines. (R. Mathiasen, F. Hawksworth, R. Gilbertson).

75-F-2 Quantification of rates of spread and intensification of dwarf mistletoe in ponderosa pine stands. (G. Dixon, F. Hawksworth).

76-F-3 Importance of flavonols as chemotaxonomic indicators in *Arceuthobium* and *Phoradendron* (D. Crawford, F. Hawksworth).

76-F-4 Inoculation studies to determine the host ranges of *Arceuthobium campylopodum* and *A. occidentale* in California (W. Mark, R. Scharpf, F. Hawksworth).

76-F-5 Biology and epidemiology of *Peridermium* associated with lodgepole pine dwarf mistletoe (F. Hawksworth).

77-F-1 Evaluation of herbicides as chemical control agents of dwarf mistletoe (Donald M. Knutson).

77-F-2 Dwarf mistletoe loss assessment - Medicine Bow National Forest, Wyoming (D. Drumond, D.W. Johnson, F.G. Hawksworth and O. Dooling).

77-F-3 Assessment of timber volume losses caused by southwestern dwarf mistletoe (*A. vaginatum* subsp. *cryptopodum*) on the Prescott National Forest, Arizona (D. Drummond, MAG, J. Walters R-3).

77-F-4 Impact of Douglas-fir dwarf mistletoe (*A. douglasii*) on Douglas-fir trees in the Southwest (F. Hawksworth, RM, J. Walters R-3).

77-F-5 Evaluation of silvicultural control for dwarf mistletoe (*A. vaginaturm* subsp. *cryptopodum*) in campgrounds (J. Walters).

77-F-6 Implementation of the simulated yield program SWYLD2 in dwarf mistletoe-infested ponderosa pine stands (J. Walters).

G. Stem Diseases - Stains and Decays

63-G-1 A study of *Ophiostomaceae* wood staining fungi in North America (R.W. Davidson).

66-G-1 Hazard in red fir on federal recreational lands in California (L.A. Paine).

72-G-1 Synoptic key to fungi causing decay in spruces in North America (K.J. Martin and R.L. Gilbertson).

72-G-2 Characterization and development of heartwood stain in *Populus trichocarpa* (A.A. Gokhele).

72-G-3 Studies of the host range and control of canker stain *Ceratocystis fimbriata* f. *platani* of plane tree (A.H. McCain).

73-G-1 Decay associated with logging damaged conifers in Oregon and Washington (P.E. Aho).

73-G-2 Tests of wound dressings on artificial injuries on western hemlock and sitka spruce (P.E. Aho).

73-G-3 Decay hazard in advanced regeneration of tolerant conifers in Oregon and Washington (P.E. Aho) (Formerly 49-G-6.)

73-G-4 The role of microorganisms associated with bark beetles attacking conifers (H.S. Whitney). (Formerly 72-G-5).

73-G-5 The biology and pathology of *Polyporus volvatus* (C.G. Shaw).

76-G-1 Incidence, extent and rate of decay associated with grand fir tops killed by the Douglas fir tussock moth (Aho, Wickman).

76-G-2 Evaluation of blue stain penetration and checking in recently killed lodgepole pine in northeastern Oregon (R. Harvey and J. Hodfield).

77-G-1 *Fomes fraxinophilus* stem rot of green ash: incidence and damage (J.W. Riffle).

H. Stem Diseases - Rusts and Cankers

53-H-1 Testing progeny of resistant pines for susceptibility to white pine blister rust in the Inland Empire (R.T. Bingham).

53-H-1 Status-of-control plots (M. Srago and J. Byler).

61-H-1 Streamlining pollination and progeny test methods in breeding for blister rust resistance in western white pine (R.T. Bingham).

61-H-2 Breeding and selection for climatic adaptation in inter-species hybrids, toward accumulation of a pool of rust-resistance genes from other white pines of the world (R.T. Bingham).

66-H-1 Comparative physiology of varieties of western white pine with respect to their reaction to the blister rust fungus (R.J. Hoff).

66-H-2 Level and trend of natural inactivation of blister rust cankers (R.D. Hungerford and C.D. Leaphart).

66-H-3 Persistence of natural inactivation of blister rust cankers (R.D. Hungerford and C.D. Leaphart).

66-H-4 Numbers and kinds of resistance-genes and their relation to rust symptomatology (G.I. McDonald).

66-H-5 Precise estimates of heritability and combining ability of rust resistance (G.I. McDonald).

66-H-6 Development and pathogenicity of *Hypoxylon fuscum* on northwestern species of alder (*Alnus*) (J.D. Rogers).

67-H-1 Etiology of aspen cankers (T.E. Hinds).

69-H-1 Thinning and pruning western white pine to control the blister rust disease (C.D. Leaphart and R.D. Hungerford).

69-H-2 Distribution of blister rust infections in western white pine crowns (R.D. Hungerford).

70-H-1 Amino acid utilization profiles for different isolates of *Tuberculina maxima* (E.F. Wicker).

71-H-1 Seasonal and yearly canker development (R.D. Hungerford).

71-H-2 Cytology and ontogeny of *Cronartium ribicola* (J.Y. Woo).

71-H-3 Forest tree rusts of western North America (Y. Hiratsuka) (formerly 67-H-8 and 67-H-9).

72-H-1 Investigation of natural inactivation of white pine blister rust cankers in Europe (E.F. Wicker).

73-H-1 White pine blister rust (R.S. Hunt).

74-H-1 Rust fungi of Cupressaceae and Taxaceae: taxonomy and life histories (R.S. Peterson).

74-H-2 Free amino acid profiles of aeciospores of pine stem rusts (C.D. Leaphart - 148).

74-H-3 Biology of *Hypoxylon serpens* (J.D. Rogers).

74-H-4 Biology, development, and systematics of *Hypoxylon* and its allies (J.D. Rogers).

74-H-5 Biology of *Cytospora* species causing brown stain in pine logs (J.D. Rogers).

76-H-1 The imperfect stage of *Cenangium singulare* on aspen cankers (T. Hinds).

77-H-1 An evaluation of the growth and fate of comandra rust cankers on lodgepole pine (D.W. Johnson).

77-H-2 Occurrence of fir broom rust (*Melampsorella caryophyllacearum*) on white fir trees in the central and southern Rocky Mountains (J. Walters, R-3, D. Johnson R-2).

77-H-3 Western gall rust: infection and epidemiology in ponderosa pine provenance plantings in Nebraska (G.W. Peterson).

77-H-4 *Botryodiplodia hypodermia* canker of siberian elm: factors affecting fungal growth and disease development (J.W. Riffle).

I. <u>Wilt and Blight Disease</u>

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

74-I-1 Control of Dutch elm disease using vector phermones (Coop. with USFS, NEFES and CSFS, C.B. Helburg, D.E. Leatherman, and J.G. Laut).

77-I-1 Distribution of Dutch elm disease and its principal vector, the smaller European elm bark beetle in Montana urban areas (Oscar J. Dooling, Steve Kohler - MT state).

77-I-2 *Sirococcus* shoot blight damage to western hemlock regeneration at Thomas Bay, Alaska. (FS-INT-RWU-2205-149, Wicker, Laurent, and Israelson).

77-I-3 *Diplodia pinea* tip blight of pines: etiology of stem infections (G.W. Peterson).

77-I-4 *Herpobasidium deformans* blight of honeysuckle: infection and control (J.W. Riffle).

J. <u>Defects and Decays of forest products</u>

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

68-J-1 Deterioration of stored pulp chips in outdoor piles (R.S. Smith).

68-J-2 Role of heartwood microflora in the breakdown of thujaplicin in western red cedar heartwood (B.J. Van der Kamp).

71-J-1 The evaluation of potential wood preservatives--Thiram and Thiram-Oxathiin mixtures (R.S. Smith and Mrs. C.B. Johansen).

71-J-2 An analysis of aspen chip deterioration during outside storage (R.S. Smith and Mrs. C.B. Johansen).

71-J-3 Bioassay of pentachlorophenol within cell walls of Cellon-treated wood (W.W. Wilcox).

72-J-1 Decay and shock resistance of western red cedar transmission pole in service (J.W. Roff and W. McGowan).

72-J-2 Utilization of decayed wood in pulp manufacture (K. Hunt).

72-J-3 Degradation and preservative treatments of western red cedar shingles and shakes (A.J. Cserjesi, R.S. Smith and T. Littleford).

72-J-4 Effect of pathological conditions of properties and utilization of California woods (W.W. Wilcox).

73-J-1 Interaction of fungi and chemicals - pentachlorophenol (A.J. Cserjesi). (Formerly 66-J-2).

76-J-1 Microdistribution and efficacy of preservatives in treated wood and their effects on microorganisms (W.W. Wilcox).

K. Miscellaneous Studies

66-K-1 Ecology of *Tuberculina maxima* (E.F. Wicker).

66-K-2 Nutritional requirements of *Tuberculina maxima* (E.F. Wicker).

67-K-1 Impact of hazardous tree failure on forested recreation sites (L.A. Paine).

67-K-2 Factors involved in mechanical failure of hazardous trees in recreation sites (L.A. Paine).

67-K-3 Effectiveness of hazard reduction programs on recreation sites - losses and various costs of protection (L.A. Paine).

71-K-1 Death and decline of Ohia and Koa forests in Hawaii (R.V. Bega, O.E. Holtzman, and W.H. Ko).

71-K-2 Studies of Rocky Mountain fungi, with emphasis on parasitic fungi (W.G. Solheim).

71-K-3 Taxonomic and cultural studies in the forest fungi (A. Funk).

71-K-4 Species of *Mycospaerella* on Salicaceae in western interior of Canada (H. Zalasky).

71-K-5 Winter injury in poplar - a histological study (H. Zalasky).

71-K-6 Prevention of winter injury to conifers and other hardwoods (H. Zalasky).

72-K-1 The pathology of Ohia decline in Hawaii (R.V. Bega).

72-K-2 Species susceptibility to mechanical failures on recreation sites - replacement of hazardous species (L.A. Paine).

73-K-1 Trees - development and people (K.W. Russell). Objective: to develop a guide on how to do it right for architects, planners, contractors, and homeowners.

73-K-2 Forest disease simulation model (W.J. Bloomberg).

73-K-3 Fungi of Washington state and the Pacific Northwest (R. Chacko, R.A. Blanchette, and C.G. Shaw).

74-K-1 The role of ectomycorrhizas in conversion of nitrogen from inorganic to organic forms (C.P.P. Reid and R. France).

74-K-2 Selection and induction of drought-resistance in trees from ecotypes of the Colorado Front Range: Interaction of tree ecotype with its mycorrhizal symbiant (C.P.P. Reid and M. Cline).

74-K-3 Biological delignification of wood (C.G. Shaw).

76-K-1 Developing guidelines for silvicultural control in immature western hemlock stands PC-40-275 (W. Bloomberg, R. Smith, A. Thomson).

76-K-2 Etiology and importance of a new twig disorder of aspen (C. Livingston, T. Hinds).

76-K-3 Effects of pathogen control on performance of container-grown Douglas-fir seedlings (Thies, Owston).

76-K-4 Evaluation of the rate of deterioration of mountain pine beetle killed lodgepole pine in northeastern Oregon. (R. Harvey, J. Hadfield).

76-K-5 Evaluation of Truban and Banrot for disease control at the Westfir Nursery. (D. Goheen).

77-K-1 Inoculation of containerized Engelmann spruce and lodgepole pine seedlings with ectomycorrhizal inoculum from two potential natural sources and an artificial (laboratory-produced) source for comparison of effectiveness (D. Hildebrand, L.S. Gillman and T.D. Landis).

77-K-2 Evaluation of *Pisolithus tinctorius* inoculum produced by Abbott Laboratories for ectomycorrhizal development in Region Two nurseries (L.S. Gillman and C. E. Cordell, SE Area. A cooperative research venture between USDA, Forest Service, Abbott Laboratories, State Forestry agencies and several Regions of the National Forest System).

77-K-3 Develop a format with which to integrate disease and insect information with biotic, climatic, and edaphic site factors so that potential for damage may be identified and used in the land management planning process. (Ralph E. Williams, Mark McGregor, Oscar J. Dooling).

77-K-4 Use of preseribed fire for fibre management PC-41-302 (S.J. Muraro).

77-K-5 Development of operational use of biological control of forest pests in British Columbia PC-45 (H.S. Whitney).

77-K-6 Evaluation of hazard trees in recreation areas (E. Sharon).

77-K-7 Inoculation of ponderosa pine seedlings with *Pisolithus tinctorius* (J. Riffle, J. Walters, National Nursery Mycorrhizae Evaluation Project).

77-K-8 Biological Decay of Logging Residues. (R.A. Blanchette, S. Dubreuil, M. Mackenzie, R. Chacko, O. Maloy and C.G. Shaw).

77-K-9 Evaluation of *Pisolithus tinctorius* inoculum produced by Abbott laboratories for ectomycorrhizal development on pine species in container and bare-root nurseries in the great plains (J.W. Riffle).

77-K-10 Ectomycorrhizae of container seedlings: production of symbiont inoculum, synthesis of mycorrhizae, and effects on survival and growth of seedlings in field plantings (J.W. Riffle, and R. Tinus).

## NEW PUBLICATIONS

AHO, PAUL E. AND ANITA HUTCHINS. 1977. Micro-organisms from the pith region of suppressed grand fir understory trees. USDA For. Serv. Res. Note PNW-299, 5 p.

AHO, PAUL E., RAMON J. SEIDLER, HAROLD J. EVANS, AND ARTHUR D. NELSON. 1976. Association of nitrogen-fixing bacteria with decay in white fir. Proc., 1st Int. Symp. on Nitrogen Fixation 2:629-640. Wash. State Univ. Press, Pullman.

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WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

DWARF MISTLETOE COMMITTEE REPORT

HIGHLIGHTS OF 1977 DWARF MISTLETOE RESEARCH

John G. Laut, Chairman

1. Taxonomy, Hosts, and Distribution

a. As part of the continuing saga of Arceuthobium south of the border, another paper is in press in "Britonnia". Three new dwarf mistletoes are described, all of which were formerly included under Arceuthobium globosum: A. Globosum subsp. grandicaule subsp. nov. (Mexico and Guatemala); A. aureum sp. nov. subsp. aureum (Guatemala); and A. aureum subsp. petersonii subsp. nov., (Chiapas, Mexico). Arceuthobium guatemalense is recorded for the first time in Mexico. Significant range extensions are recorded for A. abietis-religiosae, A. divaricatum, A. gillii subsp. nigrum, and A. rubrum. New hosts are reported for several taxa. Nineteen members of the genus are presently known from Mexico, and at least 3 (and possibly 4) from Guatemala. (F. G. Hawksworth, RM Station, Fort Collins, and D. Wiens, University of Utah).

b. Analyses of morphological, physiological, and chemical characters of the dwarf mistletoe parasitizing bristlecone pine on the San Francisco Peaks, Arizona, indicate that the dwarf mistletoe is A. microcarpum, not A. cyanocarpum as suggested previously. A. microcarpum causes severe damage in two bristlecone pine stands on the San Francisco Peaks, but only about 12 percent of the bristlecone pine area on the Peaks is affected by the parasite. The probability of A. microcarpum spreading into presently non-infested stands is low. Principal hosts of A. microcarpum on the San Francisco Peaks are Pinus aristata and Picea engelmannii. This is only the second report of a North American dwarf mistletoe parasitizing species in 2 genera as principal hosts. Pinus strobiformis and Abies lasiocarpa var. arizonica are rare hosts, and this is the first report of a dwarf mistletoe parasitizing 4 different host species at a single location. (R. L. Mathiasen, University of Arizona, and F. G. Hawksworth, RM Station, Fort Collins, Colo.).

c. Analyses of morphological, physiological, and chemical characters of the Southwestern and Mexican dwarf mistletoe populations parasitizing Pinus strobiformis as a principal host and currently recognized as Arceuthobium apachecum and Arceuthobium blumeri indicates there are taxonomically significant discontinuities between these populations. Geographically consistent differences in shoot color, growth habit, lateral staminate spike dimensions, and perianth lobe color were detected, but differences in shoot size and perianth lobe number were apparently the result of geographic variation. Several additional morphological characters examined were found to be continuous. Differences in the flowering periods of A. apachecum and A. blumeri may represent a physiological discontinuity, but some geographic variation was detected for this character also. Additional physiological discontinuities were not detected, but chromatographic analysis of these species did detect some chemical differences. Both taxa consistently cause the formation of witches' brooms, contrary to previous reports. The presence of geographically consistent discontinuities between A. apachecum and A. blumeri indicates that these populations deserve taxonomic recognition. Their classification at the subspecific level may be more repersentative of their natural relationship, but until further studies of the Series Campylopoda are completed, A. apachecum and A. blumeri should be retained as species. Both species exclusively parasitize Pinus strobiformis and cause high mortality. The mortality rate in stands heavily infested by A. apachecum was 30 times that of non-infested stands and that for A. blumeri was 20 times greater. (R. L. Mathiasen, University of Arizona).

d. Data are still being collected on the distribution of Arceuthobium in the Pacific Northwest. These data are being sent to Frank G. Hawksworth to improve our general knowledge of mistletoe and host ranges. (Bob Tinnin, Portland State University).

e. Arceuthobium laricis was found infecting western hemlock (Tsuga heterophylla) at Growden, Sherman Creek, Colville National Forest, Washington. We believe this to constitute the first report of this parasite-host combination. (Wicker and Intini, USFS, INT-Station, Moscow.)

II. Physiology and Anatomy

a. A chemo-taxonomic study of the flavonoids is being conducted on the genus Arceuthobium. To date 28 taxa have been examined. The flavonoids in the genus seem to be basically Myricetin-3-O-galactoside (in 17 taxa) and Quercetin-3-3-galactoside (in 23 taxa). Two old-world species examined (A. oxycedri and A. juniperi-procerae) differ from the New World species in having only 3-O-glucosides and no 3-O-galactosides. The Mexican A. verticilliflorum, which is perhaps the most primitive dwarf mistletoe, lacks all 3-O-glycosides. (D. Crawford, Ohio State University, and F. G. Hawksworth, RM Station, Fort Collins, Colo.)

b. Arceuthobium tsugense aerial shoots fix substantial amounts of carbon-14 when exposed to $^{14}CO_2$ for one hour in the light. About 10% of the label was found to be lipid. Apparent (or net) photosynthesis by excised aerial shoots appeared to be 25-30% of the dark respiration rate, suggesting a comparable degree of autotrophy. (Published in Am. J. Botany 62, 765 1975). (J. R. Miller and R. D. Tocher, Portland State University).

c. Owing to the fairly active degree of lipid biosynthesis in Arceuthobium aerial shoots, we have extracted and partially characterized the lipids of several dwarf mistletoes in July and in November. Wax esters and triacyl glycerides predominate. Total lipids represented 4-8.5% of the dryweight in November collections. The triacyl glyceride fatty acids were linoleic (18:2) which made up over 50% of the total, with lesser amounts of oleic (18:1), palmitic (16:0) and linolenic (18:3). The degree of unsaturation increased in the autumn collection. (Hwa Chen, R. D. Tocher, P. J. Paquet, and R. J. Ackman, Portland State University).

d. Still in progress is a study of the infection process of ponderosa pine by A. campylopodum. (Clyde Calvin, Portland State University, Don Knutson, PNW).

e. Seasonal variation in the cytokinin content of two species (A. douglasii and A. tsugense) of dwarf mistletoe and their hosts (Douglas-fir and western hemlock respectively) are currently under investigation. In the case of A. douglasii, aerial shoots and first through fifth internodes of infected and uninfected host tissue are being examined. With A. tsugense I am examining aerial shoots and swellings from infected plants and comparable tissue from uninfected plants. I am employing both GIC and bioassay methods in this study. Results to date will be reported. (P. J. Paquet, Portland State University).

III. Life Cycle Studies

a. Long distance dissemination of dwarf mistletoe in ponderosa pine was studied at the Manitou Experimental Forest, Colorado. Dwarf mistletoe occurrence in an 0.8 km x 4.3 km area was plotted on 1:7920 aerial photographs. Thirty-two infection centers (satellite centers) were found in H2. They were judged to have originated by some means other than or in addition to explosive seed discharge. Satellite centers were 0.1 $m^2$ to 3000 $m^2$ in size and up to 458 m from the nearest inoculum source. They occurred on various topographical sites but never in gulches or similar confined drainages. All but two centers originated from seeds yielding female flowers. In 27 satellite centers, original infections were found. They ranged in age from 17 to 120 years. Birds were mist-netted in or near infection centers during seed dispersal in 1974-1976. A total of 411 birds representing 21 species was trapped. Birds were examined for dwarf mistletoe seeds on feathers and in fecal material. Seeds were found on feathers of mountain chickadees, pygmy nuthatches, gray-headed juncos, a chipping sparrow, and a Williamson's sapsucker. Seeds were found rarely in fecal material and were not viable. Dwarf mistletoe seeds were fed to gray-headed juncos, chipping sparrows, pygmy nuthatches, and mountain chickadees. Whole seeds were voided by the latter two species but were not viable. Tests of seed survival at pH levels and temperatures similar to those encountered in birds' digestive tracts suggest that both factors act to render passed seeds nonviable. Observations made during dwarf mistletoe seed dispersal suggest that birds are struck by explosively discharged seeds and seeds are transferred to pine foliage during subsequent foraging. Mountain chickadees and pygmy nuthatches were the only species observed foraging, apparently for insects, in dwarf mistletoe shoots. Both species were suspected to be important long-distance vectors of the parasite. (G. W. Hudler and F. G. Hawksworth, Colorado State University, and RM Station).

b. Insect and wind pollination of Arceuthobium americanum, A. vaginatum subsp. cryptopodum, and A. cyanocarpum were studied in Colorado. Dwarf mistletoes had 3 to 12 thousand pollen grains per flower; most pollen is shed in clusters of 60 to 100 grains. There was no relationship between the amount of pollen caught on microslides and distance from the closest staminate plant, at least within the first 12 m. Some pollen was dispersed up to nearly 150 m. More than 200 species of insects bearing dwarf mistletoe pollen were identified. About a half dozen species appear to be the principal pollinators of each dwarf mistletoe. An ant, Formica fusca, was the principal pollinator of Arceuthobium americanum. Copidosoma bakeri, an encyrtid wasp, was the principal pollinator of both A. vaginatum subsp. cryptopodum and A. cyanocarpum. Pollination was effected by both insects and wind. (Forest Sci. 22:473-484, 1976. F. B. Penfield, R. E. Stevens, and F. G. Hawksworth, RM Station, Fort Collins).

c. Studies are being conducted with A. americanum on lodgepole pine and A. vaginatum on ponderosa pine to determine the effective distance of mistletoe pollen dispersal. For A. americanum, 65 young lodgepole pine seedlings with only female infections were transplanted in 1977 at various distances from the edge of a 60-acre clearcut. Infested stands surrounding the clearcut will be the only pollen sources. For A. vaginatum we checked the closest pollen source to an isolated tree transplanted into a campground about 30 years ago. The tree had a large, single female infection. This isolated tree set very little fruit (less the 1/20 of 1 percent fertilized) so we searched the nearby stands for the closest pollen source. The closest male plant found was 700 feet but this was a single - poor vigor plant with very few flowers; the most likely pollen source was a group of generally infested trees some 3500 feet west of the tree with the female infection. (F. G. Hawksworth and J. M. Staley, RM Station, Fort Collins).

d. We are half done with the study on broom development of Douglas-fir dwarf mistletoe, including determination of biomass production, and increase in broom size over time. This study is part of a program relating broom size to crown size to determine when a broom becomes a significant-enough nutrient sink to cause crown decline and subsequent diameter growth loss. (Bob Tinnin, Portland State University, Don Knutson, PNW Station).

e. The mode of pollination was studied in two species of Arceuthobium, A. douglasii (in northern Utah) and A. strictum (in Durango, Mexico). Insect visitations to the male flowers of A. strictum were common. Visits were found to be rare, however, to the female flowers and to either sex of A. douglasii. Pollen was found to be consistently liberated by the wind from the well exposed anthers. Air-borne pollen concentration decreased rapidly with distance from the source. No inferences, however, could be made from the data as to dispersal distance. The paucity of insect visitations, the abundance of airborne pollen, and the absence of apomixis (in A. douglasii) were considered evidence for an anemophilous pollination syndrome. The genus as a whole appears to be anemophilous based on the uniformity of the reproductive morphology. The floral characteristics of Arceuthobium were re-evaluated with respect to their suggested role in wind pollination. (Glade Player, University of Utah).

## IV. Host-Parasite Relationships

a. The spread and intensification of Arceuthobium vaginatum subsp. cryptopodum in even-aged and two-storied stands of ponderosa pine in the Arizona, New Mexico and Colorado was examined. Prediction equations for the intensification as a function of the time since initial infection, and the spread as a function of various stand and site parameters, were derived. An equation to predict the proportion of trees infected as a function of the distance from the infection source was also developed. These equations were combined into a simulation model. For several plots tree locations were mapped. Computer programs were written to use these tree locations for generating stem maps. These stem maps clearly showed the circular pattern of spread, the distance of spread, and the relationship between spread and stand density. Separate intensification equations were derived for stands in Colorado, Arizona, and New Mexico. The rate of intensification was fastest in northern Colorado and slowest in northern Arizona. Separate spread equations were developed for even-aged and two-storied stands. Using these equations and growth equations from existing yield models, a simulation model called SPREAD was written. SPREAD will aid forest managers in making decisions concerning dwarf mistletoe-infested stands, and in the evaluation of various management alternatives. Rather than the stand dwarf mistletoe rating (DMR) currently used, a DMR based only upon infected trees is proposed. By knowing the infected trees' DMR, the distance of spread, and the proportion of trees infected within the infested portion of a stand, the amount and intensity of dwarf mistletoe in a stand can be defined. The stand can be separated into infested and uninfested portions which would aid management decisions and timber yield predictions. (G. Dixon and F. G. Hawksworth, RM Station, Fort Collins).

V. Effects on Hosts

a. A report describing infection and intensification of dwarf mistletoe in young western hemlock planted in 1963 around an infected residual tree at Nitinat, Vancouver Island, will appear in an "early" issue of Can. J. For. Rese ch. Infection in the young trees reflected earlier reported seed dispersal patterns. Zones of varying disease intensity are defined and implications of this variation for forest management are discussed. Continuation of measurements in this plantation indicate that 69% of all trees have experienced upward spread since overstory removal in 1969. The average upward spread resulting from the 1974 mistletoe seed crop (and including trees with no advances) was 13.6 cm, still well short of the average tree height growth of 51.2 cm for the same year. (R. B. Smith, PFRC, Victoria).

b. A manuscript is in press, "Effect of dwarf mistletoe on trunk taper of red firs in California". (R. F. Scharpf, PSW Station).

c. A manuscript is in the editor's shop, "Effect of Dwarf mistletoe on growth of released red firs in California". (R. F. Scharpf, PSW Station).

d. 5-year data is in on a study of mistletoe development in thinned, pre-commercial Douglas-fir stands in central Oregon. Stereo pictures, taken over 2 years, will help us to correlate broom patterns to tree growth responses. Analysis and publication expected this year. (Bob Tinnin, Portland State University).

## VI. Ecology

a. Distribution of ponderosa pine dwarf mistletoe (*Arceuthobium vaginatum* subsp. *cryptopodum*) in relation to climatic factors. Abstract of paper presented at the Fourth National Conference on Fire and Forest Meteorology, St. Louis, Missouri, November 1976. Dwarf mistletoe does not occur throughout the entire range of Rocky Mountain ponderosa pine. Distinct northern, upper altitude, and lower altitude limits exist. Temperature, precipitation and relative humidity data were collected from 93 ponderosa pine sites, 51 U.S. Weather Bureau weather stations and 42 U.S. Forest Service fire-weather stations in Arizona, Colorado, Nebraska, New Mexico, South Dakota, Texas, Utah, and Wyoming. The presence or absence of dwarf mistletoe can be predicted fairly accurately from thermal correlation diagrams which relate January and July mean temperatures. Stations with dwarf mistletoe present generally have a greater differential between these two means. Temepratures and relative humidities during certain periods of the year are also useful in delineating distribution. The northern and upper altitudinal limits appear to be cold-temperature related. No dwarf mistletoe was found in stations with a January mean temperature below 6°C. (W. R. Mark, Cal. Poly University, San Luis Obispo, and F. G. Hawksworth, RM Station, Fort Collins).

b. During dwarf mistletoe surveys on the Medicine Bow National Forest in southern Wyoming, additional information was taken to determine the relationship between lodgepole pine dwarf mistletoe intensity/frequency and habitat types. Plots were established at 3 mile intervals along roads throughout the lodgepole pine type on the forest. A recent ecological study of the forest recognizes only 2 habitat types with lodgepole pine - the *Pinus contorta* - *Vaccinium scoparum* and the *Pinus contorta* - *Carex geyeri* communities. Results of our survey are summarized below:

| Habitat type | Number of Plots | Percent with mistletoe | Average DMR Infested Plots Only |
|---|---|---|---|
| *Vaccinium* | 35 | 51 | 3.7 |
| *Carex* | 46 | 76 | 3.0 |

Thus the results of our preliminary study are equivocal: mistletoe frequency (plot basis) was highest in the *Carex* type but intensity of infection was highest on the *Vaccinium* type. (F. G. Hawksworth, RM Station, O. Dooling, R-1, Missoula, D. Drummond, MAG, Davis, and D. Johnson, R-2, Denver).

c. A description of the vegetation on Sisi Butte is in progress. This butte supports a well developed epidemic of A. douglasii west of the Cascade Divide in Oregon. (Rick Brown and Bob Tinnin, Portland State University).

d. A Comparative Distribution Study of Phoradendron juniperinum and Arceuthobium divaricatum, South Rim, Grand Canyon National Park, Arizona. A survey will be conducted to assess the distribution of two mistletoes of the Pinyon-Juniper vegetation type on the South Rim, Grand Canyon National Park, Arizona. The infection densities in relation to host and stand characteristics will be compared for both mistletoes. The main objectives of the study are to determine if the mistletoes are ecologically associated and to identify the relationships that exist between both mistletoes and the Pinyon-Juniper ecosystem. (Alyce M. Hreha and Dr. Darrell J. Weber, Brigham Young University).

e. Data collection on the amounts of fuel present in mistletoe infected and healthy stands of small pole size ponderosa pine has been completed for comparison in a study of interrelationships of fire and dwarf mistletoe. (A. Koonce, L. F. Roth and R. Martin, Oregon State University).

## VII. Control - Chemical

a. Spray treatments of approximately 10 herbicides were effective in causing considerable injury to the shoots of ponderosa pine dwarf mistletoe. Injury to the endophytic system of the parasite was probably not great since resprouting usually occurs to bring about new growth where the old plants had been destroyed. Early applications of the right spray in late March and April injured the mistletoe as did later applications and were apparently slightly less injurious to the pine needles than were summer treatments. This may make possible a certain amount of selectivity. The 3 different concentrations of each of most of the herbicides did not show differences in injury to the parasite that could be assigned to concentration. Bottle injections were somewhat less effective than in 1975 but must be developed further. Butyrac Ester, WBG, 3724, Kuron, 2139, D40 and ActiAid gave the best results of the herbicides that we tested. Treehold and Pruning Paint also have definite possibilities, as do some other asphalt and petroleum distillate compounds tried in 1975. In 1976, repeat tests with the most promising chemicals are being conducted on Arceuthobium vaginatum on ponderosa pine in the field, and on A. americanum in a greenhouse on transplanted lodgepole pines. (Arthur Moinat, Greeley, Colorado, and F. G. Hawksworth, RM Station, Fort Collins).

b. Late summer applications of glyphosate (Roundup) to 6' saplings of lodgepole and ponderosa pine had no effect the following spring on Arceuthobium americanum and A. campylopodum. Application rates were 2, 4, 8, 16, and 32 fl. oz. per acre from 65015 nozzles spaced at 20 inches on the boom. Pressure was 30 PSI and rate of travel 2 mph. All applications contained 0.25 percent Monsanto 0011 surfactant. Early autumn applications of "Roundup" for vegetation control were phytotoxic to 4 year old seedlings of ponderosa pine. Damage appeared at midsummer as growth reduction of new shoots and needles and as premature mortality of 3 and 4 year old needles. Neither shoots nor needles were deformed. (L. F. Roth and M. Newton, Oregon State University).

c. We have begun an evaluation of herbicides and boron compounds to determine whether they are differentially toxic to dwarf mistletoe and whether they are translocated within the infected tree. (Don Knutson, PNW Station).

VIII. Control - Biological

a. As part of a cooperative PL-480 project between the USDA and the Commonwealth Institute of Biological Control in Pakistan, an investigation of the insects associated with Arceuthobium oxycedri and A. minutissimum was made. Only one natural enemy, Comostola inops (Geometridae), attacks A. minutissimum. Of the several species of insects attacking A. oxycedri, Dioryctria taiella was the most destructive and probably a promising biocontrol agent. Prosinitis florivora (Lepidoptera: Blastobasidae) was the most abundant insect on A. oxycedri, but it is apparently not confined to dwarf mistletoe. Of the few natural enemies of other mistletoes belonging to the genera Viscum and Korthalsella, none seemed to be effective. (G. M. Baloch, CIBC, Pakistan, and R. E. Stevens and F. G. Hawksworth, RM Station, Fort Collins).

b. A summary of the hosts and distribution of the fungal shoot parasites of dwarf mistletoe was published as Rocky Mountain Station General Technical Report RM-36, 14 p. 1977. At least eight fungi are known to parasitize dwarf mistletoe shoots in North America. Three of these (Colletotrichum gloeosporioides, Cylindrocarpon gillii, and Wallrothiella arceuthobii) are common and occur on most of the dwarf mistletoes in the western United States. Distribution maps are presented for these 3 fungi. Pestalotia heterocornis and Cylindrocarpon sp. are reported for the first time as dwarf mistletoe parasites. The other three fungi (Pestalotia maculiformans, Metaspheria wheeleri, and Alternaria alternata) are rare or local as mistletoe parasites. Although some of these fungi may decimate dwarf mistletoe shoots and fruits in certain localities in certain years, their overall role in limiting dwarf mistletoes seems to be minor. (F. G. Hawksworth, RM Station, Ed Wicker, INT Station, and R. F. Scharpf, PSW Station).

c. For some time a pine rust similar to Cronartium comandrae has been known to be associated with Arceuthobium americanum on lodgepole pine in the Rocky Mountains. The rust parasitizes pine, but apparently only where dwarf mistletoe infections occur. A Masters project has been started to investigate the biology, host relationships, and life cycle of the rust. (W. Nishijima and Chris Dixon, Colo. State University, and F. G. Hawksworth, RM Station, Fort Collins).

d. Spittlebugs were found feeding on southwestern dwarf mistletoe shoots in three locations of the Apache-Sitgreaves National Forest. Efforts are underway to identify the insect species and to determine the extent of shoot mortality associated with the infestations (J. Walters, USFS, R-3).

## IX. Control - Silvicultural

a. A 10-year progress report on a study of silvicultural control of dwarf mistletoe in young lodgepole pine stands was published as Rocky Mountain Region, FI&DM, Technical Report R-2-10, 12 p., 1977. The results suggest that sanitation to control dwarf mistletoe is feasible in some young lodgepole pine stands. The degree of infestation in the stand, not strictly stand age, is the best criterion to decide whether sanitation is practical. A general guide from this study is that stands with more than about 40 percent of the trees infected are too heavily infected to attempt strict sanitation (removal of all infected trees).

In such stands the high numbers of reinfected trees would necessitate removal of so many trees that stocking would be seriously reduced. In these studies all of the 20-year-old, and most of the 30-year-old, stands had fewer than 40 percent of the trees infected. Most of the 40-year-old stands had more than 40 percent of the trees infected, but in the one that had less than 20 percent infestation, sanitation appears to have been successful. These plots demonstrate the effects of two strict sanitations (removal of all infected trees). Current specifications for dwarf mistletoe control in young lodgepole pine stands recommend thinning to specific growing stock levels, and leaving lightly infected trees, if necessary, to obtain the desired spacing. Studies on the long-term effects of such thinning in stands of various mistletoe intensities are being conducted by the Rocky Mountain Station. (F. G. Hawksworth and T. E. Hinds, RM Station, Fort Collins, D. W. Johnson and T. D. Landis, RM Region, Denver).

b. In the 10-year study of sanitation of infected, young lodgepole pine stands, the final examination of plots in British Columbia has just been completed, and the Alberta plots were examined in 1976. Results will be tabulated and summarized this winter. (G. A. Van Sickle, PFRC Victoria).

c. A cooperative pilot control project and research study was begun in 1977 on the Cleveland National Forest in California - "Reduction of dwarf mistletoe caused mortality of Jeffrey pine by broom pruning". This study was undertaken to see if mortality can be reduced in high value recreational areas by increasing tree growth and vigor through broom pruning. (R. S. Smith, R-5 and R. F. Scharpf, PSW Station).

d. Studies were begun in 1977 to evaluate the efficacy of silvicultural control of dwarf mistletoe on Jeffrey pine on the Plumas N. F. Various combinations of thinning and pruning operations have been conducted over the past 10-20 years on the Plumas in an attempt to "eradicate" dwarf mistletoe. Field evaluations will be made to determine the success or failure of these operations. (J. R. Parmeter, Univ. of California and R. F. Scharpf, PSW Station).

e. A Region 6 Forest Service Manual Supplement was issued to all R-6 National Forests describing dwarf mistletoe management policy. Demonstration plots are being established throughout Region 6 to illustrate proper techniques for managing dwarf mistletoe infected stands. (J. Hadfield, R-6, USFS).

X. Surveys

a. Throughout the West Yellowstone Basin, lodgepole pine occurs in climax, all-aged stands. Arceuthobium americanum occurrence is spotty; casual inspections in July 1976 showed infestation to be either heavy (all trees infected) or nonexistent. A survey in November on two sale areas (2,068 acres) showed only 30 percent (690 acres) of the areas infested. Large dwarf mistletoe-free areas exist in both areas; the option of uneven-aged management is still available to the land manager. Publication: Dooling, O. J., J. D. Bortz, and M. W. Maxwell. 1977. Dwarf mistletoe survey, Hebgen Lake Ranger District, Gallatin National Forest, Montana. USDA Forest Service Northern Region FIDM Report No. 77-13 (O. J. Dooling, R-1 USFS).

b. A special survey in a severely infected 23 acre, 20-year-old western hemlock stand which had just been spaced by the owner indicated that the operation had little value in reducing infection levels. Before and after values are, respectively, 83 and 98 percent of trees infected, 2.5 and 2.1 average infection rating per tree with 19 and 20 infections per tree. Old and current infections have been tagged to observe the effect of stand opening on the relative production of aerial shoots and seeds. (G. A. Van Sickle, PFRC., Victoria).

c. A new computer program (SWSUMMARY) has been developed to summarize field data for input in the simulated yield program SWYLD2 (RMYLD) for use in dwarf mistletoe-infested stands. The SWSUMMARY program prepares stand condition variables from survey data. Stand tables summarize tree density, basal area, and disease incidence by 1-inch diameter classes. Average age and height information, as well as site index data, are summarized. The program input may be entered conversationally by use of a mass-storage file or in batch mode. Unique characteristics of SWSUMMARY include: ease of use, minimal cost, flexibility of output format, and ease of modification. (B. Geils and J. Walters, USFS, R-3).

d. Dwarf mistletoe loss assessment - Medicine Bow National Forest, Wyoming. Objective of this pilot project is to estimate both the incidence of and cubic foot volume loss due to lodgepole pine dwarf mistletoe on the Medicine Bow National Forest. Stage I inventory data together with yield models developed for lodgepole pine, as well as road survey techniques, will provide independent estimates of dwarf mistletoe incidence and volume loss. Plans are operational by 1981 and available to provide loss data for one Region each year thereafter. (D. Drummond, D. W. Johnson, F. G. Hawksworth, and O. Dooling, M.A.G., R-2, RM Station, and R-1, USFS).

XI. <u>Miscellaneous</u>

a. I have seen dwarf mistletoes called many things but I was surprised to find this annotation for an infected tree along a nature trail in Southwestern Colorado, "Many ponderosa pines in this area have horny yellow coral fungi growing from their branches". (R. C. Thobium).

b. An updated FAMULUS master tape, which has over 7100 references, is now operational in Fort Collins and in Berkeley. It contains 2,150 references on <u>Arceuthobium</u>. Last year we filled 55 requests and we have had 50 requests so far this year. A users guide for the system was published as USFS General Technical Report RM-30, 5 p., 1976. We are looking into the possibility of reproducing the index on micro-fiche cards. This could reduce the 1600 pages of printout to about nine 4 x 6 inch cards. (F. G. Hawksworth, RM Station, and R. F. Scharpf, PSW Station).

c. Ph.D Thesis: A spread and intensification model for mistletoe in ponderosa pine. G. E. Dixon, Colorado State University, 135 p., 1976 (see abstract under IV).

d. Ph.D Thesis: Bird dissemination of <u>Arceuthobium vaginatum</u> subsp. <u>cryptopodum</u>. G. W. Hudler, Colorado State University, 82 p., 1976 (see abstract under III).

e. Ph.D Thesis: The taxonomy and epidemiology of dwarf mistletoes parasitizing white pine in Arizona. Robert L. Mathiasen, University of Arizona, 1977 (see abstracts under I).

f. Ph.D Thesis: Pollination and wind dispersal of pollen in *Arceuthobium*. Glade Player, University of Utah, 1976 (see abstract under III).

Additions

IX Control - Silvicultural

Trials to demonstrate and evaluate the use of prescribed fire to control dwarf mistletoe in lodgepole pine stands have been initiated in southcentral British Columbia. Approaches include the use of broadcast burning to:

a) eradicate infected residuals after harvesting.

b) destroy unmerchantable, badly infected stands.

c) eradicate infected understory trees by underburning prior to harvesting (S.J. Muraro, PFRC, Victoria.)

A pre-W.I.F.D.W.C. tour to examine and evaluate lodgepole pine dwarf mistletoe control programs was held from October 13-16. The tour, coordinated by the Can. For. Serv. (John Muraro, Dick Smith, Al Van Sickle) and the B.C. For. Serv. (Alan Vyse), was truly international in flavor with participation from the U.S.A. (Frank Hawksworth and party from Colorado; Fred Baker, Univ. of Minnesota; John Hart, Michigan State Univ.), Sweden (Owe Martinsson), Washington, D.C. (Dan Brown), and Canada (including many B.C. For. Serv. management and protection personnel). Control programs reviewed included eradication of infected residuals by hand and by drag scarification, fringe planting with resistant species, destruction of infected fringe with a hydro-axe, prescribed burning before, after and instead of harvesting and sanitation in immature infected stands. (R.B. Smith and A. Van Sickle, PFRC, Victoria).

I. Taxonomy, Hosts and Distribution

A pre-W.I.F.D.W.C. tour to Horne Lake, Vancouver Island on Oct. 17, was attended by 20 persons. Emphasis was placed on the large area (at least 650 ha.) of shore pine that is subject to infection by hemlock dwarf mistletoe, the contrast in infection levels on the two major hosts (high on pine and low on western hemlock in some areas and the reverse in others) and some statistically significant morphological differences found when mistletoe collected from hemlock was compared with mistletoe growing on shore pine. (R.B. Smith, PFRC, Victoria).

## REPORT: COMMITTEE ON FOREST RECREATION HAZARDS

The committee met at a luncheon meeting on October 19. Fourteen persons attended.

The interest in the Committee and the need for it were discussed. It was moved and seconded that the Recreation Hazard Committee be disbanded, and an effort be made to complete outstanding items. The motion carried.

The outstanding items that should be completed include an outline for training field personnel in tree hazard recognition and evaluation, and a selected list on forest disease hazard problems. It is believed that these items are nearly complete, and will be provided to the WIFDWC membership by the past chairman.

Acting Meeting Chairman

(s) Jim Byler

## Disease Control Committee

## Highlights of 1977 Control Investigations

Kenelm Russell, Chairman

At the committee meeting in Victoria we discussed the following:

1. Pesticide Registration.

    There is a need for new data to substantiate registration requirements on both sides of the border. A panel to review the complexities of registration at a future meeting would be helpful. Space will be provided on future report forms on registration information or progress. More use should be made of minor use labeling. Most chemical control is devoted to non-forest use such as nurseries, Christmas trees, shade trees or other ornamentals.

2. Foliage Diseases.

    There is a great need for registered controls for numerous needle diseases for Christmas tree growers.

3. Root Diseases.

    Control aspects of this group should remain with this committee.

4. Chairman.

    Ken Russell will serve another year.

## I. SEEDLING DISEASES

### A. Charcoal root disease in nursery seedlings

Host: Sugar pine
Causal Organisms: Macrophomina phaseoli
Control: Chemical
Development Stage: Pilot Operational - Field Trial

Tested 3 formulations of Methyl bromide plus chloropicrin (98 + 2) (75 + 20) (67 + 33) applied both in spring or fall. All formulations effective. (M. Srago, A. McCain, R. Smith; USFS R-5, Univ. of Cal., Berkeley).

### B. Phoma needle blight in nursery seedlings

Host: Douglas-fir
Causal Organisms: Phoma spp.
Control: Biological
Development Stage: Field Trial

Nursery beds inoculated with mycorrhizal root tips prior to planting insure seedling infection and good growth. Uninfected seedlings under 2" high are defoliated by Phoma during the winter wet months and up to 90% die. Mycorrhizal infection increases seedling size to where they are unaffected by the loss of lower needles. Test plots are effective. (M. Srago, A. McCain, R. Smith; USFS, R-5 and Univ. of Cal., Berkeley).

### C. Grey molds and others

Host: B.C. coniferous nursery and container seedlings
Causal Organisms: Botrytis cinerea and others
Control: Chemical or Cultural
Development Stage: Full Operation to In Vitro

Some control recommendations using fungicides and selected cold storage temperatures have been implemented with considerable success. Studies of Benlate resistence and temperature responses are continuing. (J.C. Hopkins; P.F.R.C.).

### D. Botrytis grey mold in container seedlings

Host: Sequoia sempervirons
Causal Organisms: Botrytis cinerea
Control: Chemical
Development Stage: Field Trial

Chlorothalanil and dicloram provided the best control. Captan, thiram, basic copper sulfate and mancozel were less effective. The Botrytis present is tolerant to benomyl. (A. McCain; Univ. of Cal., Berkeley).

## II. FOLIAGE DISEASES

A. Phaeocryptopus spp. on grand fir
Host: *Abies grandis*
Causal Organisms: *Phaeocryptopus gaumanni*
Control: Chemical
Development Stage: Field Trial

Experiment is continuing. Fungicide trial will be evaluated winter 1977-78. More trials next summer. (K. Russell; WDNR, Olympia).

B. Swiss needlecast on Douglas-fir
Host: *Abies grandis*
Causal Organisms: *Phaeocryptopus gaumanni*
Control: Chemical
Development Stage: Field Trial

Experiment was established using four fungicides. Determined spore release occurs in mid fall. Inoculation tests under way in greenhouse. Fungicides to be evaluated fall 1978. (K. Russell; WDNR, Olympia).

C. Rhabdocline needlecast and Swiss needlecast
Host: Douglas-fir
Causal Organisms: *Rhabdocline weirii*, *Phaeocryptopus gaumanni*
Control: Chemical
Development Stage: Field Trial

Detection evaluation or impact and control. See PDR, Sept. 1977. Three to five year summary on both diseases forthcoming in 1978. Registration being sought after 1977-78 evaluation. Used maneb, chlorothalonil, benomyl, ferbam, bordeaux. (H. Morton; Univ. of Mich.).

## III. STEM DISEASES AND WILTS

A. Dutch elm disease
Host: American elm
Causal Organisms: *Ceratocystis ulmi*
Control: Chemical - Biological
Development Stage: Demonstration Trial

Under a federally funded program, total integrated control demonstration trials will be established in four Colorado cities. Sanitation of vector brood wood and diseased trees, chemical prevention using methoxyehlor against vectors and MBC-P versus fungus and root graft treatment will be carried out. Demonstration of elm utilization will be included. (M. Schoemaker; Colo. St. Forest Service).

B. Dutch elm disease
Host: *Ulmus* spp.
Control: Chemical
Development Stage: Pilot Operational

A comparison of "root flare" versus trunk injection revealed that districution of carbendazim and thiobendazole in the crown was better with trunk injections. (A. McCain; Univ. of Cal., Berkeley).

C. White pine blister rust
Host: *Pinus monticola* natural stands
Causal Organisms: *Cronartium ribicola*
Control: Chemical
Development Stage: Field Trial

Chemical control poor, but benomyl is statically the best, when applied in the spring. (R. Hunt; P.F.R.C.).

D. Cytospora abietis canker
Host: *Abies concolor* in natural stand
Causal Organisms: *Abietis concolor*
Development Stage: Full Operational

Prescription is being written. (E. Wood; USFS, R-5, Berkeley).

## IV. ROOT DISEASES

A. Armillaria root rot
Host: Ponderosa pine natural stands
Causal Organisms: *Armillaria mellea*
Control: Biological - Silvicultural
Development Stage: Full Operational

We are in the final stages of developing a field guide for management of infected stands. A combination of species selection, special marking and stump removal is used. The first large (500 acre) timber sale has been marked. (K. Russell; WNDR, Olympia).

B. *Fomes annosus*
Host: Western hemlock natural stand
Control: Biological
Development Stage: Field Trial

Successful colonization of hemlock stumps by *Polyporus virsicolor*, *Haematostereum sanguinolentum* and *Hematoloma capnoides*. (D. Morrison; P.F.R.C.).

C. Fomes annosus
Host: Western hemlock natural stands
Control: Silvicultural
Development Stage: Field Trial

1. Thinning trial area: three foot stumps left in stands when approximately 3000 stems-per-acre are reduced to 800.
2. Conducting field survey of F. annosus incidence using gas powered drill (12 lb). Incubating chips. (H. Blair; Quinault DNR).

D. Root diseases
Host: Douglas-fir and western hemlock in natural stands and plantations
Causal Organisms: P. weirii and F. Annosus
Control: Chemical - Biological
Development Stage: Field Trial - In Vitro

Use of sewage sludge to control root rots in clearcuts and existing stands. Preliminary results of lab studies and field trials of buried blocks showed some control is possible. (R. Edmonds; Univ. of Wash.).

E. Root rot complex
Host: Western conifer natural stands
Causal Organisms: P. weirii, A. mellea and others
Control: Silvicultural
Development Stage: Field Trial

Stump removal by high explosives in selected centers of grand fir, lodgepole pine and subalpine fir appears feasible. (A. Partridge; Univ. of Idaho).

F. Laminated root rot in natural stands and plantations
Host: Western conifers
Causal Organisms: Phellinus weirii
Control: Silvicultural
Development Stage: Pilot Operational - Field Trial

Several long term experiments have been established in the field. (W. Thies; USFS, Corvallis).

## BUSINESS MEETING MINUTES

The business meeting of the 25th WIFDWC was called to order by Chairman Graham at 11:00 AM, October 21, 1977, in the Imperial Inn, Victoria, B.C.

The minutes and treasurers report as printed in the Proceedings of the 24th meeting were approved.

Old Business and Committee Reports

-Moved, seconded and approved to disband the Air Pollution Committee.

-Moved, seconded and approved to disband the Forest Hazard Committee. The Executive of 26th conference was directed to contact Peter Gaidula regarding any unfinished business (see committee report following).

-Dwarf Mistletoe Committee met at lunch October 18. The annual report was presented (see following the minutes). Bob Scharpf reported on the upcoming Symposium and received input from the members.

Frank Hawksworth reported on present status of FAMULUS.

Dick Smith reported on some simulation studies being done at the PFRC, Victoria.

-Disease Control Committee met at lunch October 19. The committee report follows the minutes.

-Forest Root Disease Committee had its founding meeting at lunch October 18. Charlie Driver was elected.

Historian, Gordie Wallis is still looking for contributions that pertain to the life and times of WIFDWC. He noted that each year the Secretary should send correspondence etc., of even remotely historical value to him. Members are urged, especially, to send copies of photographs and anecdotes so that a continuing photo album can be put together. Wicker suggested such an album be brought, each year, to the meeting.

Interim Program Chairman, Jim Walter's report follows the minutes. Of particular note - he received many favorable comments on the scheduling of committee meetings at lunch time. This was a successful innovation and is recommended to future local arrangement people.

Honorary Membership. It was pointed out that since the 12th conference, and confirmed at later meetings, honorary membership is automatically bestowed on members when they retire from principle employment as pathologists and that no election is necessary. Neil MacGregor and Ed Andrews have therefore been "promoted" to Honorary Life Members of WIFDWC.

Forest Pathology Education. Frank Hawksworth reported that Harry Powers, on behalf of the S.A.F. committee on Forest Pathology is conducting a nationwide survey, via questionnaire, on the status, quality etc., of pathology education in U.S. Forestry Colleges. Members are urged to cooperate when contacted.

Meeting Sites. A lengthy discussion on the 1978 meeting place and time was held. Of special importance was the relation of WIFDWC to the 1978 APS meeting at Tucson. Ed Wicker reminded the membership that traditionally the specific site and time of our meeting is at the discretion of the host group and the new executive. Given this perogative, discussion is suggestive and for guidance only. Wicker went on record as strongly objecting to any move to make WIFDWC a satellite of APS, or any other organization even temporarily. APS must not be allowed to influence the conduct of our meetings. These sentiments were given solid accord by the members.

Bib Gilbertson, representing the host group outlined his intentions of having WIFDWC in Tucson, the week preceeding APS, perhaps starting on Wednesday, October 25 (APS is October 29 - November 2) so that those wishing to participate in APS can stay. It was moved, seconded and approved that the preceeding discussion is guidance only for the arrangements.

Larry Weir, along with the Governor of Oregon, the Mayor of Salem, the Director of the Chamber of Commerce Convention Bureau and Kathleen invited WIFDWC to hold the 27th meeting (1979) in Salem, Oregon. There being no other invitations Salem was unanimously approved.

Correspondence. The Chairman read a note of well-wishing from Life Member Hal Offord and also noted that, through correspondence received, Rudolfo Salinas is alive and well in Mexico City. Chairman noted that hopefully we may have some Mexican attendees at Tucson next year.

It should also be recorded that during the banquet a letter expressing regrets that her attendance at the function could not be arranged this year, was received from the Office of Queen Elizabeth II. We toasted her anyway.

New Business. None

Election of Officers. For the first time, at least within the recollection of this Secretary, a slate of candidates (6) for chairman was presented. With no experience to guide us it was decided to have a preliminary vote, by show of hands, and a run-off between the top two candidates. The end result was that Richard S. Smith, Jr. (Berkeley Dick) was elected to chair the 26th conference.

The railroad got back on the track with the unanimous selection of Dave Drummond as Secretary-Treasurer.

There being no further business the meeting was adjourned at 12 Noon (more or less).

WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

TREASURER'S REPORT

| | |
|---|---|
| Balance on hand following 24th meeting | $ 232.52 |
| Total interest paid July 1, 1977 to September 30, 1977 | $ 3.59 |
| TOTAL | $ 236.11 |

Expenses Twenty-fourth WIFDWC Meeting

| | |
|---|---|
| Twenty-fourth proceedings printing (partial cost only; used entire 24th meeting balance to help pay for proceedings, November 30, 1977) | $ 236.11 |
| Balance from Twenty-fourth meeting, November 30, 1977 | $ 0.00 |

Receipts Twenty-fifth WIFDWC Meeting

Note: All receipts and expenses show Canadian dollars except proceedings printing entry. Balance entries show American dollars.

| | |
|---|---|
| Registration (102 persons) | $ 2116.00 |
| Total | $ 2116.00 |

Expenses Twenty-fifth WIFDWC Meeting

| | |
|---|---|
| Conference room rentals | $ 289.00 |
| Committee lunches | $ 385.00 |
| Field trip | $ 280.00 |
| Banquet | $ 822.00 |
| Information center operation | $ 96.00 |
| Miscellaneous and tips | $ 146.00 |
| Total | $ 2018.00 |

| | |
|---|---|
| Balance from twenty-fifth WIFDWC meeting (2116.00-2018.00) | $ 98.00 |
| *Balance November 30, 1977 TOTAL | $ 151.12 |

*Shows $53.12 gain in exchanging from Canadian to American dollars because the banquet bill was paid in American dollars.

Deposit held: Washington State Employees Credit Union
P.O. Box WSECU
Olympia, WA 98507
Account No. 936258

AFFIX PFRC FILE No. 1180-38/118
(when completed
return to C.R.
for filing)



BUCKINGHAM PALACE

7th July, 1977

Dear Mr. Hunt,

I am commanded by The Queen to thank you for your letter about Her Majesty's visit to Canada in the autumn.

I fear Her Majesty will only be visiting Ottawa at this time and will not therefore be passing through Victoria. The Queen hopes nonetheless that you will have an enjoyable celebration.

Yours sincerely
Robert Fellowes

Richard Hunt, Esq. RLM July 18/77

Copy to Mr. Macdonald

# INTERIM PROGRAM CHAIRMAN'S REPORT

James W. Walters

The following topics were suggested for the 1978 WIFDWC:

1. An update on the Westwide Dwarf Mistletoe Loss Assessment Group - 1977 results and 1978 progress.
2. Report on Third International Congress of Plant Pathology.
3. A panel discussion of "Forest Pathology in Mexico."
4. A panel on habitat-type-forest disease relationships (e.g., Douglas-fir dwarf mistletoe in various habitat types).
5. Report on the registration process for fungicides/insecticides (i.e., perhaps with a humorous touch).
6. What's new with *Fomes annosus*?
7. Identification and control of *Elytroderma deformans*.
8. Occurrence and effects of non-biological diseases in the forest ecosystem (e.g., lightning, chloride toxicity, sunscald, winter injury, air pollution).
9. Detection of fir broom rust by aerial survey/photography.
10. The need for dwarf mistletoe tree resistance breeding program similar to that of white pine blister rust.
11. A three-member panel on biological control of forest diseases (introduction and perspectives, biocontrol of several major forest diseases, innovative approaches and the future of biocontrol).

Program Suggestions

1. Continue committee meetings during extended lunch periods (1½-2 hours). A brief agenda of committee meeting topics was suggested.
2. Participants bring at least 100 copies of their "new" "active" and "terminated" projects list.
3. Eliminate oral description of above list from WIFDWC meeting <u>or</u> assure only titles, personnel, and objectives are given.
4. Provide more space and improved format for publication sign-up (i.e., put unit names over project lists).
5. Encourage more use of display tables.
6. Provide meeting rooms with adequate ventilation.
7. Registration Social - provide larger room and encourage attendance; may continue honor-system beer format to assure relaxed atmosphere.

## WIFDWC HONORARY LIFE MEMBERS

Stuart Andrews
Warren V. Benedict
Richard T. Bingham
Thomas S. Buchanan
Toby W. Childs
Ross W. Davidson
David E. Etheridge
Lowell J. Farmer
Raymond E. Foster
John R. Hansbrough
Homer J. Hartman
George M. Harvey
Dwight Hester
Benton Howard
James W. Kimmey
Charles D. Leaphart
Paul C. Lightle
James L. Mielke
Douglas Reed Miller
Alex C. Molnar
Virgil D. Moss
Harold R. Offord
Clarence R. Quick
Jack W. Roff
William G. Solheim
Phillip Thomas
Conrad P. Wessela
Ernest Wright
Bratislav Zak
Wolf G. Ziller

### New Life Members

Ed Andrews
Neil McGregor

## SOCIAL ACHIEVEMENT AWARD WINNERS

| 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 |
| 21 | Estes Park | Tom Laurent |
| 22 | Monterey | Bob Bega |
| 23 | Missoula | Art McCain |
| 24 | Coos Bay | None Awarded |
| 25 | Victoria | Ray (Founder) Foster |

WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

Membership List

*Registered at 25th WIFDWC, Victoria **Guests

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