

PROCEEDINGS OF THE 45th ANNUAL WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

**Prince George, British Columbia
September 15-September 19, 1997**



Proceedings of the 45th Annual Western International Forest Disease Work Conference

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**Compiled by:
Rona Sturrock
Pacific Forestry Centre
Victoria, British Columbia**

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Western International Forest Disease Work Conference

45th Meeting - September 15 - 19, 1997

Prince George, B.C.

Program

Monday - September 15

1:00 - 5:00 pm Workshop: Using the Western Root Disease Model (vers. 3.0) - Bowron Room
4:00 - 7:00 pm Registration - Catering Foyer
7:00 pm ⇒ No-host social - Catering Foyer

Tuesday - September 16

7:00 - 8:30 am Rust Committee Breakfast - Winston's Dining Room
7:30 - 8:30 am Registration and Poster setup
8:30 am Chairperson's Welcome - Tabor Room
8:45 am Local information
9:00 - 11:30 am Brief Regional, University, Provincial etc. reports
(10:15 - 10:45 am) Coffee
(10:45 am) Keynote Address - Janna Kumi (Assistant Deputy Minister - Operations Division, British Columbia Ministry of Forests, Victoria, B.C.)

11:30 am - 1:00 pm Hazard Tree Committee Lunch - Winston's Dining Room

1:00 - 3:00 pm **Panel: Boreal Disturbance Ecology.** Moderator - Paul Hennon (USDA Forest Service, Juneau, Alaska) - Tabor Room

Effects of climate on ecological effects of fire at multiple scales. Craig DeLong (B.C. Forest Service, Prince George, B.C.)

Fire and disease interactions. Brad Hawkes (Canadian Forest Service (CFS), Victoria, B.C.)

Spruce beetle and root pathogens as disturbance agents in sub-boreal spruce forests of central British Columbia. Staffan Lindgren (University of Northern British Columbia (UNBC), Prince George, B.C.)

Patterns of vegetation response to biotic disturbance in northern forests. Phil Burton (Symbios Research and Restoration, Smithers, B.C.)

3:00 - 3:30 pm Coffee Break

3:30 - 5:00 pm **Special Papers.** Moderator - Rona Sturrock (CFS) - Tabor Room

Responses of the black stain root disease insect vector *Hylastes nigrinus* to Douglas-fir pruning in southwest Oregon. Brennan Ferguson (Oregon State University, Corvallis, OR)

Canker diseases of Pacific Madrone (*Arbutus menziesii*). Marianne Elliott (University of Washington, Seattle, WA)

A comparison between western root disease model predictions and real data. Susan Frankel (USDA Forest Service, San Francisco, CA)

7:00 pm ⇒ Ice-cream Social and Poster Session

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Wednesday - September 17

7:00 - 8:30 am Dwarf Mistletoe Committee Breakfast - Winston's Dining Room

8:30 am - 5:00 pm Field Trip - East of Prince George, Bowron River

Thursday - September 18

7:00 - 8:30 am Root Disease Committee Breakfast - Winston's Dining Room

8:30 - 10:00 am **Special papers. Moderator - Dan Bernier (Bio-Geo Dynamics, Prince George, B.C.) - Nechako Room**

Permanent plots for studying the spread and intensification of larch dwarf mistletoe and the effects of the parasite on growth of infected western larch on the Flathead Indian Reservation, Montana: results from the five-year re-measurement. Jane Taylor (USDA Forest Service, Missoula, MT)

Incidence of butt rot in two consecutive rotations of *Picea abies* in southwestern Sweden. Gudmund Vollbrecht (Southern Swedish Forest Research Centre)

10:00 - 10:30 am Coffee Break

10:30 am - 12:15 pm **Panel: Mixedwood Management and Forest Health. Moderator - Suzanne Simard (B.C. Ministry of Forests, Kamloops, B.C.)**

Intensive management of young mixed forests: effects on forest health. Suzanne Simard (B.C. Ministry of Forests, Kamloops, B.C.)

Influences of paper birch (*Betula papyrifera*) on microbial communities in soil and their possible implications for Armillaria root disease of conifers. Tom Forge (Lakehill Applied Soil Biology, Kaleden, B.C.)

A comparison of rhizosphere bacterial populations in conifer, broadleaf and mixedwood stands: could Pseudomonads play a role in reducing incidence of Armillaria root rot? Rhonda DeLong (UNBC)

Mixedwood management and forest health: lessons from the mixed conifer forests of Idaho. Jim Byler (USDA Forest Service, Missoula MT)

12:15 - 5:00 pm Field Trip - Southwest of Prince George, Pelican Forest Service Road

6:00 pm ⇒ Banquet UNBC - Upper cafeteria

Friday - September 19

8:00 - 10:00 am **Panel: Forest Practices and Long Term Forest Health. Moderator - Hadrian Merler (B.C. Ministry of Forests, Kamloops, B.C.)**

Forest health in British Columbia: after the forest practices code. Stefan Zeglen (B.C. Ministry of Forests, Nanaimo, B.C.)

Tower of Babel [A philosophical discussion of forest health and related terms]. Bart van der Kamp (University of British Columbia, Vancouver, B.C.)

Challenges associated with root disease management in western Oregon. Ellen Michaels Goheen (USDA Forest Service, Central Point, OR)

Five steps to healthy ecosystems. Craig DeLong (B.C. Ministry of Forests, Prince George, B.C.)

10:00 - 10:30 am Coffee Break

10:30 am - 12:30 pm Business meeting - Nechako Room



Richard Reich.



Kathy Lewis and Jim Arthurs.

CHAIRPERSON'S OPENING REMARKS

Walt Thies
USDA FS, PNW Research Station
Corvallis, OR

Good morning and welcome to the 45th Western International Forest Disease Work Conference.

I would like to extend a special welcome to those of you who are attending for the first time. This conference is very informal and we encourage your questions and discussion throughout the meeting. It is our goal that by the end of the first coffee break no one will still feel like a visitor. We expect fewer participants this year than normal, but we hope the smaller group size will increase audience participation.

It is good to be back in beautiful British Columbia. The conference has been here 11 times in its 45-year history. This is one of the few areas where the colorful travel brochures are an understatement of the natural beauty and where local folks have raised hospitality to an art form.

Prince George is a good choice for this conference. This is the most northerly location in British Columbia for our meeting and will give us a chance to look at and talk about boreal ecosystems. Prince George has a long history. The area was settled over 200 years ago and existed primarily as a trading center until logging started in the late 1800s. The town grew slowly until the 1960s when pulp mills were built; the population then grew from 15,000 to 50,000 in a decade. Today it is the fourth largest city in the Province with a population of 75,000. Some feel that the city wasn't really complete until the Cougars ice hockey team moved its franchise here 3 years ago.

Prince George has many things of which to be proud: It is the home of a new university, the University of Northern British Columbia, which boasts an outstanding forestry school. It has a fine park system that includes 120 parks within the city limits. It has at least 36 major festivals or special celebrations each year, including the Sand Blast in summer—skiing on sand—and the Prince George Iceman in winter—a challenge that includes skating, cross-country skiing, running, and swimming. Perhaps the event should be called the Iceperson, with Kathy Lewis, a member of this conference, a five-time winner. Perhaps the early history of this conference preceded us; the city council recently announced the completion of a \$46 million jail and \$26 million court house.

The fact that we are here and the conference has started is testament to the hard work of this years organizing committee, let me introduce them: Kathy Lewis—program chair, Richard Reich—local arrangements, Rona Sturrock—Secretary, and John Schwandt—treasurer. I have asked Pete Angwin to be our interim program chairman, so during the week please share your ideas for future meetings with Pete.

It is not unusual for a forest pathologist to work in the western United States or British Columbia for 35 or 40 years. While this offers needed stability, times change and the continued viability of our profession is dependent on an influx of new blood—the graduate students and new hires provide that.

There is another group that we would also like to recognize [Honorary Life Members introduced]. WIFDWC is fortunate in having many of our retired members continue to attend our conference. Like the rest of us, they are here to learn and keep up on what is happening with forest pathology in the west. For the rest of us, their presence and willingness to share is a priceless resource. Although we publish papers and write reports, ours is still largely an oral tradition with a considerable amount of significant information left unwritten. Through discussion we pass along valuable observations and experience. I encourage each of the graduate students and new hires to take note of the Honorary Life Members and make a point this week of spending some time with each one. Introduce yourself, get to know them, pick their brain for some of that unrecorded information and opinion; it will be time well spent.

I do not consider myself either old or ready for retirement, but thinking about the newcomers has made me aware of the passage of time. I started Federal service in 1969 and began with the Forest Service and attended my first WIFDWC in 1973. About that time our older than average graduate student, was just starting to discover girls, most of the graduate students were beautiful preschoolers, and a few were just a concept. It started me thinking about the way things were

when I attended my first WIFDWC in 1973, 24 years ago, and changes in our profession since then. Where I am going with this is that I am optimistic about the future of forest pathology in the West; I see this as a unique time for our profession; there are more of us, we have more capability, more respect, more influence, and more challenges than ever before. This is an exciting time to be working in forest pathology and an excellent time to be just starting in the profession. WIFDWC and our profession have grown, evolved, and changed with the times I believe that we can provide more and better service now than when I started. Let me offer examples in a few general areas to support my point.

Job opportunities: There are more jobs available for forest pathologists now than 25 years ago. In 1973, the B.C. Forest Service had 3 forest pathologists; now there are at least 23. By my count, in the Western United States, the number of jobs for forest pathologists has at least doubled in the same time. There has been an obvious shift in the kinds of jobs; there are fewer research positions in the Federal labs and universities but many more jobs in direct technology transfer, extension, and consulting. Regions 5 and 6 of the U.S. Forest Service are examples: in 1973 there were 6 forest pathologists but by 1997 there were 16. In the same time the Pacific Northwest Research Station and the Pacific Southwest Research Station went from a total of 9 research plant pathologists to 3 and UC Berkeley lost all 3 research faculty positions. In British Columbia, the number of research positions remained about the same. Overall the number of positions for forest pathologists in the West is increasing.

Diversity: Our profession was male dominated in the past; for example, we list 97 Honorary Life Members of this conference, but only one is a woman. That is changing. Of the professional forest pathologists attending WIFDWC in 1973, 4 percent were women, by 1996, that was up to 32 percent. We can argue about the reasons for change or the rate of change, but I think we can agree on two points: The change is moving in the right direction, and our profession and WIFDWC are much the better for it. Additionally, in the past there was a stereotype for many forestry-related professions; now we seek diversity in age, gender, race, skills, and interests.

Technology : Through technology, we have all become more efficient and our productivity has increased. In 1973, you were high tech if you had an electric typewriter; letters and manuscripts were typed and if changes were needed, everything was retyped. Now, computers remove a lot of that drudgery from our jobs and let us complete many paperwork tasks more quickly and communicate more effectively. In 1973, it would have taken two of us almost 3 weeks to collect the heights of 1,400 40-year-old Douglas-fir; last month we did that task in 3 days using a laser survey instrument. In 1973, we used a staff compass and chain to lay out grids and plots, and a 15-acre study area would require four of us working 4 weeks. Now the same tasks can be done by three people in a week. In 1973, if you were starting on a new topic, a thorough literature search might take 3 to 4 weeks in a well-stocked library. Today that same task can be done in 20 to 30 minutes. It would not be unfair to say that today a new hire pathologist can accomplish three to five times as much per week as I could when I was first hired. Now, that is a humbling thought.

The profession: The nature of our jobs as forest pathologists and the public awareness of forest diseases have changed dramatically since I started. In 1973, forest pathologists were asked to identify causal agents after damage was done and occasionally asked our opinion as to corrective measures. Now we are asked how to manage forest diseases, to participate as a full partner in long-range planning, and to help make natural resource policy. In 1973, diseased trees were viewed as a bad aspect depending on the desired outcome. Today managers are concerned about the impact loss; disease now is seen as part of a larger process, a natural part of the ecosystem with both good and bad aspects on many things such as succession, increased fire risk, carbon recycling, and soils, to name but a few. Both foresters and the public are now more aware of forest diseases; for example, in 1973 few forest managers in the Pacific Northwest knew anything about laminated root rot, but now few forest managers are unaware of this disease. Rona Sturrock and I printed the laminated root rot manual in July 1995, within 16 months approximately 8500 copies were distributed. Most were requested by foresters, small land owners, arborists, city planners, and homeowners living at the forest urban interface as well as those in urban areas with big conifers in their yards. In the past, the public just accepted changes brought about by diseases and insects, but that is no longer the case. Forest health is now seen as a reason for managing. In 1973, newspapers and magazines seldom mentioned forest disease, a few articles per year at best. Now forest health, insect, and diseases are mentioned weekly and often daily.

As a net result of these changes, our profession is stronger. This is an exciting time to be working in forest pathology whether just starting out or at a later career stage. In many ways, these are the good old days.

WIFDWC 1997

As we participate in this conference, learning and sharing, let us make a special effort to learn from the retired members. They sponsored their own trips and some came a long distance; I encourage you to take advantage of the opportunity to learn from them. Let us also make a special effort to get to know the newest members of our profession and seek ways to help them get off to a good start.



Walt Thies (left, foreground) and colleagues listening attentively to Kathy Lewis.

KEYNOTE ADDRESS

Janna Kumi, RPF
B.C. Ministry of Forests, Victoria, B.C.

I thank you for the opportunity to be with you this morning and for the invitation to address the 45th Western International Forest Disease Work Conference here in Prince George.

On behalf of the British Columbia Forest Service, I extend greetings to this international group of forest pathologists, who come from Mexico up through the western United States and Canada. We wish you every success for this conference, and for your continuing efforts to develop effective forest management practices that prevent or reduce disease impacts to our forest resources.

To some of you here, I hope I am not a stranger. I was once a member of WIFDWC and had pleasure of organizing the local arrangements for the 1987 conference at Nanaimo, B.C. I am sure some of you old timers will remember that event. The mayor of Nanaimo, that swash buckling pirate - Black Frank - joined us in his full regalia that evening, and the characteristic WIFDWC call was performed several times. I hope some of you still aim to perform that ritual sometime during this conference.

The point I really want to make is that I truly appreciate the amount of effort that it takes organizing and hosting these work conferences. This is one of the most valuable working organizations of foresters and scientists in western North America, and the Forest Service has supported this conference for many years. And we are proud to have been part of its success.

My own personal regret is that I am now so far removed from forest pathology, which is a shame. I don't know if I should say this, but there is a certain amount of comfort in seeing my old friends Armillaria, Black Stain and mistletoe still on the agenda. I'm sure knowledge about them has increased leaps and bounds. I can tell you, that when I'm on the occasional field trip, I still check tree tops for root rots.

I am far removed, but I'm not disinterested in your work and progress.

Forest health, including disease management, is a major component of our forest management and, consequently, of our Forest Practices Code. As head of the Division responsible for implementing the Forest Practice Code on the ground, I am keenly interested in how we integrate disease management within the context of sustainable use.

Because that is what the Code is all about - sustainable use. And the Code expects us to achieve sustainability by:

- balancing the productive, spiritual, ecological and recreational values;
- conserving biological diversity, soil, water, fish and wildlife, and other forest resources;

while:

- managing forests to meet our needs today without compromising future needs;

by:

- providing stewardship based on a land ethic.

Of course, these concepts are recognized immediately by our American colleagues in the audience, as part of the philosophy of Aldo Leopold which he wrote about in his Sand County Almanac. The goal for all of us is how to articulate these grand concepts into actual forest management practices on the ground.

What makes that task particularly challenging in B.C. is:

- the vast size of this province - 95 million hectares or almost 240 million acres;
- about half supports productive forests but only a quarter is considered harvestable;
- 95% of the province's forest land is owned by the crown;

- we have a population of only 3.8 million - that's a very small tax base and a large area requiring services;
- because of our long indented coastline, several mountain ranges and great plateau's and plains, the province has great biological, cultural and geographic diversity, and includes an extraordinary diversity of both water and land-based ecosystems;
- we have very large areas of original forests, which give us lots of planning options and opportunities for conservation. They also present us with difficult management choices and make us the centre of world attention.

And lastly:

- we are very dependent economically on our timber harvest. Wood, paper and allied products make up over half the value of B.C.'s manufacturing shipments. About 15% of B.C.'s total employment is in the forest industry.

So you can see that the economically derived social benefits are very important to B.C. We have found that defining sustainability, on the ground, has not been easy.

To review, we have a valuable forest resource on which we must integrate the management of timber harvest, wildlife, fisheries, range and forage, recreation, botanical forest products, domestic and community water supplies, scenic areas, cultural and heritage resources - and in all of this we must conserve biodiversity and not forego future options

So how do we manage to assess a desired amount of each forest value and then set and attain appropriate objectives that are publicly acceptable? We have found that the only way is through a lot of public input.

To achieve this, the B.C. Government has undertaken a number of initiatives designed to do basically two things:

1. To carry out appropriate, publicly supported land use planning, that includes identifying areas for protection and for timber harvesting at appropriate levels of intensity. In other words, defining where harvest can take place.
2. To ensure that where timber is allowed to be harvested, that the practices are sustainable. In other words, how it takes place.

Looking first at #1 - the province's land use planning has been completely overhauled with the introduction of a comprehensive planning framework. The Protected Areas Strategy was established in July 1993 to increase protected areas from 6 to 12% of the provincial landbase by the year 2000. At this time, we are approaching 10%.

Strategic land use planning is either completed or underway for 75% of the province. Forest sector interests and communities define what level of forest land management will take place, and at what intensity.

Once we've defined where harvest may take place, how it takes place is governed by the Forest Practices Code, which was introduced June, 1995.

The legislation supporting the Code clearly outlines the obligations of forest companies and government agencies for careful stewardship, and the role of the public in forest management decisions. The Code is supplemented by regulations, and guidebooks on appropriate management of provincial forest and range lands. Together these form a forest management system that is consistent, enforceable and auditable.

This brings me to where you, and your expertise in forest health and disease management come in. We must take an ecosystem approach to forest management. All components that make up a forest ecosystem must be taken into consideration when we make site prescriptions:

- We leave wildlife trees to maintain biodiversity at the stand level.
- We protect riparian zones, and partially cut in management zones adjacent to them.
- And coarse woody debris must be left on the forest floor for nutrient cycling and habitats.

One could get the impression that the Chief Forester has legislated the entrenchment of insect, fungal and bacterial rights.

Which brings me to the challenges which face all of us, but you in particular.

How to optimize fibre production while recognizing the role that insect and disease organisms play in ensuring that the overall health of the forest is maintained. And we need to do this at a time when fiscal constraints are evident in drastically reduced budgets. Yes, Forest Health originated as pest control in the service to the forest owner. The current objective is now much more than this, but its purpose is still economic. The basic purpose of disease management is ultimately to serve the resource management objectives of society. But it is integral to sustaining our ecosystems so the charge to you as an organization, is to preserve the integrity of our forest ecosystems, while achieving the productive capacity objectives society has set.

So I think that you and I have some very difficult and interesting times ahead. Of course, I sincerely wish you the very best, and every success in your discussions of these, and other issues pertaining to forest diseases at your conference this week.

Thank you.



Janna Kumi.

Panel - Boreal Disturbance Ecology

PAUL HENNON - MODERATOR

Summary of Panel Papers: Disturbance in the Boreal and Sub-Boreal Forests of North America

Paul Hennon
USDA Forest Service - FPM
Juneau, AK

Our panel explored the disturbance process in North American boreal and sub-boreal forests with an emphasis on the forests surrounding Prince George, British Columbia. Information on natural disturbance is vital to a basic understanding of how forests function and change. Concepts of disturbance are gaining popularity among administrators and forest managers. They see utility in this information because most management activities can be viewed as a form of physical disturbance with ecosystem consequences that can be compared to natural processes. Although management has only recently discovered this field, disturbance ecology has been a well-established discipline of ecology for decades.

Previous discussions on disturbance at WIFDWC have involved debates of whether or not pathogens are disturbance agents in forests. In one notable case, pathogens were listed as allogenic factors that were not defined as disturbance agents because they were considered an internal part of ecosystems. This restrictive view ignores the interaction among internal and external factors to drive the disturbance process. In our panel, we hoped to go beyond terminology and discussions about individual agents so that we could focus on the interaction of factors that result in disturbance. We attempted to explore the interactions of biotic and abiotic factors and consider the overarching influence of climate. In addition to discussing the disturbance process, we also covered ecosystem response to disturbance and how subsequent stand development might then affect the various disturbance agents and processes.

Craig DeLong, regional ecologist from Prince George, described the role of fire in shaping the forests of Prince George area. Fire return cycles range from about 100 to 1000 years with considerable local variation as a response to precipitation patterns. Levels of ecologically important disease appear to be proportional to time since disturbance; thus, older stands on sites that have not burned in the previous several centuries have high levels of heart rot and root disease. An example of such a stand was observed during the field trip in a wet western hemlock, western redcedar forest. The stand was several centuries old and had very high levels of heart rot. Craig also described the negative correlation between disturbance patch size and precipitation: larger fires are found on drier sites. In comparing the spatial scales of natural disturbance and timber harvesting, recent harvests are typically smaller than fires have been on most sites.

Brad Hawkes, fire science researcher from the Pacific Forest Centre in Victoria, described different types of fire (e.g. ground, surface, and crown) and the different consequences to the site of each [Full paper follows]. Ground fires that burn underground are slow but result in lethal temperatures at a much greater depth than fast-moving surface and crown fires that only superficially heat soil and initiate little direct change below ground. Thus, different types of fires result in different vegetation patterns and likely influence pathogens. Brad used several examples to illustrate possible interactions of fire and disease. In the southern U.S., fire is used to control brown spot disease (caused by *Mycosphaerella dearnessii* (*Scirrhia acicola*)) of longleaf pine by burning during winter months. Also, disease can influence fire behavior (e.g., dwarf mistletoe brooms causing fires to "crown" in infected trees). Currently there is little interaction between pathologists and scientists in fire science. Brad made a plea for pathologists and fire scientists to interact with him and others in his discipline.

Staffan Lindgren, associate professor in the forestry program at the University of Northern British Columbia, described the disturbance roles of spruce beetle and root pathogens in white spruce forests. Spruce beetle can cause widespread tree mortality in white spruce stands. An association of pathogen, insect and their host may occur when trees weakened by root disease can be attacked by spruce beetle, but preliminary findings indicate that beetles do not prefer trees infected with *Inonotus tomentosus*. The spruce beetle is capable of operating at scales of time and space similar to fire. In the absence of fire, however, root disease-generated gap processes change the structural attributes

of stands in such a way that mortality tends to be limited in terms of stems, although volume losses may be high as the beetle "high grades" spruce. In the Prince George area, spruce stands older than 200 years appear to be dominated by root pathogen-induced gap dynamics processes, with spruce beetle acting as a high grading agent of mature spruce. Spruce dominance is retained by an ample supply of nurse logs caused by early mortality of subalpine fir, and a relatively open canopy.

Phil Burton, ecologist and consultant from Smithers, described a graphical display that illustrates spatial and temporal scales of disturbance and the death spiral (decline) of dying trees. Where disturbance such as wildfire is infrequent, forest stand development is allowed to proceed and stands can reach old age where disease levels are often high. Sites with more frequent disturbance have a repeatedly truncated stand development in which older stages are not attained, so the diseases associated with old stand age do not become abundant. Phil pointed out that the response of understory vegetation to forest tree diseases has been little studied, but could be expected to exhibit the same range or responses (especially "release" of numerous shrub species) as in eastern stands which have suffered from spruce budworm outbreak.

We described a number of interactions among biotic and abiotic factors in the disturbance processes of the forests in the Prince George area. It should be clear to ecologists, fire scientists, entomologists, pathologists, and others, that no one discipline can alone make progress in our understanding of the complex causes and effects of forest disturbance. This field is an excellent place to integrate disciplines of forest science.



Phil Burton and Paul Hennon.

Fire and Disease Interactions

Brad Hawkes, PhD, R.P.F
Fire Research
Pacific Forestry Centre
Victoria, B.C.

Relating fire to forest disease dynamics is more than just indicating an area was burned. Fire ecological research over the past 20 years has been attempting to better understanding the relationships between fire behavior characteristics and ecosystem responses. Alexander (1982) published an article directed at biologists and ecologists to encourage them to consider characterizing fire behavior in their fire effects research. This article is also very important for pathologists to consider in their research if fire might play a role in explaining disease occurrence and dynamics.

This brief paper will describe three basic types of fire, their general behavior characteristics (e.g. in terms of penetration in the forest floor and mineral soil), and how these characteristics might relate to some basic groups of forest diseases. This paper is not based on an extensive literature review. Acknowledgment is given to Eric Allen, Forest Health, Pacific Forestry Centre, Victoria, B.C. for providing ideas and direction for this discussion. Fire scientists need to be working more with pathologists (and vice-versa) in cooperative/multi-discipline research on fire effects to better understand fire's role in forest disease dynamics. The panel on forest disturbance being held at this meeting shows a growing interest in this area (fire's role in understanding forest disease dynamics).

Fire Type

A single wildfire or prescribed fire that is burning in forested areas can have a range of fire types and intensities. The main types of forest fire are ground fire (subsurface fire), surface fire, and crown fire (intermittent, active, and independent).

A ground fire burns in the ground fuel layer (usually the forest floor). It usually smoulders at a very slow rate-of-spread (1-3 cm/h) and therefore does not usually cover extensive areas unless it occurs after the passage of a surface fire. This type of fire can produce a lot of forest floor consumption and soil heating because of the extended heat transfer into the soil.

A surface fire burns the surface fuel layer (usually litter and woody material), excluding the crowns of the trees. Rate-of-spread is usually much higher than a ground fire with spread rates of up to 15 m/min. Fire intensity (the energy output of a fire equal to the product of available fuel energy and the fire's rate of advance) can be used to predict flame length. Flame length has been directly correlated to tree crown scorch and therefore to tree damage and mortality. Below-ground heating is not well correlated to fire intensity but more with the forest floor depth-of-burn and soil moisture content.

A crown fire advances through the crown fuel layer, usually in conjunction with the surface fire. There are various types of crown fire relating to its continuity of spread in the crowns (intermittent or active) and whether a surface is part of it (independent). Crown fires usually kill all the above ground vegetation including the trees and affect extensive areas (up to 1-2 million ha for a single fire in the Boreal forest burned over a couple of months) with rate-of-spread up to 100 m/min. There can be very little soil heating during crown fires in spite of the high fire intensity if forest floor depth-of-burn is not deep.

Historical Fire/Disease Research

Most of the past fire/disease research has been conducted in the south-eastern part of the United States. Underburning (surface fires) of long-leaf pine (*Pinus palustris*) forests has been a long-term practice, especially the use of fire to control brown spot needle blight (*Scirrhia acicola*) in the grass stage of long-leaf pine development. Some work was also done in understanding Annosus root rot (*Heterobasidion annosum*) and the use of fire for thinning. Stem decays in fire scarred southern hardwoods have also received some attention. Another area of

research in the U.S. has been in the relationship of fire to dwarf mistletoe (*Arceuthobium* spp.). The rate and type of decay in fire killed timber has been investigated to predict the amount of time available for salvage logging.

Root Diseases

Root diseases are most affected by fire in terms of the heat penetration into the forest floor and mineral soil layers. A general rule is that most surface and crown fires will not affect root disease directly with heat. These types of fires would indirectly affect root disease occurrence and spread by killing trees and allowing the dead root systems to be fully colonized and therefore assist in disease spread. There is some agreement among pathologists that there is not much difference in root disease infection and spread between partial cutting (creates exposed tree stumps) and fire killed trees. The difference in root disease infection and spread may occur more by killing or cutting larger trees in the stand (and their associated larger root systems) (i.e. thinning from above) rather than smaller trees (usually occurs with surface fires but not usually with partial cutting).

One area of disease research has been the length of time a fungus survives on a particular site. Some research in the Prince George area has shown that *Inonotus tomentosus* can survive up to 30 years in spruce stumps (Lewis and Hansen 1991). If fire helps promote tree species that are resistant to root rot early in vegetation succession (e.g. hardwoods) sequence then there is chance that the disease may not be present when susceptible conifers regenerate. Of course, this is not the usual approach in forest management where plantations are established immediately after harvesting and site preparation.

Differences in heat penetration because of differing forest floor depth-of-burn can be illustrated using temperature/time data collected on a slash burn south of Prince George in 1987. This burn had a high fire intensity, although depth-of-burn averaged only 1.9 cm in a forest floor with a pre-burn depth of 9.2 cm. Temperatures at 3 cm depth in the forest floor averaged only 46 °C (below the lethal temperature for most organisms of 60 °C) although there were some spots that reached 108 °C. At 7 cm depth the average temperature was only 23 °C (similar to the ambient temperature at that depth). The mineral soil was not affected by the fire in terms of heat penetration.

In British Columbia, the feeder root disease fungus *Rhizina undulata* tends to be promoted by slashburning. It has been a problem in survival of tree plantations in B.C.

Stem Diseases

Surface fires are the main concern for stem disease because they can cause basal scarring on trees and provide an entry point for stem diseases. There has been an increase in the use of fire in the dry forests of southern B.C. and western parts of the U.S. in ponderosa pine/Douglas-fir stands. Models have been developed in the U.S. and Canada which help predict tree mortality from surface fire of different intensities. I have not come across any models that predict basal scarring from fire. This would be necessary if inferences are to be made about possible increases in stem diseases from underburning.

Mortality caused by stem rusts like comandra blister rust can help increase surface woody fuel load in the forest stands. This increase in fuel load could lead to higher fire intensities in these stands. Applying fire to control stem rusts would not be practical since most of the tree would be killed with the fire intensity required to kill the rusts.

Leaf/Needle Diseases

Leaf and needle diseases would be very difficult to control by fire because of their position in the tree crowns. If infected leaves or needles fall to the forest floor surface then a surface fire might help destroy some or all of the fungus/spores present. One success story has already been mentioned for long-leaf pine although fire is applied in its "grass" stage and the seedling is able to re-sprout needles after the fire. A surface fire in a stand of aspen invested with poplar leaf blight (*Venturia* spp.) would easily kill the trees and would not be useful for disease control.

Dwarf Mistletoe

Considerable research has been conducted in understanding the role of fire in the distribution and abundance of dwarf mistletoe. The direct effects of mistletoe on trees (mortality, stunted trees, spike tops, witches' brooms, and resin-infiltrated stem cankers) tend to increase fire potential and flammability of the infested stands. Fire protection, past partial cutting of large trees, and insects and diseases outbreaks have created favourable conditions for dwarf mistletoe, especially in the dry forests of southern B.C. Underburns which continue to promote a multi-layer stands perpetuate the dwarf mistletoe problem. Sanitation cuts would be much more effective than relying on fire to control mistletoe.

The Challenge to Pathologists and Fire Scientists

There is much to learn about fire and disease interactions. I have only briefly addressed the stand level fire relationships. There are also landscape level issues related to fire regimes and stand successional patterns as they relate to forest disease dynamics. I would encourage forest pathologists to rub shoulders (will not cause a fire) more with fire scientists (and the other way as well) in order to conduct more multi-discipline research to understand the relationships among fire, disease, and insects.

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Special Papers

RONA STURROCK AND DAN BERNIER - MODERATORS

Responses of the Black Stain Root Disease Insect Vector *Hylastes nigrinus* to Douglas-fir Pruning in Southwest Oregon

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Abstract:

Response of the black stain root disease insect vector *Hylastes nigrinus* to Douglas-fir pruning in southwest Oregon was monitored from May through June using sticky traps. Pruning had occurred either during the periods May-October or November-April of the preceding year. More *H. nigrinus* were collected on plots pruned during November-April versus May-October, as well as on pruned versus unpruned plots. Highest responses were seen in open-canopied stands pruned during the period November-April. Insect feeding activity on Douglas-fir roots was observed to be higher in plots with the highest insect response compared to unpruned plots. Pruning can be timed seasonally to minimize the response of *H. nigrinus* during their spring flight period. Pruned, open-canopied stands with undried slash still on the ground during April and May are likely at increased risk of future black stain root disease development.

Introduction:

Black stain root disease (BSRD) of Douglas-fir (*Pseudotsuga menziesii*) is caused by the vascular fungal pathogen *Leptographium wageneri* var. *pseudotsugae*, which can be transported from diseased trees to healthy trees by the root-feeding insect vectors *Hylastes nigrinus* (Mannerheim), *Pissodes fasciatus* (LeConte), and *Steremnius carinatus* (Boheman). Incidence and severity of BSRD is high across southwest Oregon and northwest California, and has been correlated with the presence of prior soil disturbance and precommercial thinning (Hansen 1978).

BSRD infection centers occur often in 15-25 year old plantations, causing mortality of small groups of trees. Intertree movement of the fungus is through root grafts or short distance growth through the soil between roots (Hessburg and Hansen, 1986), while long distance spread is by insect vector. The vectors are attracted to the volatiles from cut stumps and slash (Witcosky et al., 1987).

Witcosky et al. (1986) showed that precommercial thinning resulted in increased responses of BSRD vectors onto thinned sites. A significantly greater number of insects were trapped in the thinned vs. the non-thinned treatments, as well as in the thinning treatments done in winter and spring versus summer and fall.

Objectives:

- I. Determine if *H. nigrinus* responds to pruning slash in Douglas-fir.
- II. Determine if season timing of pruning in Douglas-fir can affect the response levels of *H. nigrinus* during their spring flight period.

Treatments:

Treatments I - Prune during the period June-September of the previous year.
Treatment II - Prune during the period November-April of the previous year.

Methods:

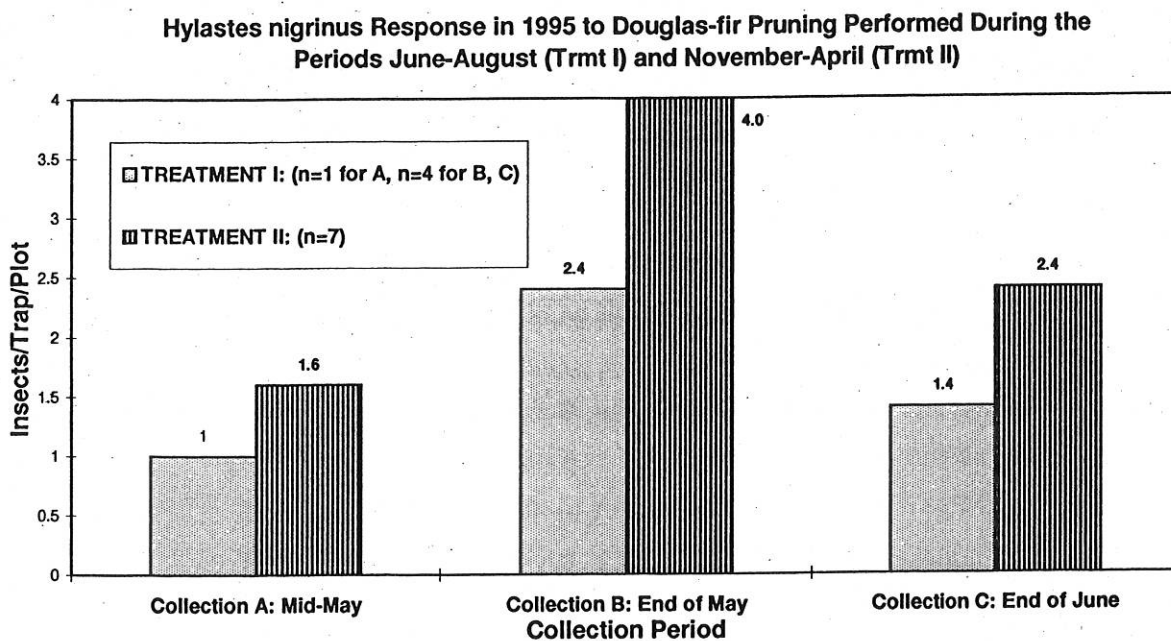
This experiment was repeated in 1995 and 1996, with insect trapping taking place from late April or early May through the end of June. Pruned plots to be used for insect trapping were selected from a list of all Douglas-fir stands which had been pruned by our project cooperators during the preceding year. This list was then divided into two groups; those which had been pruned during June-October, and those pruned during November-April. Five stands from each of these lists were then chosen at random. Each pruned stand was paired with a nearby unpruned stand.

Traps were constructed following the methods of Witcosky (1986). Two traps were placed 60 meters apart within the pruned and unpruned plots, at least 25 meters from the nearest road. Screens were replaced on the pruned plots one month after installation each year. Insects were collected in mid- and late-May, then once at the end of the June.

Results were calculated as the number of insects/trap/plot. Differences between the pruned and unpruned plot pairs were used for analysis after square-root transformation. Two graphs were produced for each year's data. The first groups data only by the two treatment types. The second breaks the November-April prunings (Trmt II) into two classes, those which had relatively closed canopies, and those that had relatively open canopies. These classes were based on crown gap measurements taken in each stand after trapping was completed.

Results:

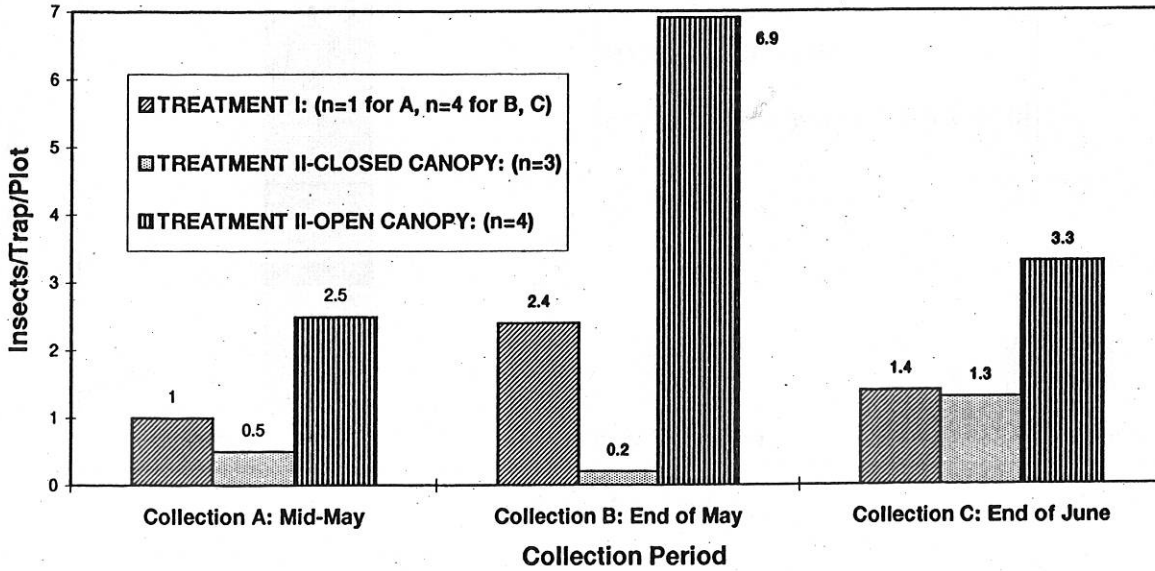
Figure 1.



P-values between treatment types: Collection A: p = NA
 Collection B: p = 0.55
 Collection C: p = 0.18

Figure 2.

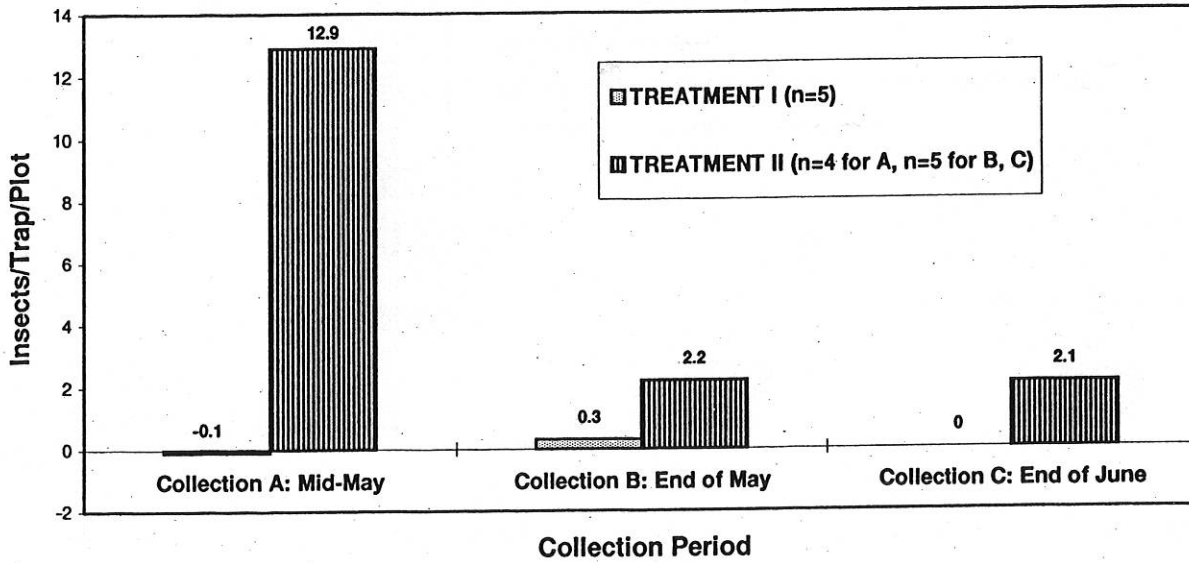
Hylastes nigrinus Response in 1995 to Douglas-fir Pruning: Treatment II Plots Stratified by Canopy-Closure Class



P-values between treatment types: Collection A: $p = NA$ between Trmt I and Trmt II-Open
 $p = 0.55$ between Trmt II-Closed and Trmt II-Open
 Collection B: $p = 0.14$ between Trmt I and Trmt II-Open
 $p = 0.02$ between Trmt I and Trmt II-Open
 Collection C: $p = 0.02$ between Trmt I and Trmt II-Open
 $p = 0.05$ between Trmt I and Trmt II-Open

Figure 3.

Hylastes nigrinus Response in 1996 to Douglas-fir Pruning Performed During the Periods June-August (Trmt I) and November-April (Trmt II)



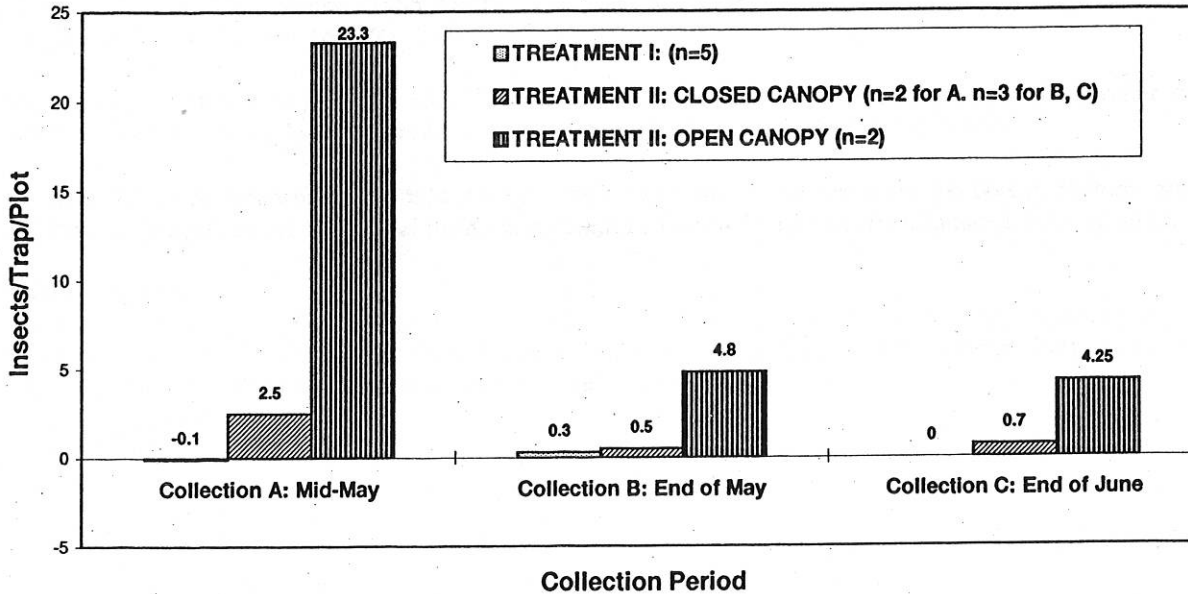
P-values between treatment types: Collection A: **p = 0.08**

Collection B: **p = 0.14**

Collection C: **p = 0.05**

Figure 4.

***Hylastes nigrinus* Response in 1996 to Douglas-fir Pruning: Treatment II Plots Stratified by Canopy-Closure Class**



P-values between treatment types: Collection A: $p = 0.01$ between Trmt I and Trmt II-Open
 $p = 0.21$ between Trmt II-Closed and Trmt II-Open
 Collection B: $p = 0.003$ between Trmt I and Trmt II-Open
 $p = 0.02$ between Trmt I and Trmt II-Open
 Collection C: $p = 0.03$ between Trmt I and Trmt II-Open
 $p = 0.30$ between Trmt I and Trmt II-Open

Conclusions:

Objective I: Does *H. nigrinus* respond to pruning in Douglas-fir?

Yes. However, response to pruned stands was highly variable depending on factors such as canopy closure, amount of pruning, and the time of year in which pruning took place. Only rarely were any *H. nigrinus* caught in unpruned control plots.

Objective II: Can seasonal timing of pruning affect the response levels of *H. nigrinus*?

Yes. This study showed an often times significantly higher vector response to plots pruned during November-April compared to the plots pruned during June-October. Plots exhibiting the highest vector response in the period November-April also had the least canopy closure. Perhaps most importantly, an observational study of feeding activity on Douglas-fir roots showed very heavy feeding activity on roots from a stand with one of the highest vector responses, while roots sampled from its paired control plot had only two or three *H. nigrinus* feeding attempts.

In conclusion, the risk of future BSRD development is very likely increased in stands where pruning is done in the period November-April within open-canopied stands of Douglas-fir.

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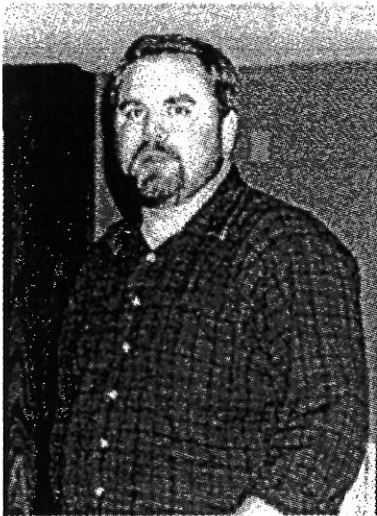
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Acknowledgments:

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Brennan Ferguson.



Marianne Elliott.

Canker Diseases of Pacific Madrone (*Arbutus menziesii*)

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Abstract

Pacific madrone (*Arbutus menziesii* Pursh) is a broadleaf evergreen tree that is native to the Pacific coast. It has been declining due to environmental stress and a disease complex including two canker fungi, *Nattrassia mangiferae* Nattrass and *Fusicoccum aesculi*. Samples were taken from 480 cankers of varying ages to determine the incidence and severity of the disease. The samples were cultured and samples containing *N. mangiferae*, *F. aesculi*, and *Trichoderma spp.* were counted. The fungus *N. mangiferae* was found most often in the canker margin and least often at a distance of 8 cm from the margin. *F. aesculi* was found most often in small diameter wood and at a distance of 1 cm from the margin. *Trichoderma spp.* was found most often in older cankers. It is possible that *Trichoderma spp.* is replacing *N. mangiferae* in older cankers.

Introduction

Pacific madrone is a tree native to the western US and British Columbia. It is an attractive tree that is much prized in urban landscapes. The species has been declining over the past 20 years due to a disease complex which includes two canker fungi, *N. mangiferae* and *F. aesculi*. These fungi cause cankering and dieback of the trees, and sometimes death. The symptoms are thinning of the crown and branch dieback.

Nattrassia mangiferae causes large, raised cankers on the branches and main stem. It infects through wounds, heat-injured bark, and intact bark at temperatures of 25°C (Davison 1972). The cankers kill the branch by girdling, and cause water stress by interfering with water movement in the xylem. Rapidly spreading cankers have a smooth margin. *F. aesculi* causes dieback where the limbs and twigs appear burned. Tiny black pycnidia are visible on the leaves and twigs. This fungus can be present in the wood without causing disease. Symptoms will develop when the host becomes drought-stressed (Boyer 1995). Sometimes both fungi are found in the same canker (English 1974). The twig dies back from the tip, and the canker is centered on the branch stub. Both fungi are very common and have a wide range of hosts. They spread by means of airborne spores.

The purpose of this study was to determine the incidence of *N. mangiferae* in cankers of different age classes, and the extent of fungal growth in the wood. Further objectives were to identify other important fungi in the wood, such as *F. aesculi* and *Trichoderma spp.*, and to observe differences in microbial populations of different age classes of cankers.

Methods

The madrone trees sampled in this study were located on four sites in the Seattle area. Two of the sites were natural areas in county parks, one in an urban park, and one was at the University of Washington campus. Samples were taken from four age or size classes of cankers on madrone trees. The age classes were the following:

1. Newly forming cankers without a callus ridge.
2. Cankers with a small amount of callusing.
3. Cankers with a large, raised callus ridge.
4. Old cankers containing decay fungi.

Groups 1 and 2 were most often found on small diameter branches, and groups 3 and 4 were found on the main stem of mature trees.

Samples of the cambium and outer xylem were removed with a chisel at the distances of 0 cm, or at the margin of the canker, 0.5 cm, 1 cm, 2 cm, 4 cm, and 8 cm. The samples were surface sterilized in a dilute solution of sodium hypochlorite and rinsed in deionized water. They were then placed in petri dishes containing 2% malt extract agar

and incubated at 25 C. The cultures were examined after a week and the number of samples containing *N. mangiferae*, *F. aesculi*, and *Trichoderma spp.* were counted.

Results and Discussion

The number of samples containing *N. mangiferae* declined significantly ($p < 0.001$) with distance from the canker margin (Table 1). There was an approximately 50% decrease between 0 and 0.5 cm. The fungus was found in only 18% of the samples at the distance of 8 cm. Pruning of small branches beyond this distance may be effective in reducing the disease.

	<i>N. mangiferae</i>	<i>Fusicoccum</i>	<i>Trichoderma spp.</i>
0 cm	72	2	6
0.5 cm	33	4	3
1 cm	28	5	3
2 cm	30	4	2
4 cm	20	2	3
8 cm	15	2	4
p-values	1.17×10^{-7}	0.477	0.731

Table 1. Number of cankers containing fungi at 6 distances from canker margin. $n = 80$ samples/distance.

Differences between age classes were significant for *N. mangiferae*, with the fungus being found most often in cankers of age class 3 (Table 2). These are actively growing cankers on large diameter wood. One reason that the fungus was not found as often in age class 1 cankers is that heat-injured bark has the same appearance as a newly forming canker, and some samples may have come from branches that had been damaged by the sun.

More *F. aesculi* was found in age class 1 and 2 cankers, in small diameter branches. It was found most often at the distance of 1 cm from the margin, as opposed to the other two fungi, which were found most often at the canker margin. Small diameter branches in the upper crown exhibit symptoms of dieback more often than large diameter branches and the main stem. These branches are the first to be under water stress during a period of drought, causing the fungus to become active. Additional water stress due to *N. mangiferae* cankers on the main stem and large branches will also decrease the water supply to the upper branches.

Age class	<i>N. mangiferae</i>	<i>F. aesculi</i>	<i>Trichoderma spp.</i>
1	50	9	3
2	38	5	8
3	88	2	3
4	52	3	7
p-values	0.031	0.044	0.295

Table 2. Number of cankers containing fungi in four age classes. $n = 120$ samples/age class.

There were no significant differences among the age classes and distances for *Trichoderma spp.*, but it is interesting to note that the most *Trichoderma spp.* was found in age classes 2 and 4, both of which contained low amounts of *N. mangiferae* (Table 2). A possible control method for cankers on large diameter branches and the main stem would be to increase the amount of *Trichoderma spp.* in order to limit the growth of *N. mangiferae*. *Trichoderma* has been used as a biocontrol for wood decay fungi with some success (Lonsdale 1990). There seemed to be no relationship between the amounts of *Trichoderma spp.* and *F. aesculi* in the cankers.

Conclusions

Nattrassia mangiferae cankers on large diameter wood will cause water stress on smaller branches. Dieback caused by *F. aesculi* may result if the fungus is present in the wood. For the purpose of controlling the disease, pruning small branches beyond 8 cm will reduce the amount of infection. Using *Trichoderma spp* as a biocontrol for *N. mangiferae* in cankers on large branches and the main stem may be an option, either alone or in combination with a systemic fungicide.

Acknowledgments

This research was funded by Save Magnolia's Madrones.

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Appendix 1. Tables

	0 cm	0.5 cm	1 cm	2 cm	4 cm	8 cm	total
AC 1	18	7	8	6	6	5	50
AC 2	17	8	3	6	3	1	38
AC 3	20	9	6	11	7	5	88
AC 4	17	9	11	7	4	4	52
total	72	33	28	30	20	15	

Table 4. *N. mangiferae*

	0 cm	0.5 cm	1 cm	2 cm	4 cm	8 cm	total
AC 1	1	1	3	2	1	1	9
AC 2	1	0	1	1	1	1	5
AC 3	0	1	0	1	0	0	2
AC 4	0	2	1	0	0	0	3
total	2	4	5	4	2	2	

Table 5. *F. aesculi*

	0 cm	0.5 cm	1 cm	2 cm	4 cm	8 cm	total
AC 1	2	0	0	1	0	0	3
AC 2	1	2	2	0	0	3	8
AC 3	1	1	0	0	1	0	3
AC 4	2	0	1	1	2	1	7
total	6	3	3	2	3	4	

Table 6. *Trichoderma spp.*

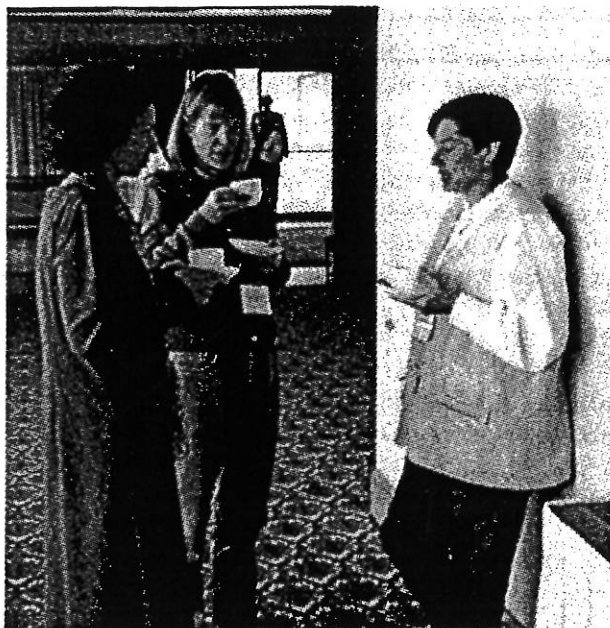
A Comparison Between Western Root Disease Model Predictions and Real Data

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Simulations of 26 permanent plots in fir stands infected with Annosus root disease (caused by *Heterobasidion annosum*) demonstrate that the Forest Vegetation Simulator with the Western Root Disease Model is, on average, accurately predicting mortality for 13 years. 1981 data was processed using the Forest Vegetation Simulator (FVS) - with and without the Western Root Disease extension model, then compared to measurements made in 1994/95. The 0.1 acre plots, from the Pest Damage Inventory on the Stanislaus and Eldorado National Forests, are centered around dead true firs infested with Annosus root disease. Tree mortality center enlargement has been mapped and monitored at these plots from 1981-1995. On average, the actual mortality calculated from the data over the 13 year period was 657 cu. ft. mortality per acre. The FVS model with the Western Root Disease Model predicted 650 cu. ft. per acre. The FVS model without the root disease model under predicted mortality calculating mortality at 160 cu. ft. per acre.



Susan Frankel, Sally Campbell, & Ellen Michaels Goheen.

Permanent Plots for Studying the Spread and Intensification of Larch Dwarf Mistletoe and the Effects of the Parasite on Growth of Infected Western Larch on the Flathead Indian Reservation, Montana: Results From the Five-Year Re-Measurement

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INTRODUCTION

In 1991, a study was initiated on the Flathead Indian Reservation (IR) in northwestern Montana with the following objectives: (1) to quantify the spread and intensification of larch dwarf mistletoe (*Arceuthobium laricis* (Piper) St. John) in western larch (*Larix occidentalis* Nutt.) with and without overstory removal and with and without precommercial thinning, (2) to quantify the growth effects due to dwarf mistletoe in western larch with and without overstory removal and with and without precommercial thinning, (3) to provide a visual demonstration of the treatment effects on stand growth and development, and (4) to provide data for the validation of the dwarf mistletoe spread and impact model extension of the Forest Vegetation Simulator (Hawksworth et al. 1995). The complete study plan, including a description of sample design, site treatment, plot establishment, and a summary of the baseline data taken at plot establishment, can be found in a previous report (Taylor et al. 1993). The purpose of this report is to detail the results from the measurement of the study plots in 1996, with an emphasis on the increase in dwarf mistletoe infection and the growth of the host trees in the first five years of the study.

METHODS

As a brief review, the study site is located in the North Valley Creek Area on the southern end of the Flathead IR in northwestern Montana. The site had been selectively harvested in 1972 and the site preparation following harvest encouraged prolific natural regeneration. Before our study treatments were carried out, the tree component on the site consisted of a mature, predominantly western larch overstory with a heavily stocked understory of western larch, alpine fir, Douglas-fir, lodgepole pine, grand fir, Engelmann spruce, and ponderosa pine saplings (listed in descending order of occurrence). The western larch overstory trees were heavily infected with dwarf mistletoe with most trees showing extensive brooming and receiving a Hawksworth dwarf mistletoe rating (DMR) of 5 or 6 (Hawksworth 1977). There were an average of 37 infected larch overstory trees per acre in the entire study area prior to treatment. The average DMR of the overstory larch was 4.78 (sd=0.80) and the average DMR of the infected overstory larch (DMI) was 4.92 (sd=0.66).

The study was set up as a split plot design with four replications of two plots, each receiving one of two overstory treatments ((1) overstory removal, (2) no overstory removal). Each plot was divided into two 1/4-acre square subplots, each receiving one of two thinning treatments ((1) thinned to a 12 by 12-foot spacing, (2) no thinning). Subplots that were neither logged nor thinned were designated as controls.

In 1991, pre-numbered metal tags were attached to understory trees identified as crop trees on all subplots. On the thinned subplots, the crop trees were the residuals following thinning. On the unthinned subplots, crop trees were designated using the same criteria used to select trees on the thinned subplots and they were tagged on a 12 by 12-foot spacing. By tagging similar trees on both the thinned and unthinned subplots, comparable data sets were created for use in future data analysis.

In the 1996 measurement, the following data items were collected for all live understory crop trees: diameter at breast height (DBH), tree height, height to bottom of the live crown (later used to compute live crown ratio), DMR for each crown third (lower, middle, upper), crown class, and the three most damaging agents on the tree (in addition

to dwarf mistletoe). Records were noted for trees that had died, and attempts were made to determine cause of death; however, measurements were not taken on dead trees for use in any data analyses of growth and yield or dwarf mistletoe spread and intensification. The overstory trees on the unlogged plots were examined for mortality, but no other data was taken.

All statistical analyses were performed using the statistical program SPSS, version 6.1 (SPSS INC, 1994).

RESULTS AND DISCUSSION

Out of the 1,237 understory trees originally tagged in 1991, 1,186 were re-measured in 1996. Fifty-one trees were recorded as dead or missing. Twenty-eight were sub-alpine fir, Douglas-fir, and grand fir that had been cut for Christmas trees. Five larch, three Douglas-fir and one ponderosa pine had been killed by *Armillaria ostoyae* (Romagn.) Herink. One larch was dead from suppression effects, seven larch and one spruce were never located, and five larch were dead from unidentified causes. Only four larch were found to have been killed by dwarf mistletoe; in each case the mortality resulted from a girdling stem infection and each killed tree had a DMR=1. No mortality had occurred in the overstory trees.

Analysis of Treatment Effects. ANOVA was used to compare the variables of DMR, DMI, height, and diameter between (a) the overall plot treatment of overstory removal vs. no overstory removal, and (b) the interaction of thinning and overstory treatments. Results indicated that there were no significant differences between any of the treatments for any of the analyzed variables ($P=0.05$). Plots receiving the unlogged with thinning treatment appear to have a much higher percentage of larch infected than the other three treatments (Table 1). However, ANOVA results indicated that the difference was not statistically significant ($P=0.05$). Although the above measured variables were not significantly different between treatments, field observations found the dwarf mistletoe plants to be larger and more robust in the overstory removal with thinning treatment. The plants may be responding directly to the greater availability of sunlight, or perhaps they are responding to a tree response that was great enough to benefit the plants while not great enough to significantly effect tree growth.

Dwarf Mistletoe Spread and Intensification 1991-1996. A comparison of infection data between 1991 and 1996 (Table 1) indicates that both incidence and severity of dwarf mistletoe infection increased slightly in the 5-year period. The percentage of all trees infected increased from 57 to 63 percent, and the percentage of larch infected increased from 73 to 77 percent. The average DMR increased from 0.8 (sd=0.3) to 1.1 (sd=1.1), and the average DMI increased from 1.3 (sd=0.2) to 1.8 (sd=0.9).

Table 1. Number of live trees, percent larch, percent total trees infected, percent larch infected, average dwarf mistletoe rating (DMR), average dwarf mistletoe rating of only infected trees (DMI), average tree height, and average diameter at breast height (DBH) for understory crop trees on each subplot in 1991 and 1996, grouped by treatment.

Treatment	# Trees	% Larch	% Total Infec.	% Larch Infec.	Ave. DMR	Ave. DMI	Ave. Hght (ft)	Ave. DBH (in)
Logged & Thinned								
1991	352	80	62	78	0.8	1.3	10.3	1.0
1996	331	83	68	79	1.1	1.7	15.7	2.0
Logged & Thinned								
1991	322	82	57	69	0.8	1.3	11.5	1.1
1996	304	85	58	67	1.0	1.6	15.9	2.5
Unlogged & Thinned								
1991	279	79	60	77	0.9	1.4	12.2	1.1
1996	274	79	71	90	1.4	2.0	16.9	1.9
Unlogged & Unthinned								
1991	284	77	50	67	0.8	1.4	11.9	1.2
1996	277	77	56	70	1.0	1.6	17.5	1.9
Totals								
1991	1,237							
1996	1,186							
Total means								
1991		80	57	73	0.8	1.3	11.5	1.1
1996		81	63	77	1.1	1.8	16.5	2.1

Infection data were broken down by the number of trees in each DMR class and by the number of trees with infections in each crown-third (lower, middle, upper) (Table 2). This breakdown shows that the majority of infected trees had an infection rating of one or two (as reflected in the low average DMR). However, the percentage of trees in the higher DMR classes has increased slightly in the five-year period. The two trees receiving a rating of six in 1996 had both lost their tops to a girdling dwarf mistletoe bole infection. Therefore, the high ratings reflected the loss of total crown area, not an intensification of the dwarf mistletoe into the upper crown third. Throughout the study area, infections were still concentrated in the bottom crown-third, but the percentage of trees with infections in the upper two-thirds of the crown almost doubled in the five-year period.

Table 2. Number of infected trees in each dwarf mistletoe rating (DMR) class, and the number of trees with dwarf mistletoe infections in each crown-third, grouped by treatment and summarized to compare 1991 and 1996 results.

	Number of Infected Trees by DMR						# of Trees with Infections in Each Crown-Third		
	1	2	3	4	5	6	Low	Mid	Up
Logged & Thinned	118	60	41	2	1	0	218	98	4
Logged & Thinned	92	48	26	1	1	2	168	77	4
Unlogged & Thinned	78	61	43	11	0	0	187	117	19
Unlogged & Unthinned	65	54	16	4	1	0	138	78	5
Total (1996)	353	223	126	18	3	2	711	370	32
Total (1991)	479	169	44	1	0	0	680	198	2
% of Total Number of Infected Trees (1996)	49	31	17	3	0.4	0.3	98	51	4
% of Total Number of Infected Trees (1991)	69	24	6	0.1	0	0	98	29	0.3

Although the numbers indicate a slight increase in dwarf mistletoe infection in the study area, this information needs to be interpreted with some caution. The general increase in incidence and severity does not simply point out an increase in dwarf mistletoe infection. Some trees did become infected for the first time during the five-year period, but there are other factors reflected in these calculations: 1) several trees died or were removed over the five-year period (i.e. calculations were done using 1,237 trees in 1991 and 1,186 trees in 1996), 2) some infections died, resulting in once infected trees becoming "clean", 3) many of the now visible infections could have been latent, meaning the actual infection was there during the 1991 measurement, but symptoms were not visible, and 4) many infections that were recorded in 1996 may have been missed in 1991.

Tree Growth 1991-1996. A comparison of average tree height and diameter between 1991 and 1996 showed that the trees grew an average of five feet in height and one inch in diameter in the five-year period (Table 3). Mean height and DBH were computed for infected and uninfected trees in 1991 and 1996 (Table 3). The average height and diameter growth rates were similar for infected and uninfected trees, so it appears that dwarf mistletoe is not causing any growth effects at this time. In both years, the infected trees were taller and bigger in diameter than the uninfected trees. Students t-tests (SPSS 1996) showed that the height difference between infected and uninfected trees was statistically significant ($P < 0.001$), but the diameter difference was not. These results indicate that the taller trees have a greater probability of becoming infected because they are bigger targets for the reception of dwarf mistletoe seeds.

Table 3. Comparison of the average height and DBH for all trees, uninfected trees, and infected trees for 1991 and 1996.

Year	Ave. Hght. (ft) (all trees)	Ave. Hght. (ft) (uninfected)	Ave. Hght. (ft) (infected)	Ave. DBH (in) (all trees)	Ave. DBH (in) (uninfected)	Ave. DBH (in) (infected)
1991	11.5	8.7	13.1	1.1	0.8	1.2
1996	16.5	13.1	18.2	2.1	1.7	2.2

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Jane Taylor.

Incidence of Butt Rot in Two Consecutive Rotations of *Picea abies* in Southwestern Sweden

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Abstract

The incidence of butt rot at clear felling of six mature Norway spruce stands and at first thinning of the following rotation of Norway spruce was examined in southwestern Sweden. Butt rot incidence was estimated on a systematic sample of stumps by visual examination of the stump surfaces shortly after felling. The incidence of butt rot at final felling was not related to the incidence of butt rot at first thinning in the following rotation. *Heterobasidion annosum* was the most common cause of decay. The results suggest that the incidence of butt rot in Norway spruce due to *H. annosum* does not necessarily have to increase from one rotation to the following.

Introduction

Root and butt rot in Norway spruce (*Picea abies* (L.) Karst.) may be caused by many fungal species. The economically most important species in Scandinavia are *Heterobasidion annosum* (Fr.) Bref. and *Armillaria* spp. of which the former is the most common and causes the most severe damage (Yde-Andersen 1958, Holmsgaard et al. 1968, Johansson 1980). *H. annosum* is mainly dispersed by basidiospores which colonise freshly cut stumps and wounds (Rishbeth 1951a, Isomäki and Kallio 1974). The vegetative spread of the disease from infected stumps and trees to adjacent trees takes place by means of root contacts and root grafts (Rishbeth 1951a,b). Transmission of genets of *H. annosum* from one generation of Norway spruce to the following generation has also been demonstrated (Stenlid 1987, Piri 1996).

According to Jørgensen et al. (1939) and Yde-Andersen (1978), it is likely that second and later rotations of Norway spruce may suffer from more severe attacks of *H. annosum* than the first. It can be questioned whether this is due to transfer of infection from the first rotation, or a greater abundance of sporophores associated with old-growth stumps contributing to an increased spore infection potential in the second rotation. The sporophores could account for a fast development of butt rot if the first and later thinnings are carried out during the period of the year when spore infections occur (Vollbrecht and Jørgensen 1995, Brandtberg et al. 1996). At first thinning of a stand, the incidence of butt rot is probably mainly dependent on the transfer of *H. annosum* from old-growth stumps and roots. If this route of spread is important for the transfer of *H. annosum* between generations and for the subsequent build up of the butt rot incidence, the incidence of butt rot at first thinning should be correlated to the incidence of butt rot at final felling of the previous rotation. Accordingly, if the first rotation is heavily infected by *H. annosum*, the second rotation should also risk heavy infections.

The aim of this study was to evaluate the relation between the incidence of butt rot at final felling and the incidence of butt rot at first thinning of the following rotation.

Materials and methods

The study consisted of six sites situated in southwestern Sweden (56°42'N, 13°6'E)(Table 1). At each site, the butt rot incidence was examined in two consecutive rotations of Norway spruce (*Picea abies* (L.) Karst.). The first rotations of Norway spruce were clear felled during wintertime in the period 1961 to 1968. The time between clear

felling and planting of the second rotation varied between zero and three years (Table 1). The number of planted seedlings varied between 1600 and 4400 per hectare (Table 1). Stand 1 was planted with four different spacings. First thinning of the second rotations was carried out during wintertime when spore infections are rare (Brandtberg et al. 1996). The stand age at first thinning was 26-32 years (Table 1). No additional thinnings have been carried out. The incidence of butt rot at clear-felling and at first thinning was estimated by visual examination of the stump surfaces shortly after felling (Table 1). All stumps were observed in five meter wide strips placed along systematic transects through the stands (Persson 1975). The number of stumps surveyed were adjusted to stand-area. In stand 1, the incidence of butt rot at first thinning was known but no figures of the original number of stumps surveyed at first thinning were available.

As it is difficult to identify standing trees damaged by root and butt rot from external signs (Kallio and Tamminen 1974, Vollbrecht and Agestam 1995), and since there is little or no difference in the incidence of butt rot in different tree classes (Werner 1971, Vollbrecht and Agestam 1995), the butt rot frequency at stump height for the thinned trees within a plot was regarded to be representative of the butt rot frequency in the remaining stand (Holmsgaard et al. 1968, Bryndum 1969, Vollbrecht and Agestam 1995).

Identification of the decay causing organism was not made at clear felling. In stand 4 at first thinning, to identify the decay causing organism, stem discs at stump height were taken immediately after felling from a random sample of thinned trees with incipient or advanced decay. In the other stands thinnings had been carried out 2 - 9 years before this study was carried out (Table 1). Therefore, to identify the decay causing organism, bore cores were taken at stump height from 50 randomly selected trees in each stand using an increment borer. In stand 1, no bore cores were taken to avoid conflicts with other scientific activities. Consequently no identification of the decay causing organism was made. The bore core was directed towards the pith of the tree (Stenlid and Wästerlund 1986). 2,6-dichlorophenolindophenol was used to make it easier to detect incipient decay (Johansson and Stenlid 1985). If the bore core was found to be decayed, a new bore core was taken. Stem discs and bore cores with advanced or incipient decay were transferred to plastic bags and incubated at +20°C for 10 days. *H. annosum* was regarded as the cause of the discoloration if colonies of *H. annosum* were detected by their conidial stage. Classification of other butt rot causing agents was not made.

Figures for the rot incidences were calculated as percentages of the total number of stumps examined in each stand. A linear regression model was used to analyse trends in the data set. The frequency of butt rot in the second rotation was chosen as the dependent variable.

Results

The butt rot incidence in the previous rotation varied from 7 to 45 % and in the subsequent rotation from 8 to 18 % (Table 1). The regression model shows, though not significantly, a slightly negative trend ($\beta = -0.22$, $p = 0.052$, $R^2 = 0.65$), i.e. stands with a high incidence of butt rot at final felling, show a lower butt rot incidence at first thinning than stands with a low butt rot incidence at final felling. *H. annosum* was found to be the most important decay causing fungus in the present rotation (Table 1).

Discussion

The results of this study imply that there is no positive correlation between the incidence of butt rot at final felling of Norway spruce and the incidence of butt rot at first thinning of the following rotation of Norway spruce (Table 1). It is possible that old decayed stumps are less important in the transfer of *H. annosum* between rotations and the subsequent build up of *H. annosum* infections. This may be due to decomposition of old infected roots, presence of competitive antagonistic fungi associated with decaying wood, or a decreasing infection potential with age in genets of *H. annosum*. According to Sinclair (1964) severe attacks of *H. annosum* in later rotations of Norway spruce can be due to spore production associated with an abundance of sporophores on old-growth stumps. Abundant distribution of spores of *H. annosum* increases the risk for infection of freshly cut stumps. In addition to infection of butt rot vegetatively transferred from the previous rotation, spore-infection of thinning stumps will lead to heavy infections of *H. annosum* in the latter stages of the rotation.

In one stand the frequency of decayed trees infected by *H. annosum* was only 50 %. However, only four decayed trees were found. Consequently, the number of samples was too small for determining the *H. annosum* frequency

reliably. The decay in trees not infected by *H. annosum* might have been caused by *Armillaria* spp. (Schönhar 1994). It is also possible that the decay was caused by *H. annosum* but the fungus had not produced any conidia during the incubation period.

Since no information is available about which agent caused the butt rot registered in the previous rotation, it can be argued that we do not know whether this butt rot was caused by *H. annosum* or some other agent. However, since *H. annosum* was found to be the most frequent butt rot causing agent in the present rotation, and since all thinnings were carried out during wintertime when spore infections of stumps are rare (Brandtberg et al. 1996), it is likely that the butt rot registered in the previous rotation was also primarily caused by *H. annosum*. However, it cannot be ruled out that the butt rot in the previous generation might have been caused by *Stereum sanguinolentum* as a result of logging damage or by *Armillaria* sp. The former fungus does not attack uninjured trees of the second rotation and *Armillaria* sp., generally a weak pathogen, has possibly attacked the second rotation with less intensity than *H. annosum*.

Although this study is based on limited data material, the results imply that even if the previous rotation of Norway spruce was heavily infected by *H. annosum*, it is possible that the economic losses due to *H. annosum* in following rotations of Norway spruce can be reduced by silvicultural practices, i.e. either if thinnings are carried out during winter conditions (Brandtberg et al. 1996) or if stump treatment is carried out in all thinnings (Korhonen et al. 1994, Pratt 1994, Brandtberg et al. 1996). Forest management without thinnings should also be considered.

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Table 1. Characteristics of the stands studied. "Land use" is the previous land use. "H" is hardwood stands and "C" is *Calluna* heath land. "H100" is the site index, i.e. dominant height at 100 years of age. "Soil" is the soil type and texture, where S-L-T is sandy-loamy-till and G-S is gravel soil. "Age" is the stand age of the previous rotation at final felling. "S1" is the number of surveyed stumps at final felling of the previous rotation. "B-R" is the incidence of butt rot in surveyed stumps. "Plant." is the number of years between final felling and planting. "Seedlings" is the number of planted seedlings per ha. "Thg." is the stand age at first thinning of the second rotation. "S2" is the number of surveyed stumps in the present rotation. "T-S2" is the number of years between thinning and identification of the decay causing organism. "H.a." is the frequency of decayed trees in the present rotation infected by *H. annosum*.

Site	Previous rotation				Present rotation									
	Land use	H100 (m)	Soil	Age (yrs.)	S1 (no.)	B-R (%)	Plant. (yrs.)	Seedlings (ha ⁻¹)	Thg. (yrs.)	S2 (no.)	T-S2 (yrs.)	B-R (%)	H.a. (%)	
1	H	G35	S-L-T	80	111	7	0	1600-4400 ¹	32	-	-	18	-	
2	H	G32	S-L-T	97	175	15	1	3300	26	94	2	14	50 ²	
3	H	G33	S-L-T	95	69	32	0	4400	27	99	3	14	87	
4	H	G33	S-L-T	95	69	32	3	3300	27	60	0	14	86	
5	H	G33	S-L-T	96	69	32	0	2500	28	113	2	10	73	
6	C	G32	G-S	69	125	45	0	4400	26	154	9	8	86	

¹Planting was carried out with four different spacings in the range from 1600 to 4400 seedlings per hectare.

²Based on 4 decayed bore core samples.

Development of Biological Control Strategy for Management of Dwarf Mistletoes

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INTRODUCTION

To date, research studies on biological control of dwarf mistletoes have been restricted almost entirely to collecting, identifying and cataloging the indigenous fungal and insect parasites of all mistletoe species. There have been no practical efforts to utilize them as biological control agents. Thus, this paper addresses many aspects of the first phase of the project including, discovery, identification and incidence of fungal parasites on western hemlock dwarf mistletoe pathosystem, as well as, some suggestions for promising approaches of research which may eventually lead to effective biological control strategies of these damaging parasitic plant.

In western Canada and US, as well as in parts of Asia and Mexico, dwarf mistletoes (*Arceuthobium* spp.) cause more damage to commercially important conifer species than any other pathogen. Losses result from variety of factors, including a reduction in growth (height, diameter, and volume), and wood quality (Hawksworth and Wiens, 1996). Moreover, infected trees appear to be more susceptible to damage caused by secondary infections by fungi and insects. Thus, in the forest industry and in developed and recreational areas, control of dwarf mistletoes is a fundamental concern.

Traditionally, control measures of dwarf mistletoes were either stand manipulation and/or eradication of the infected trees. The changes in forestry practices has lead to a reduction in cut block size and a move to a more partial cutting operations. These methods can have an important impact of dwarf mistletoe spread and intensification because the ratio of edge trees to seedlings will be increased. To date, chemical control methods have been extensively tested, but a chemical that reduces mistletoes infection has not been found (Unger, 1992). A biological control strategy for dwarf mistletoes should have the following characteristics: 1) it should parasitize only the target mistletoe, not the host or other vegetation; 2) Its activities should seriously interfere with the life cycle of the mistletoe; 3) It should have the potential for building up epidemics on target mistletoe; 4) It must be able to persist throughout the range of the target mistletoe (Hawksworth, 1972). Another aspect of the ideal biological control agent would be its ability to penetrate the mistletoe tissue without requiring a wound, by using favorable conducive formulation for the establishment of the biocontrol agents. The establishment of an equilibrium between fungal parasites and its host (dwarf mistletoes) in the natural environment will insure long lasting control of dwarf mistletoes by biological control agents.

There are no comprehensive accounts of the fungal parasites growing on *Arceuthobium* spp.. The only extensive list of the mycoflora associated with a specific dwarf mistletoe and its host is reported by Hawksworth and Wiens, 1996, which is based on many reports such as those by: Baranyay, 1966; Funk et al., 1973; Funk and smith, 1981; Hawksworth et al. 1977; Muir, 1973; Kuijt, 1963; Wicker and Shaw, 1968; Mark et al. 1976, and others (See pages 82-83, in Hawksworth and Wiens, 1996).

The specific objective of this research project is the development of biological control strategy for management of dwarf mistletoes.

MATERIALS AND METHODS:

As outlined in Shamoun and Thomson (1996), the overall objectives of this research project are:

- collection of fungi associated with dwarf mistletoe shoots and swellings on western hemlock trees, with purification and identification of collected fungi.
- collection of dwarf mistletoe seeds and establishment of seed viability for subsequent tissue culture experiments.
- establishment of a protocol for *in vitro* tissue culture of western hemlock dwarf mistletoe.

- trial and evaluation of techniques to establish dwarf mistletoe infections, to be used as experimental units in a controlled environment.
- determination of the biological properties of fungal parasites of interest, namely *Colletotrichum gloeosporioides* and *Nectria neomacrospora*.

In addition to the above proposed activities, the project had further completed the following:

- establishment of a field trial at which potential fungal parasites (*C. gloeosporioides* and *N. neomacrospora*) of western hemlock dwarf mistletoe can be studied *in situ*.
- development of liquid- and solid-based fungal formulations to be used in the field trials.

RESULTS:

1. Fungal parasites collection, purification and identification

Collection sites were identified as those that would provide suitable material for fungal parasites and dwarf mistletoe seed collections, and that would represent different ecotypes. In all, five sites in southern Vancouver Island were identified for intensive sampling, four in the Cowichan Lake area and one in the Victoria watershed, and additional samples were collected from six other sites (Table 1). Samples collected in spring and fall displayed symptoms of fungal parasitic action, such mistletoe shoots bearing ruptured lesions and hemlock branches with mistletoe swellings covered with exuding resins. From these diseased tissues, fungal parasites were isolated, purified and identified (Table 2), with a subsequent database of 200 samples created.

Fungi of special interest that have been isolated include *N. neomacrospora* (anamorph *Cylindrocarpon cylindroides*) and *C. gloeosporioides*. *Nectria neomacrospora* damages the endophytic system of the dwarf mistletoe plant and has been associated with an open, resinous canker of mistletoe swellings. *Colletotrichum gloeosporioides* is a widespread fungal parasite of several dwarf mistletoe species and causes dieback of shoots and berries, spreading quickly and easily, and can ultimately destroy more than half the shoots within a dwarf mistletoe infection.

Table 1. Summary of dwarf mistletoe hyperparasite collection sites and dates, and number of field samples and fungal isolates.

Site no.	Locality	Collection dates	No. of field samples collected	No. of isolates obtained
1	Cowichan Educ. Centre Cowichan Lake, BC	May, June, October 1996	21	52
2	Nitinat Single Tree Site, Cowichan Lake, BC	May, June, October 1996	14	23
3	Shaw Creek, Cowichan Lake, BC	May, June, October 1996	11	34
4	Harrison Hot Springs, Harrison Lake, BC	July 1996	1	10
5	Greater Victoria Watershed, Victoria, BC	July 1996	15	47
6	Beaverdell, Grand Forks, BC	August 1996	1	1
7	Mary's Peak, Corvallis, OR	August, September 1996	8	8
8	Horne Lake, Parksville, BC	September 1996	1	1
9	Cayacuse Mt., Cowichan Lake, BC	September, October 1996	4	4
10	Shirley Sooke, BC	January, April 1997	7	4
11	Holt Creek Duncan, BC	May 1997	2	2

Table 2. Identification of putative dwarf mistletoe hyperparasitic fungi collected from field sites in Spring 1996 to Spring 1997.

Fungi identified	Collection Sites*	No. of isolates in collection
<i>Aureobasidium</i> sp.	5	1
<i>Colletotrichum gloeosporioides</i>	1, 3, 9, 11	2
<i>Coniothyrium</i> sp.	1	3
<i>Cylindrocarpon cylindroides</i>	1, 2, 9, 11	2
<i>Epicoccum</i> sp.	1, 5	5
<i>Fusarium</i> sp.	2	2
<i>Gloeosporium</i> sp.	1	1
<i>Hormonema</i> sp.	1, 2, 4, 5	21
<i>Monochaetia</i> sp.	1, 3, 4	3
<i>Mucor</i> sp.	1, 4	2
<i>Nectria neomacrospora</i>	2, 7, 10, 11	2
<i>Penicillium</i>	1, 2	3
<i>Phoma</i> sp.	1, 2, 3, 5	21
<i>Pithomyces chartarum</i>	1	1
<i>Sclerophoma</i> sp.	1, 3, 5	14
<i>Seimatosporium</i> sp.	5	3
<i>Trichoderma</i> sp.	1, 4, 5	9
<i>Truncatella</i> sp.	1, 5	8
<i>Cylindrocarpon gillii</i>	11	1

* see Table 1 for site location.

2. Mistletoe seed collection and *in vitro* culture

Callus production techniques for *Arceuthobium* spp., namely *A. pusillum*, have used a variety of mistletoe plant material, including seeds and other explants (Bonga, 1971). *In vitro* dual culture offers a controlled and simplified system for studying some host-pathogen interactions. Tissue culture systems, including callus of conifers and hardwoods, have been used to screen the aggressiveness of certain decay fungi. Similar technology is being sought to investigate and screen the virulence of fungal parasites for their potential as biocontrol agents of dwarf mistletoe. Our goal is to obtain mistletoe callus, an undifferentiated plant tissue, developed through the efforts of the

project graduate student, which can be challenged by fungal applications and fungal pathogenicity could be assessed. Approximately 10,000 seeds were collected from the Cowichan Lake, B.C. area and stored at 4°C. Viability tests, including visual (seed colour and vigour), chemical (tetrazolium chloride), germination tests, indicated an overall seed viability of 16%. Successful *in vitro* seed germination and further development of holdfasts was obtained through screening different media amended with 5 types and 9 concentrations of growth regulators. Viable seeds were used in subsequent tissue culture assays with the goal of producing dwarf mistletoe callus. Assays incorporated 8 types of growth media, several types of explants (seeds with coats, seeds without coats, germinated seeds, seedlings, embryos, shoots, and pedicels), and a range of 9 concentrations of growth promoting auxins and cytokinins. As well, varying light intensities and temperature levels were used. After several months, mistletoe callus was successfully produced on two media types, primarily from the radicles of germinated seed. This is the first report of tissue culture of *A. tsugense*, only the second *Arceuthobium* spp. to be successfully cultured with these techniques (Deeks et al., 1997). Other methods attempted included the use of mistletoe root tip cells and of protoplasts for callus production, neither of which were successful. Another method underway is the transformation of mistletoe explants using *Agrobacterium*, with the intent of inducing a crown gall-type of callus production. Tissue culture of the host plant, western hemlock, was successfully completed with callus production obtained from stem explants on two different media amended with varying amounts of growth regulators (Cheng, 1976).

3. Techniques for establishing dwarf mistletoe infections

By establishing experimental units of dwarf mistletoe on western hemlock under a controlled greenhouse environment, the efficacy of biological control treatments can be determined more readily. Two techniques were employed to establish dwarf mistletoe infections on young, potted hemlock seedlings, seed inoculation and grafting of scions with mistletoe infections. For seed inoculation, twenty hemlock seedlings (2 years-old) were inoculated with viable mistletoe seeds, with three inoculation points per tree at either 1st or 2nd year side or main branches. In addition, seven older hemlock seedlings (4-5 years-old, 1.5 m height) were inoculated with six inoculation points per tree. In total, 200 seeds were placed at the base of hemlock needle bundles, with the seed hypocotyl touching the stem. After 1.5 months, 68% of the seeds had germinated (radicles emerged), and after 5 months, 73.5% seeds had germinated, of which 95% were firmly attached to the host.

Grafting of dwarf mistletoe infected branches onto healthy western hemlock seedlings was completed in an attempt to establish experimental units to be used in the screening of fungal parasites. Forty-one potted hemlock seedlings (3 years old) were used as stock plant and 84 scions were collected from field sites. Scions consisted of young hemlock branches infected with mistletoe, demonstrated by hemlock branch swellings, with or without mistletoe stems present. Grafting was completed by the staff at Cowichan Lake Research Centre using several techniques such as standard grafts, patch grafts, T-buds, budding, and direct grafting of detached mistletoe stems. Although all necessary precautions were taken to give the scions the most suitable conditions for their growth and survival, none of the scions survived after 2.5 months incubation. The main detrimental factor may have been the advanced age of the scions which exceeded that normally used in hemlock grafting procedures.

4. *In vitro* screening of fungal parasites as biocontrol agents for *A. tsugense*

Certain fungi that were isolated from diseased mistletoe shoots, such as *C. gloeosporioides*, are known as fungal parasites of several species of dwarf mistletoe. To develop *C. gloeosporioides* as a biocontrol agent, information on biological properties, such as growth characteristics as influenced by temperature, were first collected. Fungal colonies grew between 10-30°C, with maximum growth at 20°C, and no growth occurred at 5°C or 35°C. Conidial germination occurred between 10-35°C, with a maximum germination at 30°C. No germination occurred at 5°C or 40°C, although conidia remained viable at these temperatures (Figure 1).

Colletotrichum gloeosporioides was then tested for infectivity and virulence on healthy mistletoe shoots and seeds. Mistletoe-infected hemlock branches were collected and maintained in nutrient solution under greenhouse conditions. A spore suspension of the fungus was brushed onto healthy mistletoe shoots (with 8-10 replicate branches) and subsequently re-isolated from diseased stems after 14 days. The experiment could not be sustained for longer periods due to branch dieback. *Colletotrichum gloeosporioides* also readily infected germinating seeds when applied as a spore suspension or as a mycelial plug in close proximity to the seeds. Symptoms of seed infection appeared as early as 7 days from inoculation, with seeds and radicles becoming discoloured and degrading. Control seeds remained green with healthy radicles for 1.5 months.

From our field observations and literature review (Funk et al., 1973; Kope et al., 1997; Muir, 1977; Smith and Funk, 1980), we have observed the potential use of *N. neomacrospora* and *C. gloeosporioides* as a biological control agents for *A. tsugense*. *Nectria neomacrospora* damages the endophytic system of mistletoe and prevents the re-sprouting of mistletoe shoots. Meantime *C. gloeosporioides* causes damage on shoots and berries of the mistletoe and interfere and interrupt the life cycle of dwarf mistletoe.

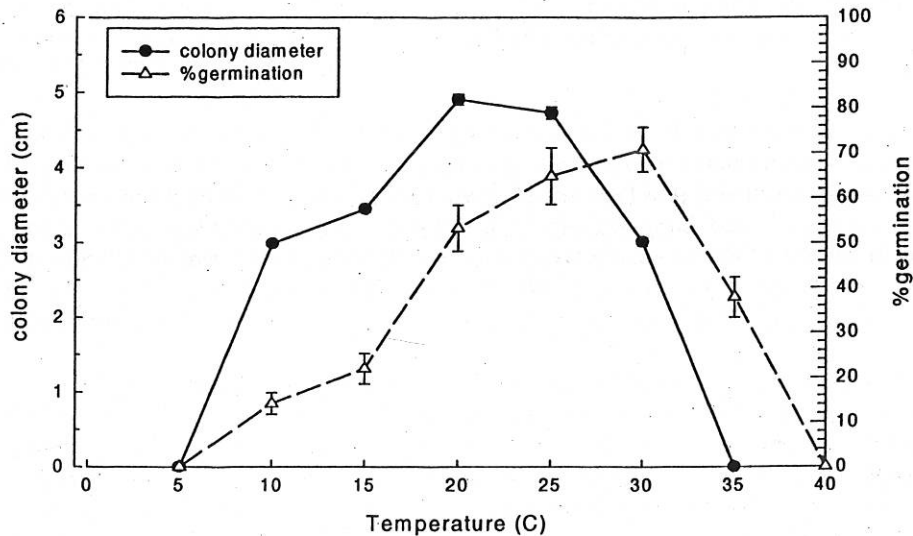


Figure 1. Effect of temperature on *Colletotrichum gloeosporioides* %germination after 24 hr (n=900) and on colony diameter after 15 d (n=10), with standard error bars.

5. Field trials- Testing and evaluation of *C. gloeosporioides* and *N. neomacrospora* as biocontrol agents for *A. tsugense*

These two fungal parasites were produced in mass inocula on media selected for optimum growth and sporulation. An inert carrier system to deliver the fungi under field conditions was then developed through laboratory testing. Five different formulations were assayed (due to patent issues involved in this research, formulation ingredients will not be disclosed in this article). A field site with young western hemlock trees heavily infected by *A. tsugense* was selected at Holt creek, Duncan, BC. Qualitative and quantitative pre-treatment data on dwarf mistletoe and their host trees was collected in mid- August, 1997. Dwarf mistletoe clusters were inoculated on September, 1997, using a completely randomized design, with 4 treatment: Formulated *C. gloeosporioides*, Formulated *N. neomacrospora* (Using the anamorph stage conidia of *Cylindrocarpon cylindroides*), Formulation alone and Water control. Inoculum was applied as an aerial spray, with 30 replicates per treatment. Short- term observations at 50 days post- treatment show a high percent mistletoe shoot mortality for both fungal parasites treatments, and also some for the formulation treatment alone. (This was expected for formulation treatment because the micro-environmental conditions were very conducive for infection and establishment for background naturally occurring inoculum for both fungi). Observations, data collection and monitoring of this experiment will continue for 3-5 years post-treatment.

DISCUSSION:

To date, there are successful stories about production of biological control agents for management of agricultural weeds and forest competing vegetation. Examples of these products are: COLLEGO, which is a product of *Colletotrichum gloeosporioides* f. sp. *aeschynomene* for control of northern jointvetch weed in soybean and rice fields in the US. (Templeton, 1992). DeVINE is a product of *Phytophthora palmivora*, registered as a mycoherbicide

for control of stranglervine (*Morrenia odorata*) in citrus groves in Florida (Riding, 1986). In Canada, a dry formulation of *Colletotrichum gloeosporioides* f. sp. *malvae*, under the trade name BioMAL, was registered for control of round-leaved mallow (*Malva pusilla*) in strawberry field crops (Mortensen, 1988). In forestry situation, *Chondrostereum purpureum*, a primary wood invader and the causal agent of silver leaf disease of fruit trees and other shrubs, has been investigated for biological control of unwanted woody plants. A collaborative research agreement was established between Canadian Forest Service-Pacific Forestry Centre, Victoria, BC, and MycoLogic Inc., University of Victoria, BC, to commercialize this fungus and the registration efforts are currently underway. *Chondrostereum purpureum*, under the trade name ECOclear, has progressed to pre-commercial stage for use in conifer reforestation sites and utility rights-of-way in an integrated forest vegetation management strategies (Shamoun et al., 1996).

These successful initiatives have lead us to develop a biological control strategy for the management of dwarf mistletoes under a partial cutting system. When openings are created in stands, the trees along stand edges increase in growth rate, as do the mistletoe plants in these trees. Thomson (1979) demonstrated that dwarf mistletoe capsules are oriented towards stand openings, promoting spread of infection. It has been observed that as the crowns of trees expand, the mistletoe plants in the interior of the crown eventually die out, and if the rate of growth of the trees sufficiently exceeds the spread characteristics of the mistletoe, the trees can escape the mistletoe and return to a healthier condition.

An effective biological control strategy therefore, does not have to eradicate mistletoe from entire stands. Our philosophy is based on the idea that treating affected trees bordering new stand openings, or single residual trees within openings, will sufficiently retard the growth and spread of the mistletoe and that the crowns of the trees will outgrow the infections. Seed discharge from mistletoe within the crown, prior to death of the mistletoe plant, will then primarily result in intensification within that crown rather than spread to the new, adjacent plantations (Thomson, 1975).

The efficacy of the fungal parasites proposed as candidate biological control agents (*C. gloeosporioides* and *N. neomacrospora*) for management of *A. tsugense* can be enhanced with an inert carrier (formulation) such as diluents and surfactants, used to either alter the physical characteristics of the target mistletoe plant to a more desirable form, or to improve or modify fungal spore germination, pathogen virulence, or environmental requirements. These factors greatly determine the biological control potential of the candidate fungal parasites. The control strategy therefore aims at reducing spread from affected trees to seedlings planted following stand openings by forest harvesting (in particular under partial cutting system) or silvicultural activities. Affected trees bordering openings, or residual trees throughout openings, will be treated. The areas requiring treatment will be identified during pre-harvest prescription, or during surveys preceding silvicultural treatments. Threshold mistletoe ratings for treatment, in relation to stand attributes such as mean, dbh, age, and density, will be identified during the study. Only those patches exceeding the threshold will require treatment. We believe that our approach (based on ecologically sound management tool for dwarf mistletoe) will be effective in retarding mistletoe development following stand openings, resulting in significant in spread to adjacent plantations. We are confident that the biological control strategy developed for management of western hemlock dwarf mistletoe, will be transferable to other mistletoe pathosystems.

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Pine Pitch Canker In México ¹

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INTRODUCTION

Pine pitch canker disease was first reported in 1946, affecting *Pinus virginiana* in USA (Hepting and Roth, 1946). Since this initial report, the disease has been found to be widely distributed throughout Southeastern United States in Florida, Mississippi, Tennessee, North and South Carolina, Georgia, Virginia Alabama and Texas (Barrows-Broadus, 1987). In 1986 it was detected in California affecting natural stands of Monterey pine (McCain *et al.*, 1987). The disease is also present in Haiti, Russia, Japan and Iraq.

In México, the disease was first noticed in Michoacán, but the causal agent was reported as *Heterobasidion annosum*. *Fusarium* was considered to be an associated fungus but not the causal agent of the disease (Vázquez Collazo and Martínez Barrera, 1980).

In 1987 the disease was reported in the state of Nayarit affecting *Pinus douglasiana* (pers. com. Ma. Eugenia Guerrero, 1988). The disease was subsequently detected in Jalisco (Cibrián Tovar and Villa Castillo, 1988) and Tamaulipas. Gutierrez Rodríguez, (1991) reported the disease in natural stands and plantations of *P. douglasiana* in Nayarit.

From 1988 to 1993 research studies were conducted to evaluate different aspects of the disease, such as its distribution, host range, symptomatology, susceptibility in laboratory tests and identification of the agent causal.

MATERIAL AND METHODS

Field trips were conducted in 13 states including the Federal District to collect samples from symptomatic trees.

Samples from resin soaked phloem and xylem tissue were used to isolate the fungus. The pitch canker pathogen was isolated by using traditional techniques. Initial isolations were cultured on PCNB-Agar and then transferred to Potato-Sucrose-Agar (PSA) to obtain better growth. Pure cultures were obtained to use for inoculation and identification.

A new technique for inoculation of the fungus into healthy seedlings was developed, because other techniques did not prove to be effective. This technique consisted of 7 steps:

- 1) First step was to remove the fascicles of the shoot.
- 2) A horizontal cut or wound to the epidermis was made.
- 3) A vertical cut or wound was made to make a T form wound.
- 4) The epidermis was separated to expose the xylem.
- 5) The inoculum (circles of 1 cm diameter media containing the fungus) was placed in contact with the xylem.
- 6) The T form wound was sealed.
- 7) A piece of gauze was used to protect the wound.

Two kinds of control were used in the inoculation tests: the first control consisted of following the same process used in the inoculation but with no fungus in the media, and the second control consisted of unwounded seedlings. The fungus was recovered from all inoculated seedlings using the same procedure for isolation.

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In total 620 pine seedlings of 12 species were inoculated, using 14 strains of the fungus. Each strain was inoculated into five plants of each species (Tables 1 and 2).

Table 1. Pine seedlings inoculated and number of strains used.

SPECIES	N° OF STRAINS INOCULATED	N° OF PLANTS INOCULATED
<i>Pinus ayacahuite</i>	14	70
<i>Pinus pseudostrobus</i>	14	70
<i>Pinus montezumae</i>	14	70
<i>Pinus douglasiana</i>	14	70
<i>Pinus patula</i>	14	70
<i>Pinus michoacana</i>	12	60
<i>Pinus leiophylla</i>	10	50
<i>Pinus rudis</i>	8	40
<i>Pinus halepensis</i>	8	40
<i>Pinus cembroides</i>	8	40
<i>Pinus greggii</i>	6	30
<i>Pinus pringlei</i>	2	10

Table 2. Precedence of strains used for inoculation.

N° OF STRAIN	PINE SPECIES
1	<i>Pinus maximinoi</i>
2	<i>Pinus pseudostrobus</i>
3	<i>Pinus arizonica</i>
4	<i>Pinus discolor</i>
5	<i>Pinus montezumae</i>
6	<i>Pinus rudis</i>
7	<i>Pinus oocarpa</i>
8	<i>Pinus douglasiana</i>
9	<i>Pinus durangensis</i>
10	<i>Pinus leiophylla</i>
11	<i>Pinus michoacana</i>
12	<i>Pinus ayacahuite</i>
13	<i>Pinus hartwegii</i>
14	<i>Pinus cembroides</i>
15*	<i>Pinus pringlei</i>

* This strain only was used to inoculate seedlings of *P. pringlei*

RESULTS AND DISCUSION

The disease was found in 13 states of the country associated with 19 pine species (Table 3). The altitudinal range in which the disease was found was very variable ranging from 1400 to 2900 meters.

Table 3. Host range and distribution of pine pitch canker in México.

D. F. DURANGO	<i>P. pseudostrobus</i>	MICHOACAN	<i>P. oocarpa</i>
	<i>P. durangensis</i>		<i>P. maximinoi</i>
	<i>P. discolor</i>		<i>P. montezumae</i>
GUERRERO	<i>P. pringlei</i>	MORELOS	<i>P. michoacana</i>
	<i>P. rudis</i>		<i>P. pseudostrobus</i>
HIDALGO	<i>P. leiophylla</i>	NUEVO LEON	<i>P. hartwegii</i>
JALISCO	<i>P. douglasiana</i>		<i>P. arizonica</i>
EDO.MEX.	<i>P. pseudostrobus</i>	PUEBLA	<i>P. cembroides</i>
	<i>P. leiophylla</i>		<i>P. montezumae</i>
	<i>P. ayacahuite</i>		<i>P. oaxacana</i>
	<i>P. pringlei</i>	TAMAULIPAS	<i>P. estevezii</i>
	<i>P. radiata</i>		<i>P. rudis</i>
	<i>P. hartwegii</i>		<i>P. montezumae</i>
	<i>P. halepensis</i>		<i>P. oocarpa</i>
	<i>P. radiata</i>	VERACRUZ	

Note: The disease was also reported on *Pinus douglasiana* from Nayarit (Gutiérrez Rodríguez, 1991)

The following symptomatology was observed in the different pine species:

Resin streaming. This was the most obvious symptom, it was present in all pines under study. The presence of cankers was very characteristic only in *Pinus leiophylla* and was absent in *P. cembroides*. Resin streaming always emanated from the cankers.

Discoloration and dieback of branches were observed.

A bole canker on the main stem was observed in at least 12 species. Cankers on large branches with resin streaming were very helpful in identifying those trees affected by the pitch canker fungus. In some cases the bark was destroyed and cracked due to the heavy resin flow.

Pitch soaking. Discoloration of the wood beneath the cankers and resin soaked areas were observed in 17 species. From these tissues (healthy and diseased), chips were obtained to use in the isolation of the pitch canker fungus. Infected branches were often observed, and provided material from which the fungus was isolated.

Four insects were found to be associated with the disease, *Eucosma sonomana*, *Dendroctonus frontalis*, *Pityophthorus sp.* and *Rhyacionia sp.*, but it was not possible to determine what relationship the insects have with the pitch canker fungus.

The pitch canker fungus was consistently isolated from collected samples.

The pathogenicity tests show that all isolates inoculated into healthy seedlings were virulent for all pine species. In total 620 seedlings were inoculated and 429 exhibited the symptoms of infection, representing an infection rate of 69.1%. None of the 120 seedlings used as controls exhibited infection.

Differences in virulence were observed in the different species of pines. *Pinus ayacahuite* was the least susceptible species exhibiting 18.5% infection, while *Pinus cembroides* had the highest infection rate with 100% diseased seedlings. The least susceptible species were *Pinus halepensis* (27.5%); *P. douglasiana* (34%); *P. leiophylla* (40%) and *P. pringlei* (40%). Pines with moderate susceptibility were *Pinus michoacana* (75%) and *P. greggii* (76%); and pines with high susceptibility were *Pinus pseudostrobus* (85.7%), *P. montezumae* (88.5%), *P. patula* (90%) and *P. rudis* (95%) (Table 4).

Pinus patula and *P. greggii* have never been found to be attacked by pitch canker in the field, but were susceptible in the greenhouse inoculation tests.

Table 4. Incidence and infection of pine seedlings inoculated with 14 different strains and number of plants that exhibited the symptoms of the disease.

PINE SPECIES	N° OF PLANTS INOCULATED	N° of PLANTS w/ INFECTION	INFECTION %
<i>P. ayacahuite</i>	70	13	18.5
<i>P. pseudostrobus</i>	70	60	85.7
<i>P. montezumae</i>	70	62	88.5
<i>P. rudis</i>	40	38	95.0
<i>P. douglasiana</i>	70	50	34.0
<i>P. patula</i>	70	63	90.0
<i>P. greggii</i>	30	23	76.6
<i>P. michoacana</i>	60	45	75.0
<i>P. cembroides</i>	40	40	100.0
<i>P. leiophylla</i>	50	20	40.0
<i>P. pringlei</i>	10	4	40.0
<i>P. halepensis</i>	40	11	27.5
TOTALS	620	429	69.1

The symptoms observed on the inoculated seedlings were:

1. Wilting and discoloration of the shoot.
2. Bending of the shoots and deformity.
3. Death of shoots and greenish brown and discoloration.

IDENTIFICATION OF THE CAUSAL AGENT

More than 200 isolates were obtained from pine, all of them for identification. The characteristics of the cultures were:

Color in the different cultures was always white when the fungus began its growth and changed during its development to light pink, dark pink through violet and purple. Also the color of the media changed from light red to dark purple. These changes in the color of the fungus and the media are characteristic as described by Kuhlman *et al.*, 1978 and Barrows-Broadus, 1987.

The growth of the cultures on average was 9 cm in diameter in 14 days. Microscopic slides were made to identify the fungus, observing the formation of the typical structures as described by Nelson, Toussoun and Marasas (1983). These structures were easy to observe after 21 days of growth. The best development of the cultures was at temperatures of 24°C to 32° C. Microconidia and macroconidia were always observed, their measurements, on average, were 10 X 2.8 mm; and 4.0 mm in length by 3.8 mm wide (Kuhlman, *et al.*, 1978; Blakeslee *et al.*, 1980 and Barrows-Broadus, 1987). The presence of polyphialides produced on two and three open ends and simple phyalides were typical to identify the fungus as *Fusarium subglutinans* (Kuhlman *et al.*, 1978), no chlamidospores were found Koch's postulates were tested. The fungal isolates recovered from infected tissues were found to be identical to those used for inoculations (Barnard and Blakeslee, 1980).

The asexual fruiting bodies (sporodochia), were only found on two species of pines: *P. radiata* at México State and *P. douglasiana* at Jalisco State.

CONCLUSIONS

The pitch canker has a wide distribution and host range in México, it is currently distributed in 14 states affecting at least 19 pine species. The pitch canker affects young and old trees, mainly in natural stands without clear evidence of outbreaks. The symptomatology observed was: cankers on boles and branches; discoloration of shoots and needles; dieback; resin soaking and discoloration of the wood; death of new growth and deformation of the shoots and resin streaming. The sporodochia only were found on *Pinus radiata* and *P. douglasiana*.

The causal agent of the disease was identified as *Fusarium subglutinans* (assistance in identification was provided by Tomas Miller from the University of Florida).

The pathogenicity of the fungus was tested by inoculating 14 strains into 12 different pine species; 620 seedlings were inoculated and 429 developed the infection, the fungus was recovered from diseased tissues.

The causal agent is specific to pines and there is no evidence that the disease is exotic to México.

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Panel - Mixedwood Management and Forest Health

SUZANNE SIMARD - MODERATOR

Intensive Management of Young Mixed Forests: Effects on Forest Health

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Diversity - in the plant community, the microbial community and the ecosystem as a whole - plays a seminal role in buffering against disturbance and maintaining healthy links between plants and soils (Perry et al. 1989).

Introduction

The Interior Cedar Hemlock (ICH) zone supports the most species rich and productive forests in the British Columbia Interior due to its long growing season, relatively long frost-free growing period, and abundant precipitation. The productivity, diversity and proximity to major waterways and communities of the ICH has made it a focus for some of the most intensive forest management practices in the Interior. Intensive forest management, which historically has been considered the most successful strategy for commercial sawlog production, includes (1) clearcutting, (2) broadcast burning, (3) planting interior Douglas-fir, interior spruce or lodgepole pine, (4) weeding to reduce competition from unwanted broadleaves, and (5) spacing conifers to favour the planted conifers (Simard and Vyse 1994). Recently, this practice has been criticized by the public, mainly due to concerns over the use of clearcut logging, herbicides, biodiversity and forest health.

This paper offers definitions for mixed species forests and forest *ecosystem* health, and reviews how British Columbia's current legislation affects our ability to manage diverse tree species mixtures and forest health. It provides some evidence for how intensive management reaches timber production goals; but how it also can result in some unexpected and unwanted outcomes for forest health.

Mixtures and Ecosystem Health Defined

This paper focuses on the mixed tree species forests that dominate the south and central parts of the ICH zone, where up to 13 tree species can coexist on a single site. Climax forests are dominated by western redcedar and western hemlock, and seral forests can also contain various mixtures of interior spruce, Douglas-fir, interior spruce, subalpine fir, western white pine, western larch, lodgepole pine, ponderosa pine, paper birch, cottonwood, and trembling aspen. Seral forests that develop following wildfire are usually even aged and are characterized by shade tolerant cedar and hemlock growing under the canopy of faster growing, shade intolerant broadleaves and conifers. Paper birch commonly dominates the upper canopy in young stands. As the stands develop, cedar and hemlock are slowly released into canopy gaps created by senescence of shorter-lived seral species, windthrow, selective harvesting, and infestations by *Armillaria* or *Phellinus* root disease. *Armillaria ostoyae* and *Phellinus weirii* are the dominant fungal pathogens and are widespread throughout the ICH zone (Morrison *et al.* 1991). The highly complex, seral, mixed species forests of the southern ICH contrast with the seral *mixedwood* forests of the north eastern Sub-boreal Spruce (SBS) zone, where tree species diversity is characteristically low (predominantly white spruce and trembling aspen, with lesser amounts of subalpine fir, balsam poplar, and/or black cottonwood) (Peterson *et al.* 1989).

In order to evaluate whether intensive forest management is affecting forest health, it is necessary to define what we mean by forest health. There has been considerable debate over the past five years about the definition of *ecosystem*

health (e.g., Swanson *et al.* 1993, Kolbe *et al.* 1994, Perry 1994), and I have borrowed from this debate to define, for this paper, forest ecosystem health. The definition I offer is a considerable expansion of our traditional use of the term *forest health* which, in government bureaucracies, usually means insect and disease (pest) management.

A healthy forest ecosystem is in a condition in which *all components* are intact and functioning 'normally'. Hence, forest ecosystem health is a measure of the condition of the ecosystem relative to its 'normal, intact' state. To function normally, the basic requirements of the components must be met (i.e., organisms at all trophic levels must satisfy their needs for food, shelter and reproduction; the physical fabric such as water, soil and climate, must be in a condition to support the requirements of the organisms). In addition, a healthy ecosystem is capable of constraining its own fluctuations within certain bounds, and has some degree of predictability and constancy (e.g., of diversity, productivity) in certain potentials. It constrains its fluctuations through feedbacks among organisms and their environment, and within and between hierarchical levels. To do this requires strong linkages among hierarchical components. Healthy ecosystems are further characterized by resistance and resilience. Resistance is the ability of the ecosystem to absorb disturbances and resilience is the ability to bounce back to a healthy state following disturbance. Healthy ecosystems which satisfy these conditions are usually characterized by complexity (e.g., species and structural diversity), as well as productivity and water quality that reflect the site's biology, geology and climate. Healthy ecosystems, by virtue of their complexity and strong linkages, are resilient to natural disturbances.

An important problem we face with this broad definition is our difficulty in defining what is 'normal' and what are appropriate 'bounds and potentials'. We don't know whether our current forest practices of fire suppression, clearcut logging, road building, and intensive plantation management are outside bounds where ecosystems can recover their gross primary productivity following further disturbance. We don't know, for example, whether our intensive management practices simplify systems, and, based on Holling and Meffe (1995), will result in gradual loss of resilience. However, we can measure the effects of our practices on productivity, complexity, and incidence of, for example, disease.

In the following section, I review four guidelines in the Forest Practices Code of British Columbia (1995) that affect our ability to manage diverse, mixed species forests, and that may have measurable effects on forest ecosystem health. Those that encourage management of diverse tree species mixtures are contained in the Root Disease Management and Biodiversity Guidebooks, and those that encourage simplification of the communities are contained in the Establishment To Free-Growing and Green-up Guidebooks of the Forest Practices Code of British Columbia (1995a-d).

Forest Practices Code and Management of Mixtures and Root Disease

The guidelines for management of root diseases resulting from *Armillaria ostoyae* and *Phellinus weirii* are based on 'ecosystem-based forest management (and) strive to maintain the functions of root pathogens while not creating conditions that favour these pathogens over the other ecological site factors' (Forest Practices Code of British Columbia 1995a). The recommended silviculture and stand management prescriptions for the B.C. Interior are briefly summarized in Table 1. Where disease incidence is less than 8%, the recommended silviculture prescription is for regeneration of immune (deciduous species and western redcedar for *P. weirii*; none for *A. ostoyae*), tolerant (lodgepole pine, western white pine and ponderosa pine for *P. weirii*; ponderosa pine, western larch, trembling aspen and paper birch for *A. ostoyae*) or moderately susceptible (western hemlock, Engelmann spruce and western larch for *P. weirii*; western redcedar, western hemlock, lodgepole pine and western white pine for *A. ostoyae*) species. Where planting is prescribed, alternating species in mixtures is recommended. The recommendation for species mixtures is based on field observations of forest pathologists and the experimental work of Morrison *et al.* (1988), who found that the incidence of *Armillaria* root disease among susceptible conifers was lower in mixed plantings with paper birch or western redcedar, than in pure plantings of Douglas-fir or lodgepole pine. To that end, the guidebook states:

"A prescription of broadleaved/conifer mixes rather than pure conifers generally will result in lower root disease levels and regeneration risk, and is often the only choice in areas with high levels of disease and few acceptable alternate conifer species. This tactic can provide additional benefits in satisfying wildlife values and biodiversity issues, while still providing significant forest cover and supply of fibre" (Forest Practices Code of British Columbia 1995a).

Table 1. Guidelines for silviculture and stand management prescriptions where disease incidence is minimal, moderate or high (Forest Practices Code of British Columbia 1995a).

Prescription	Incidence of <i>Armillaria</i> or <i>Phellinus</i> root diseases		
	Minimal (<2%)	Moderate (2-8%)	High (2-8%)
Silviculture	No restrictions on harvesting or regeneration strategies; unless disease is absent, favour immune, tolerant or moderately susceptible species.	Regenerate immune, tolerant or moderately susceptible species; plant alternating species mixtures.	Push-over or conventional harvest followed by stumping, and then regenerate with any species; if above not possible, regenerate with tolerant or immune species.
Stand Management	No restrictions on stand management strategies.	Only treat to fulfill obligations for basic silviculture; restrict manual brushing to where prevention of mortality is required; do not brush for conifer release; do not thin below maximum density levels.	No stand tending unless inoculum reduction is conducted; accept reduced stocking or, in extreme conditions, consider rehabilitation of the stratum.

Stand management prescriptions where root disease incidence is between 2-8% also encourage retention of species mixtures by recommending brushing only to prevent conifer mortality, not for release to improve growth. Brushing in the ICH has historically resulted in treatment of most broadleaved trees on a site, particularly paper birch. Fortunately, on most ICH sites where *Armillaria* and *Phellinus* root diseases are problematic, brushing usually is not necessary to prevent mortality and most commonly is carried out for conifer release (Mather *et al.* 1996; Simard 1997).

The recommendations of the Biodiversity Guidebook concur with those of the Root Disease Management Guidebook with respect to maintaining species diversity at the stand level (Forest Practices Code of British Columbia 1995b). In brief, biodiversity recommendations at the stand level are to (1) choose native species, (2) establish mixed species plantations, (3) avoid stand tending that reduces natural diversity, and (4) avoid species conversions. In addition, broadleaved tree species are recognized as providing critical habitat for several wildlife species.

The free-growing requirement throws a wrench, however, into implementation of the root disease and biodiversity management recommendations for maintaining tree species diversity. According to the Establishment to Free-Growing Guidebook, only select conifer species are considered ecologically suitable crop trees, and all broadleaved tree species are considered competing brush (Forest Practices Code of British Columbia 1995c). Within a minimum age since establishment (5 years in the ICH zone), crop trees must reach a minimum height, be healthy (*i.e.*, free of insects and disease), and *be 150% the height of surrounding brush within a 1 m radius*. Historically, competition from 'brush' has been considered the dominant influence on crop tree performance, and application of the free-growing requirement has resulted in broadcast treatment of broadleaved tree species, particularly paper birch, in mixed plantations in the southern ICH (Simard and Vyse 1994). The Green-up Guidebook falls in step with the free-growing legislation, stating that green-up is achieved only when a stand of well-spaced, acceptable conifer species reaches an average height of 3 m. Again, broadleaved tree species are not acceptable (Forest Practices Code of British Columbia 1995d).

The free-growing and green-up requirements have over-ridden other management objectives since they were legislated, and continue to do so under the Forest Practices Code. They have helped fuel intensive management on our productive ICH sites, with the primary goal of achieving predictable, high volume yields of conifer tree species that are commercially valuable today. While the legislation has ensured that cut-over stands are well-stocked and established before licensees can revert the tenure back to the Crown and, perhaps more importantly, harvest adjacent

stands, it also has resulted in many cases in unforeseen and undesirable consequences. In the following section, I examine some of these consequences in mixed stands of Douglas-fir and paper birch.

Intensive Management Effects on the Health of Young Mixed Forests

The free-growing legislation has been supported by short-term research which, in many cases, demonstrates maximum conifer growth in the absence of competing vegetation (e.g., Simard 1990, Wagner and Radosevich 1991). When performance was evaluated in terms of wood volume production, for example, Simard (1990) retrospectively showed that Douglas-fir saplings growing in the ICH zone performed best in the absence of neighbouring paper birch. Douglas-fir performance improved due to increased availability of light and soil moisture with decreased birch competition. Manipulative experiments in the southern interior of B.C. also demonstrate that paper birch density reductions benefit Douglas-fir growth in the short term (Simard and Heineman 1996, Mather *et al.* 1996). Nine years after paper birch was treated with glyphosate (birch averaged 11% cover), for example, stem diameter of neighbouring Douglas-fir was 3 cm larger (9.6 cm vs. 6.7 cm; $p < 0.05$, $n=3$) than where it was growing among untreated paper birch (40% cover) (Simard and Heineman 1996). There was no added benefit to Douglas-fir, however, of reducing birch cover from 15% to 7% using a higher application rate of glyphosate (2.1 ai kg/ha versus 1.1 ai kg/ha). These results suggest that retaining low densities of paper birch do not negatively impact growth of Douglas-fir.

The effects of brushing treatments on biodiversity vary according to the ecosystem components examined and the diversity metrics analyzed. In the experiment of Simard and Heineman (1996), diversity of vascular plant species was not significantly affected by brushing treatments when measured as species richness nor when analyzed with Shannon's or Simpson's diversity indices ($p > 0.05$). These results concur with five other long-term brushing experiments in the southern Interior (Simard and Heineman, unpublished). They also agree with the Ministry of Forests claim that silvicultural practices in British Columbia do not decrease tree species richness (British Columbia Ministry of Forests 1992). Although our brushing practices do not appear to decrease species richness, they do have pronounced effects on the vertical and spatial complexity (structure) of the communities (Mather *et al.* 1996). For example, in the experiment of Simard and Heineman (1996), the distribution of functional groups of plants was significantly shifted toward a decrease in broadleaved trees, and an increase in shrubs and herbs.

Changes in diversity or structure of plant communities can affect other groups of organisms, such as cavity nesting birds, small and large mammals, and soil microbes. In the experiment of Simard and Heineman (1996), for example, moose unexpectedly browsed 50-70% of Douglas-fir leaders one and two years following broadcast glyphosate applications to neighbouring paper birch, and browsed comparatively few leaders in untreated control plots. Moose browsing was greater where birch was treated with glyphosate because of greater physical access to Douglas-fir leaders (height of Douglas-fir double that of neighbouring paper birch) than in untreated control plots (height of Douglas-fir half that of paper birch), and because of the herbicide impact on availability of birch. Normally, healthy birch provides year-round browse to moose and other ungulates (McNichol and Timmerman 1981).

In another study of paper birch and Douglas-fir interactions, Jones *et al.* (1997) showed that the evenness (component of diversity) of the ectomycorrhizal community on two-year-old Douglas-fir root systems was greater when it was grown in mixture with paper birch than when it was grown in pure stands. They suggested that this increased diversity resulted from ready inoculation of Douglas-fir roots by colonized paper birch roots because of a readily available carbon supply (from birch roots), and from favourable modification of the soil, both chemically and biologically, by the presence of paper birch. Simard *et al.* (1997) also showed that Douglas-fir seedlings with access to root systems of overstory paper birch and Douglas-fir trees, were host to a greater richness and diversity of ectomycorrhizal fungi than seedlings that were grown in isolation. Seedlings with a greater diversity of mycorrhizal fungi performed better (*i.e.*, greater net photosynthetic rate, greater height growth) than those grown in isolation. These results suggest that maintaining tree species diversity results in greater ectomycorrhizal diversity and better seedling performance than does single species management.

While stands that contain one or a few commercially desirable tree species can be of high economic value, there is some evidence that they are more susceptible than mixed stands to insect outbreaks (e.g., Alfaro *et al.* 1994) and pathogen infestations (e.g., Morrison *et al.* 1988). We have begun to document greater mortality due to *Armillaria* root disease among susceptible conifers following brushing of paper birch from mixed plantations. For example,

Armillaria-related mortality among Douglas-fir was 23% nine years after paper birch and associated "weeds" were brushed (manual cutting or broadcast glyphosate), and only 15% where they were left untreated (Simard and Heineman 1996). Similar trends are being measured following a range of operational brushing treatments in species mixtures in southern B.C. In PROBE installations (Simard 1993), mortality of Douglas-fir five years after manual and/or chemical brushing treatments has averaged 8%, compared to only 4% where birch and associated "weeds" were left untreated ($p < 0.05$, $n = 16$). There are several possible mechanisms by which disease incidence increased following brushing: (1) the creation of dead or dying stumps increased inoculum, (2) the continuity of inoculum was increased, (3) there was a higher probability of infection of remaining Douglas-fir stems, (4) there were increases in growth rates of remaining susceptible trees, resulting in faster root-root contact, and (5) there may have been a negative effect on the health of the belowground microbial community, reducing the stand's overall resistance to infestation. Note that these brushing treatments have increased disease incidence from moderate to high levels, which call for either acceptance of lower stocking levels or rehabilitation of the site (Table 1, Forest Practice Code of British Columbia 1995a).

Recognition of these unwanted consequences, and public opposition to several intensive management practices, has resulted in some changing silvicultural practices in the southern Interior ICH. Along with increases in the use of alternative silviculture systems to clearcutting, has been a dramatic reduction in the use of herbicides since the late 1980's, and exceptions made to the free-growing standard by some District Managers to accept a few broadleaf tree species in conifer plantations. The next step is to recognize the unique silvical requirements of broadleaf tree species and retain higher densities in more diverse spatial and vertical arrangements in mixed plantations. Some ecological meaningful guidelines for managing density and spatial pattern of paper birch in mixed plantations are provided in Simard (1997).

Summary

Rather than pursuing short-term, high economic returns through establishment of plantations with few conifer species and weeding to achieve free-growing status, management of forested ecosystems should promote diversity, system stability and resilience. Maintaining diversity in plant and microbial communities appear to stabilize systems and may ensure recovery of healthy ecosystems following disturbance. When mixed with paper birch, for example, regenerating Douglas-fir will be inoculated more rapidly and with a greater diversity of soil micro-organisms than when grown in single species stands, thereby increasing its net photosynthetic rate and productivity. In addition, damage or mortality among Douglas-fir due to browsing or root disease may be minimized when it is grown in mixture with paper birch. Ensuring that species and structural diversity are not compromised by silvicultural practices will require some modification to our definition, enforcement and interpretation of the free-growing and green-up legislation. Fortunately, there is enough flexibility in the free-growing legislation that changes already have begun to occur at the ground level in the past few years.

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Influences of Paper Birch (*Betula papyrifera*) on Microbial Communities in Soil and their Possible Implications for Armillaria Root Disease of Conifers

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Introduction

Armillaria ostoyae causes growth reductions and mortality of Douglas-fir (*Pseudotsuga menziesii*) and all other commercially valuable conifer species in the southern interior of British Columbia (Morrison et al. 1991). Paper birch (*Betula papyrifera*) is one of only a few tree species resistant to *A. ostoyae* (Morrison et al. 1991). Paper birch grows throughout the Interior Cedar-Hemlock biogeoclimatic zone and moist variants of the Interior Douglas-fir zone, often in mixtures with Douglas-fir and other conifers susceptible to *A. ostoyae*. Thus, understanding interactions between paper birch and *A. ostoyae* are critical to understanding the response of *A. ostoyae* to management of mixed stands.

Infection of Douglas-fir by *A. ostoyae* may be reduced in stands that also contain paper birch. At one experimental site in the southern interior of B.C., the number of trees in disease centres was lower in plots of mixtures of Douglas-fir and paper birch than in plots of Douglas-fir alone (Morrison et al. 1988). Recently, Simard (1997b) observed that removal of juvenile paper birch from young mixed stands resulted in increased mortality of Douglas-fir by *A. ostoyae*.

The apparent suppression of *A. ostoyae* in stands with birch has not yet been studied sufficiently to reveal mechanisms. One likely hypothesis is that roots of paper birch function as a physical barrier to rhizomorph growth, increasing the mean distance between inoculum sources (previously infected stumps and large roots) and susceptible roots. Another hypothesis, which is not mutually exclusive from the first, is that microbial communities developing under paper birch are more antagonistic to *A. ostoyae* inoculum survival and rhizomorph growth than those developing under Douglas-fir. The increase in mortality associated with birch removal (Simard 1997b) is consistent with both hypotheses and could also result from the colonization of recently-killed birch root systems, leading to increased inoculum levels. However, there are no published data indicating whether the roots of recently-killed paper birch are sufficiently colonized by *A. ostoyae* to contribute to inoculum build-up.

The effects of paper birch on nutrient cycling processes and soil properties are profoundly different from those of conifers. Relative to conifer species, paper birch deposits more labile carbon into the soil ecosystem, increasing gross microbial respiration. As a result of the birch roots and associated changes in microbial activity, the presence of birch also increases soil pH and base cation availability, and reduces forest floor organic matter accumulation and, possibly, concentrations of nitrate and ammonium in soil solution (Bradley and Fyles 1996; 1995). Although such changes in soil processes and properties are undoubtedly linked to changes in the structure of soil microbial communities, little is actually known of how microbial communities under birch differ from those under conifers.

The primary objectives of this paper are: 1) to review research on the effects of biotic factors on survival and rhizomorph growth of *Armillaria* in soil; 2) to review research on how mycophagous microfauna (protozoa and nematodes) and ectomycorrhizae may affect *A. ostoyae* in soil; and 3) to present recent data on communities of microfauna and ectomycorrhizae that develop under paper birch and Douglas-fir. We will focus on mycophagous

microfauna (protozoa and nematodes) and ectomycorrhizae because saprophytic bacteria and fungi have been better represented in previous research on microbial antagonists of *Armillaria* and other conifer root rots (e.g. Reaves & Crawford 1994; Dumas 1992; Pearce & Malajczuk 1990; Hutchins 1980; Rishbeth 1976). Our goal is to consider interactions which may not have been previously considered but are nonetheless relevant to understanding the survival and activity of *A. ostoyae* in soil.

Biological antagonism to *Armillaria* in soil

A number of previous studies utilizing laboratory assays have demonstrated that various saprophytic bacteria, actinomycetes and fungi isolated from forest soil are antagonistic to growth of *Armillaria* and other root-rotting fungi (rots (e.g. Reaves & Crawford 1994; Dumas 1992; Hutchins 1980). These studies do not indicate whether measurable antagonism actually occurs in soil. Microbial communities in soil are diverse, and pathogen suppression is likely to result from the combined, perhaps even synergistic, action of many antagonists. An approach more relevant to understanding the ecology of *Armillaria* may be to first determine if there is any evidence that survival or infectivity of *Armillaria* is significantly affected by biological factors in natural soil, and then attempt to identify which factors have particularly important influences.

Swift (1968) studied forest soils in central Africa that were suppressive to the formation of *Armillaria mellea* rhizomorphs. The suppressive soil could be made conducive to rhizomorph formation by autoclaving. Furthermore, the suppressiveness could be restored by adding sterile water extracts of non-autoclaved soil. The nature and origin of the inhibiting substances in the extracts were not determined. Malajczuk and Pearce (1990) reported that a cord-forming *Hypholoma* sp. colonized *Eucalyptus* stumps, resulting in the exclusion of inoculated *Armillaria luteobubalina*. Blenis et al. (1989) reported that inoculum survival and infectivity of *A. ostoyae* varied considerably among five different soils in Alberta. Differences among the soils could not be easily explained by differences in pH, organic matter content, availability of mineral nutrients or oxygen concentrations, leaving the possibility that an inhibitory biota was responsible for the apparent suppression. Unfortunately, their experiments did not compare autoclaved or biocide-treated soils to non-treated soils.

Mycophagous microfauna

Among the potential antagonists of pathogenic fungi in soil, mycophagous amoebae and nematodes have been the most acutely overlooked. Mycophagous amoebae are common in some forest soils (Old & Oros 1980; Couteaux 1985), and Chakraborty et al. (1985) demonstrated that mycophagous amoebae can reduce colonization of pine roots by the ectomycorrhizal fungus, *Rhizopogon luteolus*. Although mycophagous amoebae are also known to reduce the incidence of root diseases of agricultural crops (Chakraborty et al. 1984), their effects on forest pathogens have not been studied. Likewise, nothing is known of their occurrence and abundance in forest soils of the Pacific Northwest.

The suppression of *Pythium*, *Rhizoctonia*, and *Fusarium* root rots of horticultural crops by mycophagous nematodes has been demonstrated (e.g. Lootsma and Scholte 1997). Only one study has considered the effects of mycophagous nematodes on a forest pathogen. Riffle (1973) planted sterile Ponderosa pine seedlings into an agar-sand medium previously inoculated with an *Armillaria* sp. from New Mexico, and then added aseptic *Aphelenchoides composticola* or *A. cibolensis* to the microcosms. Subsequent mortality of the pine seedlings was significantly reduced by the presence of either nematode species. The nematodes were observed to feed on, and cause visible damage to, mycelia and rhizomorphs in the medium. Although these data clearly indicate that infectivity of an *Armillaria* sp. can be reduced by feeding of mycophagous nematodes, the experimental conditions were highly artificial and the extent of damage that may occur in soil under field conditions remains unknown. Similarly, Sutherland and Fortin (1967) and Riffle (1975) have demonstrated that mycophagous nematodes can suppress formation of ectomycorrhizae.

Mycophagous nematodes are abundant in forest soils in the Pacific Northwest. As part of a larger study on effects of paper birch on function of the soil ecosystem, the abundance of mycophagous nematodes in 10, 50 and 80 year-old stands of paper birch and Douglas-fir were studied in fall of 1996 and spring of 1997 (Table 1). Thirteen genera of mycophagous nematodes were found. The dominant genera were *Filenchus* and *Aphelenchoides*. Data on population densities from fall of 1996 were not significant but suggested that mycophagous nematodes may be less abundant in

stands of Douglas-fir than in stands including paper birch. Data from spring of 1997 indicate that the abundance of mycophagous nematodes does not differ significantly between stands of paper birch Douglas-fir.

Table 1. Population densities (nematodes/100 g dry soil) of mycophagous nematodes in forest floor of pure and mixed stands of paper birch and Douglas-fir.

	Fall 1996		Spring 1997	
	<u>80 year</u>	<u>10 year</u>	<u>50 year</u>	<u>80 year</u>
Paper birch	13225	5479	3358	3858
Douglas-fir	10121	5613	2902	5439
Mixed	14055	2647	4299	3718
P-value	0.22	0.02 (stand-type x age interaction)		

Ectomycorrhizae

Ectomycorrhizal fungi protect bareroot nursery seedlings from root-rots caused by *Fusarium*, *Pythium*, and *Phytophthora* (e.g. Duchesne 1994). Ectomycorrhizae may suppress disease via several mechanisms, including mechanical blockage, induced host defense response, antibiosis (e.g. oxalic acid, pisolithin), immobilization of nutrients, and altered rhizosphere microbial communities (Duchesne 1994). Historically, research on the effects of ectomycorrhizae on root diseases of conifer seedlings has focused on interactions at ectomycorrhizal root tips and fine roots, typical infection sites for *Fusarium*, *Pythium* and *Phytophthora*. *A. ostoyae* infects large roots and the root collar, suggesting that it may not be subject to the protective influences of ectomycorrhizae. However, the hyphal network emanating from ectomycorrhizal roots is extensive (Bowen 1994), and the processes of antibiosis, immobilization of nutrients, and altered microbial communities are likely to operate in non-rhizosphere soil.

Communities of ectomycorrhizae which form on juvenile Douglas-fir grown in proximity to paper birch differ from those which form on Douglas-fir grown in proximity to other Douglas-fir (Jones et al. 1997; Simard et al. 1997a). For example, Simard et al. (1997a) found that growing Douglas-fir seedlings near paper birch caused increased colonization of the Douglas-fir roots by two particular ectomycorrhizal fungi (E-strain I, Tuber), and reduced colonization by four other ectomycorrhizal fungi (*Thelephora*, E-strain II, *Laccaria*, and *Rhizopogon*). These data demonstrate that the relative abundances of dominant ectomycorrhizae forming on Douglas-fir root systems are altered by the presence of paper birch in the stand. The implications for *A. ostoyae* remain unknown.

In conclusion, there is some indication that the presence of birch may reduce infection of neighboring Douglas-fir by *A. ostoyae*. A number of possible mechanisms can be postulated, including the development of a soil biota that is more antagonistic to inoculum survival and rhizomorph growth. A few previous studies suggest that biological suppression of *Armillaria* may occur under field conditions, but the data are not conclusive. Mycophagous nematodes are important grazers of fungi, including *Armillaria*, and could have an important influence on the conduciveness of soil to inoculum survival and rhizomorph growth. Preliminary field data suggest that the mycophagous nematode community does not differ significantly between stands of paper birch and Douglas-fir. Simard et al. (1997b) have demonstrated that the presence of neighboring paper birch influences the ectomycorrhizal community which form on roots of juvenile Douglas-fir. If measurable biological suppression is found to occur in soils of the southern interior of B.C. and be related to the presence of birch, then interactions between the dominant ectomycorrhizae in stands with birch and *A. ostoyae* may be a fruitful avenue of research.

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**A Comparison of Rhizosphere Bacterial Populations in Conifer, Broadleaf and Mixedwood Stands:
Could Pseudomonads Play a Role in Reducing Incidence of Armillaria Root Rot?**

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The role of rhizosphere bacteria as a possible natural control agent of the fungal root pathogen *Armillaria ostoyae* is addressed in this study. Greenhouse and laboratory experiments are being used to investigate the role of fluorescent pseudomonad bacteria in the resistance of paper birch (*Betula papyrifera*) to infection by *Armillaria ostoyae*. Soils were collected from pure birch, pure Douglas-fir (*Pseudotsuga menziesii*) and mixed stands of the two species in young (8-15 years) and mature (85-100 years) stands in the wet Interior Cedar Hemlock zone north of Kamloops, British Columbia. Soil was sampled in 3 replicates of each stand type. Birch and Douglas-fir seedlings were grown in the collected soils in a greenhouse bioassay to bait the rhizosphere pseudomonads associated with the roots of these two species. After 8 months, seedlings were harvested and populations of rhizosphere pseudomonad bacteria were estimated using standard plate count techniques. The Douglas-fir seedlings grown in the young birch soils yielded the highest populations of bacteria with an average of 8.48×10^5 fluorescent pseudomonads/gram dry root. The soil collected from the young mixedwood and young Douglas-fir stands had significantly less ($P=0.050$) bacteria, with relative populations of 4.32×10^5 and 1.96×10^5 respectively. The mature stands had less than half of the pseudomonad populations of the young stands when compared in each of the birch, mixedwood and Douglas-fir soils ($P=0.041$). The birch seedlings had fewer bacteria in each soil type when compared to the Douglas-fir seedlings and there was no significant differences between the soil types. This is likely due to the fact that these birch seedlings experienced freezing temperatures of -10°C due to greenhouse malfunction. This experiment is currently being repeated after the soils were resampled in all 18 stands.

In the second phase of this project approximately 700 fluorescent pseudomonad isolates from the 18 soil/stand types will be challenged with *Armillaria ostoyae* isolates in dual culture laboratory experiments. This *in vitro* experiment will compare the incidence and degree of antagonism exhibited by fluorescent pseudomonad bacteria from the various soil types toward *Armillaria ostoyae*. This project will contribute to the knowledge of the below ground ecology of the rhizosphere of birch and Douglas-fir and the ecological role of hardwood species like paper birch in reducing losses to *Armillaria* root rot in managed forests.

Mixed Wood Management and Forest Health: Lessons From the Mixed Conifer Forests of Idaho

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I will discuss mixed species management vs monocultures, whether the preferred practice is to grow native species in the mixtures that generally occurred on specific sites or whether to grow conifer species that are most valuable commercially. This is pretty much a non-issue in the States, and the short answer is mixed wood management of native species. Certainly in the US Forest Service, mixed plantings are the rule, or, where feasible, natural regeneration that aims to perpetuate forests of native serals that historically occurred on the site. Monocultures are perpetuated only where they occurred naturally, such as with lodgepole pine on some sites.

There are a number of reasons for favoring mixtures of native species, both biological and political. To explain the logic I'll briefly cover the following topics:

- Characteristics of the various conifers in the warm, moist forests of northern Idaho.
- Information on how forests change successionaly.
- The management situation on public lands in Idaho.
- Finally, I'll conclude with additional comments about mixed wood management.

NORTHERN IDAHO CONIFERS

Nine conifer species are present in the warm, moist forests, although some may be more common in the hotter, drier sites and others on the cooler sites. I'll comment briefly on each:

--Western white pine was historically the most common and economically important species. It occurred in pure or mixed species stands. It was able to gain a competitive edge following the very large stand replacement fires that were common in the past and could live until 200-300 years of age, provided mountain pine beetle and fire held off that long. The impact of the introduced white pine blister rust has been severe, however, and the amount of white pine has been drastically reduced. Perhaps 5% of the acreage formally occupied by white pine type has been replanted with resistant pine, although planting has decreased in recent years as less regeneration harvesting is done.

--Western larch was also common in the past, in combination with white pine and on sites that were somewhat drier than that which best supported white pine. It reached large sizes and old ages in the past, most frequently where mixed severity wildfires reduced stand density, thus favoring this fire resistant species. However, it competes poorly without fire or stocking control on white pine sites, which may regenerate with thousands of seedlings per acre, many of them climax species. It also appears quite susceptible to snow damage, from the heavy, wet, snowfalls that are common in Northern Idaho Mountains.

--Douglas-fir is common to abundant in stands that are pole sized or smaller, but is the most susceptible species to root pathogens that are characteristic of the area. In mixed species stands with root disease tolerant species, removal of the Douglas-fir by disease shifts composition toward the less susceptible species. But in pure Douglas-fir stands, virtually the entire stand can be removed. Douglas-fir was planted quite widely during the sixties and seventies, but intentional management for pure Douglas-fir is generally avoided now.

--Grand fir is highly-susceptible to root disease on some sites, but appears less-so on others. It appears quite susceptible to drought on the drier sites, and even a moderate drought can trigger widespread fir engraver beetle activity. It is the climax species on the drier sites.

--Western red cedar or western hemlock are the climax species on the wetter sites. Their long-term performance on all drier, upland sites is largely unknown, because until recently they were restricted to wet sites that were infrequently impacted by wildfire.

--Engelmann spruce and subalpine fir can occur in the mix, but these are more abundant at the higher elevations where they often predominate.

--Lodgepole pine does quite well up to 80-100 years of age, but stands break up due to mountain pine beetle and several diseases at about that time.

--Ponderosa is adapted to drier sites, but does not perform well on moister sites.

SUCCESSION

A Region 1 team led by Sue Hagle is completing an analysis of the successional influence of pathogens and insects in the warm, moist forests of Idaho. One aspect of the project involves a GIS analysis of how a sample of stands changed with regard to forest type and structural stage over a 40 year period, 1935 to 1975. Forest type was assigned by predominant species. Four structural stages were designated: seedling-sapling, pole, mature, and mixed storied class with low-density.

A general finding was that these forests were very dynamic, and that insects and diseases were involved in most of that change. Ninety percent of the stands changed in type or stage during that time. Pathogens or insects were associated with 75 % of the change. Most of the change was toward climax species, in the absence of fire or management.

We can better understand how different species may perform long-term from looking at results on successional development of pole-sized stands. Data from the Clearwater National Forest illustrates the trends. Only about a quarter of the stands that were classed as white pine poles in 1935 were still white pine of any structural stage in 1975. This is not unexpected, since blister rust became epidemic about that time. The shift was toward other seral species, Douglas-fir and lodgepole pine, and climax grand fir and cedar. But pole stands of other species also failed to mature. Most Douglas-fir pole stands changed to cedar or hemlock, either mature stands or multi-storied, open stands. Those that remained Douglas-fir either stayed in the pole stage or moved to the multi-story, semi-open class, changes that we attributed largely to root disease. About half of the lodgepole pine changed to another species, and most of that remained in the pole stage, or changed to a multi-storied, semi-open condition, due to the activities of mountain pine beetle and other agents.

The overall trend during the 40 years was a loss of white pine and western larch, the potentially long-lived seral species that had dominated these sites until recent decades, and a major increase in climax species. Serals that tend to be short-lived in these sites, Douglas-fir and lodgepole pine, increased during the time frame, but indications are that root diseases and bark beetles are now moving stands toward climax species at a fairly high rate. This general trend has continued across the range of the white pine and western larch. Continuous Forest Inventory data for Idaho show that western white pine type decreased by 93% from 1954 to 1991, and that western larch decreased by 72% (Brown and Chojnacky, 1996).

MANAGEMENT

Management objectives are crucial to decisions about what species to favor and questions about mixed-wood management. Information about species performance and the ways forests change is also crucial for deciding what management is ecologically feasible.

Early in the century, timber harvesting was mainly "economic selection", to remove high value white pine and cedar. Economics didn't allow much more than this, but the value of these species created an industry that was largely responsible for European settlement of the land, and provided livelihoods to several generations of northern Idahoans.

Following WW II, the economics allowed the harvest of other species, including western larch, much of it by clearcutting. Douglas-fir plantations were established, especially during the 1960's and early 1970's. Rust-resistant white pine became available during the mid-1970's, when mixed plantings of white pine, western larch and

sometimes other species were planted. Many other species regenerated naturally. The emphasis during this time was on sawlog and fiber production on a fairly short rotation.

Management objectives have become much less clear during the past decade or so. Timber production is still important to many, but watershed conditions, threatened or endangered wildlife species, and biodiversity have become major issues. Restoration, of both aquatic and terrestrial ecosystems, is the preferred alternative for the Columbia River Basin EIS. But it is not entirely clear what that means.

CONCLUSIONS

Species selection depends upon management objectives, what people want from their forests, and upon what is technically, economically and politically feasible. If the management objective is fiber production, a number of species are feasible, either as monocultures or as mixtures. Risks of economic loss from diseases and insects are highest for monocultures, particularly from introduced agents.

If our objectives include biodiversity, it follows that we will manage for all native species. In most western ecosystems including this one, this means emphasizing mainly seral species since they have been reduced in abundance. In Northern Idaho this means that western white pine and western larch have been greatly reduced. From the standpoint of biodiversity of animals and non-tree plants, it is highly desirable to maintain at least representative samples of all historic tree species and structural types including mature forest and old growth. It is generally assumed that the best hope of maintaining the multitude of native species is to maintain the habitat that native animals and non-tree vegetation evolved in and may be dependent upon.

From the biological perspective, it is clear that different conifer species perform differently on these sites. One's initial impression is that there are many choices, and if we lose one why not replace it with another? But the native conifers are not interchangeable. The choices are limited if the objective is to maintain forest cover or produce timber volumes beyond age 80-100.

The successional information shows the dynamic nature of these forests. Fire ecology studies show that both mixed severity and stand replacement wildfires played the major role in maintaining western white pine and western larch on these sites in the past. Our data demonstrate high rates of insect and disease caused change in the absence of fire and management. Successional modeling, done as part of the Columbia River Basin science project, confirms that it indeed took a great deal of fire on the land to maintain these seral species as the predominant types. Prescribed fire can be a tool for maintaining the species today. But the amount and severity of the wildfires of the past, which included stand replacement fires of tens of thousands of acres, is surely unacceptable today. Thus, extensive management including considerable regeneration harvesting is clearly needed if the serals are to be restored, but that is politically unacceptable at present. The restoration of western white pine will likely require a long-term commitment to not only planting, but continuing monitoring, research and development, and that commitment is not yet certain.

So what do we do in the current climate of uncertainty? Given the lack of consensus about management objectives, the most reasonable approach may be to provide as many options as we can for generations coming after us. Under this scenario, it still makes sense to plant western white pine and western larch following regeneration harvests and fires. If we can use our limited management opportunities to reforest with and manage for those historically dominant seral species that are now being lost, future generations will have the option of continuing with restoration, harvesting them and managing for fiber on short rotations, or other options.

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Panel - Forest Practices and Long Term Forest Health

HADRIAN MERLER - MODERATOR

Forest Health in British Columbia: After the Forest Practices Code

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Nanaimo, BC

On June 15, 1995, British Columbia's first Forest Practices Code (FPC) took effect. The Code comprises the "law" governing forest practices on public land within the province. The FPC was developed as a response to increasing protests over forest practices in the province and was an attempt to recapture public confidence. Over the past two years, the FPC has been largely successful at accomplishing the latter while the first goal still remains elusive.

The old *Forest Act* consisted of the Act and 24 supporting regulations. It covered mainly administrative functions such as forest tenure, licences, and authority to approve plans and prescriptions. Forest health (or pest management at the time) was covered primarily under two areas dealing with authority to access lands and (very) minimum content standards for pre-harvest silviculture prescriptions. The new *Forest Practices Code of British Columbia Act* consists of the Act, 16 supporting regulations, and over 40 brand new guidebooks (covering topics from biodiversity to visual impact assessment). The act and regulations supply the legal requirements for the conduct of forest practice while the guidebooks provide the best professional advice on how to comply with these requirements. The old *Forest Act* reverts to primarily an administrative document. The FPC does not apply on private land.

Forest health now has prominent display in no less than two sections of the Act and four sections of the *Operational Planning Regulation*, the main legal document dealing with operational plans and prescriptions. These sections outline specific requirements that the licence holder must fulfill prior to receiving approval to harvest. Other sections also deal with forest health issues such as sanitation logging, recovery of diseased and damaged timber, etc. There are nine guidebooks dedicated to forest health topics (root diseases, dwarf mistletoes, stem rusts, tree wounding and decay plus some dull, entomological stuff) that cover all aspects of detection, assessment, and treatment of pests.

What impact has the FPC had on forest practices? For one, it created a huge training effort. Every Forest Service employee, from clerks to the Chief Forester, attended training sessions on the Code. The FPC has also put increased emphasis on planning, especially at the landscape level (the FPC does not cover regional or so called "higher-level plans" which are handled by a separate process). Landscape-level Forest Development Plans submitted by licensees must be publicly advertised and reviewed, referred to interested parties (such as native bands and other government agencies), and signed by a Registered Professional Forester (RPF) prior to being approved by the Ministry of Forests. The onus is now on the writers of plans and prescriptions to know their sites thoroughly and convey all relevant information through the silviculture or stand management prescription.

The Ministry has placed a large emphasis on compliance and enforcement to ensure that plans are carried out as prescribed and that penalties are levied for violations. For example, from June 1996 to June 1997 Ministry staff conducted over 34,500 field inspections identifying 2,083 problems that resulted in 183 violation tickets being issued for a total of over \$580,000 in fines. The government has promised that along with the "stick" (fines of up to \$1 million per incident which, so far, no one has claimed) there would be a "carrot" in the form of more secure access to wood supply and faster approval of plans and prescriptions. An independent Forest Practices Board has been created to investigate complaints lodged directly by the public.

The impact of the FPC has been felt directly in forest health. One of the gains that has been realized is an increased awareness of forest health. This has resulted in greater efforts to understand what to look for and how to find it. The requirements in plans and prescriptions has forced a better recognition of potentially limiting site factors, including pests. Perhaps most importantly, foresters increasingly acknowledge the risk to stand objectives of ignoring pest problems.

What has yet to be demonstrated is whether the Forest Practices Code has actually resulted in a better application of treatments on the ground. Or whether we are starting to attain a better understanding of the action of pests and their potential impact over time. We are still trying to better fit the role of forest health into the greater hierarchy of the practice of forestry in British Columbia.

For those interested in obtaining copies of Forest Practices Code Guidebooks, contact the author or phone the Ministry of Forests, Public Affairs Branch, Victoria at 1-800-565-4838. Publications are also available on the world wide web at <http://www.for.gov.bc.ca>.



Fred Baker and Stefan Zeglen.

Tower Of Babel
[A Philosophical Discussion of Forest Health and Related Terms]

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I've been asked to speak about 'Forest Health' and related terms on a philosophical level. Let me start by recalling some of the things we have heard here this week. Bob Edwards spoke of the 'browns' and 'greens' in his Faculty, a division many of us have experienced, and a division that reasonable argument does not appear able to bridge. Al, the Regional Manager here at Prince George made a stirring appeal for dependable scientific information in order to guide decision making, but at the same time there was a hint of despair that such information will ever form the essential and critical basis for decisions. Jim Byler went to the heart of the matter, I think, when he observed that we don't know what we are managing for. If there are no goals, then there can be no management. Any intervention in the forest is then as good or bad as any other since it can no longer be determined whether a particular action achieves what we want.

I believe that these instances are all examples of a general malaise of western society. A great change in how we understand the world and the role of science in our world is underway. To get at this, I would like to start with an old myth that goes back to the beginnings of our civilization. And by 'Myth' I do not mean something imaginary as opposed to factual or scientific, but rather a story that carries a truth not easily expressed in expository prose. Here is the myth in a recent translation.

'Now the whole world had one language and a common speech. As men moved eastward, they found a plain in Shinar and settled there. They said to each other, "Come let's make bricks and bake them thoroughly." They used brick instead of stone and tar for mortar. Then they said, "Come let us build ourselves a city with a tower that reaches to the heavens so that we may make a name for ourselves and not be scattered over the face of the whole earth."

But the Lord came down to see the city and the tower that the men were building. The Lord said, "If as one people speaking the same language they have begun to do this, then nothing they have planned to do will be impossible for them. Come, let us go down and confuse their language so they will not understand each other. So the Lord scattered them from there over all the earth, and they stopped building the city.'

So much for the myth. Now if we read this as a factual (or fictitious) historical account, and begin to argue about whether the remains of the city of Babel might actually be found, we shall have missed the point of the story. In the book from which this is taken, the city stands for a philosophical dwelling place of man, a place where he can be at home. Similarly, 'making a name for ourselves' means something like self-determination, making our own rules, discovering/determining for ourselves who we are.

In the west, that has been going on for a long time. The building of the city and the tower might be identified with the long progress of western civilization starting with the Greeks, and more recently with what has been called the Enlightenment Program, a philosophical movement that rejects all but Reason working on objective observation as the basis of knowledge. The rise of modern science and technology finds its roots at least in part in the Enlightenment. All of us have been educated within that Enlightenment tradition, usually without being explicitly aware of it. Most of us still hold to that tradition: 'science may be slow, and it may make false starts, but in the end it is the only way to dependable knowledge and true understanding'.

My purpose here today is to point out that in the minds of many, science is no longer regarded as the dependable source of true knowledge (and, incidentally, also to shake your confidence in science as such a source). Having done that, that is, having painted a picture of the Postmodern World I shall finally be in a position to get to the topic originally assigned, namely to talk about terms such as 'Forest Health'.

So first about science. I would like to call myself a scientist, and I love my work. As I see it, that work consist of two complementary activities. The first requires creative observation and imagination in order to see something new. Most would call that activity 'formulating a hypothesis'. The second consists of experimental tests of that hypothesis to determine its validity. Now note the form of such tests: The hypothesis, (if it is any good), makes certain testable predictions, and the experiments are set up to determine whether these predictions are true. The form of reasoning involved here goes as follows. The hypothesis says: this is a dog. If the hypothesis is true, the object of our study should have four legs. So we do the experiment, and indeed the thing has four legs. Is it therefore a dog? This, I submit, is the best science can do. It is good at rejecting hypotheses (the object has six legs: hence not a dog), but not at confirming. And this, we have been taught (and perhaps teach ourselves) is the "Scientific Method", the way to all truth! Suffice it to say that more and more people begin to realize that perhaps the 'Truths' of science are much more limited than some of the propaganda claims. The best science can claim is that it describes the way the world might possibly be, not the way it is. The old question the Greeks asked themselves ('If you don't know what the truth is, how will you recognize it as the truth when you see it) remains a real question for us.

Another problem about science arises when we direct our attention the to scientist herself. So long as she remains the competent, objective observer, concerned about things outside herself, all is fine. But what if she begins to study herself, for instance the way her mind works. Since her mind is now the subject of the study, it cannot at the same time function as the mind of the objective observer. Perhaps, you say, but what if she studies the mind of others - that would circumvent the problem. Well, it does, but it raises another one. The standard way of approaching study of the brain (I'm assuming a strong mind-brain link here) is to think of the brain as a complex machine ultimately definable in terms of chemistry and physics. But if that is so, where is the place of Reason? As many have pointed out, there are two sorts of grounds for holding a particular position on a question: one is logical deduction from accepted premises, and the other is because some influence (drunkenness, mental illness, some powerful obsession, etc.) overrides proper reasoning. Now if the thoughts we think are merely the byproduct of electrons and molecules following the laws of Physics in our brains, then logic has no place, and the grounds on which we hold our opinions are of the second type. For consider, the laws of physics operate without mistakes. If two people disagree about a matter, who shall be declared right? Both have brains in which the electrons and molecules follow the laws of physics.

Here then are two philosophical difficulties with science. These and similar questions have raised second thoughts about science as a way to the truth in academia. At the same time, other kinds of issues are undermining the authority of science in the popular mind. Let me raise two. First, the promises of science (and technology) often don't come to pass. Remember how computer driven technology was going to reduce the normal work week to a couple of days? Or think of the battle to overcome cancer. I can remember a film that I saw in highschool on the topic. It was only going to be a matter of a few more years, or a decade at the most, and we would have it licked! Or take the case of research applications. I'm sure you have all reviewed some that promise vastly more than could possibly be delivered by the work proposed. No wonder then that some are saying of science 'the emperor has no clothes on'.

And that leads to another matter. Scientist are human. They are increasingly (and to some extent rightly) seen as having a personal stake in the enterprise. It isn't merely an objective search for truth, but personal prestige, and (often) a good income, also play a role in the conduct of science.

All this has meant that increasingly people are abandoning science as a source of truth or guidance. Witness the growth of alternative medicine, or of astrology and various 'New Age' movements. Right or wrong, science no longer has the place it used to have. Instead we have all sorts of substitutes as approaches to truth. This in part for the kinds of reasons I have enumerated above, but (so it seems to me) largely because the alternatives appear to many to be more appealing. Science hasn't been rejected so much as merely become irrelevant to many.

And so we find, in our modern western society, that the Tower of Babel story is coming true all over again. Have you for instance ever tried to argue with one someone who holds to astrology as the source of dependable guidance? They speak a different 'language'. The best arguments carry no weight for them. Welcome to Postmodern world. Truth is no longer objective, but merely personal. "Whatever I feel comfortable with is true for me."

Now the structures and institutions of our society go back to an earlier day, and so for the moment things continue to function more or less as before. Scientists continue their work as before, attempting to throw light on how the world

around them functions. Governments seek input and advice from scientific panels, and continue to hand out research grants. Corporations continue to depend on technology to improve their bottom line. However, a ground swell of change is underway, and I don't think this is just a temporary phenomenon. I say so because the claims of science have indeed been too strong, and at all levels from academia to politics to the common world of Joe Doe, this is being recognized. And in its place comes not just a single new approach, but many, mutually exclusive approaches to truth, all competing in the marketplace of ideas, but with no way to choose between them. There is no longer a common set of criteria or methods by which one could choose: each approach is fully justified by its own criteria. And so we have feminists, relativists, perspectivists, social constructivists, scientists, etc. all proclaiming to show the way. If you doubt the seriousness of all this, look at the book review by Paul Forman in *Science* (276:750-752). The review describes a call to arms to the faithful to do battle with the 'new onslaught against science and reason', but the reviewer in fact debunks the attempts, and shows that the onslaught is not without reason. And then the review is published in *Science*!

Now what has all this stuff to do with terms like 'Forest Health'? Well, this. Governments and managing institutions face a difficult task nowadays because so many conflicting demands are placed upon them. In itself, that is not new. What is new, is that the means to decide between options are no longer agreed on. Consensus is no longer possible. Instead, we have temporary standoffs between the parties, based on the political power they happen to wield at the moment. (i.e. If membership in WC2 declines, the cut of timber on the B.C. coast and in Oregon goes up.) Whatever actions or management goals are proposed, some groups are bound to oppose them. Now politicians like to keep everyone happy, and how do senior managers achieve this? Well, simply by defining goals and objectives in terms that are so vague that everyone can agree with them. Such, in my view, is the case with the term 'Forest Health'.

We are told that a healthy forest is one in which the ecosystem functions fully and properly, one in which diversity and the consequent stability are maintained. What might that possibly mean? Or rather, which conditions would be considered 'not healthy'? Ecology is the study of relationships between organisms and their biotic and abiotic environment, and of the phenomena that occur at whole-organism and higher order levels. Such a study is possible and fruitful under a wide set of conditions. Thus I can speak of the ecology of my driveway, studying nutrient and energy fluxes, the role of lichens and mosses in altering the local environment, and so on. In fact, that driveway is a fully functioning ecosystem in which higher order phenomena of ecology such as succession can be observed and described. Is my driveway an 'unhealthy' or 'diseased' ecosystem? Could we argue that it does not function properly? Surely the basic laws of chemistry and physics which underlie function at an ecological level (although they cannot fully describe it) operate fully and properly on my driveway. I can only conclude that by my definition, and following my understanding of ecology, my driveway can indeed be seen as a properly functioning ecosystem. Similar arguments can of course be made about any set of conditions that one might find or create. So I come to the conclusion that the definition of a healthy ecosystem does not exclude any ecosystem, because there is no such thing as an improperly functioning ecosystem. The adjectives 'healthy' and 'properly' are superfluous and meaningless.

But of course they aren't. Health and sickness have real meaning for humans, health being the desirable state. And there lies the sly trick of those who need to keep peace in a world where there is no real agreement. Each party will interpret the word "healthy" within its own system of values. Thus farmers may speak with pride of a healthy wheat field (about the most barren environment ever created), and foresters speak of healthy plantations and decadent forests, while certain environmentalists call those same plantations 'severely disturbed' ecosystems, and the old forests healthy ones. You see, by using the term Forest Health, we have created an illusion that we know what we want. Everybody wants healthy forests. However, the definition of what a healthy forest might be (and what conditions would be 'not healthy') inevitably involves value judgments. 'Health' is not a precise scientific term when used in this context, but merely masquerades for one. And so, for a while, peace is maintained, but it doesn't help: there is no guidance in the goal 'let's have healthy forests'.

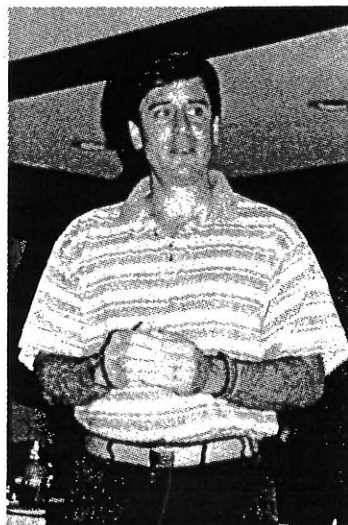
Now to eliminate confusion, I need to expand a bit upon what is often understood by the term 'proper functioning'. Usually, what the speaker has in mind is that the ecosystem is functioning in a way that has not been influenced by human action (and often a strongly held belief that human intervention is almost always negative and destructive). In other words, the undisturbed natural ecosystem is set up as the desirable norm. But this is a belief or value judgment, not a matter of objective fact. Why should the undisturbed ecosystem be the goal of management? If we really meant that, then the best approach is for all of us to commit suicide. And do we really mean that ecosystems such as the hemlock looper killed stand we saw is the desirable state? It's certainly a natural one.

So, let's get rid of this subtle doublespeak. If we want to argue that natural systems are best, let's say so. And as to the term 'Forest Health', let us put it behind us as a poorly conceived notion. Instead, let's talk of the role of pathogens in ecosystems and the way that various interventions in these systems promote or retard disease, and then, quite independently decide whether, in each of the management contexts we encounter, the effects of diseases on the forests we manage are desirable, neutral, or detrimental, and take action accordingly.

Thank you.



Bart van der Kamp (sitting, foreground) and others contemplating forest health.



Hadrian Merler.

Challenges Associated with Root Disease Management in Western Oregon

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When I first joined the Forest Pest Management staff in the Pacific Northwest, our most serious challenge regarding root disease management in western Oregon was that of recognition; land managers needed to be able to recognize root diseases, understand their impacts on tree growth and yield, and include root disease considerations in silvicultural prescriptions. In the context of the resource management objectives of the 1980s a great deal of progress was made towards meeting this challenge. Root disease surveys became routine over large ownerships. Management strategies were studied. Silvicultural prescriptions incorporating root disease-oriented species manipulation and thinning regimes were implemented on thousands of acres.

Resource management objectives have shifted in recent years and there are many new questions. Wildlife habitat considerations are many and sometimes conflicting. How to provide, enhance, and maintain late successional forest characteristics across a fragmented landscape previously managed with high yield timber objectives as priority is a challenge in itself. The subject of management is more often the landscape rather than the forest stand, yet our inventories, models, and planning scales are based on the stand rather than the landscape. Understanding the disturbance processes that influenced landscapes prior to the arrival of European-Americans has and still requires much research. Root diseases have been recognized as disturbance agents particularly related to gap dynamics, but their importance is often unrecognized by many resource managers. Understanding and relating the roles root disease play in creating openings, standing dead, and down woody material as well as a variety of ecological processes is important. Understanding and relating how current conditions relate to historic levels of root disease activity is a relatively new challenge for us. Exotic species have also gained importance; *Phytophthora lateralis*, the cause of Port-Orford-cedar root disease has become a management challenge on many fronts, including those biological, social and political.

Some specific challenges:

Late Successional Reserves: The signing of the Record of Decision to the Northwest Forest Plan designated thousands of acres in large blocks of contiguous forest land as Late Successional Reserves (LSRs). LSRs are to be managed to preserve, maintain, and enhance late successional forest characteristics including large trees, multi-layered canopies, standing dead trees, and down woody material. They include much land that is currently in young plantations as well as intermediate-aged and older stands. Disturbance agents including fire, insects and diseases are considered to be important components of late successional stands. Only "catastrophic" losses by these agents are discouraged.

In most situations, root disease effects would be considered consistent with LSR goals; root diseases create gaps and openings resulting in layering and species diversity, create standing dead and down woody material, and are important in nutrient cycling. However, many of the plantations and middle-aged stands in the LSRs of western Oregon have very high levels of root disease inoculum. In many of these stands root disease-susceptible species were planted and have been favored during juvenile spacing treatments. Past harvest activities have favored root disease fungi through creation of stumps and compacting soils. We then must question whether root diseases, under these conditions, will positively influence stand development towards achieving LSR objectives or whether such high inoculum levels will slow down or even preclude the obtaining of those objectives.

In the Coast Range of Oregon a root disease assessment is currently underway to determine if or under what time frame LSR objectives will be met given the occurrence of laminated root in many young Coastal LSR stands. A series of surveys completed in the 1980s suggest that approximately 16 percent of the area in Douglas-fir type in the Coast Range is in laminated root rot pockets. Recent data collected during the mid 1990s via the Current Vegetation Survey (CVS) indicate that 17 percent of the CVS plots within the LSR have root disease. CVS plot data representing young stands with root disease will be modeled using the Forest Vegetation Simulator and the Western Root Disease Model to predict vegetative development over time. A team including an ecologist, silviculturist,

wildlife biologist, and plant pathologist will then assess how root disease influences development of LSR characteristics in the Coast range and what treatments may be needed to achieve LSR objectives as quickly as possible.

In the southern Oregon Cascades LSR Assessment, potential root disease impacts were discussed in the document and recommendations regarding rot disease management were included. These recommendations imply that information about root disease incidence is gathered prior to stand entries done to enhance LSR characteristics. These include:

In stands less than 25 years old with greater than ten percent of the area in root diseases, thinning should be avoided unless root disease susceptible species can be discriminated against in favor of root disease resistant species. Recommended species are listed by each root disease.

In stands greater than 25 years old, root disease impacts should also be considered before entering stands. Root disease-resistant species should be favored. Soil compaction and excessive wounding should be avoided. In stands with greater than 25 percent of their area in root disease, and none or few opportunities for species manipulation, the recommendation is to leave the stand alone and avoid additional entries. When a high degree of crown closure is desired, root disease openings should be planted with resistant species.

Considering root diseases when managing for late successional stands brings up questions of past management and spatial and temporal scale. How much have we influenced inoculum levels by harvest and planting? Will the disturbance effects resulting from root disease allow us to bring young stands into late successional character as quickly as possible or will root disease delay or preclude meeting those objectives? How much of the landscape is in stands where root disease impacts should be considered detrimental and are those stands scattered throughout or concentrated on the landscape?

Higher Elevation Sites: Other root disease related challenges to management occur in many of our higher elevation stands where laminated root rot in particular, and annosus root disease to a lesser extent, exert a profound influence on stand structure, stocking, and composition. Most often we are not concerned about these sites; root disease is an important agent of diversity in these often pure mountain hemlock stands. On many sites, western white pine readily seeds in and grows, providing a considerable portion of the large tree structure in root disease pockets. But, the impact of white pine blister rust in many areas has changed the vegetation dynamics. Western white pine is killed by blister rust at an early age; larger western white pine do not occur or exist in much lower numbers than prior to the introduction of the rust. The influence of rust and root rot on vegetative diversity, structure and composition are only now becoming apparent. Impacts will be more serious in the future as these large trees and perhaps this species disappear in these areas.

Planting root disease pockets with rust resistant western white pine would seem the logical solution, but the challenge is in how to do it. Most of these sites are outside of the normal timber production designations; they are in wilderness or recreation areas. Access is difficult and the planting window is narrow. Funds are not readily available to plant trees in areas where timber has not been sold to pay for planting. "Ecosystem restoration" dollars are few and at this time seem to be spent predominantly for activities associated with riparian restoration rather than upland restoration. Add to this the debate about whether or not it is appropriate to plant in designated wilderness and you cannot help but wonder about how these areas will develop over time. Will the role of root disease change from creator of diversity to one of stocking reducer and what influence will reduced stocking have on other ecosystem process?

Port-Orford-Cedar Root Disease: The introduction of *Phytophthora lateralis* to the range of Port-Orford-cedar in southwestern Oregon has had significant cost, both ecologically and economically, and has posed management challenges at the biological, sociological, and political levels.

Strategies for controlling Port-Orford-cedar root disease include: closing roads and restricting operations to reduce movement of infested soil, cleaning vehicles and equipment before entering or leaving specified areas to remove soil that may contain spores, berming roadsides to reduce splash and runoff, removing Port-Orford-cedar from roadsides to prevent infestation of disease free stands, identifying resistant trees and breeding them, and retaining Port-Orford-

cedar in portions of the stands where conditions are unfavorable for the disease. Public interest is high regarding many of these strategies. Road closures are unacceptable to some members of the public and closures become more and more expensive due to the need to thwart efforts to remove locks, drive around barriers, or destroy the gates outright. Other members of the public would like to use Port-Orford-cedar's susceptibility to the fungus as a reason for limiting all access and harvest on federal lands. Long term monitoring data on treatments are as yet unavailable; this makes acceptance of the treatments limited. Policy that bridges different agencies and geographic boundaries is not written although much effort is currently in place to coordinate monitoring activities and guide information collection and flow across these boundaries. And the species itself must sort through the difficulties associated with the introduction of an exotic!

No doubt these challenges make the job more interesting. There are many questions and much to learn. Fifteen years after my arrival in Portland, I find that recognizing, understanding, and managing root diseases are still at the top of my professional challenges. The differences between then and now are that I must gain a better understanding of historical role of root diseases, their role as relates to ecological processes and vegetative dynamics, and their impacts relating to complex resource objectives. And, I must pass my knowledge and understanding on to a much wider array of resource scientists and managers, with mixed understanding of forest dynamics.



Ellen Michaels Goheen.

Five Steps to Healthy Ecosystems

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Introduction

A common theme in current forest management policy is that harvesting should be designed to achieve the landscape patterns and habitat conditions that are maintained in nature by natural disturbance regimes. The underlying assumption is that the biota of a forest is adapted to the conditions created by natural disturbances and thus should cope more easily with the ecological changes associated with forest management if the patterns created resemble those of natural disturbances. Using this as a basis I propose five steps to increasing the probability of maintaining healthy ecosystems.

Five step to healthy ecosystems:

Step 1. Map and describe homogeneous ecological units in the landscape i.e. homogeneous climate, topography and species composition (e.g. biogeoclimatic units combined with gross topography - montane, plateau)

Step 2. Describe characteristics of natural forest for unit.

- disturbance rate and patch size distribution for primary natural disturbance agents
- effects on stand and soil for primary natural disturbance agents
- stand development over time for most common forest types and effects of pests, wind etc. on this development
- tree species diversity and spatial arrangement for common forest types

Step 3. Determine main impacts of management on natural characteristics.

- *fire control* - alters age class structure or understory density particularly in areas with previous high wildfire disturbance rates
- *harvesting* - changes age class structure or stand structure depending on silviculture system used
- *tree species selection or preference and density* - changes stand composition and structure
- *pest control* - alters stand structure and may reduce diversity at stand level
- *site preparation* - alters vegetation and soil organism communities

Step 4. Take measures to alter practices or mitigate impacts.

- harvest more or less
- allow fires to burn or use prescribed fire
- change patch size and green up requirements
- employ alternate harvesting systems which more closely approximate characteristics of dominant natural disturbance processes
- change site preparation practices
- alter species selection, density, timing of planting, and free growing guidelines

Step 5. Manage for diversity. Many past practices, rules or guidelines were directed towards homogeneity (e.g. NSR, species selection guidelines, minimum stocking, free growing guidelines, fanatical preoccupation with BRUSH)

- move towards managing for standard deviations not minimums and maximums
- minimize management of low level impacts of fire, wind, pests

Posters

In Vitro Culture of Western Hemlock Dwarf Mistletoe

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Abstract

Dwarf mistletoes (*Arceuthobium* spp.) are widespread and destructive parasitic flowering plants. *A. tsugense* (Rosend.) G.N. Jones *subsp. tsugense* is a parasite of western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) on the coast from Alaska to California. A research project has been established to investigate the use of native fungi to control dwarf mistletoe. The project involves generating callus (undifferentiated tissue) from seeds placed on tissue culture medium. The callus will later be challenged with fungi to determine any inhibition of callus growth which correlates with fungal virulence. Seeds were collected from the Cowichan Lake, B.C. area and were placed on Harvey's medium with 2,4-dichlorophenoxyacetic acid (2,4-D) (.1, .5 or 1.0 mg/L) and 6-benzylaminopurine (BA) (.001, .1 or 1.0 mg/L). The seeds germinated and formed elongating radicles. There was radicle formation with all treatments but holdfasts formed only on media containing 2,4-D at .5 or 1.0 mg/L with all concentrations of BA. Radicles either split at the tip, swelled to become spherical holdfasts, or developed holdfasts at the tip. Callus arose from split radicles and split holdfasts. Light microscopy of the callus revealed undifferentiated cells that were spherical and densely stained. Future research will involve bulking up callus production via media/environmental modifications. Dual cultures can then be created involving mistletoe callus and potential biological control agents (i.e. *Nectria neomacrospora* and *Colletotrichum gloeosporioides*) to assess the ability of the fungi to inhibit callus growth.



Shannon Deeks.

Role of Diseases as Disturbance Agents in an Old-Growth Forest, Olympic National Park, Washington

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Introduction

There has been much recent interest in the role of natural disturbances, caused by fire, wind, diseases and insects, in creating the structure and function in old-growth forests in the Pacific Northwest (Franklin et al. 1987, Hennon 1995, Schowalter et al. 1997, Spies 1997). On December 31, 1996 a large wind storm caused extensive blow down in the Hoh River Valley in Olympic National Park, Washington affording an opportunity to examine the interaction of wind and diseases in creating canopy gaps. The objective of this study was to determine the role of root and stem diseases in creating conditions that are favorable to blow down, stem breakage and the creation of canopy gaps in an old-growth forest.

Materials and Methods

The study sites were in the lower Hoh River Valley, Olympic National Park, Washington just inside the park boundary. Plant communities were in the (*Tsuga heterophylla* Raf. Sarg) zone described by Franklin and Dyrness (1973). Also present in the area were Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), western redcedar (*Thuja plicata* Donn) and Sitka spruce (*Picea sitchensis* (Bong) Carr). The forest is uneven-aged with the oldest trees about 600 years old. The tallest trees in the watershed are >90 m in height, but the canopy is broken up and uneven. Largest trees are Douglas-firs and maximum diameter at breast height (dbh) was 310 cm (Edmonds et al. 1993). The wind storm on December 31, 1996 created many patches of different sizes in the forest.

Two medium sized gaps (0.8 ha or 1.9 acres) were selected for study; one along the Hoh-Bogachiel trail (230 m elevation) and the other in the West Twin Creek Watershed (315 m elevation). One-tenth ha square plots were established in the center of each gap and the following determined; log, snag or tree dbh, species, direction of fall and the presence of root disease or stem decay.

Results and Discussion

All the blown down trees were western hemlock. The age of trees in the gaps ranged from 40 to 110 years. The surrounding forest is uneven aged and large Douglas-fir and western red cedar trees in the vicinity are as old as 600 years. Tree diameters averaged 47.0 and 52.7 cm in the West Twin Creek and Hoh-Bogachiel plots, respectively. There were 19 total blown down or snapped trees in the West Twin Creek gap and 11 in the Hoh-Bogachiel gap (Table 1).

Table 1. Numbers and percentage of blown down and snapped off trees in 0.1 hectare plots with *Armillaria* present on the roots, decayed roots and bole decay in the two canopy gaps.

Gap	Blown down trees with <i>Armillaria</i>		Blown down trees with root decay		Snapped off trees with decay	
	No. of trees	Percent	No. of trees	Percent	No. of trees	Percent
West Twin Creek	12/17	71	7/17	41	1/2	50
Hoh-Bogachiel	4/4	100	3/4	75	5/7	71

Armillaria spp. (probably *A. gallica*) was present on the roots of almost all the trees that blew down. Some roots had root lesions, broken off roots, decay, and rhizomorphs. Others had little decay, but rhizomorphs were evident. There were few above ground symptoms based on the conditions of the crowns and there was no resin flow at the base of the trees. Seventy-one percent of the blown down trees in the West Twin Creek gap and 100 percent of the trees in the Hoh-Bogachiel gap had *Armillaria* on the roots (Table 1). Forty-one percent in the West Twin Creek gap had well decayed roots, while 75 percent had well decayed roots in the Hoh-Bogachiel gap. A few trees had snapped off near the base. Those trees either had *Perenniporia subacida* (West Twin Creek) or *Heterobasidion annosum* (Hoh-Bogachiel) present. Trees that snapped off higher generally had decay present (Table 1), mostly caused by *H. annosum*. There were more snapped off trees than blown down trees in the Hoh-Bogachiel plot than the West Twin Creek plot and 71 percent of these had decay compared to 40 percent in the West twin Creek plot (Table 1).

Most trees fell or snapped in a similar direction (averaging 89 degrees in the West Twin Creek gap and 126 degrees in the Hoh-Bogachiel gap). Landscape position may have been important since the gaps were located at the boundary of the upper river terrace and a steep slope. There was a lot of dwarf mistletoe on the blown down trees.

From this sampling it would appear that windthrow and stem breakage and the creation of canopy gaps was strongly related to the presence of the disease organisms *Armillaria* spp., *H. annosum* and *P. subacida* and not just to wind alone.

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**Responses of Black Stain Root Disease Insect Vectors
to Commercial Thinning of Douglas-fir in Southwest Oregon**

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Introduction:

Black stain root disease of Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) is endemic at low levels across its host's range, but occurs with higher incidence and severity in southwest Oregon. The disease is caused by the fungal pathogen *Leptographium wageneri* var. *pseudotsugae*, which colonizes host tracheid cells. Three root and root collar feeding insects are known to vector the sticky spores of the fungus from diseased trees to healthy trees or freshly cut stumps, including the weevils *Steremnius carinatus* (Boheman) and *Pissodes fasciatus* (LeConte) (Coleoptera: Curculionidae), and the bark beetle *Hylastes nigrinus* (Mannerheim) (Coleoptera: Scolytidae).

Both *H. nigrinus* and *P. fasciatus* are capable of flight and likely responsible for long-distance spread of the fungus, while *S. carinatus* is flightless and likely involved in short-distance spread within stands. *Hylastes nigrinus* and *S. carinatus* are attracted to the volatiles produced from drying Douglas-fir slash and stumps (Witcosky et al., 1987), and all three vectors exhibited increased response to plots which had been precommercially thinned during winter and spring, as opposed to summer and fall, in southwest Oregon (Witcosky et al., 1986).

Objective:

Our objective was to determine whether Douglas-fir stands commercially thinned during the previous winter and spring are more attractive to black stain root disease vectors during their spring flight period than stands thinned during the previous summer and fall.

Methods:

The experiment was repeated in both 1995 and 1996 using six stands (n=6) from each of the two treatment types. Stands were chosen at random from a list of all Douglas-fir stands commercially thinned during the previous year by our private industry cooperators. The two treatments consisted of 1) thinning during the period June-September of the previous year, and 2) thinning during the period October-April of the previous year. Each thinned stand was paired with an adjacent, unthinned stand to form plot pairs.

Traps were installed during late April or early May. A single transect consisting of five pitfall traps and two sticky traps was placed in each thinned and unthinned plot. Pitfall traps were placed 20 meters apart in a straight line, with the two sticky traps positioned 10 meters from each end. Pitfall trap catchments were filled with a 1:1 solution of antifreeze and distilled water.

Insects were collected from sticky traps at mid-May, the end of May, and the end of June, at which time the traps were removed. Insects were collected from pitfall traps at mid-May, the end of May, and at the end of June, July, and August. Data analysis was performed using the difference between thinned and unthinned plots.

Results:

Hylastes nigrinus

The response of *H. nigrinus* in both 1995 and 1996 was significantly greater in both the summer/fall and winter/spring thinnings as compared to the control plots. In addition, the response to the winter/spring thinnings was significantly

greater in comparison to the summer/fall thinnings. The response of *H. nigrinus* to thinned stands is much greater, and expressed over a longer period of time, than that of *P. fasciatus*.

Although relative response trends were the same in both years, the level of response was much lower in 1996. One reason for this may have been the extremely wet spring, which could have delayed the drying of slash and subsequent release of attractive volatiles during the peak *H. nigrinus* flight period.

Pissodes fasciatus

The response of *P. fasciatus* varied somewhat from that of *H. nigrinus*. Its response to winter/spring thinnings in both 1995 and 1996 was significant, but not so to summer/fall thinnings. *Pissodes fasciatus* seems to exhibit a more focused response than *H. nigrinus*, preferring the most recently thinned stands that have a fairly heavy slash load.

Steremnius carinatus

This vector exhibited the least clear response pattern to commercially thinned stands. Overall averages showed that its response was not significant to either treatment in 1995, although the July and August data show a markedly higher response to winter/spring thinnings than to summer/fall thinnings. In 1996 the response was significant in both treatment types. However, *S. carinatus* responded more readily to winter/spring thinnings in 1995, but to summer/fall thinnings in 1996.

The variation in response by *S. carinatus* is confusing. One factor which may be important is the proximity and acreage of mature, unthinned stands. Use of such stands as control plots revealed that some of them had very high numbers of *S. carinatus*. Perhaps the response level of this flightless weevil to commercially thinned stands depends in large part upon the availability of a population which can respond over short distances.

Conclusions:

- * Black stain root disease vectors do respond to commercial thinning in Douglas-fir.
- * Douglas-fir thinning which takes place during the previous winter and spring results in significantly greater response from *H. nigrinus* and *P. fasciatus* than does thinning done during the previous summer and fall.
- * Vector response within treatment types is highly variable.
- * Responses of *H. nigrinus* and *P. fasciatus* to unthinned stands is very low.

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Ethanol in Douglas-fir and Ponderosa Pine with Black Stain Root Disease

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Diseased and healthy Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) were identified at two black-stain root disease (*Leptographium wageneri* var. *pseudotsugae* Harrington & Cobb) centers in the Oregon Coast Range near Coos Bay. Ethanol concentrations in the sapwood of diseased trees near the root collar were significantly higher (from 4 to 24 X) than in healthy trees for all months during the year, except January and June. Roots from diseased trees in October had significantly higher ethanol concentrations in the phloem (5 X) and sapwood (19 X) than the corresponding tissue from healthy trees. Sapwood from ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.) was sampled above the root collar in June, near Burns, Oregon. Trees with roots infected by *L. wageneri* var. *ponderosum* (Harrington & Cobb) Harrington & Cobb had a significantly higher (30 X) mean ethanol concentration in the sapwood than healthy trees. Ethanol concentrations at various positions around the root collar of both species, and in the roots of Douglas-fir varied substantially within a tree. Ethanol may play an important role in the biology of *L. wageneri* root disease and beetle-pathogen interactions in conifers.

Hydraulic Conductivity in Diseased Roots of Ponderosa Pine

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Roots from healthy and diseased mature ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.) were excavated from a site near Burns, Oregon. The diseased trees were infected with black-stain root disease (*Leptographium wageneri* var. *ponderosum* (Harrington & Cobb) Harrington & Cobb) and annosus root disease (*Heterobasidion annosum* (Fr.) Bref.). Axial hydraulic conductivity of the roots was measured under a positive pressure of 5 kPa, and the conducting area was stained with safranin dye to determine the specific conductivity (k_s). In diseased roots, only 8-12% of the cross-sectional xylem was conducting water. Resin soaked xylem completely restricted water transport and accounted for 13 - 16 % of the loss in conducting area. In roots with black-stain, 17% of the loss in conducting area was associated with unstained xylem, possibly resulting from occlusions or embolisms. The k_s using the entire cross-sectional area of roots infected with black-stain was 4.6% of the k_s in healthy roots, whereas the k_s of roots infected with annosus root disease was 2.6% of healthy roots. These low values are in part the result of a large number of diseased roots (72%) with no conducting xylem. The k_s of disease-free roots from diseased trees was only 70% of the healthy roots from healthy trees. The lower k_s in diseased and disease-free roots of diseased trees could hinder water uptake, subsequently increasing water stress in diseased trees and making them more susceptible to insect attack and colonization.

Projecting Dwarf Mistletoe Impacts in Jack Pine Stands

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ABSTRACT

The dwarf mistletoe *Arceuthobium americanum* causes the most serious disease of jack pines in the Prairie provinces of Canada. Losses are significant now, but will increase as the parasite spreads and kills more trees. A model was developed to project mistletoe impacts in individual jack pine stands. Stand age, cover type, site class and crown closure are entered from the keyboard. Mistletoe location and stand boundaries are obtained from field surveys, delineated on a map, and digitized into the model. At 10yr intervals, the model provides the area of infestation, the amount of volume present in the stand and lost to dwarf mistletoe, and the area of the stand requiring treatment. These projections allow forest managers to make informed decisions about if and when to harvest the stand and/or control dwarf mistletoe.

Introduction

Jack pine dwarf mistletoe (JPDM) is a common inhabitant of jack pine forests of Alberta, Manitoba, and Saskatchewan. In the important jack pine producing forests of Manitoba, JPDM significantly reduces volume on more than 58,000 of 140,000 ha of forested lands (Baker et al 1992; J. Brandt, pers. comm). Foresters are aware of JPDM, but are uncertain about future impacts on timber volume, especially in young stands which have yet to experience significant mortality. This project was started to develop a tool for projecting JPDM impact.

The Jack Pine - JPDM System

Jack pine occurs in even-aged stands, which reach rotation age after 60-100 years depending on site quality. Jack pines are harvested by clear cutting, and regenerated with seed from slash or by planting.

JPDM causes large witches' brooms, and kills trees within 10-20 years of initial infection. This rapid mortality results in mortality centers surrounded by an area of infected trees, and then an area of uninfested jack pine. The disease gradient is steep, such that the distance from the uninfested edge to an area of 100% infection is 27 m, and after an additional 39 m there are essentially no live trees (Baker and Durham 1997). Along this disease gradient, volume (considering only losses to mortality) is reduced by 50% within 16 m of the edge of the infestation.

The Projection Model

A Pascal computer program (JPINE) was written to project the area of mortality caused by JPDM, the area where volume loss has occurred, the area of infestation, and the treatment area. Then, using unit volumes for a stand of the appropriate stand type and age, the volumes on each of these areas is computed.

When mortality reduces volume below operable levels (variable with site; approx 55 m³/ha) the volume on that area is 0, because an operator will not harvest it. This area occurs approximately 16m from the edge of the infestation.

Volume loss is a function only of reduction in stand density caused by mortality. Losses to brooming or cull are not considered. We conservatively used the midpoint between the infestation edge and the mortality center as the boundary for the area which has lost volume. The volume on this area is assumed to be that of a crown closure 3 stand. In crown closure 3 stands, we do not compute volume lost, because any significant reduction will reduce their volume below operable levels, and that loss would be considered in the area of mortality.

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The area of infestation is where JPDM is present; it includes the areas of mortality and volume loss. Outside the area of volume loss, the volume of an uninfested stand is used.

The treatment area is the area within a buffer distance (20 m) of the infested area. This area would be included in any treatment to ensure eradication of latent infections.

Spread occurs at fixed periods (10 yr) and allows dwarf mistletoe to move into uninfested portions of a stand. Spread rates are about 0.7 m/yr and vary by cutting class and region.

Field Procedures

Transects are run through stands at 25 m intervals. Surveyors, using hip chains, simply record the starting point, the hip chain reading when they move into or out of infestations (whether they can see JPDM within 12 m of their line). These distances are then transferred onto a stand map (1" = 100 m, Figure 1).

Mistletoe Impact Projection

Stand name, stand type (forest subtype, site quality, cutting class and crown closure) and stand age are entered from the keyboard. Stand boundaries and mistletoe location are digitized from stand maps. At each 10 yr period until the stand reaches rotation age, JPINE projects the areas of treatment and infestation, stand volume with and without JPDM, and volume loss. Tables for each of the four stands are printed. What would you do?

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Figure 1. Office map of four stands in Manitoba showing transect lines and location of dwarf mistletoe along those lines. Original scale before reproduction was 1"=100m.

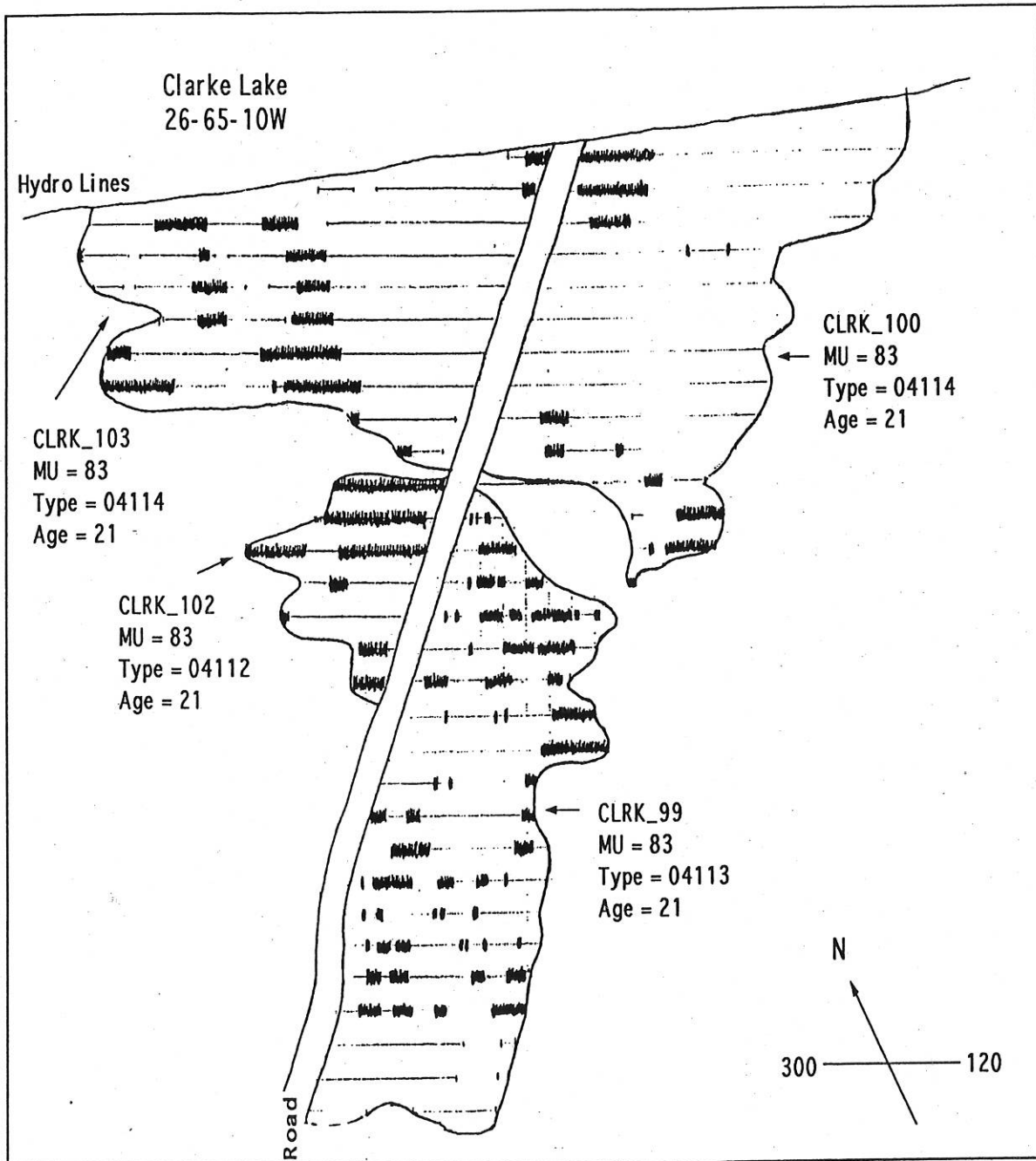


Table 1. Output tables from JPINE for the four stands in Figure 1.

clrk_99a

Stand Type 04113
Stand Area 8.4

Management Unit 83
Stand Age 21

Stand Age	Infested Area (ha)	Rotation Volume w/ Treatment (cubic m)	Stand Volume			Percent Lost	Treatment Area (ha)
			w/o DM (cubic meters)	W/DM	Lost		
21	1.0	121	0	0	0	0	6.8
31	3.3	75	0	0	0	0	7.4
41	5.5	46	221	87	134	61	7.8
51	6.8	31	322	70	253	78	8.0
61	7.5	--	423	54	369	87	8.2
71	7.8	--	525	42	483	92	8.3
81	8.1	--	626	31	595	95	8.3

Treatment areas may not be accurate because infection centers coalesced.

clrk100

Stand Type 04114
Stand Area 8.6

Management Unit 83
Stand Age 21

Stand Age	Infested Area (ha)	Rotation Volume w/ Treatment (cubic m)	Stand Volume			Percent Lost	Treatment Area (ha)
			w/o DM (cubic meters)	W/DM	Lost		
21	0.4	708	0	0	0	0	2.8
31	1.2	621	0	0	0	0	3.5
41	2.0	543	437	401	36	8	4.2
51	2.8	470	590	491	99	17	4.8
61	3.5	--	743	551	193	26	5.3
71	4.1	--	896	587	309	35	5.9
81	4.7	--	1049	605	444	42	6.4

Treatment areas may not be accurate because infection centers coalesced.

WIFDWC 1997

clk_102a

Stand Type 04112
Stand Area 1.9

Management Unit 83
Stand Age 21

Stand Age	Infested Area (ha)	Rotation Volume w/ Treatment (cubic m)	Stand Volume		Lost	Percent Lost	Treatment Area (ha)
			w/o DM (cubic meters)	W/DM			
21	1.1	4	0	0	0	0	1.8
31	1.4	1	0	0	0	0	1.9
41	1.7	-0	49	13	36	73	1.9
51	1.8	-0	71	9	62	87	1.9
61	1.9	--	94	3	90	96	1.9
71	1.9	--	116	0	116	100	1.9
81	1.9	--	138	-0	138	100	1.9

Treatment areas may not be accurate because infection centers coalesced.

clrk103

Stand Type 04114
Stand Area 7.8

Management Unit 83
Stand Age 21

Stand Age	Infested Area (ha)	Rotation Volume w/ Treatment (cubic m)	Stand Volume		Lost	Percent Lost	Treatment Area (ha)
			w/o DM (cubic meters)	W/DM			
21	1.4	479	0	0	0	0	3.9
31	2.1	398	0	0	0	0	4.5
41	2.9	339	395	314	81	21	5.0
51	3.8	291	534	373	161	30	5.4
61	4.5	--	672	402	271	40	5.7
71	5.1	--	810	402	409	50	6.0
81	5.5	--	949	386	563	59	6.2

Treatment areas may not be accurate because infection centers coalesced.

Special Demonstration of the Arborsonic Decay Detector

Scott Baker

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It was my pleasure to attend the 1997 WIFDWC meeting in Prince George BC. I attend a lot of tree related conferences and I am always intrigued by the great people that seem to end up working with trees.

During the field day I had the opportunity to demonstrate a recently developed device for detecting decay in trees or poles, the Arborsonic Decay Detector or AD². Developed by Fujikura Europe the original tool was developed to help manage utility industry's pole inventories. Phil Wade of Fujikura has had a lead role in the development of the AD² and has led the team that worked to adapt the tool and its output to use on living trees.

The AD² uses ultrasonic transmission of high frequency sound (77Khz) and produces a measurement of sound propagation delay time at a resolution of 1 µsec. In testing of most trees 2-4 plugs of bark 1.5" in diameter must be removed from the tree to allow the transducer and receiver to make direct contact with the xylem tissue of the tree. Measurements are made first across one diameter (two plugs removed) and if decay is indicated across a second diameter (additional two plugs removed). If decay is present quadrant measurements are made using the four plugs now removed. Analysis of these results provide a clear indication of the extent of the decay. In cases where cosmetics of the tree are important the bark plugs are glued back in place and new tissue forms under the plug to close the wound.

To make measurements one determines the distance (d) between the two test points used in millimeters. This measurement divided by two will equal the propagation time expected in sound wood (no decay). The presence of decay causes the signal to detour around the affected tissue resulting in a longer propagation time. A simple table has been developed to aid in determining the extent of decay present. A strong knowledge of tree anatomy is needed to make good use of this device as determining when to test a tree and then how to determine the optimum test points.

At the field day I showed how the device could determine the extent of hidden butt rot in potentially valuable timber stands. I also showed how decay in roots could also be monitored. It is also clear that the tool could be used to monitor the progress of decay pathogens in research situations.

I find the information from the AD² to be very reliable. It is useful to note that one can monitor snags to learn when they approach a point where they are no longer structural sound a useful thing to know when managing "wildlife trees". As well one can monitor decay in a tree that is active but not as yet causing the tree to be a candidate for removal thus preserving the tree longer. I have been using this device for a year along with other tools most notably the Resistograph drill. I am excited to see what the research community will find when these tools become part of their equipment.

If you have questions please contact me at 206-528-4770 or via Email at scottdb@halcyon.com and thanks for having me along I learned a lot!



Scott Baker.

Committee Reports

Dwarf Mistletoe Committee

Jerome S. Beatty and Robert Mathiasen

I. Taxonomy, Hosts, and Distribution.

a. Additional work has begun on the taxonomic relationships of shore pine dwarf mistletoe and hemlock dwarf mistletoe. Specimens of both taxa were collected in June and more will be collected in September and October for morphological measurements. Phenology data are being collected for both taxa from populations on Vancouver Island. Host range data were collected from near Horne Lake, Vancouver Island in June and additional host range data will be gathered in October from other localities. Future work may include examining molecular characters also. (R. Mathiasen, Northern Arizona University, Flagstaff, AZ; Ed Wass, Canadian Forest Service, PFC, Victoria, BC; Simon Shamoun, Canadian Forest Service, PFC, Victoria, BC; Dick Smith, Grand Forks, BC).

b. Additional host susceptibility data were collected for hemlock dwarf mistletoe and mountain hemlock dwarf mistletoe populations from California and Oregon in July. Additional populations of mountain hemlock dwarf mistletoe heavily parasitizing true firs (*Abies* spp.) were discovered in central Oregon. (R. Mathiasen, Northern Arizona University, Flagstaff, AZ).

c. After noting that a new (1994) plant identification handbook issued by the BC Ministry of Forests for coastal British Columbia used the Gill classification for *A. campylopodum* rather than the Hawksworth and Weins (H. & W.) treatment, I wrote (July/94) the authors with my concerns. Following a long period with no reply I made further inquiries and was told my letter had been passed on to Dr. George Douglas head of the Conservation Data Centre in Victoria who oversees proper use of plant scientific names. I arranged to see him (April/95) and passed on several pertinent papers and the 1972 H. & W. Monograph. Later, I gave him updated information distributed at the 1995 WIFDWC in Montana which represented content from the yet unpublished 1996 monograph. In April/96, a letter from Dr. Douglas contained the following points:

1. We, (the editors of Vascular Plants of BC), and a number of other botanists in BC and adjacent states of the US are in agreement that the minor phases within some of our *Arceuthobium* species are best recognized at the forma level.
2. In our manual, we do not treat an entity unless it can be keyed out by morphological characters and illustrated.
3. The editors will, however, provide the reader with the Hawksworth and Wiens 1996 key, place all names in synonymy and refer to pertinent research, thus allowing the reader to use the H. & W. names if they so desire.

The last concession was likely made as a result of my pointing out that the vast majority of published papers dealing with *Arceuthobium* over the past two decades follow the H. & W. system. Unfortunately, the 1996 publication of "Plants of Southern Interior BC" leads to more uncertainty by using western dwarf mistletoe as the common name of *Arceuthobium americanum*. (R. B. Smith, Grand Forks, BC).

II. Life Cycles.

a. The overall sex ratio of western hemlock dwarf mistletoe (*Arceuthobium tsugense* (Rosendahl) G. N. Jones subsp. *tsugense*) was 1:1 (n = 1608 plants) in the crowns of six large, mistletoe-infected western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) at the Wind River Canopy Crane Research Facility in south central Washington. One tree, however, had a female-biased sex ratio and another had a male-biased sex ratio, and plants in the lower crowns (less than 20 m in height) exhibited a female-biased sex ratio. (R. Mathiasen, Northern Arizona University, Flagstaff, AZ; Dave Shaw, U. Washington, WRCC, Carson, WA).

III. Host-Parasite Relations.

- a. Six hundred dwarf mistletoe-infected western larch (*Larix occidentalis* Nutt.) ranging in age from 10-20 years were sampled to determine the approximate age and height at which they were initially infected by larch dwarf mistletoe (*Arceuthobium laricis* (Piper) St. John). The age of each observable mistletoe infection was determined for each sapling and the age and height of the trees when they were initially infected was estimated based on the age of the oldest mistletoe infection. Few of the young larch sampled were infected before they reached seven years in age or 1.5 m in height. However, most of the young larch were infected before they were 14 years old or four m in height. Initial age and height of infection were significantly influenced by the infection intensity of the overstory larch growing within 12 m of the infected saplings. Because parasitism by larch dwarf mistletoe can be extremely damaging to western larch, infected overstory larch should be removed or killed before nearby larch regeneration reaches seven years in age or one m in height when minimizing infection of the regeneration is a management objective. (R. Mathiasen, Northern Arizona University, Flagstaff, AZ).
- b. Additional quantitative data are being collected on the host relationships of larch dwarf mistletoe in the Pacific Northwest. This information will be used to better evaluate the natural host susceptibility classifications for larch dwarf mistletoe. A manuscript is being prepared for publication. (R. Mathiasen, Northern Arizona University, Flagstaff, AZ).
- c. A study to quantify the level of parasitism on subalpine fir by Douglas-fir dwarf mistletoe in the Pacific Northwest was started in 1993. Quantitative data were collected from new areas where Douglas-fir dwarf mistletoe was discovered on subalpine fir in Washington. In 1997 additional data were collected from new locations in Washington. (R. Mathiasen, Northern Arizona University, Flagstaff, AZ).

IV. Wildlife Interactions.

- a. American marten use rust and dwarf mistletoe brooms in northeastern Oregon. The dense, misshapen branching of witches' brooms sometimes found in conifers provides unique wildlife habitat in forests of the interior West. Brooms may serve as food or hiding and nesting habitat for invertebrates and vertebrates. Brooming is usually caused by rust fungi, by parasitic plants, the dwarf mistletoes, or by a needle cast fungus *Elytroderma deformans*. Sixty-nine percent of the rest sites in brooms were in rust brooms and 31% in dwarf mistletoe brooms. Rest sites in rust brooms occurred in Engelmann spruce (66%), subalpine fir (24%), and grand fir (10%). Rest sites in dwarf mistletoe brooms occurred in western larch (47%), Douglas-fir (44%), lodgepole pine (5%), and ponderosa pine (4%). Most (92%) broomed trees were living. Trees averaged 50 cm dbh (range = 19-116 cm). Marten used brooms all year, although use in summer was greater (68%) than in winter (32%).

We speculate that during winter, subnivean rest sites provided more shelter from cold temperatures and inclement weather than did rest sites in brooms. In winter, rust brooms were more used (35%) than mistletoe brooms (26%), probably because the dense brooms formed by rusts provided more shelter and insulation than the more open branching of dwarf mistletoe brooms. (C. Parks and E. Bull, USDA Forest Service, La Grande, OR).

MISCELLANEOUS

- a. When collecting fungal hyperparasites in Aug/96 for Simon Shamoun's project, I commonly observed larvae of the thickset hairstreak butterfly (*Mitoura spinetorum*) feeding on shoots of *A. americanum*. In the spring of 1997, I visited the same area (ca. Lat. 49 deg. 27 min.; long. 119 deg. 05 min.) several times to see if the butterflies could be spotted (the "needle in the haystack" approach), to no avail. In the fall of 1997, my co-worker (Ann) and I systematically scanned 72 infections and found only one larva. I would appreciate hearing from anyone with information on this insect. (R.B. Smith, Grand Forks, BC).

Hazard Tree Committee Meeting

John Pronos

The Hazard Tree Committee met for lunch on Tuesday, September 16, 1997. Jim Hoffman chaired the meeting and twenty-five people attended. The following is a summary of what was discussed:

The dates of the next Hazard Tree Workshop are May 19-21, 1998, in Hood River, Oregon. The 3-day meeting will be split between indoor sessions and 2 field trips. The site for the indoor portion is the Hood River Hotel and because of the size of the meeting room, attendance will have to be limited to 70. The plan is to evaluate defective trees in the field on one day, have them dissected to reveal internal decay, and return on a second day to view the trees. Keith Sprengel is handling local arrangements and the field trips.

A special project proposal to fund the National Tree Failure Reporting Project was sent to the USDA Forest Service, Forest Health Protection Staff in Washington, DC. Their decision was that they would not be the only staff to fund the program and additional sources would need to be found. None has been found to date.

The group then discussed what topics were the highest priority for presentations at the Hood River Hazard Tree Workshop. From a list of 18 suggested topics, the following were chosen as most important (from most to least): Legal issues and obligations; evaluating site factors that contribute to failures; new innovations and techniques; discuss specific defects and how to rate them; wildlife trees versus worker safety; vegetation management programs in developed sites; and specific tree failure profiles. A smaller group will meet in Sacramento, California during October, 1997, to finalize a workshop program.



Lori Trummer and Kathy Lewis.

Rust Committee Meeting

J.W. Schwandt

About 15 members gathered for the rust breakfast on September 16, 1997. The following is a brief summary of the discussions that took place. The veracity of this information is not guaranteed, so for the most accurate information, contact the individual listed by each topic.

Richard Hunt was unable to attend the meeting, so John Schwandt chaired the meeting when it became clear that no one else had been contacted by Rich. After a brief introduction of all attending, a great deal of discussion regarding high elevation pines took place.

WHITEBARK PINE

Jim Hoffman (R-4, Boise, Idaho) discussed the efforts his office is making plus the surveys that have been conducted by the University of Idaho graduate student (J.J. Smith) which found that the worst rust infections occurred in the most moist habitats. Hadrian Merler (Kamloops Region pathologist, BC Ministry of Forests) found similar results: the driest areas had the lowest infection.

Jerry Lynn Harris (Rapid City, South Dakota Service Center) is very interested in survey methodology, and Jim volunteered to send his survey procedures to her and several others in attendance.

Alex Woods from Smithers, BC (pathologist Prince Rupert Region) has observed 80-90 % infection in young (less than 30 years old) whitebark pine even though hundreds of kilometers from the nearest western white pine. He has pruned some trees to try to reduce impact. He also reported damage from an insect.

Bart van der Kamp reported that Don Norris (Nelson, BC) is very concerned and says there are areas with 100% mortality in some mountains.

David Piggin (forester, Kamloops Region) expressed concern about the possibility of losing the high elevation white pines as a successional component.

Ellen Goheen (SW Oregon Tech Center) and John Schwandt mentioned that there is a whitebark pine symposium being planned for September of 1998 in Whitefish, Montana. Ellen volunteered to mail copies of the announcement to interested parties. Jane Taylor (Missoula) was going to try to get more info about the agenda and topics.

COMMANDRA RUST

Dave Piggin reported that he had a problem with commandra rust on ponderosa pine associated with off-site seed lots. He has not seen much problem on locally adapted stock, and has installed some semi-permanent plots to monitor disease progress. He also has seen some dead tops on ponderosa pine in Kamloops which he felt might be commandra, but has not found any aecia fruiting. Bart van der Kamp has seen similar situations, where commandra may have caused dead tops in ponderosa pine but couldn't find it sporulating.

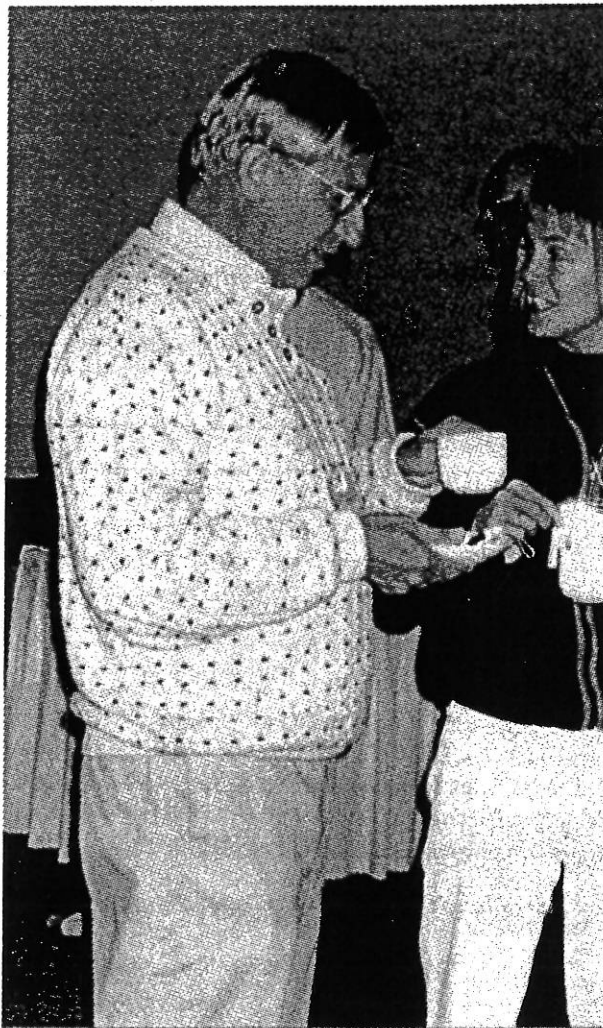
Alex Woods showed some very detailed stem maps of lodgepole pine stands that had a combination of commandra, stalactiform and western gall rust.

WHITE PINE BLISTER RUST

John Schwandt (Coeur d'Alene, Id) briefly discussed the current situation regarding unusually high mortality and infection levels in genetically improved (F2) white pine in Idaho. GERAL McDonald has found at least three areas where the improved stock is not meeting expected survival levels. All of these areas were considered "high risk" sites, and the stock is still performing above expected levels in lower risk sites.

John surveyed 15 additional plantations scattered across northern Idaho, and found one plantation with over 90% infection, two with over 60% infection and 5 others with over 30% infection; (the other 7 plantations had infection levels from 2.5% to 27%). The worst infection levels were usually associated with areas with abundant Ribes. Although mortality levels in all these plantations were relatively low, many of the cankers seem to have occurred in the past few years, so mortality rates might increase dramatically if these new cankers become lethal. In order to monitor mortality, John is tagging individual cankers on several trees to compare their progression to that of cankers on natural regeneration nearby.

John also gave a brief report of the "rust Busters" meeting where blister rust researchers discussed this situation. Several hypotheses have been suggested to account for the new infections on genetically improved stock (including environmental, and rust modification), but there is no consensus at this time. The Canadian foresters are extremely concerned about this since they are considering replanting cutover areas with Idaho F2 stock as part of their standard management procedures aimed at meeting "free-to-grow" requirements for new stands. Additional meetings are planned to develop a strategy that will help to answer some of these questions.



John Schwandt and Jane Taylor.

Root Disease Committee Meeting Report

Ellen Michaels Goheen

The Root Disease Committee met for breakfast on Thursday, September 14, 1997. Twenty-eight members were present.

Don Goheen reported on the IUFRO Root and Butt Rot Working Party Conference that he recently attended in Carcans, France. Other WIFDWCers attending this IUFRO Conference included Greg Filip, Everett Hansen, Duncan Morrison, Terry Shaw, Kathy Lewis, Bill Otrosina, and Ellen Michaels Goheen. Don presented some highlights of the meeting. He also cautioned the group to be on the lookout for upcoming name changes for *Phellinus weirii* and *Heterobasidion annosum*, as we know them. The proceedings of the Conference will be available in a year or so from the Institute Nationale Recherche Agriculture, Nancy, France. The next meeting of this working party will be held in Quebec City, Canada in September, 2001.

Ellen reported that the Root Disease Committee-sponsored workshop on Using the Western Root Disease Model, held Monday, September 15th, (see below) was a great success. Twelve people signed up, 25 actually attended, software was working on every laptop but one, and the group was actively engaged in modeling for the entire afternoon.

Walt Thies mentioned that there will be a meeting of the *Phellinus* cooperative sometime in spring 1998.

The rest of the meeting was spent in a lively and informative discussion of ongoing root disease projects.

The following reports were submitted this year:

Canadian Forest Service

Summary of Projects

1. Commercial thinning and spacing

- Cowichan Highway commercial thinning trial: testing bridge-tree removal.
- "Susceptibility" of manually and chemically spaced Douglas-fir to colonization by *Phellinus weirii*.

2. Root disease management strategies

- Planted tree (Douglas-fir) survival and growth following push felling for *P. weirii* management. Shawnigan Lake site.
- Interplanting of western redcedar and white pine seedlings in young stands (10-15 years) with laminated root rot and/or Armillaria root disease.

3. Hardwood cropping

- Decay of *P. weirii*-infected stumps under Douglas-fir and red alder canopies.

4. Identification of disease-tolerant coastal Douglas-fir for tolerance to *P. weirii*

- Screening coastal Douglas-fir for tolerance to *P. weirii*.
- Quantification of general and specific (endochitinase-like) proteins in *P. weirii*-infected roots.

For more information contact: Rona Sturrock, Canadian Forest Service, Pacific Forestry Centre
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B.C. Ministry of Forests

Project: Nichyeskwa Creek Tomentosus Root Disease Control Trial. The Nichyeskwa Creek Tomentosus trial is located approximately 100 km north-east of Smithers, BC in the Bulkley Forest District (126° 26' N, 55° 44' E).

Objectives: The Nichyeskwa Creek Tomentosus Control trial has two objectives: 1) To test the efficacy and efficiency of destumping areas that are infected with *Inonotus tomentosus* root disease. 2) To test the efficacy of two alternative treatments, hardwood cropping and range fallow, in the natural reduction of *I. tomentosus* inoculum over time. The first four of the hardwood cropping and range fallow treatment areas will be planted with interior spruce five years following plot establishment, with the remaining four and three treatment units to be planted at year 10 and 15 respectively. This approach will provide information on the natural reduction of subsurface *I. tomentosus* inoculum over time.

Activity Summary: The 11.5 ha trial site at Nichyeskwa Creek was photographed at 1:3000 scale in May, 1995. These photographs were to be used to stump map the entire trial area. The stump species, diameter and whether the tree was dead or alive at the time of harvest was recorded for each stump that was 20 cm or greater in diameter over the 11.5 ha site.

A study was conducted to determine the accuracy of drilling roots to identify *I. tomentosus* in comparison to the stump top survey method of disease identification. Twenty stumps which had no stain or pitted decay, and twenty stumps with stain and pitted decay were randomly selected. Four roots from each of the stumps were sampled by taking a core using an increment borer. The root was considered infected only if pitted decay characteristic of *I. tomentosus* was present. The stump top and the drilling survey were summarized in a co-op report. Analysis of the data resulted in several findings: 1) Spruce and pine stumps showed different proportions of infection for both *I. tomentosus* and *P. pini*; 2) Spruce stumps showed a higher proportion of infection for *I. tomentosus* than for *P. pini*; 3) Pine stumps showed a lower proportion of infection for *I. tomentosus* than for *P. pini*. The root drilling survey showed that there was the possibility of encountering no infection in four roots drilled from a stump with decay present at the stump surface. The survey also showed that there was the possibility that stumps determined to be uninfected according to the stump top survey had *I. tomentosus* in the roots.

A 1:300 scale map was generated from the low level aerial photographs. The tagged stumps were located and labeled on an acetate overlay of the map and infected stumps were marked in red. The site was divided into forty-four 40 m x 40 m plots for a total of eleven replications of each treatment. The plots were arranged so as to utilize the greatest amount of infection based on the basal area of pitted decay. The pitted decay for each plot was totaled and the plots were divided into three levels of disease incidence: low (0-182 cm²), medium (184-327 cm²) and high (342-546 cm²). The plots within each disease incidence level were then randomly assigned one of four treatments:

- 1) Control- planted with a susceptible species (interior spruce).
- 2) Range fallow- seeded with alsike clover and birdsfoot trefoil (nitrogen fixing legumes).
- 3) Hardwood cropping- allowed aspen suckering and planted cottonwood whips.
- 4) Stumping- inverted stumps with excavator and planted interior spruce.

Stumping occurred over a total of 1.76 ha distributed in eleven 40 x 40 m treatment units. Stumps of all species including aspen, were pulled from the forest floor and inverted. The 1:300 scale stump map was used during the stumping operation so that it was possible to determine the exact stump the excavator was removing. This allowed for the time and motion study to incorporate the effects of differences in stump species, diameter and disease status on the time required to remove stumps. Copies of the FERIC report (Field Note No: Silviculture-91) are available from the Prince Rupert Forest Region office in Smithers.

The accuracy of line transects surveys on the Nichyeskwa Creek Tomentosus Trial was assessed. This study was a paper exercise in which 12, three meter wide transects 100 m long were drawn on an acetate overlay of the 1:300 scale stump map. The stump census allowed for a comparison of the survey results with the known incidence of root disease. The incidence of Tomentosus in the susceptible species (Sx and Pl) was 37.5 %. The mean incidence of the

12, three meter wide 100 m transects was 40.0%. The survey results were therefore quite representative of the true population as determined in the stump census. However, these survey results were based on information derived from stump top examinations. Based on the earlier study which compared stump top assessments to root drilling, the latter method of disease detection is only 70% accurate as compared to stump top surveys. Typically, a transect survey for *Tomentosus* root disease would be conducted pre-harvest and so could only rely on root drilling information. Given the limitations associated with pre-harvest assessments of *Tomentosus* root disease, the post-harvest stump top survey is recommended for *Tomentosus*.

A Detrimental Site Disturbance survey of the stumped portion of the Nichyeskwa Creek Stumping Trial was done. Five plots were randomly chosen from both the stumped treatment and the control. Four 15 m transects were located within each treatment unit. These transects were located 5 m in from the corners of the plots and ran at 45 degrees to the center of the plot. The transects were assessed at each meter interval as a point assessment. The results of the survey indicated that the stumped area contained an average of 23.3% detrimental disturbance. Although this is well within the allowable 40% for the silviculture prescription it is well over the standard allowable level of 6%. The impact of this level of disturbance on tree growth remains to be seen. The control areas contained no detrimental disturbance.

A residual inoculum study was conducted as a test of the efficacy of stumping for the removal of *Tomentosus* inoculum. Roots from 36 interior spruce stumps that had been previously identified as being infected with *I. tomentosus* were excavated. Twenty of the stumps were rated as live at the time of harvest and 16 were rated as dead at the time of harvest. A 3 m radius was delineated around each selected stump. A quarter section of the complete radius was randomly selected and was excavated to a depth of 50 cm and all roots were removed and their volume estimated. The volume of infected roots was divided into two classes; "old" *Tomentosus* in which the root was too decayed to be considered infectious, and *Tomentosus* in which the remaining root inoculum still appeared to be infectious. This division was subjective and was based solely on the appearance of the roots. Root volumes were determined by averaging the end diameters of the root sections and multiplying that value by the length of the root section.

The average diameter of the infected stumps was 76.1 ± 3.5 cm (95% confidence interval) and the average percentage of stump area with *Tomentosus* caused pitting was 66.6%. The stump removal treatment in this trial resulted in the removal of approximately 75% of the total root volume. Approximately 55% of the residual root volume was infected with *Tomentosus* and on average 13% of a stumps roots contained "old" *Tomentosus*. The mean volume of total residual roots left in the ground was $0.076 \text{ m}^3 \pm 0.063 \text{ m}^3$ (95% confidence interval). There was no clear relationship between the percentage of stump surface area with *Tomentosus* pitted decay and the total residual root volume left in the ground. There was similarly no good relationship between the stump diameter and total residual root volume left in the ground.

The two alternative treatments, broadleaf cropping and leguminous fallow, were planted in the spring of 1996. Much of the deciduous cropping was left to the natural resprouting of the aspen. In areas with insufficient resprouting, cottonwood whips were planted. The legume fallow treatment units required some seed-bed preparation in the form of hand piling and small burns. The seeding rate was approx. 10 kg/ha. The seeding mix was 50% birdsfoot trefoil and 50% alsike clover. The seeding success was patchy and generally only the low microsites contained clover and trefoil by the end of the 1996 growing season.

The first planting of spruce within the alternative treatments will occur in the spring of 2001 in 4 of the 11 treatment units. The second planting will occur in 2006, in four more of the treatment units assigned to the alternative treatments. The final planting of the remaining 3 treatment units in each of the alternative treatment areas, will occur in 2011.

The stumped and control areas were planted May 28-30, 1996 with interior spruce (Seedlot # 3985 Sxw 415B SCI Smithers). Seedling survival at the end of the growing season was excellent. The treatment units were planted at an average density of 1600 trees/ha. Fifty sample trees in each of the planted treatment units (11 stumped and 11 control) were measured and tagged during the summer of 1997.

For more information contact :

Alex Woods, Regional Forest Pathologist for the Prince Rupert Forest Region (250 847-7478) or e-mail ajwoods@mfor01.for.gov.bc.ca

Southwest Oregon Forest Insect and Disease Technical Center

Project: Multi-stand Assessment of Root Diseases in the southern Oregon Cascades

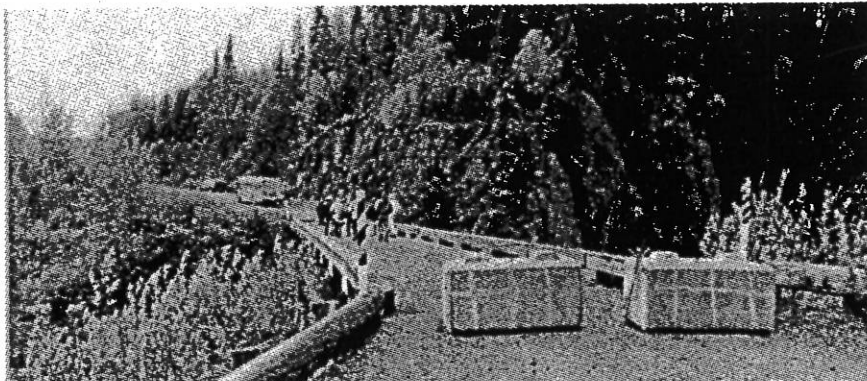
A stand by stand assessment of root disease incidence and severity is being completed in a 6000 acre planning area on the Butte Falls Ranger District, Rogue River National Forest in southwest Oregon. During walk-through reconnaissance, silviculture prescription writers and experienced stand exam crews are identifying root disease pathogens, noting hosts affected, and estimating impact based on a 0-9 root disease severity rating (RDSR) scale. This scale combines estimated impacts of root disease on the principal canopy layer and whether the root disease is distributed as distinct pockets or is scattered throughout the stand. Preliminary analysis indicates that fungal pathogens are present in approximately 90% of the stands. Four root diseases are present in the area: laminated root rot, annosus root disease, Armillaria root disease, and black stain root disease. Many stands have more than one root disease present; in a small proportion of the stands, all four root diseases have been identified. A majority of stands visited and analyzed fall into the lower root disease impact ratings; however, the entire range of severities is reported.

The information is being used to describe current conditions in the planning area. RDSRs form the basis for a root disease GIS layer at the District. The information along with dwarf mistletoe information and vegetative descriptors also gathered in the reconnaissance, is being used to prioritize stand treatments.

RDSRs also form the core of input keywords for the Western Root Disease Model (WRDM). Stands in the planning area will be simulated using the Forest Vegetation Simulator and the WRDM to predict vegetative development over time. Analysis and modeling will be completed in 1998.

For more information contact:

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Field trip: Bridge blocked – time to walk!

Workshop: Using the Western Root Disease Model vers. 3.0

Ellen Michaels Goheen

The WIFDWC Root Disease Committee sponsored a pre -WIFDWC Workshop on Monday, September 15th on using the newest version of the Western Root Disease Model, version 3.0 (WRDMv3). WRDMv3 combines the original version of the Western Root Disease Model that simulates the effects of Armillaria root disease and laminated root rot with the Annosus Root Disease/Bark Beetle Model. WRDMv3 is an extension to the Forest Vegetation Simulator (FVS) and runs via the user-interface SUPPOSE. Instructors were Susan Frankel, USDA FS, R5 Plant Pathologist, Matt Thompson, USDA FS, FHTET Systems Analyst, and Ellen Michaels Goheen, USDA FS, R6 Plant Pathologist.

Attendees were introduced to the basic assumptions behind the WRDMv3. Keywords that are used to provide model input were described and an example simulation of Armillaria root disease in a stand in central Oregon, complete with a Stand Visualization System animation of the run, was shown. Participants completed a number of hands-on exercises demonstrating various aspects of the WRDMv3 including a basic laminated root rot simulation, and Annosus root disease simulations showing stump infection and the effects of borate application. Bark beetle functions embedded in the model were described and attendees did an exercise showing the effects of turning off bark beetle functions. Model modifiers were discussed and experimented with. Inventory keywords, how to input various types of inventory information, and the pros and cons of inventory keyword combinations were also described and demonstrated. The Workshop wrapped up with a discussion of how the WRDMv3 is currently being used at both the stand and landscape level.

Twenty-five WIFDWCers and twenty laptop computers attended the session. Software was successfully loaded, everyone completed all the exercises, and the class stayed on until the scheduled wrap up at 5:00 PM! We look forward to hearing reports of successful simulations of root disease with the WRDMv3 throughout the west in years to come.



Alex Woods demonstrating how forest pathologists get the job done!?

BUSINESS MEETING MINUTES

Prepared by Rona Sturrock

Chairperson Walt Thies called the meeting to order at 10:30 a.m. on Friday, September 19 in Prince George, British Columbia. The business meeting minutes for the 1996 WIFDWC meeting in Hood River, OR were approved as written with the following clarification noted: it is the responsibility of the 'Railroad Committee' to nominate only the Chairperson and Secretary for meetings; the approved meeting Chairperson then has the responsibility to nominate a Program Chair. The deaths of Honorary Members (HM) Neil McGregor and Ray (John) Hansbrough and the declining health of HM Dave French, were noted. Tom McGrath was proposed and recognized as an Honorary Member. (Sec. Note: Although they were not specifically named at the business meeting, as of 1997 Allen Van Sickle and Pritam Singh are also recognized as Honorary Members).

John Schwandt, WIFDWC Treasurer, reported a balance of \$5264.45 at the close of the 44th meeting in Hood River, OR. A copy of the Treasurer's Report follows here.

Committee Reports

There was no report from the Disease Control Committee although members of the committee met. Discussion about whether the Committee would continue to exist concluded that as long as there is interest by members in meeting, the Committee should continue.

Greg Filip, acting for Bob Mathiasen as Chair for the Dwarf Mistletoe Committee, reported that the group met; Simon Shamoun presented an interesting paper (included in these '97 Proceedings as a Special Paper); a full report from the Committee will be provided to the Secretary for inclusion in these Proceedings.

Jim Hoffman, acting for John Pronos as Chair for the Hazard Tree Committee, reported that the group met and that arrangements and topics for an upcoming Hazard Tree Workshop for May 19-22, 1998 in Hood River, OR were discussed.

Ellen Michaels Goheen, Chair for the Root Disease Committee, reported that a large group of participants had a productive breakfast meeting. Topics presented/discussed included: 1) the successful and well-attended Workshop on 'Using the Western Root Disease Model - Version 3.0' (see write-up following Root Disease Committee Report), held on September 15, 1997 in conjunction with WIFDWC '97, 2) a meeting of the Coastal Phellinus Management Cooperative, proposed for the spring of 1998 by Walt Thies, and 3) a workshop on aerial detection of root disease proposed for the winter of 1997/98 by Ken Russell.

John Schwandt, acting for Rich Hunt as Chair for the Rust Committee, reported much interest by committee members in research on Whitebark pine.

Future Meetings

The 46th WIFDWC will be held at the University Inn in Reno, Nevada on September 28 - October 2, 1998. The 47th WIFDWC will be held in Breckenridge, Colorado from September 13-17, 1999. This will be a joint WIFDWC-WIFIWC meeting. John Laut suggested that travel arrangements made through Colorado Springs vs Denver might be less expensive. Looking to the year 2000, Jerry Beatty, on behalf of Susan Frankel/Region 5, proposed an invitation to Hilo, Hawaii for the 48th meeting of WIFDWC. The theme for the meeting would be Exotic Plant/Forest Diseases; dates to be investigated by Susan Frankel. A motion to accept the proposal was carried by the Assembly.

The Railroad Committee reported on it's selection of officers for the 1998 meeting: Bob Edmonds, Chairperson, Lori Trummer, Secretary. A Program Chair will be selected by the Chairperson at a later date. These selections were approved, seconded, and passed unanimously.

Old Business

WIFDWC Bylaws – Background: During the business meeting of the 1996 WIFDWC at Hood River OR, there was much discussion about membership in WIFDWC (e.g. who is entitled to Honorary Life Membership, what the Bylaws say or don't say, etc.) To sort out this situation, John G. Laut (Honorary Member) graciously volunteered to review all past WIFDWC Proceedings to: 1) find any Bylaws and 2) review and 'codify' all official actions so that current members would have a reference point for the Organization's 'parliamentary' history. John prepared a three-part Report (included in these Proceedings) consisting of an historical review of all 'official' actions of the WIFDWC membership, a summary of the Organization's current status re motions/bylaws, and a set of personal recommendations (Bylaws) for consideration by the membership. The Bylaws proposed by John Laut were mailed to the WIFDWC membership in September 1997 for their consideration.

Discussion: A motion was made by John Laut to bring to the 1997 table, nine amendments to the 1957 WIFDWC Policy statement which were proposed /tabled in 1961 but never formally accepted. The motions tabled in 1961 were discussed and a motion to accept them was rejected, thus putting them officially 'to rest'. John Laut then tabled the Bylaws he proposed and moved that they be accepted. Discussion ensued on wording in several sections of the proposed Bylaws. A motion was made and carried to reject the proposed Bylaws so that they could be 'find-tuned' by a Bylaw Committee which would present a revised version for consideration/voting at the 1998 meeting. A Bylaw Committee composed of Susan Frankel, Walt Thies, Jerry Beatty, and Rona Sturrock was suggested by Walt Thies. Lastly, the Assembly recognized John Laut for the tremendous job he did.

New Business

Ken Russell raised the subject of the WIFDWC Social Achievement (SA) Award and moved that 1) the Award be retired and 2) a committee be appointed to create a new award(s) and associated criteria for winning it. Discussion ensued on how the SA Award and the reasons for winning it had changed through the years. There was recognition by the Assembly that while the SA Award has significant historical value, it does not truly reflect the professionalism that the WIFDWC membership wishes to maintain. A new award(s) will strive to do this. A 'New Award' Committee consisting of Ken Russell, Susan Frankel, Greg Filip, and Simon Shamoun was proposed as was a motion to have the annual winner of the new award be the 'keeper' of the retired SA Award. All motions were seconded and passed. The Committee will provide information on the new award(s) in mailouts for the 1998 meeting.

Vidar Nordin (Honorary Member), present at the Business Meeting, remarked on the quality of the 'younger' WIFDWC professionals and in particular noted the achievements of Dr. Kathy Lewis, RPF who was named Forester-of-the-Year in 1997 by the Association of British Columbia Professional Foresters. See the page following here for a description of Kathy's award.

The meeting was adjourned at approximately 11:30 a.m.

Respectfully submitted by Rona Sturrock, WIFDWC 1997 Secretary



Rona Sturrock.

Forester-of-the-Year

Katherine J. Lewis, Ph.D., RPF

The Forester-of-the-Year Award recognizes a registered professional forester who has made outstanding contributions to the profession of forestry, and/or the Association of BC Professional Foresters (ABCPF) and their community during the last five years.

This year, the award is presented to Dr. Katherine (Kathy) J. Lewis in recognition of her dedication and contributions to forest practices and education in British Columbia.

As one of the first professors hired by the Natural Resources Management program of the University of Northern British Columbia, Kathy has played an instrumental role in the development of the university's primary program. Her energy, commitment and solid grounding in forest practices have been critical to the program's growth. Kathy's keen understanding of the skills, knowledge and abilities that foresters must possess, and her dedication to helping students meet these requirements, has made her popular amongst both her peers and students.

Despite a heavy teaching schedule, Kathy has continued to conduct research critical to British Columbia's forest sector, including studies into tree pathogens, forest health and management practices. She also conducts research for the McGregor Model Forest and is chair of its technical steering committee.

Kathy is a strong link between academia and professional foresters within the province. She is fully committed to her dual roles as a university professor and a registered professional forester and represents both perspectives as she shapes future foresters. Her dedication and energy make her an ideal role model for students, faculty and other professional foresters alike.

Not only is she active within academia, Kathy also works tirelessly within the profession and the community. She is a member of the ABCPF's Board of Examiners, sits on the Science Council of BC's forestry advisory committee and volunteers for Cariboo section of the Canadian Institute of Forestry. Kathy is an avid runner, and volunteers her time to run and ski with the visually impaired; for the last three years she has been the chair of the annual Iceman Competition.

It is because of her great contributions to both the profession and to forest education, the Association of British Columbia Professional Foresters proudly presents Kathy Lewis with the Forester-of-the-Year Award.

Kathy Lewis [R] and WIFDWC colleagues.



Kathy in full field gear.



Special Report on WIFDWC Bylaws and Review of Parliamentary Activity

Prepared by John G. Laut, Honorary Member

INTRODUCTION

During the business meeting of the 1996 WIFDWC, at Hood River OR there was much discussion about membership in our organization -- who is entitled to Honorary Life Membership; how, or when to "purge" the membership list or mailing list; what the "BY-LAWS" said or didn't say etc. In a moment of weakness this author volunteered to review all past proceedings in order to: A. Find any BY-LAWS; and B. Review any official actions of the membership and attempt to "codify" them or otherwise pull them together so that the current members of WIFDWC could have a reference point for our parliamentary history. This report fulfills that obligation.

It is in three parts. The History section reviews, chronologically, the official actions of the WIFDWC membership. An "official" action for my purposes is one that was duly moved, seconded and voted upon during the Business meeting of any Conference. I have NOT included the routine motions concerning the selection of officers or selection of annual meeting sites. The results of these votes are available in the lists contained in each annual Proceedings. Nor have I included votes or resolutions that were basically a "one-time" occurrence or had little bearing on future WIFDWC business. The Summary section attempts to summarize the current situation of any of the recurring issues: where we are and how we got there. The third section contains my personal recommendations for action by the WIFDWC membership. These will be presented as motions during the 1997 Business meeting for consideration.

1. LEGISLATIVE HISTORY

The proceedings of the first 3 meetings of WIFDWC contain no formal minutes of business meetings other than the choosing of the next meeting site, and the naming of a new Chairman.

At the 4th meeting (1956) an "ad hoc" committee, chaired by G.P. (Phil) Thomas, was formed to "evaluate the objectives, organization, and activities of the Western International Forest Disease Work Conference." This committee presented their report the following year (1957, Salem OR) at the 5th Conference (5th Proceedings, pp.120-126).

The report had several sections, each with one to several recommendations, with committee comments. The items covered were:

- A. Objectives
- B. Organization
 - I. Membership
 - II. Officers
 - III. Affiliation with other groups
 - IV. Meeting locale
 - V. Meeting frequency
- C. Activities

The report was accepted as presented and the Committee was dissolved.

Based on the report and recommendations Dr. Thomas then proposed "A Statement of Policy Concerning Conference Organization and Activities" containing 8 sections (5th, pp 126-128). After discussion it was moved, seconded and carried that "the Statement as read be accepted as Conference Policy".

Because it is the foundation of our Conference, that 1957 Statement is reprinted in its entirety and appended to this report. All current WIFDWC members and affiliates should take time to read it. It will periodically be referred to as "the 1957 Policy".

At the 7th meeting (1959) there were several official "opinions" placed on the record to guide future Conferences. Some of these were of short term nature -- e.g. Future program subject matter, but three are considered to be of continuing impact:

A. Project lists should be brought up to date and presented in full in the Proceedings at intervals of approximately 5 years.

B. The use of **tape and other transcribing equipment** (emphasis added, JGL) to record presentations or discussions would interfere with informality and free expression of opinions and **should not be condoned** except following unanimous approval of all members present.

C. Future Conference Chairmen (sic), on opening day, shall appoint an Interim Program Chair to gather suggestions and opinions to guide Conference Chairman (without obligation) in planning the subsequent meeting.

In 1960, at Centralia (8th, p.91) the 1957 Policy was amended to add Section IX, to read as follows:

"Subsequent amendments to this Statement will require a not less than two-thirds affirmative vote, as determined by ballots cast by eligible members, such vote to be determined through letter ballot distributed by the Chairman or officer designated by him (sic). Eligible members will be determined as the number of persons, excluding guests, whose names appear in the Membership List of the Proceedings issued immediately prior to the date of issue of the letter ballot."

This amendment, proposed by R. E Foster, and seconded by J. W. Kimmey, was carried unanimously.

That action was followed by a motion (Foster/Lightle) containing 9 separate, further amendments to the 1957 Policy, with the total effect of defining and specifying membership requirements (pp. 91-92). Each of those 9 were passed. (Ed. Note: These are presented in full in this report)

BUT, it was then pointed out that according to the new "Section IX" (see above) approval must be gained through a mail ballot. It was also pointed out that many members were not "sufficiently aware of the concepts of the motions, or of the interpretations that are likely to be made, if they are passed."

It was decided that the Council would prepare a mail ballot to determine whether the membership agrees to postponement of action on the listed motions (amendments? JGL) until the next meeting. R. E. Foster agreed to head a committee to look into this area and to present a report at the 1961 meeting.

At Banff, in 1961, Chairman F. G. Hawksworth indicated that the letter ballot to consider the 9 policy amendments in open session had passed and discussion was opened. Subsequently it was moved, seconded and passed to table all 9 amendments and the issue of membership definitions was left wide open.

In 1962 "difficulties in keeping the membership list accurate and up-to-date were mentioned" and each member was asked to provide "addresses of individuals whose names should be added or deleted."

The status of forest pathology graduate students was discussed. It was moved, seconded and passed that graduate students be charged no registration fee but, since banquet attendance is optional, they be charged the banquet fee if they chose to attend.

Also in 1962 the "Hazards in recreational areas" committee was created.

In 1963 a committee was formed to consider holding a joint meeting with the (western) entomology work conference. That committee subsequently, in 1964 (12th Proceedings), recommended such a joint meeting to be held in March of 1966 (and defer the fall 1965 and 1966 meetings of our Conference). The subsequent motion was defeated (15-8) by a show of hands.

Also in 1964 (p. 113) a resolution, subsequently moved, seconded and passed, defined the "Honorary Membership" classification as "... members of the Conference who retire from continuous employment in forest pathology." This definition was made "retroactive to include all past members of WIFDWC who have retired, and that registration fees be paid by the Conference for honorary members.

At the 15th Conference (1967, p.108) the Honorary membership classification was clarified (by carried motion) to show that it begin "with termination of principle employment and that such designation be irrevocable."

Student membership was also redefined (moved, seconded, carried) as "any individual enrolled in forest pathology in a university and who is not more than 50% employed."

This Conference (1967) also chartered the Forest Disease Control Committee (15th, p. 109).

The business meetings of the 16th, 17th and 18th Conferences were strictly routine with no noteworthy official actions.

In 1971 there was a lengthy discussion concerning membership in WIFDWC. After referring to the Statement of Policy adopted at the 5th Conference (1957), and to the motions presented at the 8th and tabled at the 9th meetings (still technically "on the table" JGL.) It was moved, seconded and carried that:

"With the exception of the Mexican delegation, a membership requirement of attending at least one conference during a consecutive 5 year period (emphasis added, JGL) is hereby established Guests and invited participants should only receive a copy of the Proceedings for the Conference they attended. Their names will not be retained or added to membership lists."

In 1972 the membership voted to pursue a joint meeting with the Western Forest Insect Work Conference (WFIWC) sometime between Sept. 1974 and March 1975. As a result the 21st Conference (1973) approved a proposal made by a joint WIFDWC-WFIWC committee to meet jointly in California sometime between February 15 and April 15, 1975. The regular fall meeting of WIFDWC for 1974 was canceled.

The 22nd WIFDWC was held in 1975 at Monterey California. During this meeting it was proposed that the two Conferences (WIFDWC and WFIWC) merge. A motion in the WIFDWC business meeting was made that such a merger not occur but that WIFDWC endorses the principle of periodic joint meetings.

It was also moved, seconded and carried that the 23rd WIFDWC be held in the fall of 1975, as regularly scheduled. It was also decided that future meeting sites will be chosen **TWO** years in advance.

The 24th Conference, in 1976, saw considerable discussion, proposals, counter-proposals, amendments and votes concerning the Achievement Award. (Ed. Note -- no previous reference to this award has been noted in the review of all past business meeting minutes!)

It was moved, seconded and carried that the Award competition be divorced from the Banquet and that the "event" be moved to an earlier night so that the Award could be presented at the Banquet. It was also moved, seconded and carried that the AA committee make their selection before midnight of the night before the Banquet. (Note -- as a long-standing member of this committee this official action has generally been ignored! JGL).

It was also officially decided, by appropriate motion and vote, that commercial sponsorship of conference special events will not be allowed.

Also, at this meeting (1976) The Conference members reaffirmed the 1957 Policy on distribution of Proceedings as: "... should be made to all persons known to be qualified for membership and who have an active interest in WIFDWC " (p. 125).

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The 1977 Conference (25th) officially disbanded the Forest Hazard Committee and the Air Pollution Committee (date of formation not known).

The business meetings at the 1978, '79 and '80 Conferences were devoid of any significant action.

The 1981 business meeting was notable in that the "meeting" (presumably only the business meeting, ed.) was taped and a copy of the tape is in the Archives of WIFDWC in Victoria (see notes of the 7th (1959) Conference re recording, JGL). The secretary-treasurer presented an updated mailing list based on "guidelines provided in the bylaws 'purging' anyone, other than a life member, who has not attended a meeting within the last 3 years."

Ed. Note: This review has failed to find any Bylaws, and that in 1971 the members approved purging of membership lists after 5 years of non-attendance. The 1981 Secretary seemed to have several lapses that year -- maybe going for that elusive Achievement Award?

1982 and 1983 business meetings covered only routine matters.

The 32nd Conference, 1984 established the Rust Committee. It was also moved, seconded and carried that "From now on the Proceedings will be mailed only to paid registrants and honorary members who have indicated a desire to receive it, and will be made available to all others at cost."

The 1985 meeting saw discussions, and proposals, concerning removal of "International" from our name. The end result was officially moved, seconded and carried that our Conference name will not be changed. We will continue to be called the Western International Forest Disease Work Conference.

The next significant action, in 1987, approved a joint meeting with the WFIWC in Central Oregon in 1989.

This Conference also directed the Chairperson to appoint an ad hoc committee to develop a public involvement activity plan for consideration of the members at the 1989 meeting.

The 1988 Conference officially adopted a policy of selecting meeting sites 3 years in advance.

1989 -- No official actions. Note that there is no mention of the 1988 directed ad hoc committee, nor any report from that group.

The 1990 minutes contain the following: "We propose to institute a tradition of joint forest pathology/entomology meetings every 5 years." There evidently was no official action taken to "institute a tradition". However the Entomology group's invitation to join them in 1994 was accepted.

The 1991 minutes record considerable confusion in reference to the proposed joint meeting -- whether it would be in 1994 or 1995.

This question was clarified in 1992 (40th Conference) and the joint meeting was confirmed to be in March, 1994, in Albuquerque NM.

In 1993 the Tree Hazard Committee was re-instituted. It was also moved, and subsequently carried, to appoint a committee to draw up criteria for persons to be added to the "Honorary Life membership" category. (Ed. Note -- committee not named?)

In 1994 it was "suggested" that we advertise future meetings through APS, SAF & the Pacific Division, APS newsletters. No official action was taken on the suggestion.

The 1995 attendees discussed the distribution of the mailing list (membership list) to anyone requesting it. It was officially decided to leave such distribution up to the organizing committee of each Meeting.

The question of Honorary membership was revisited after several people were "elected" to that category. A committee of 3 was appointed to "look into the process of selecting individuals for Honorary Life Membership" (see note under 1993, above).

It was moved, and subsequently carried, that the Executive Committee of each WIFDWC can decide who, and how many, outside speakers they want to invite to the meeting, and that travel costs for such speakers can be paid from registration fees.

The 1996 meeting saw several items that pertain to this review. In the order in which they appear in the Minutes (p.120-121):

The Chairman noted that we are scheduled for a joint meeting with WFIWC in 1999, based on the (policy) that we meet jointly every 5 years, with location and time selection alternating between the groups. (Such a policy was suggested in 1990 but no official action was taken ed.)

There was extensive discussion on Honorary Life Membership, leading to a discussion on membership requirements etc. This in turn led to a question about the existence of BY Laws -- do they? Where? And ultimately to this review.

That was followed by discussion on distribution of Proceedings to Honorary members. It was moved, seconded and carried that all Honorary members be queried each year, by the Secretary-Treasurer, as to whether they wish to receive a complimentary copy of the Proceedings and that only those responding in the affirmative will receive a copy. (It is assumed that such a query would be mailed with, or concurrently with, the final meeting announcement ed.)

The Proceedings also contain (p.125-126) an analysis of the Honorary Membership situation, prepared by the Committee that was formed in 1995.

It was moved, seconded and carried, that papers for each year's Proceedings must be submitted by November 1 the year of the meeting.

This concludes the chronological review of major "legislative" actions of the first 44 years of Western International Forest Disease Work Conference. The following section attempts to interpret the current status of the major questions, organized by subject.

2. SUMMARY

The Western International Forest Disease Work Conference has **NO** formally adopted BY-LAWS!

At the 5th Conference (1957) Dr. Phil Thomas proposed "A Statement of Policy Concerning Conference Organization and Activities" containing 8 sections (5th, pp 126-128). After discussion it was moved, seconded and carried that "the Statement as read be accepted as Conference Policy".

Because it is the foundation of our Conference, that 1957 Statement is presented here. All current WIFDWC members and affiliates should take time to read it. It will periodically be referred to as "the 1957 Policy".

THE 1957 "POLICY"

The following is copied from Proceedings of the 5th WIFDWC, 1957, Salem OR (pp. 126-128).

A Statement of Policy Concerning Conference organization and Activities:

- I. Objectives. To provide through discussion at a professional level a continuing opportunity for forest pathologists in western North America to exchange views on problems of mutual interest and concern to their field as regards research, survey, control, and extension activities.

II. Values. Values that can be expected to accrue to pathologists and their sponsoring agencies as the result of Conference activities are:

1. Provision of an opportunity for contact and personal assembly of western forest pathologists beyond the local level and, consequently, for alleviation of professional isolation.
2. Provision for a pooling of ideas and points of view, some of which never reach publication and most of which would be made available long in advance of publication.
3. Provision through the printed transactions of meetings of a clearing house for notification of the initiation or completion of research or survey projects. Provision through the same medium of a continuing record of the accomplishments of different research agencies, contributions to panel discussions of selected topics, and an index of western forest pathologists and their affiliations.
4. Provision for investigation of a standard approach to and the manner of reporting on particular problems for the purpose of integrating the results of one project into those of a similar nature.
5. Provision for investigating the possibilities of cooperative action on problems of broad interest for the purpose of assuring effective participation by agencies having limited funds and personnel.
6. Provision for the further education and training of pathologists through the medium of group discussions involving persons having diverse and specialized backgrounds.
7. Provision of a unique opportunity for educators to keep abreast of developments in forest pathology and, thus, an opportunity for them to constantly revitalize courses of instruction at universities.
8. Provision of an opportunity for administrators or research representatives of agencies to gain an over-all acquaintance with research activities in forest pathology in the west.

III. Membership. Membership to be open to persons actively engaged in:

1. Research, survey, control, or extension activities pertaining to tree diseases or deterioration of forest products,
2. Administration of the activities listed in (1), and
3. University teaching of forest pathology or forest products pathology.

IV. Officers. Officers of the Conference to consist of a chairman and a secretary, elected by the attending members at the termination of each Conference meeting. The chairman-elect to be empowered to appoint persons from the membership to assist him and the secretary to conduct the affairs of the Conference.

V. Meetings.

Frequency. The Conference endorses the holding of annual meetings but will, on vote of the membership, change the time of any particular meeting when circumstances dictate that such action be taken.

Date. The conference endorses the holding of late-fall meetings but will, on vote of the membership, change the interval between any two meetings when circumstances dictate that such action be taken.

Location. The Conference endorses the holding of meetings within the general area of Victoria, British Columbia -- Spokane, Washington -- Portland, Oregon but will, on vote of the membership, hold meetings beyond this area when circumstances dictate that such action be taken.

- VI. Relationships with other groups. The Conference rejects in principle direct affiliation with other groups but endorses in principle concurrent meetings and joint sessions with other groups when such associations are clearly in the best interests of the Conference.
- VII. Transcripts of meetings. The Conference will issue a transcript of each meeting, to be known as the Proceedings, following the format of the 3rd Conference transcript. The Proceedings will be issued to all persons known to be qualified for membership within the Conference and who have demonstrated an interest in its activities. To avoid any conflict of interests between the Conference, its members, and the sponsoring agencies of its members, each issue of the Proceedings will be prefixed by the following statement:
- "The content of these Proceedings are not available for citation or publication in whole or in part without the consent of the authors concerned."
- VIII. Finances. The Conference will regulate its finances in such a way as to make each meeting self-supporting. Financial records of the Conference will consist, therefore, of an accounting of revenues and expenses pertinent to each meeting and shall be rendered during the business session of each meeting.
- IX. (Note this section added by vote of the 1960 Conference) Amendments. Subsequent amendments to this Statement will require a not less than two-thirds affirmative vote, as determined by ballots cast by eligible members, such vote to be determined through letter ballot distributed by the Chairman or officer designated by him (sic). Eligible members will be determined as the number of persons, excluding guests, whose names appear in the Membership List of the Proceedings issued immediately prior to the date of issue of the letter ballot.
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Since 1957, as outlined in the opening section of this report, the Conference has officially adopted (through duly passed motions in open meetings) several items. Some of these may be controversial, some are contradictory to each other or to the Policy of 1957. **NONE** of these meet the criteria spelled out in Section IX and might be considered to be not in effect!

Nevertheless these actions are summarized here, grouped by the corresponding Section of the 1957 Policy.

Sections I and II have not been amended nor added to.

III. MEMBERSHIP

The approval of Section IX, in 1960, was followed by a motion (Foster/Lightle) containing 9 separate, further amendments to the 1957 Policy, with the total effect of defining and specifying membership requirements (pp. 91-92). Each of those 9 were passed.

BUT, it was then pointed out that according to the new "Section IX" (see above) approval must be gained through a mail ballot. It was also pointed out that many members were not "sufficiently aware of the concepts of the motions, or of the interpretations that are likely to be made, if they are passed."

It was decided that the Council would prepare a mail ballot to determine whether the membership agrees to postponement of action on the listed motions (amendments? JGL) until the next meeting. R. E. Foster agreed to head a committee to look into this area and to present a report at the 1961 meeting.

At Banff, in 1961, Chairman F. G. Hawksworth indicated that the letter ballot to consider the 9 policy amendments in open session had passed and discussion was opened. Subsequently it was moved, seconded and passed to table all 9 amendments and the issue of membership definitions was left wide open.

In 1962 "difficulties in keeping the membership list accurate and up-to-date were mentioned" and each member was asked to provide "addresses of individuals whose names should be added or deleted."

However the membership category has seen several changes. The major change was to add 2 additional categories of membership (in addition to the General category): Graduate Students and Honorary Life Members.

In 1962 the status of forest pathology graduate students was discussed. It was moved, seconded and passed that graduate students be charged no registration fee but, since banquet attendance is optional, they be charged the banquet fee if they chose to attend. This category was further defined in 1967 as "any individual enrolled in forest pathology in a university and who is not more than 50% employed."

In 1964 (p. 113) a resolution, subsequently moved, seconded and passed, defined the "Honorary Membership" classification as "... members of the Conference who retire from continuous employment in forest pathology." This definition was made "retroactive to include all past members of WIFDWC who have retired, and that registration fees be paid by the Conference for honorary members.

At the 15th Conference (1967, p.108) the Honorary membership classification was clarified (by carried motion) to show that it begin "with termination of principle employment and that such designation be irrevocable."

In 1971 there was a lengthy discussion concerning membership in WIFDWC. After referring to the Statement of Policy adopted at the 5th Conference (1957), and to the motions presented at the 8th and tabled at the 9th meetings (still technically "on the table" JGL.) It was moved, seconded and carried that:

"With the exception of the Mexican delegation, a membership requirement of attending at least one conference during a consecutive 5 year period (emphasis added, JGL) is hereby established.... ."

The 1981 business meeting was notable in that the "meeting" (presumably only the business meeting, ed.) was taped and a copy of the tape is in the Archives of WIFDWC in Victoria (see notes of the 7th (1959) Conference re recording, JGL). The secretary-treasurer presented an updated mailing list based on "guidelines provided in the bylaws" purging "anyone, other than a life member, who has not attended a meeting within the last 3 years."

Ed. Note: This review has failed to find any Bylaws, and that in 1971 the members approved purging of membership lists after 5 years of non-attendance. The 1981 Secretary seemed to have several lapses that year -- maybe going for that elusive Achievement Award?

It was moved, and subsequently carried in 1993, to appoint a committee to draw up criteria for persons to be added to the "Honorary Life membership" category. (Ed. Note -- committee not named?)

In 1995 the question of Honorary membership was revisited after several people were "elected" to that category. A committee of 3 was appointed to "look into the process of selecting individuals for Honorary Life Membership" (see note under 1993, above).

In 1996 there was extensive discussion on Honorary Life Membership, leading to a discussion on membership requirements etc. This in turn led to a question about BY-LAWS -- do they exist, where? Etc., and ultimately to this Review.

The 1996 Proceedings also contain an analyses of the Honorary Life membership situation, prepared by the committee named in 1995. Note -- this analysis was not presented during the business meeting discussions (ed.)

IV. OFFICERS

In 1959 an "official opinion" was adopted that future Conference Chairmen (sic), on opening day, shall appoint an Interim Program Chair to gather suggestions and opinions to guide Conference Chairman (without obligation) in planning the subsequent meeting.

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V. MEETINGS

(see also following section re joint meetings with WFIWC)

It was decided in 1975 that future meeting sites will be chosen **TWO** years in advance.

The 1988 Conference officially adapted a policy of selecting meeting sites **THREE** years in advance.

VI. RELATIONS WITH OTHER GROUPS

In 1963 a committee was formed to consider holding a joint meeting with the (western) entomology work conference. That committee subsequently, in 1964 (12th Proceedings), recommended such a joint meeting to be held in March of 1966 (and defer the fall 1965 and 1966 meetings of our Conference). The subsequent motion was defeated (15-8) by a show of hands

In 1972 the membership voted to pursue a joint meeting with the Western Forest Insect Work Conference (WFIWC) sometime between Sept. 1974 and March 1975. As a result the 21st Conference (1973) approved a proposal made by a joint WIFDWC-WFIWC committee to meet jointly in California sometime between February 15 and April 15, 1975. The regular fall meeting of WIFDWC for 1974 was canceled.

The 22nd WIFDWC was held in 1975 at Monterey California. During this meeting it was proposed that the two Conferences (WIFDWC and WFIWC) merge. A motion in the WIFDWC business meeting was made that such a merger not occur but that WIFDWC endorses the principle of periodic joint meetings. Motion was carried.

It was also moved, seconded and carried that the 23rd WIFDWC be held in the fall of 1975, as regularly scheduled.

The 1990 minutes contain the following: "We propose to institute a tradition of joint forest pathology/entomology meetings every 5 years." There evidently was no official action taken to "institute a tradition". However the Entomology group's invitation to join them in 1994 was accepted.

The 1996 Chairman noted that we are scheduled for a joint meeting with WFIWC in 1999, based on the (policy) that we meet jointly every 5 years, with location and time selection alternating between the groups. (Such a policy was suggested in 1990 but no official action was taken ed.)

The 1996 Conference approved the issuance of an invitation to WFIWC for a joint meeting in Colorado in the fall of 1999.

VII. TRANSCRIPTS OF MEETINGS

In 1959 it was suggested that Project lists should be brought up to date and presented in full in the Proceedings at intervals of approximately 5 years. Also in 1959 an "opinion" was rendered that :The use of **tape and other transcribing equipment** (emphasis added, JGL) to record presentations or discussions would interfere with informality and free expression of opinions and **should not be condoned** except following unanimous approval of all members present."

In 1971 it was moved, seconded and carried that: " Guests and invited participants should only receive a copy of the Proceedings for the Conference they attended. Their names will not be retained or added to membership lists."

The 1976 Conference members reaffirmed the 1957 Policy on distribution of Proceedings as: " ... should be made to all persons known to be qualified for membership and who have an active interest in WIFDWC " (p. 125).

It was also moved, seconded and carried in 1984 that "From now on the Proceedings will be mailed only to paid registrants and honorary members who have indicated a desire to receive it, and will be made available to all others at cost.

The 1996 Conference also saw discussion on distribution of Proceedings to Honorary members. It was moved, seconded and carried that all Honorary members be queried each year, by the Secretary-Treasurer, as to whether they wish to receive a complimentary copy of the Proceedings and that only those responding in the affirmative will receive a copy. (It is assumed that such a query would be mailed with, or concurrently with, the final meeting announcement ed.)

In 1996 it was moved, seconded and carried, that papers for each year's proceedings must be submitted (to the Secretary) by November 1 of the year of the meeting.

VIII. FINANCES

IX. AMENDMENTS

(Added in 1960)

Subsequent amendments to this Statement will require a not less than two-thirds affirmative vote, as determined by ballots cast by eligible members, such vote to be determined through letter ballot distributed by the Chairman or officer designated by him (sic). Eligible members will be determined as the number of persons, excluding guests, whose names appear in the Membership List of the Proceedings issued immediately prior to the date of issue of the letter ballot.

Other items not classified:

Permanent Committees:

1957 -- The Dwarf Mistletoe Committee was formed.

1966 -- Recreation Hazards Committee was formed.

1968 -- Forest Disease Control Committee was chartered (15th proc. P.109).

1972 -- Air pollution Committee formed.

1977 -- The Air Pollution Committee, and the Forest Hazard Committee were both officially disbanded.

1978 -- The Root Disease Committee was formed.

1984 -- Tree (Stem) Rust Committee was established.

1993 -- Tree Hazard Committee was re-instituted.

Miscellaneous:

The 1985 meeting saw discussions, and proposals, concerning removal of "International" from our name. The end result was officially moved, seconded and carried that our Conference name will not be changed. We will continue to be called the Western International Forest Disease Work Conference.

In 1976 there was considerable discussion, proposals, motions, amendments and votes concerning the Achievement Award. (eds. Note -- No other mention of this award, other than the Winners List, was noted in this review of proceedings)

It was finally moved, seconded and carried that the Award competition be divorced from the Banquet and that the "event" be moved to an earlier night; then the Award would be presented at the banquet. It was also carried that the Award Committee make their selection by midnight of the day preceding the banquet.

Also in 1976 it was moved, seconded, and carried that commercial sponsorship of conference social events will not be allowed.

It was moved, and subsequently carried in 1995, that the Executive Committee of each WIFDWC can decide who, and how many, outside speakers they want to invite to the meeting, and that travel costs for such speakers can be paid from registration fees.

The 1995 attendees discussed the distribution of the mailing list (membership list) to anyone requesting it. It was officially (by vote) decided to leave such distribution up to the organizing committee of each Meeting.

The "TABLED" Motions

As mentioned in the Historical Section (p. 3) there were 9 amendments to the 1957 Policy Statement proposed by Foster/Lightle in 1960 that were discussed through the 1961 meeting when they were formally Tabled. Since these amendments are still "on the table", subject to discussion and final action they are presented here as shown in the Proceedings of the 8th Conference, 1960:

"Moved by R.E Foster, seconded by P.C. Lightle, that the statement of policy printed in the Proceedings of the Fifth Conference, and as subsequently amended, be further amended by the following nine motions:

1. That a classification of "honorary member" be established and that this designation be assigned at the pleasure of the conference to members who, following long and valued contributions to the field of forest pathology and to the proceedings of the work conference, have retired from active continuous employment in forest pathology.
2. That attendance be restricted to honorary members, members, and invited guests.
3. That invitation of guests be left to the individual members, but that members inviting guests should use considerable discretion, keeping in mind the objectives of the conference. Members should inform Council whenever possible that they wish to invite a guest so that a formal invitation may be extended and so that Council will have an indication of the size of attendance to be expected.
4. That invitations to guests be specific in regard to their duration.
5. That the presence of guests at business or other meetings be at the pleasure of the Council.
6. That the regional boundaries of the Western Region be designated as that region in North America lying west of the one-hundredth meridian south of the 49th parallel, and west of the Alberta-Saskatchewan boundary north of the 49th parallel.
7. That membership be restricted to those persons who, in the opinion of Council:
 - (1) are resident within the Region and qualified for membership,
 - (2) may not reside within the Region but who are directly concerned with the administration of activities in the Region which fall within the scope of the Work Conference, or
 - (3) may not reside within the Region but who carry on activities which fall within the scope of the Work Conference and who are and have been active participants in the Western Work Conference as determined through regular attendance and contribution.
8. That Council revise the membership list annually, adding or deleting names as required, to ensure that it consists of only active, qualified members.
9. That, unless approved by Council, the distribution of the Proceedings be restricted to members and honorary members.

PROPOSED ACTIONS TO BE TAKEN AT THE 1997 CONFERENCE.

1. "Untable" the 9 motions from 1960 and call for a vote on all 9. I recommend that all 9 be defeated so that we can start with a clean slate and define membership categories as we wish. Actually the effect here will be to leave the categories defined as per the most recent votes by various conferences.
2. All official votes (duly moved, seconded and passed), as noted in the Laut 1997 Review of Parliamentary Activity and subsequent to the 1957 Statement of Policy, be declared valid as official actions of the various annual conferences, with the proviso that the latest action for any particular item shall be the prevailing one.

3. Section IX of the Statement of Policy be amended as follows (underlined sections are suggested changes):

Subsequent amendments to this Statement will require a not less than two-thirds affirmative vote of the members present at the business meeting, provided that such proposed Amendment(s) has (have) been presented in writing to all attendees prior to or at Registration for the Conference at which the Amendment is to be considered.

4. The 1957 Statement of Policy shall become the By-Laws of the Western International Forest Disease Work Conference and that they be further amended to reflect Statement 2 above, as written in the attached Proposed By-Laws of September 1997.

WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE
BY-LAWS (proposed)
September 1997

- I. Objectives. To provide through discussion at a professional level a continuing opportunity for forest pathologists in western North America to exchange views on problems of mutual interest and concern to their field as regards research, survey, control, and extension activities.
- II. Values. Values that can be expected to accrue to pathologists and their sponsoring agencies as the result of Conference activities are:
1. Provision of an opportunity for contact and personal assembly of western forest pathologists beyond the local level and, consequently, for alleviation of professional isolation.
 2. Provision for a pooling of ideas and points of view, some of which never reach publication and most of which would be made available long in advance of publication.
 3. Provision through the printed transactions of meetings of a clearing house for notification of the initiation or completion of research or survey projects. Provision through the same medium of a continuing record of the accomplishments of different research agencies, contributions to panel discussions of selected topics, and an index of western forest pathologists and their affiliations.
 4. Provision for investigation of a standard approach to and the manner of reporting on particular problems for the purpose of integrating the results of one project into those of a similar nature.
 5. Provision for investigating the possibilities of cooperative action on problems of broad interest for the purpose of assuring effective participation by agencies having limited funds and personnel.
 6. Provision for the further education and training of pathologists through the medium of group discussions involving persons having diverse and specialized backgrounds.
 7. Provision of a unique opportunity for educators to keep abreast of developments in forest pathology and, thus, an opportunity for them to constantly revitalize courses of instruction at universities.
 8. Provision of an opportunity for administrators or research representatives of agencies to gain an over-all acquaintance with research activities in forest pathology in the west.

III. Membership. Membership is open to persons actively engaged in:

1. Research, survey, control, or extension activities pertaining to tree diseases or deterioration of forest products,
2. Administration of the activities listed in (1), and/or
3. University teaching of forest pathology or forest products pathology;

Provided that such activities are conducted, or are based, within the geographic areas covered by: in Canada; the Pacific Forest Research Centre and the Northern Forest Research Centre of the Canadian Forest Service (with due consideration of changes in official names); and in the United States; by U.S. Forest Service Regions 1, 2, 3, 4, 5, 6, 10, plus the Pacific island areas encompassed by the PSW research station; and all of Mexico.

"With the exception of the Mexican delegation, and Honorary members, a membership requirement of attending at least one conference during a consecutive 5 year period is hereby established. The membership list should be so purged each year.

Honorary members are those members of the Conference who have retired from continuous employment in forest pathology. Registration fees shall be paid by the Conference for honorary members. Since banquet and field trip attendance is optional, they be charged the applicable fee(s) if they chose to attend.

Student members are those individuals currently enrolled in forest pathology in a university and who are not more than 50% employed. Student members should be charged no registration fee but, since banquet and field trip attendance is optional, they be charged the applicable fee(s) if they chose to attend.

IV. Officers. Officers of the Conference to consist of a chairman and a secretary, elected by the attending members at the termination of each Conference meeting. The chairman-elect to be empowered to appoint persons from the membership to assist him and the secretary to conduct the affairs of the Conference. The Chairman, Secretary and Local Arrangements Chairman together form the "Executive" for a given conference year.

V. Meetings.

Frequency. The Conference endorses the holding of annual meetings but will, on vote of the membership, change the time of any particular meeting when circumstances dictate that such action be taken.

Date. The Conference endorses the holding of late-fall meetings but will, on vote of the membership, change the interval between any two meetings when circumstances dictate that such action be taken.

Location. The Conference endorses the holding of meetings within Western North America, as defined under Section III, Membership, but will, on vote of the attending membership, hold meetings beyond this area when circumstances dictate that such action be taken.

VI. Relationships with other groups. The Conference rejects in principle direct affiliation with other groups but endorses in principle concurrent meetings and joint sessions with other groups when such associations are clearly in the best interests of the Conference.

VII. Transcripts of meetings. The Conference will issue a transcript of each meeting, to be known as the Proceedings, following the format of the 3rd Conference transcript. The Proceedings will be issued to all persons known to be qualified for membership within the Conference and who have demonstrated an interest in its activities. To avoid any conflict of interests between the Conference, its members, and the sponsoring agencies of its members, each issue of the Proceedings will be prefixed by the following statement:

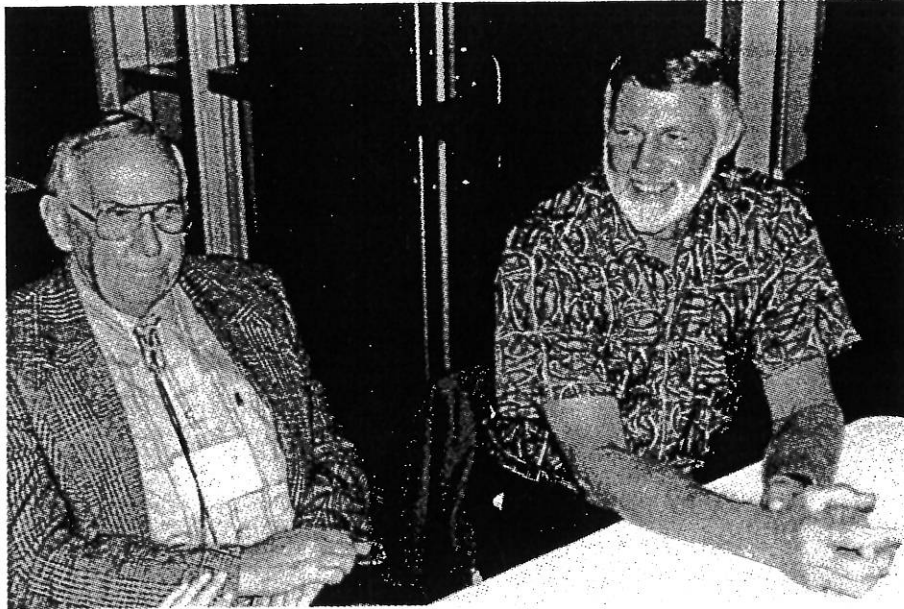
"The content of these Proceedings are not available for citation or publication in whole or in part without the consent of the authors concerned."

Guests and invited participants (non-members) should only receive a copy of the Proceedings for the Conference they attended. Their names will not be retained or added to membership or distribution lists.

VIII. Finances. The Conference will regulate its finances in such a way as to make each meeting self-supporting. Financial records of the Conference will consist, therefore, of an accounting of revenues and expenses pertinent to each meeting and shall be rendered during the business session of each meeting.

IX. Amendments.

Subsequent amendments to this Statement will require a not less than two-thirds affirmative vote of the members present at the business meeting, provided that such proposed Amendment(s) has (have) been presented in writing to all attendees prior to or at Registration for the Conference at which the Amendment is to be considered.



John Laut and Ken Russell.

TREASURER'S REPORT 45th WIFDWC

Prepared by John Schwandt, WIFDWC Treasurer

The following is a summary of transactions for the 1997 WIFDWC meeting in Prince George, British Columbia.

Meeting Participants: There were a total of 65 participants at the 1997 meeting including (approx.); 43 regular members, 5 students, 3 retirees, and 8 guest speakers.

TRANSACTION	AMOUNT	BALANCE
Balance reported at close of 44th meeting in Hood River, Oregon. (11/1/96)		5,264.45
INCOME:		
Interest paid to account from 1/1/97 through 9/30/97	153.15	5,417.60
Reimbursement from 1994 joint insect and disease meeting in Albuquerque	440.52	5,858.12
Gross registrations receipts for 1997 meeting (\$9,731.19 CA)*	6,227.96	12,086.08
Sales of Proceedings	65.00	12,151.08
PAYMENTS:		
Misc costs for 1996 meeting in Hood River, Oregon (received after 11/1/96)	-164.92	11,986.16
Printing/ binding costs for 1996 (44th) proceedings; printing was free except for covers	-310.00	11,676.16
Mailing costs for 1996 (44th) Proceedings	-142.40	11,533.76
1997 Meeting Costs		
Motel/meeting rooms/meals/breaks/etc (\$4,595.00 CA)*	-2,940.80	8,592.96
Misc supplies (name tags, holders, folders, etc) (\$562.16 CA)*	-359.78	8,233.18
Field trip transportation (\$1,604.36 CA)*	-1,026.79	7,206.39
Banquet at UNBC (\$1,668.93 CA)*	-1,068.11	6,138.28
Balance of 97 regist. remaining for printing, mailing and misc costs (\$1,300.74 CA)		
Future Meeting Costs		
1999 Deposit to reserve meeting facility at Breckenridge, Colorado	-500.00	5,638.28
1998 Deposit for Hazard Tree Conference in Hood River, Oregon (see note below)	-500.00	5,138.28
CURRENT BALANCE (as of 11/1/97)		5,138.28
Printing and mailing costs for 1997 proceedings will be subtracted from this balance and reported in next years proceedings.	???	

* Canadian dollars converted to US\$ using 36% exchange rate. NOTE: This account includes \$1,374.83 balance from May, 1995 Hazard Tree Conference.

PAST MEETING LOCATIONS AND EXECUTIVE COMMITTEES

YR	LOCATION	CHAIRMAN	SECY/TR	PROGRAM CHAIR	LOCAL ARNGMTS
53	Victoria, BC	R. Foster	--	--	--
54	Berkeley, CA	W. Wagener	P. Lightle	--	--
55	Spokane, WA	V. Nordin	C. Leaphart	G. Thomas	--
56	El Paso, TX	L. Gill	R. Davidson	V. Nordin	--
57	Salem, OR	G. Thomas	T. Childs	R. Gilbertson	--
58	Vancouver, BC	J. Kimmey	H. Offord	A. Parker	--
59	Pullman, WA	H. Offord	R. Foster	C. Shaw	--
60	Centralia, WA	A. Parker	F. Hawksworth	J. Parmeter	K. Shea
61	Banff, ALB.	F. Hawksworth	J. Parmeter	A. Molnar	G. Thomas
62	Victoria, BC	J. Parmeter	C. Shaw	K. Shea	R. McMinn
63	Jackson, WY	C. Shaw	J. Bier	R. Scharpf	L. Farmer
64	Berkeley, CA	K. Shea	R. Scharpf	C. Leaphart	H. Offord
65	Kelowna, BC	J. Bier	H. Whitney	R. Bega	A. Molnar
66	Bend, OR	C. Leaphart	D. Graham	G. Pentland	D. Graham
67	Santa Fe, NM	A. Molnar	E. Wicker	L. Weir	P. Lightle
68	Coeur D'Alene, ID	S. Andrews	R. McMinn	J. Stewart	C. Leaphart
69	Olympia, WA	G. Wallis	R. Gilbertson	F. Hawksworth	K. Russell
70	Harrison Hot Springs, BC	R. Scharpf	H. Toko	A. Harvey	J. Roff
71	Medford, OR	J. Baranyay	D. Graham	R. Smith	H. Bynum
72	Victoria, BC	P. Lightle	A. McCain	L. Weir	D. Morrison
73	Estes Park, CO	E. Wicker	R. Loomis	R. Gilbertson	J. Laut
74	Monterey, CA	R. Bega	D. Hocking	J. Parmeter	--
75	Missoula, MT	H. Whitney	J. Byler	E. Wicker	O. Dooling
76	Coos Bay, OR	L. Roth	K. Russell	L. Weir	J. Hadfield
77	Victoria, BC	D. Graham	J. Laut	E. Nelson	W. J. Bloomberg
78	Tucson, AZ	R. Smith	D. Drummond	L. Weir	R. Gilbertson
79	Salem, OR	T. Laurent	T. Hinds	B. van der Kamp	L. Weir
80	Pingree Park, CO	R. Gilbertson	O. Dooling	J. Laut	M. Schomaker
81	Vernon, BC	L. Weir	C. G. Shaw III	J. Schwandt	D. Morrison/R. Hunt
82	Fallen Leaf Lake, CA	W.J. Bloomberg	W. Jacobi	E. Hansen	F. Cobb/J. Parmeter
83	Coeur D'Alene, ID	J. Laut	S. Dubriel	D. Johnson	J. Schwandt/J. Byler
84	Taos, NM	T. Hinds	R. Hunt	J. Byler	J. Beatty/E. Wood
85	Olympia, WA	F. Cobb	W. Thies	R. Edmonds	K. Russell
86	Juneau, AK	K. Russell	S. Cooley	J. Laut	C.G. Shaw III
87	Nanaimo, BC	J. Muir	G. DeNitto	J. Beatty	J. Kumi
88	Park City, UT	J. Byler	B. van der Kamp	J. Pronos	F. Baker
89	Bend, OR	D. Goheen	R. James	E. Hansen	A. Kanaskie
90	Redding, CA	R. Hunt	J. Hoffman	M. Marosy	G. DeNitto
91	Vernon, BC	A. McCain	J. Muir	R. Hunt	H. Merler
92	Durango, CO	D. Morrison	S. Frankel	C.G. Shaw III	P. Angwin
93	Boise, ID	W. Littke	J. Allison	F. Baker	J. Hoffman
94	Albuquerque, NM	C.G. Shaw III	G. Filip	M. Schultz	T. Rogers
95	Whitefish, MT	S. Frankel	R. Mathiasen	R. Mathiasen	J. Taylor/J. Schwandt
96	Hood River, OR	J. Kliejunas	J. Beatty	S. Campbell	J. Beatty/K. Russell
97	Prince George, BC	W. Thies	R. Sturrock	K. Lewis	R. Reich/K. Lewis

SOCIAL ACHIEVEMENT AWARD WINNERS

YEAR	LOCATION	WINNER
1957	Salem, OR	Stuie Andrews
1958	Vancouver, BC	Stuie Andrews
1959	Pullman, WA	Don Leaphart
1960	Centralia, WA	Keith Shea
1961	Banff, ALB	Phil Thomas
1962	Victoria, BC	Toby Childs
1963	Jackson, WY	Alex Molnar
1964	Berkeley, CA	Reed Molnar
1965	Kelowna, BC	Art Parker
1966	Bend, OR	Gardner Shaw
1967	Santa Fe, NM	Larry Weir
1968	Couer D'Alene, ID	Bob Scharpf
1969	Olympia, WA	Dick Parmeter
1970	Harrison Hot Springs, BC	Jim Kimmey
1971	Medford, OR	Ed Wicker
1972	Victoria, BC	Vivian Muir
1973	Estes Park, CO	Tom Laurent
1974	Monterey, CA	Bob Bega
1975	Missoula, MT	Art McCain
1976	Coos Bay, OR	--
1977	Victoria, BC	Ray Foster
1978	Tucson, AZ	John Hopkins
1979	Salem, OR	Oscar Dooling
1980	Pingree Park, CO	Tommy Hinds
1981	Vernon, BC	Fields Cobb
1982	Fallen Leaf Lake, CA	John Laut
1983	Couer D'Alene, ID	Bob Gilbertson
1984	Taos, NM	Terry Shaw
1985	Olympia, WA	Fred Baker
1986	Juneau, AK	Edna Miller
1987	Nanaimo, BC	Sally Cooley
1988	Park City, UT	Don Goheen
1989	Bend, OR	Ellen Michaels Goheen
1990	Redding, CA	Frank Hawksworth
1991	Vernon, BC	Willis Littke
1992	Durango, CO	Pete Angwin
1993	Boise, ID	Mike McWilliams
1994	Albuquerque, NM	Mary Lou Fairweather
1995	Whitefish, MT	Susan Frankel
1996	Hood River, OR	Ken Russell
1997	Prince George, BC	AWARD RETIRED*

* See Business Meeting Minutes for details on retirement of the Social Achievement Award.

Honorary Members

(Living and Deceased [D])

"The classification 'Honorary Member' be bestowed on members of the conference who retire from continuous employment in forest pathology". Andrews & Hawksworth, 12th WIFDWC, 1964.

Paul Aho 84	Hans Hansen (D) 60	Roger Peterson 94
Norm Alexander 94	Homer Hartman (D) 66	Clarence Quick (D) 68
Ed Andrews 77	Bob Harvey 92	Jerry Riffle 86
Stuart "Stewie" Andrews (D) 73	George Harvey (D) 76	Jack Roff 75
Jesse Bedwell (D) 66	Frank Hawksworth (D) 91	Lew Roth 79
Robert Bega 85	Dwight Hester (D) 83	Ken Russell 96
Warren Benedict (D) 66	Tommy Hinds 85	Bob Scharpf 91
John Bier (D) 67	Ray Hoff 95	E. Mike Sharon 95
Dick Bingham 75	John Hopkins 87	Charles G. Shaw II (D) 84
Bill Bloomberg (D) 90	Benton Howard (D) 71	Pritam Singh 97
Roy Bloomstrom (D) 92	John Hunt (D) 59	Albert Slipp (D) 60
Thomas "Buck" Buchanan (D) 72	Paul Keener (D) 67	Richard B. Smith 90
Don Buckland (D) 56	James Kimmey (D) 66	Richard S. Smith 95
Hubert "Hart" Bynum (D) 72	Tom Laurent 85	Wilhelm Solheim (D) 65
Elmer Canfield 83	John Laut 93	Jack Sutherland 96
Toby Childs 68	Don Leaphart (D) 75	Al Tegethoff 80
Fields Cobb 93	Paul Lightle 73	Phil Thomas (D) 76
Ross Davidson (D) 68	Otis Maloy 91	Jim Trappe 86
Oscar Dooling (D) 86	Neil Martin 89	Allan Van Sickle 97
Charles Driver 92	Art McCain 93	Willis Wagener (D) 65
Norm Engelhart (D) 59	Tom McGrath 97	Gordon Wallis 83
David Etheridge 75	Neil McGregor (D) 77	Charles "Doc" Waters (D) 60
Lowell Farmer 65	Jim Mielke (D) 66	Larry Wier 84
Mike Finnis 84	Reed Miller 70	Conrad Wessela 66
Ray Foster 75	Alex Molnar 76	Stuart Whitney 91
Dave French 95	Virgil Moss 66	Roy Whitney 90
Alvin Funk 89	Earl Nelson 93	Ed Wicker 91
Lake Gill (D) 66	Tom Nichols 95	Ralph Williams 94
Linnea Gillman 80	Vidar Nordin 92	John Woo 86
Clarence "Clancy" Gordon (D) 81	Harold Offord (D) 65	Ernest Wright (D) 65
Don Graham 80	Nagy Oshima (D) 76	Bratislav Zak 76
John Gynn (D) 66	Lee Paine 81	Wolf Ziller (D) 73
John Hansbrough (D) 68	Dick Parmeter 91	

Conference registration fees and proceedings costs are waived for Honorary Members.

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WIFDWC 1997

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Robert Celaya State Land Dept., For. Div. 1616 W. Adams Phoenix, AZ 85007 PHONE: 602-255-4633	'94	Charles Driver 461 Ridge View Dr. Sequim, WA 98382-9589 PHONE: 360-681-2052	HM'96	Gregory M. Filip Dept. of Forest Science, FSL 020 Oregon State University Corvallis, OR 97331-7501 PHONE: 541-737-6567 FAX: 541-737-1393 EMAIL:FILIPGR@CCMAIL.ORST.ED U	'97
Tun-Tschu Chang Div. of Forest Protection Taiwan For. Research. Inst. 53 Nan Hai Road Taipei, Taiwan, Rep. of China PHONE: (02)381-7107 ext. 314 FAX: (02)314-2234	'95	Paul Dunn USDA Forest Service FIDR1/SW P.O. Box 96090 Washington, D.C. 20090-6090 PHONE: 202-205-1532	'97	Jaime Flores Universidad Autonoma Nuevo Leon Apdo 41, 67700 Linares Nuevo Leon, MEXICO	MEX
Gary Chastagner Washington State Univ. Research and Extension Center Puyallup, WA 98371 PHONE: 206-840-4528 FAX: 206-840-4671	'95	Bov Eav USDA FS - FHP/FHTET 3825 E. Mulberry Fort Collins, CO 80524 PHONE: 970-498-1777 FAX: 970-498-1660 DG:B.EAV:W04A EMAIL:/S=B.EAV/OU1=W04A@MHS -FSWA.ATTMAIL.COM	'92	Susan Frankel USDA FS - FPM 630 Sansome St. San Francisco, CA 94111 PHONE: 415-705-2651 FAX: 415-705-1140 DG:S.FRANKEL:R05A EMAIL:/S=S.FRANKEL/OU1=R05A@ MHS-FSWA.ATTMAIL.COM	'97
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