PROCEEDINGS OF THE 44th ANNUAL WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

Hood River, Oregon
September 16-September 20, 1996

Proceedings of the 44th Annual Western International Forest Disease Work Conference

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Compiled by:
Jerome S. Beatty
USDA Forest Service
WTCFID
Sandy, Oregon

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Western International Forest Disease Work Conference
44th Meeting - September 16-20, 1996
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Program

Monday--September 16

4:00 - 7:00 PM	Registration on the Mezzanine at the entrance to the Columbia Room. Everyone is invited to add to the poster: "Our Forest Pathology Family Tree". Columbia Room will be open for those who wish to set up posters.
7:00 - ???? PM	Social, Hospitality Suite 301.

Tuesday--September 17

7:00 AM	Rust Committee Breakfast, Riverview Room.
7:30 AM	Poster setup in Columbia Room.
8:00 AM	Registration, Mezzanine.
8:30 AM	Chairman's Welcome - John Kliejunas (USDA-FHP, San Francisco, CA).
8:45 AM	Local Information - Ken Russell (Washington Dept. Natural Resources, Olympia, WA).
9:00 AM	Regional, University, Provincial, Country, Personal, and State Reports.
10:00 AM	Break. Spouse meeting, Suite 301.
10:30 AM	Continue Reports.
11:30 AM	Hazard Tree Committee Lunch, Riverview Room East. Disease Control Committee Lunch, Riverview Room West.
1:00 PM	**Panel**: Exotic Forest Diseases. Moderator--Borys Tkacz, (USDA-FHP, Flagstaff, AZ).

Port-Orford-cedar root disease in the Pacific Northwest. Everett Hansen (Oregon State University, Corvallis, OR).

Pine pitch canker in California. Don Owen (California Dept. of Forestry, Redding, CA).

Pine pitch canker in Mexico. Jesus Guerra (SEMARNAP, Mexico City, Mexico).

Pest risk assessment of the importation of pine and fir logs from Mexico. Gregg DeNitto (USDA-FHP, Redding, CA).

Sending pathogens abroad: Advising the People's Republic of China on risks associated with importing logs from the Pacific Northwest. Ellen Goheen (USDA-FHP, Medford, OR).

3:00 PM Break.

3:30 PM **Panel**: Forest Fungi. Moderator--Willis Littke (Weyerhaeuser, Centralia WA).

Introduction--Willis Littke.

Biology--Chanterelle production in the Olympic Peninsula. David Piltz (PNW Research Station, Corvallis, OR).

Management--Mycological diversity: Impactful management and "Survey and Manage" for NW Forest Plan. Randy Molina (PNW Research Station, Corvallis, OR).

Social--Social interactions in forest mushroom management and harvest. Tom Love (Linfield College, Mc Minneville, OR).

5:00 PM Adjourn. Hospitality Suite 301.

7:00 PM Poster Session, Forest Fungi Display, and Ice Cream Social--Columbia Room. Coordinators: Posters and Ice Cream, Diane Hildebrand (USDA-FHP, Portland, OR). Forest Fungi Display, Willis Littke and Ken Russell.

8:00 PM Ken Russell Recognition--Columbia Room. Coordinators: Willis Littke and Greg Filip (Oregon State Univ., Corvallis, OR).

Wednesday--September 18

7:00 AM Dwarf Mistletoe Committee Breakfast, Garden Room

8:30 AM Field Trip to Mt. Adams/Glenwood area. Meet in front of the Inn.

5:00 PM Return to Hood River. Dinner on your own.

Thursday--September 19

7:00 AM Root Disease Committee Breakfast, Riverview Room.

8:00 AM **Special Papers**. Moderator--Rona Sturrock (Canadian Forest Service, Victoria, BC).

Incidence of *Armillaria* spp. in precommercial thinning stumps and spread of *A. ostoyae* to adjacent Douglas-fir trees. Mike Cruickshank (Canadian Forest Service, Victoria, B.C.).

Armillaria root disease in the Black Hills of South Dakota. Melanie Callas (Colorado State University, Ft. Collins, CO).

Studies of western hemlock dwarf mistletoe at the Wind River Canopy Crane Research Facility. Dave Shaw (University of Washington, Carson, WA).

9:00 AM **Panel**: Natural And Prescribed Fire...Burning Issues For Pathologists? Moderator-Catherine Parks, (PNW Research Station, LaGrande, OR).

Ignite-----Overview of fire-related issues. Catherine Parks

Burn-----Changes in wood of fire-killed trees, 1st year results. Jim Hadfield, (USDA-FHP, Wenatchee, WA).

Suppress-----Fire suppression and forest diseases: changing hazards in subalpine ecosystems. Paul Flanagan, (USDA-FHP, Wenatchee, WA).

Mop-up-----Group discussion.

10:00 AM **Panel**: Forest Pathology and Wildlife. Moderator--Don Goheen (USDA-FHP Medford, OR).

Douglas-fir dwarf mistletoe and wildlife habitat: management challenges. Katy Marshall and Mario Mamone (USDA-FHP, Medford, OR).

Artificially created snags for cavity-nesters. Catherine Parks (PNW Research Station, LaGrande, OR).

Pathogens, gaps and the southwestern spotted owl. Brian Geils and John Lundquist (Rocky Mountain Forest and Range Research Station, Flagstaff, AZ, and Fort Collins, CO).

11:30 AM Lunch

12:30 PM Field Trip to Cloud Cap Inn/Tilly Jane Campground, Mt. Hood NF.

6:00 PM Cookout at Parkdale.

Friday--September 20:

7:30 AM **Special Papers**. Moderator--Rona Sturrock (Service canadien des forets, Victoria, BC).

Incidence of infection and decay caused by *Heterobasidion annosum* in managed, second-growth noble fir in central Oregon. Kelly Sullivan (Oregon State University, Corvallis, OR).

Site and soil characteristics related to the incidence and spread of *Inonotus tomentosus*. Dan Bernier (University of Northern British Columbia, Prince George, BC).
A decline of ponderosa pine near Burns, Oregon. Walt Thies (PNW Research Station, Corvallis, OR).

Molecular systematics of *Rhabdocline* and closely related foliar pathogens. David Gernandt (Oregon State University, Corvallis, OR).

Landscape analysis of *Phellinus weirii* in the high Cascades of Oregon. Peter Lattin (Oregon State University, Corvallis, OR).

A destructive epidemic of Swiss needle cast in coastal forest plantations. Lori Winton (Oregon State University, Corvallis, OR).

10:00 AM Break.

10:30 AM Business Meeting.

APPENDIX 1

Poster Session

Posters will remain on display throughout the meeting, and be taken down before noon on Friday, September 20.

1. The 4 C's of Modeling and Analysis. FHTET

2. Forest Health Technology Enterprise Team. FHTET

3. Informs-R8; the Utility of Rulebase Technology in a Decision Support System. Stephen B. Williams, Ron Perisho, and David R. Holtfrerich

4. Advances in Root Disease Modeling: the Western Root Disease Model vers. 3.0. Ellen Michaels Goheen, John McLaughlin, and Judy Adams

5. Our Forest Pathology Family Tree. Ellen Goheen and WIFDWC attendees

6. Genetic Variation in Blister Rust Resistance of Sugar Pine Families at Six Sites in Southern Oregon: 10-Year Results . Richard Sniezko, Harvey Doester, and Jude Danielson.

7. Screening for Blister Rust Resistance at Dorena Genetic Resource Center. Richard Sniezko and Jude Danielson

8. Wood discoloration of *Chamaecyparis obtusa* and *Cryptomeria japonica* caused by Japanese horntail and *Amylostereum sp.* in Shikoku District, Japan. Masanobu Tabata

9. Diseases in Madrone. Marianne Elliott

10. Chanterelle production in Douglas-fir and hemlock stands in Gray's Harbor county, WA. Will Litke and John Browning.

11. A golden indicator of old-growth forest soil legacy: ecology and taxonomy of *Philoderma* spp. J. Smith, A Jumpponen, M. Larsen, and D. McKay.

12. Steam pasteurization of nursery soil to control soilborne pests. John Browning and Will Litke.

13. Swiss needle cast in western Oregon. Alan Kanaskie and Mike McWilliams.

14 Creating wildlife trees using fungi in managed forests. Catherine Parks, Greg Filip and Evelyn Bull

CHAIRMAN'S OPENING REMARKS

John Kliejunas
USDA FS, FPM
San Francisco, CA

Good morning, fellow members and guests. It is my privilege to welcome you to Hood River, Oregon, and to the 44th annual meeting of the Western International Forest Disease Work Conference.

I would especially like to welcome those of you who are attending your first conference. I hope that you will have a rewarding, and unique, experience. This is not a gathering of spectators; take a cue from some of the older members — take a risk, and participate. The success of this conference depends on the participation of all of us. I would also like to extend a special welcome to a forest pathologist colleague from Mexico, Jesús Guerra. Jesús is in charge of the risk assessment program for the Forest Health Staff, within the Division of Forest Protection, in the Ministry of the Environment and Natural Resources (SEMARNAP).

A tremendous amount of effort, and hard work, has gone into making this meeting happen. In particular, I would like to thank several individuals who are responsible for organizing this conference:

1st, our Program Chair - Sally Campbell; Sally has provided us with an excellent program, and has assembled stimulating panels and speakers in a range of interest to everyone.

2nd, our Secretary - Jerry Beatty; Jerry has already done a tremendous amount of work, especially by taking over responsibility for some of the local arrangements. Jerry also has the tedious job ahead of getting the Proceedings of this meeting out.

and 3rd, thanks to our Local Arrangements Chair - Ken Russell. This is, in my memory, Ken's third go around as local arrangements chairman. Ken already had this meeting place pretty much in hand, even before we left last year's meeting. Ken, with the help of Jerry, is responsible for arranging registration, lodging, meeting facilities, and the field trips.

It is customary here for the Chairman to offer a few words of wisdom, or a perspective, on where we are going as a profession. For those of you who know me, I seldom, if ever, have words of wisdom. However, I will offer a few comments.

My first WIFDWC was in 1975, 21 years ago, in Monterey. Back then, forest pathology was probably at its height, in terms of dollars available and in terms of numbers of individuals working in the profession. For example, in California, UC Berkeley had two professors of forest pathology, and a third active in the field; PSW had a pathology work unit, with 3 full-time pathologists, and a program in Hawaii; and FPM, which had recently hired three new pathologists (Mike Srago, Ed Wood, and Jim Byler), was flourishing. Times have changed.

Today, UC Berkeley has no forest pathologists. In fact, Berkeley no longer has a Department of Plant Pathology, which was at one time, one of the best in the country. PSW has abandoned its pathology work unit, and FPM is facing a budget crisis never before seen. Other regions of the West, both in the United States and Canada, have had similar experiences.

Back in 1975, terms like maximizing yield, pathological rotation, and forest pest suppression, were common. We now talk about biological diversity, ecosystem management, forest health, maintaining snags and course woody debris, and the beneficial effects of insects and pathogens. We are undergoing a variety of complex organizational and program changes, including re-inventing, re-structuring, down-sizing, and re-mixing after down-sizing.

However, don't be too discouraged. We are, in my opinion, responding to these changes in a positive manner. The importance of forest pathology, both publicly and politically, is gaining. Let me offer a few examples:

1) Introduced diseases, white pine blister rust and Port Orford cedar root disease, for example, continue to spread in our native forest ecosystems, and are keeping us needed.

2) With the increase of log importation, and the increase in free trade, the potential for introducing new pathogens, and new diseases, is increasing. Risk assessments are needed now, and strategies for managing these new exotic pathogens will be needed soon.
3) The re-organization of Forest Pest Management to Forest Health Protection has had positive political effects at the national level. Our dollars for staying in business come from the politicians.
4) And last, attendance at WIFDWC is higher than ever. That is a good sign; forest pathologists are not an endangered species.

My take-home message: We need to continue responding to these changes, without loss of commitment to our profession. New, and greater, opportunities and challenges will arise. We need to recognize these new opportunities, and take advantage of them. Take every opportunity you have to let the importance of forest pathology be known. If we don't tell our administrators, our publics, and the politicians who we are and what we do, who will?

My real job as Chairman is to get this meeting underway. I pronounce the 44th WIFDWC officially open. Let's have a great, and productive, meeting.

Panel - Exotic Forest Diseases

BORYS TKACZ - MODERATOR

Winning the War Against *Phytophthora lateralis*

Everett M. Hansen
Botany and Plant Pathology
Oregon State University

We don't know where *P. lateralis* came from, but since the 1920s it has been killing Port Orford cedars in the Pacific Northwest. Today the pathogen has spread throughout the range of its host with dramatic ecological and economic consequences and losses continue. It has become a touchstone for environmental activism, triggering continuing administrative appeals and lawsuits. It is time for a change.

THE PATHOGEN

Phytophthora ("plant killer") is a genus of plant pathogenic Oomycetes. These are water molds, with swimming zoospores, and thick-walled resting spores, the oospores and chlamydospores. They are unrelated to Fungi. *P. lateralis* is distinguished from other *Phytophthora* species primarily by its pathogenicity to *Chamaecyparis lawsoniana* (and *Taxus brevifolia*). It is well suited to the forests of the cedar region, favoring cool wet spring, fall and winter conditions for growth and reproduction, and surviving the hot, dry summers as thick-walled chlamydospores formed laterally on the hyphae (hence the name "lateralis"). It is carried uphill in roots, dirt and mud especially on vehicles, and washes downhill in running water attacking and killing any POC encountered.

SOME HISTORY

The disease was first reported in 1923 near Seattle in nurseries growing POC for the ornamental trade (Zobel et al. 1985). John Boyce responded from the Portland Office of the Forest Service, recognizing the aggressive nature of the disease and the threat it posed. It was only in 1942, however, that the pathogen was named. Ultimately *P. lateralis* destroyed the multimillion dollar ornamental cedar industry and it continues to spread and kill in the old POC hedgerows and landscape trees along the west coast. In 1952 it was first reported from Coos Bay in the native POC range and within a few years dead cedars were appearing throughout the lowland forests of southwest Oregon. Spread into the mountains was slower, but as logging accelerated in the 1960s and 1970s P. lateralis followed.

To this day, the response of foresters and forest pathologists to the threat has lagged behind the spread of the pathogen. John Boyce was there at the beginning, and John Hunt conducted the first disease surveys in the 1950s, but the PNW Experiment Station has not been otherwise involved. Lew Roth and colleagues at OSU started the research effort, with support from the counties in SW Oregon. Lew recognized that the disease was manageable and began working with Forest Service silviculturalists on the Powers District to devise silvicultural strategies to grow POC safely. I followed Lew in 1975.

In 1976 WIFDWC met in Coos Bay, and Lew Roth led a memorable bus trip on the mountainous roads of the Powers District. The message was clear and positive. Spread of the pathogen would be limited by the steep terrain and limited accessibility in much of the cedar range, and with care and planning cedar could continue to be grown commercially. Forest Service intentions were good at Powers, but were hampered by lack of administrative support and disruptions forced by transfer of key personnel; the effort didn't spread to other Districts. Forest Pest Management pathologists from Portland and San Francisco were increasingly involved in the 1970s and 1980s conducting surveys, disseminating information, and advising on cedar management.

The first substantial, coordinated, and sustained initiative to protect POC was instigated in 1985, not by the Forest Service but by the environmental community. The Oregon Natural Resources Council (ONRC) and the North Coast Environmental Center in California wrote a letter to the Regional Foresters of Regions 5 and 6 outlining the disease

threat and formally requesting that "the Forest Service establish an Inter-Regional Committee composed of agency and citizen members with authority to formulate a comprehensive root rot control policy binding on all Forests where Port-Orford cedar occurs." From this grew the Consensus Group of environmentalists, professors, industry representatives, and Forest Service personnel. A year later a "POC Action Plan" was endorsed by all participants, and forwarded to the Regional Foresters.

This was the beginning of the POC Coordinating Committee with Forest Service representatives from both Regions and from most of the cedar Districts and Forests. A POC czar was appointed to promote and organize the cooperative strategy. An early product was the POC Management Guidelines that spelled out a risk evaluation procedure and listed appropriate mitigation measures to be implemented whenever forest operations threatened cedar resources. The Guidelines were referenced in the Forest Plans either explicitly or by innuendo. Money was allocated to disease control operations and to research in support of the POC effort.

The POC Coordinating Committee started with energy and vision. Today it is gasping for breath. The Forest Service and BLM are continually bombarded with legal challenges and lawsuits. In defending against a recent lawsuit by ONRC and others demanding an Environmental Impact Statement for POC, the Government lawyers in effect repudiated the Coordinating Committee and denied having a "plan" for cedar management. The Government won the suit in District Court (appeal pending) but at what cost?

CURRENT SITUATION

Jim Nielson is Mr. Cedar on the Siskiyou National Forest. He spent his career on the Powers District battling the pathogen and continues in retirement. Jim has produced the first data suggesting that the "rate of increase of dead cedars is slowing." He measured the increase in the area occupied by dead cedars on old and recent aerial photos. In 3 of 4 areas disease increased by about 300% from 1977 to 1986, but by only 50% or so between 1986 and 1992. The forth location was the POC RNA on the South Fork of the Coquille River. In this unroaded area disease increase increased from 49% to 255% between 1977 and 1986 and 1992. Jim is a hopeless optimist but he freely acknowledges what his numbers mean. Most of the most vulnerable cedars are already dead, and there are fewer and fewer new areas where the disease can develop.

The road system in cedar country is largely infested and the disease continues to intensify in these areas. POC regenerates prolifically in disturbed soil, and is especially abundant, and vulnerable, immediately adjacent to roads. I resurveyed three 1/2 mile stretches of Forest Service road surveyed 7 years before by Ellen Goheen and added a forth road on private ground (Roadside Surveys for Port-Orford Cedar Root Disease" Hansen, Wilson, and Zobel. Report to the Forest Service. 14 February 1994). The Forest Service roads were in areas first infested in the 1950s. Cedars are still present along the roads in all areas, but disease continues to slowly increase, and most worrisome, the pathogen is present across the landscape below the roads (Figure 1).

The situation along streams is even more critical. Essentially all POC growing with their roots in contact with normal winter high water flows are killed within a few years of introduction of the pathogen to the stream. Mortality of cedars growing away from the streams depends on elevation above high water, and the frequency and height of flood events. In a 1993 survey of 3 infested streams, mortality of all POC (including seedlings and saplings) growing within 30 feet of winter high water line ranged from 25% to 66% ("Stream Surveys for Port-Orford Cedar Root Disease." Report to the Forest Service. Hansen, 31 December 1993) Mortality of larger trees was even higher (Table 1). The impact of POC mortality on riparian ecology depends on community structure. On serpentine soils, POC may be the only riparian tree species, and its loss has an immediate and drastic effect on stream ecology. Furthermore in the southern part of the POC range most or even all of the POC may be growing in the riparian zone. In the northern part of the range POC grows with a variety of other species, and also grows more abundantly across the landscape away from streams.

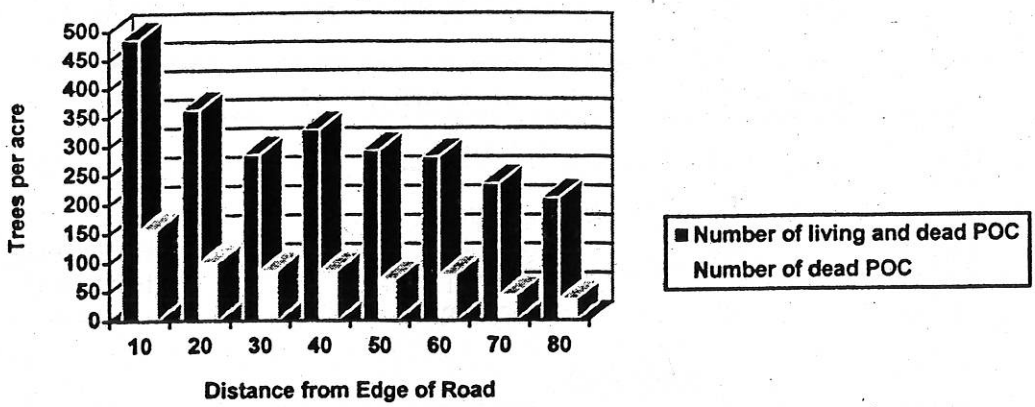

Figure 1. Total stocking of Port-Orford-Cedar (living and dead) and stocking of POC killed by *P. lateralis* by 10 foot intervals downslope from 4 roads in southwest Oregon.

Table 1. Number of pole size and larger POC surveyed and %mortality at intervals along transects from 3 streams on the Gasquet District, Six Rivers National Forest.

	Distance (feet)				
Stream	0	10	20	30	40
Coon Creek	5 (100%)	31 (90%)	16 (56%)	6 (17%)	2 (0%)
Horse Creek	2 (100%)	9 (89%)	13 (62%)	8 (38%)	10 (20%)
Knopke Creek	5 (100%)	15 (53%)	30 (27%)	44 (20%)	24 (25%)

POC is the primary host of *P. lateralis*, but not the only host. Pacific yew is also susceptible, although the pathogen progresses much more slowly and in well drained soils the tree may survive infection (Murray 1995). Along streams where cedar and yew grow together the yew is vulnerable, and mortality is high (Table 2).

Table 2. Live and *Phytophthora lateralis*-killed Port-Orford-cedar and Pacific yew within 9 m of stream centers in three *P. lateralis*-infested drainages in southwest Oregon and northwest California.

	Port-Orford-cedar		Pacific yew	
Size Class	Total	Dead (%)	Total	Dead (%)
		Middle Fork of the Smith River		
≤12 cm DBH	391	50 (13)	324	32 (10)
>12 cm DBH	504	199 (39)	74	13 (18)
Total	895	249 (28)	398	45 (11)
		Coon Creek		
≤12 cm DBH	485	236 (48)	47	15 (32)
>12 cm DBH	344	305 (89)	4	1 (25)
Total	829	541 (65)	51	16 (31)
		Elder Creek		
≤12 cm DBH	421	133 (32)	342	23 (7)
>12 cm DBH	441	276 (62)	46	2 (4)
Total	862	409 (47)	388	25 (6)

REVERSING THE TIDE

The goal of POC management should be to halt and reverse the destruction of cedar, not just slow the rate of *Phytophthora* advance. I believe that it is within our power to do just that. It will require a coordinated, range-wide strategy, but both the ends and the means are supportive of the emerging philosophy of ecosystem management in the northwest and should be enthusiastically and generously supported by the Federal agencies. I see four main elements to a successful program:

1. Identify and give maximum protection to significant disease-free watersheds.

2. Reduce inoculum loads and thus the risk of new infection.

3. Identify, improve, and deploy resistant POC.

4. Constructively engage all interested parties in the effort (Stay out of court).

1. The Forest Service and BLM should take the initiative to identify the remaining uninfected watersheds and protect those that have significant cedar values and are "protectable." Our best disease management efforts remain imperfect and we must do everything possible to ensure that the most valuable areas remain healthy until we get more confidence in our abilities. In most cases Congressional "set-asides" are neither necessary nor appropriate. All-year road closures are the weapon of choice, backed up by other disease mitigation measures in adjacent areas. Success will require a good faith effort from the Agencies and a realistic case-by-case analysis of the value and protectability of each watershed. Some roads are simply too public to close and we will have to hope for the best using less sure measures. There is great opportunity for useful public participation in the identification and analysis of these watersheds.

2. *Phytophthora lateralis* requires very precise conditions for infection and is very sensitive to environmental conditions, especially heat and drying. Indeed, the probability of successful infection is low in any specific instance. But even low probability events become likely given enough opportunity, and opportunity abounds along the numerous roads and streams of the POC region. Cedar is its own worst enemy along roads, growing as a weed

in road berms. A little bit of inoculum carried as mud on a vehicle quickly becomes a lot of inoculum as the roadside cedars are infected and produce more spores. The more the inoculum, the greater the probability of successful spread downslope from the road, and the greater the probability of spreading the pathogen further along the road system during subsequent road use. Probabilities can not be reduced to zero, but removal of weed cedar along roads will go a long way toward reducing the regionwide infection rate and the chances of introduction to new areas.

3. Introduced pathogens succeed in large part because resistance is low in the previously unexposed host population. Building resistance to *P. lateralis* in POC populations must be an integral part of a long-term disease management strategy. No variation in pathogenicity or in any other character, has been identified in *P. lateralis*, although further testing is necessary. The pathogen likely exists as a genetically simple population as a result of initial and recent introduction as one or a few individuals. A continuing program of breeding to incorporate a variety of resistance mechanisms, and careful deployment of resistant stock as it becomes available can ensure that the tree can stay ahead of changing pathogen populations.

Heritable resistance to *P. lateralis* has been identified in POC (Hansen et al. 1989) and individual trees have stood in intimate contact with the pathogen for 15 and more years. We have learned much about screening for resistance and vegetative propagation of POC. Cones can be induced on trees only a few years old through application of growth hormones. Recently a range wide collection of half-sib POC seedlings was tested for resistance. Parent trees had not been exposed to *P. lateralis*--there was no prior selection for resistance. Richard Sniezko from the Dorena Tree Improvement Center calculated family mean resistance heritabilities. They were surprisingly high, 0.21 and 0.91 for stem and root resistance tests, respectively. The family correlation between tests was low, suggesting the possibility of independently inherited resistance mechanisms (Table 3).

Table 3. Heritability of resistance to *Phytophthora lateralis* in a range-wide collection of Port-Orford cedar.

	# of Families	h^2_i	r_{fam}
Stem Test	339	0.21	0.15
Root Test	338	0.91	

4. There are two organized interest groups committed to the protection of Port-Orford cedar: the Forest Service, and the environmental community. How ironic that these two groups are locked into adversarial roles, talking to each other only through lawyers and usually in court. Beating Phytophthora is going to require sustained energy and ideas as well as gates, saws, and tree breeding. Perhaps the time is right to try yet again to let common sense and common interests prevail, to open a constructive dialog among the individuals and groups dedicated to POC. There are many obstacles. The intricacies of NEPA and Federal Advisory Committee law provide fertile ground for those looking only for a reason to say "no". But where there is a constructive common interest, a way can be found. The POC Coordinating Committee can put "environmental concerns" on its next agenda, and invite specific individuals to its meeting to address the topic, as they do now with University researchers. Alternatively, the Coordinating Committee meeting could overlap with a University sponsored public Workshop on the Future of POC. The form is not so important as the opportunity for people to rediscover shared values and civil discourse, and find ways to move beyond their mistrust. A moratorium on lawsuits would certainly make the beginning steps easier.

MORE INFORMATION

Increased protection for significant cedar resources is only prudent in the current situation. A systematic search for protectable areas followed by decisive action will also go a long way toward building trust with environmentalists. An open and pragmatic approach to selection will reduce conflict with other groups. The goal should not be to put all healthy cedar behind gates, but only the most significant and the most critical, and then only where there is a reasonable chance of success.

Reducing inoculum loads along roads is another common sense action. Scattered roads have already been sanitized with incremental benefits but a landscape strategy is needed to really make a difference. Cutting trees to waste is expensive, but cutting big old cedar trees to pay for it is divisive. Salvage of dead cedar may provide money in some cases, but agency funding is necessary if the program is to be regionally effective. The Powers District is again leading in trying to develop a comprehensive approach. Medford District BLM is also designing a landscape scale strategy to reduce risk to POC. A key element of both plans is screening roadside trees for resistance in advance of tree removal and the planned replanting with resistant material on appropriate sites.

The POC resistance program has slowly been building steam. Early results are promising enough to move from "What if?" questions to "Let's do it." The resistance identified to date is not expressed as immunity, but as reduced growth rate of the fungus in infected trees. A few individual trees have withstood infection for years, but in most cases heavy inoculation will overcome the resistance and the tree slowly dies. This level of resistance will not be useful in the most hazardous situations, but coupled with overall reduction in inoculum loads even first generation trees should have a reasonable survival rate in the field.

Screening methods are now reproducible (Table 4) and can be completed in about 4 weeks. And there are resistant trees out there to be found. In an early screening effort the Forest Service identified 200 phenotypically resistant cedars from Oregon and California. These were survivors in locales where most other cedars had been killed. We tested the parents with a branch lesion test and 13 trees showed resistance comparable to the best trees previously identified, and others were completely susceptible. About 100 trees were successfully propagated through cuttings or seed and are now maintained at the Dorena Tree Improvement Center. An outplanting trial was initiated in 1993 with 26 of these families represented. After 3 growing seasons, 50% of the seedlings from the best family survive, compared to 13% for the worst.

Seedlings from twelve of the 200 phenotypically resistant trees were included in both the outplanting test and in the large Common Garden resistance test as controls. These trees were among the best in the larger test, demonstrating the benefits of phenotypic selection in a resistance screening program (Figure 2). The same families (i.e. tree 51005 from Gasquet and its progeny) ranked near the top in all tests (Table 5). Other families (i.e. 510065, 510049) ranked high in either the root based tests, or the stem based tests, but not in both, suggesting different resistance mechanisms.

Screening roadside trees in areas of established infection for resistance was first attempted on the Medford District BLM with very promising results. In an early test (Table 6) a few trees tested as resistant as CF1, the first and still the best OSU selection. It is clear that resistance to *P. lateralis* is more than a hypothetical possibility. Planning should continue for deployment of first generation resistant material in the forest in less than 10 years, and for breeding of POC to improve the level of resistance.

CONCLUSION

None of these 4 elements is new; disconnected efforts are underway on each. Together, however, they begin to look like a hopeful vision for the future of cedar. The Forest Service and more recently the BLM have battled mightily to halt the spread of *Phytophthora* in SW Oregon and Northern California but step by step they lose ground. Environmentalists have fought for cedar in court, and have consistently lost their cases. Seems to me like an opportune time for new strategies all around.

Figure 2. Family mean lesion rates (mm/day) for 340 POC families tested for resistance to *P. lateralis* by root dip and stem dip inoculation. Previously selected control families are marked by "X"

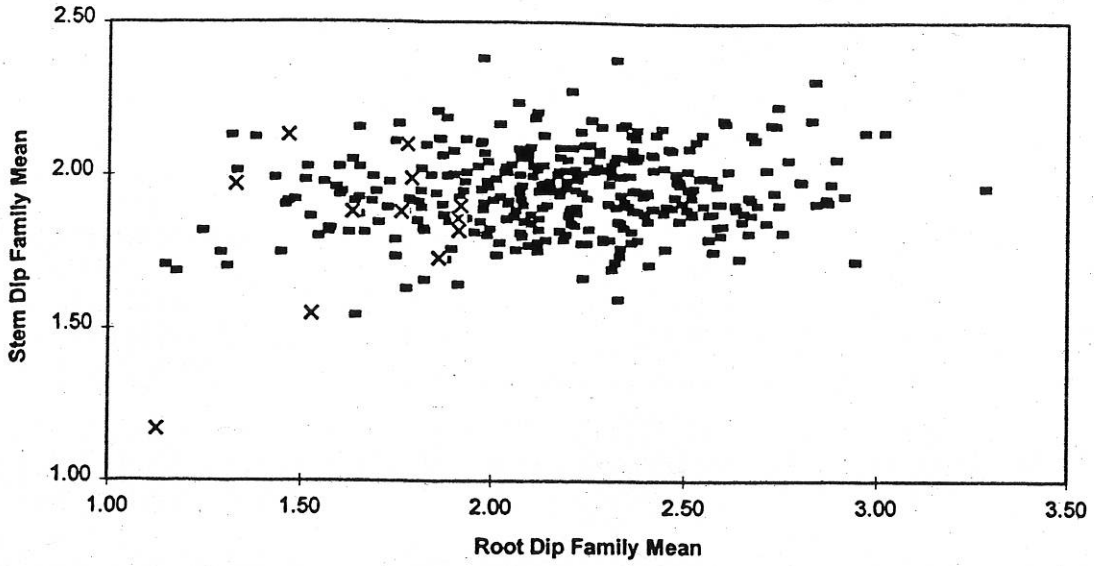

Table 4. Family ranking for 12 families tested for resistance to *P. lateralis* using 4 different tests. The Branch lesion test was on branches removed from the parent tree. Other tests were on seedlings raised from open pollinated seed from the parent tree.

RANK	FIELD SURVIVAL	BRANCH LESION	COMMON ROOT DIP	GARDEN STEM DIP
1	510015	510015	510015	510015
2	118801	510049	510063	118801
3	510065	118801	510065	510016
4	118822	510016	118801	510018
5	510049	118822	118810	118826
6	510063	510065	118822	118810
7	118826	118825	118834	118822
8	118825	118834	118825	510049
9	510016	118826	510016	510065
10	510018	510018	118826	510063
11	118834	118810	510018	118825
12	118810	510063	510049	118834

Table 5. Variability in lesion length by the branch dip method for susceptible and resistant control trees in 6 independent tests.

TEST	RESISTANT CONTROL CF-1 (mm)	SUSCEPTIBLE CONTROL HH (mm)
FOREST SERVICE 200	11.0	54.6
BLM LOW DIVIDE	11.8	63.6
BLM WILLIAMS	10.5	65.4
OSU-Dorena	9.0	50.4
BLM SUGARLOAF	10.0	42.7
BLM GLADE FORK	13.1	50.9

Table 6. Branch lesion test on 10 BLM trees from the North Fork of Silver Creek, Medford District, and 3 OSU trees. 1994.

Tree #	Lesion length (mm)	95% Tukey's
BLM8	21.1	a
BLM9	25.9	ab
OSUCF1	27.6	ab
OSUCF?	28.7	ab
BLM7	31	ab
BLM4	34	abc
BLM6	34.9	abc
BLM5	37.3	abc
BLM10	41.5	abcd
BLM1	47.9	abcd
BLM2	51	bcd
BLM3	62.1	cd
OSUNGH	68.6	d

Pine Pitch Canker in California

Donald R. Owen
California Department of Forestry and Fire Protection
Chairman of the Pine Pitch Canker Task Force

Background

Pine pitch canker (PPC), a disease of pines caused by the fungus *Fusarium subglutinans* f.sp. *pini*, was first discovered in California in 1986 (McCain et al. 1987). An initial survey conducted in 1987 located the disease in 5 counties, primarily in ornamental Monterey pine and centered in the area from Santa Cruz Co. to S. Alameda Co. (Interagency Working Group, 1987). The size of the initial infestation indicates the disease was present in Calif. for a number of years prior to its discovery.

Genetic studies clearly indicate that *F. subglutinans* f.sp. *pini* is not native to California (Correll et al. 1992). It is not known where the causal agent came from or how it entered California, but either Mexico or the Southeastern United States are the closest possible sources.

The disease has spread considerably since its initial discovery. It is now in 17 counties on or near the coast, from San Diego to Mendocino County. Because PPC has only been found near the coast, with its milder, more humid climate, there is speculation that ecological constraints may limit or slow its movement inland. The distribution of the disease and other circumstantial evidence implicate man as an important agent in disease spread. Firewood, logs with bark, nursery stock, x-mas trees, chips, cones, and seeds all are potential sources of inoculum.

Monterey pine, *Pinus radiata*, is highly susceptible to PPC disease. Trees of all sizes can be infected and killed. California's three native stands of Monterey pine were initially free of PPC. Now all three are infested. The impact of PPC on some growers of Monterey pine Christmas trees has been great, particularly in southern California.

Data on 97 mature ornamental Monterey pine at three locations in Santa Cruz Co. monitored by Dave Adams and me from 1987-1992, illustrate the impact of the disease. At the end of this five year period, roughly half of the trees had undergone significant decline due to the combined effects of disease and ensuing bark beetle attack, including 17 trees which died. Conversely, about 20% of the trees showed little evidence of impact from the disease, including eight trees that showed no symptoms of infection whatsoever.

The disease is truly a pest complex. Insects serve as vectors of the fungus, as well as contributors to tree decline and mortality. Bark beetles, family Scolytidae, are principal members of the complex, but other insects may have significant roles. The spread and impact of the disease would likely be quite different were it not for the involvement of insects. Many of the insects involved in the disease on Monterey pine also attack other pine species. A couple attack Douglas-fir.

A series of grants from California Department of Forestry and Fire Protection to the University of California from 1988-93, funded much of the fundamental research on Pine Pitch Canker in California. California Forestry Note No. 110 (Storer et al. 1995) summarizes this and other pitch canker work.

Summary of Concerns

There is no cure or effective preventative treatment for PPC. Eradication is not a viable option; the disease is well established in California. Continuing economic and environmental impacts are inevitable.

As information is gathered on PPC in native stands of Monterey pine, all indications are that the impact of the disease will be significant. Other forest health concerns for these stands include: - advanced age- overstocking
- high levels of native diseases, particularly dwarf mistletoe and western gall rust
- poor regeneration
- urbanization

- fuel buildup and disruption of historical fire regimes

Reduction of genetic and ecological diversity in native Monterey pine stands is perhaps the most significant potential impact of PPC.

Estimates of the total acreage of California's native Monterey pine stands range from 10,000-16,000 (Jones and Stokes Assocs. 1994). Monterey pine is listed as rare and endangered by the California Native Plant Society, is on the California Dept Fish and Game Special Plant List and is a Federal Candidate for endangered species listing and protection (CNPS 1995).

Although Monterey pine as a species is very susceptible to PPC, the apparent resistance of a small proportion of the population provides our best opportunity for combating the disease. A potential threat is the introduction of new strains of the fungus which could diminish or overcome this resistance. Therefore, keeping additional strains of PPC out of California should be a high priority. The current Pest Risk Assessment for importation of pine logs from Mexico will hopefully address this issue.

In addition to Monterey pine, 7 other native pines and Douglas-fir have become naturally infected with PPC and inoculation studies have shown that additional pine spp. are susceptible (Dallara et al. 1995). Bishop pine, which also has experienced mortality in native stands, appears to be second to Monterey pine in susceptibility.

In short, the potential impacts of PPC in California are great. We do not know what the ultimate impacts of this disease will be.

Pine Pitch Canker Task Force

Recognizing that the threat from PPC was growing, The California Forest Pest Council passed a resolution at it's 1994 annual meeting calling for the establishment of "a task force composed of public, private and non-profit sector members to:
1) develop short and long-term management guidelines for Monterey pine forests,
2) define research and management priorities for pine pitch canker,
3) secure support for proposed activities, and
4) allocate resources to implement guidelines and recommendations."

In December of 1994 the Pine Pitch Canker Task Force (TF) held its first meeting. The TF is a subcommittee of the California Forest Pest Council, but more broadly it is a coalition of groups and individuals committed to working on the pine pitch canker problem.

An initial conclusion of the Task Force was that slowing the spread of PPC was the best management strategy available. Although the disease has been found in numerous counties, the distribution is discontinuous with a limited number of "hot spots." PPC appears to move slowly on its own, while humans can spread it very quickly. Therefore, proper recognition, handling, and disposal of diseased material should help prevent the establishment of new infestations and reduce local spread and intensification.

One of the most important products of the Task Force is a comprehensive plan for responding to PPC. During 1995, the TF evaluated the PPC threat and established priority actions in the areas of Management, Research, and Education. These actions are outlined in The Pine Pitch Canker Action Plan (Pine Pitch Canker TF, November 1995). Some important goals are slowing disease spread, predicting future impacts, and employing natural resistance to mitigate the disease. The State Board of Forestry approved the plan in May 1996.
Implementing the Action Plan is probably the greatest challenge for the Task Force. At present the TF per se cannot accept funds, but there are a number of organizations participating in the TF who can. Already some research and management projects specifically identified in the Action Plan have been funded, but a great deal of work still needs to be done. The California Forest Pest Council recently applied for non-profit status and I anticipate the TF will soon be able to apply for grants under this designation.

Task Force Recommendations

Management Priorities

The following **regulatory actions** should be considered as a means of preventing the movement of infected plant material to uninfested areas:
- inspections of nurseries and x-mas tree farms
- requirements to debark logs before transport from infested areas
- development of downed-wood mgmt programs which would accompany tree-removal permits administered by local governments and other agencies
- prohibition on the movement of seed from infested areas.

As an adjunct to regulations, the TF has made a concerted effort to alert forestry and landscape professionals and the public of the need to slow disease spread. Our educational efforts stress disease recognition and proper handling and disposal of diseased material.

Until recently, PPC has mainly affected ornamental Monterey pine. As the disease spreads within the state and affects native trees, economic and environmental impacts will increase. We do not have a good current knowledge of PPC's distribution or its impacts. There is a need to **conduct surveys and establish monitoring plots** to assess the present and future distributions and impacts of PPC. This information would be useful for local or statewide planning efforts, in the evaluation of control efforts, and provide insight into factors influencing spread. The TF also recommends an **economic study** of the impacts of PPC to aid decision makers in developing appropriate programs, policies, and regulations in response to the disease.

There is an urgent need to **incorporate what is known about PPC into landscape, resource management and conservation plans** that are currently being developed for native Monterey pine stands. PPC will undoubtedly become an important factor influencing the future of these stands and perhaps stands of other coastal pine species.

Research priorities

Determine the survival of the pitch canker fungus and its potential insect vectors in chips, dead and live branches, on seed, etc. This information is needed to develop sound recommendations for the removal and disposal of infected and insect-infested material.

Establish permanent plots in the native Monterey pine forest of California to assess the impact of pitch canker on this unique and limited ecosystem. These plots would examine the impact of pitch canker on the genetic diversity of these native forests.

Determine the levels of resistance in native Monterey pine stands to the pitch canker pathogen and its various strains. This research will help predict the impact of the disease on native Monterey pine forests and provide resistant genotypes for future planting both in ornamental and native forests.

Determine if seed transmission of pitch canker occurs for native conifers other than Monterey pine and investigate methods of preventing seed transmission. Seed transmission is a potentially important means of disease spread. Also, disease-free seed may provide a means for preserving the genetic traits of trees lost to pitch canker.

Evaluate the potential for pitch canker to spread beyond its current distribution and impact native mixed-conifer forests. To devise effective strategies for limiting the spread of pitch canker, it is necessary to understand this potential.

Investigate the inheritance of disease resistance in Monterey pine. Although some Monterey pines appear to be resistant to pitch canker, we do not know the nature of this resistance or how it can be best utilized to protect the resource.

Educational Priorities

A variety of educational activities have been implemented or proposed by the TF in order to achieve the following goals:

1. Increase the general public's awareness of Pine Pitch Canker, its importance, current status, potential impacts, biology, etc.

2. Provide management guidelines, disease distribution and research updates, and recognition aids to urban and rural foresters, arborists, nurserymen, Christmas tree growers, and other professionals.

3. Provide information on Pitch Canker's importance to city, county, state and federal representatives and officials.

4. Raise financial and general support for pine pitch canker management and research activities.

Educational accomplishments include:

A database of organizations, government officials and media contacts to which pitch canker information is forwarded.

A bibliography of existing brochures, research papers and other literature on pitch canker and Monterey pine

A Pine Pitch Canker Poster that provides a general overview of disease impacts, distribution, history, identification, etc.

A three-dimensional display on pitch canker put together by the Pacific Grove Natural History Museum

Publications available for general distribution:
Pine Pitch Canker - A Threat to California Pines. 1995. A tri-fold color brochure emphasizing recognition and control.

Current Status of Pitch Canker Disease in California. 1995. A four page technical note covering various topics, including distribution, symptoms, and management

Pitch Canker in California. 1995. A summary of research conducted on pitch canker in Calif.

Press Releases:

Dec. 1995. STATEWIDE TASK FORCE GIVES GUIDELINES FOR CHRISTMAS TREE DISPOSAL TO SAVE CALIFORNIA PINES.

May 1996. CAUTION: PINE FIREWOOD MAY SPREAD TREE DISEASE.

June 1996. LIVING WITH PINES INFECTED WITH PITCH CANKER.

Talks and poster displays have been presented at meetings of the State Board of Forestry, County Agricultural Commissioners, Western Chapter of the International Society of Arboriculture, Pesticide Applicators Professional Association, Society of American Foresters, California Christmas Tree Growers Assoc., County Boards of Supervisors, City Councils, Chambers of Commerce, Community Services Districts, and at County Fairs.

Current educational projects include a pitch canker field tour Oct. 10 and the symposium, "Monterey Pine Forest: A Forest at Risk," Oct. 11 in Carmel, a video on pitch canker, and a TF Web-site.

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Pest Risk Assessment of the Importation of Pine and Fir Logs from Mexico

Gregg A. DeNitto
USDA Forest Service
Forest Pest Management, Shasta-Trinity National Forests
Redding, CA 96001

INTRODUCTION

Interest in the importation of significant amounts of unmanufactured wood products into the United States started around 1990. At that time, there were no specific timber import requirements. A pest risk assessment was completed for the importation of larch from Siberia and the Soviet Far East (USDA 1991). Subsequent to that, two additional assessments for the importation of radiata pine and Douglas-fir from New Zealand (USDA 1992) and radiata pine, coigue, and tepa from Chile (USDA 1993) were completed. Following these assessments, USDA Animal and Plant Health Inspection Services (APHIS) issued regulations on the importation of logs, lumber, and other unmanufactured wood articles (7 CFR Parts 300 and 319) with the intention of eliminating "any significant plant pest risks presented by the importation of logs, lumber, and other unmanufactured wood articles".

In September 1995, the Forest Service chartered the Wood Import Pest Risk Assessment and Mitigation Evaluation Team (WIPRAMET) to provide APHIS a permanent source of technical assistance in conducting pest risk assessments of exotic pests that might be introduced into the United States through the importation of wood and wood products. APHIS requested that the WIPRAMET conduct a pest risk assessment of the importation of unprocessed *Pinus* and *Abies* logs from Mexico in March 1996.

The existing regulations require wood products that originate from the non-adjacent states of Mexico to be debarked and heat-treated to eliminate harmful pests. This is the Universal Importation Option (7 CFR 319.40-6) stated in the regulations. Articles from adjacent states of Mexico can be imported without restriction and are issued a general permit "because most insects and wood pests in these areas are also indigenous to the United States, or will become so through natural migration".

APHIS has received written and verbal intentions to import or requests for permits to import unprocessed logs of at least six *Pinus* spp. and several *Abies* spp. from the Mexican states of Chihuahua (an adjacent state), Durango and Michoacan (non-adjacent states). This information, and additional information from industry and government officials in Mexico, was used to help define the scope of the assessment.

The risk assessment has three specific objectives:

1. Identify the pest organisms that may be introduced with imported unprocessed *Pinus* and *Abies* logs from Mexico.

2. Assess the potential for introduction and establishment in the United States of selected representative Mexican forest pests.

3. Estimate the potential economic and environmental impacts these pests may have on forest resources if established in the United States.

Pest Risk Assessment Process

The pest risk assessment process used conforms with the standards stated in the log importation regulations (7 CFR 319.40-11). This process has been evolving from the three previous log import pest risk assessments and most closely resembles that done for Chile (USDA 1993). This is a four step process as outlined below.

A. Collect commodity information. This step identifies what materials may be imported, their origin, processing, treatment, and handling. In addition, data on the history of pest interceptions or introductions into the United States and other countries associated with the intended import products are evaluated.

B. Catalog quarantine pests. The plant pests and potential plant pests associated with the commodity are determined. These are identified as quarantine pests if they meet one of the following criteria:

1. Non-indigenous plant pest not present in the United States;

2. Native or non-indigenous plant pest, present in the United States but has not reached probable limits of its ecological range and is capable of further dissemination in the United States;

3. Native or non-indigenous plant pest that is present in the United States and has reached probable limits of its ecological range, but differs genetically from the plant pest in the United States in a way that demonstrates a capacity for greater damage potential in the United States;

4. Native or non-indigenous plant pest that is present in the United States, but may differ in its capacity for causing damage, based on the genetic variation exhibited by the species;

5. Native or non-indigenous organism capable of vectoring a plant pest that meets one of the above criteria.

A list of potential quarantine organisms was developed and sent to scientists and specialists in the fields of forestry, forest entomology, forest pathology, and timber industry in the United States, Canada, and Mexico. Contacts were also made with professional organizations, including the American Phytopathological Society, Entomological Society of America, and Society of Nematologists. Suggested revisions to this list are being incorporated into the final list for the risk assessment.

C. Determine which quarantine pests to assess. The quarantine pests are divided into three groups depending on where they are found, either on the bark, in or under the bark, or in the wood. The pests in each of these groups are then evaluated based on available information and known or potential pest importance. Individual pest risk assessments (IPRA) are done for selected quarantine plant pests. Detailed assessments are done for known pests that inhabit each of the above three groups so that effective mitigation measures can be developed by APHIS to eliminate the known organisms and any similar unknown ones that inhabit the same locations.

D. Evaluate risk and assign risk values for each of the following elements for each IPRA.

1. Probability of pest establishment
    a. Pest with host at origin
    b. Entry potential
    c. Colonization potential
    d. Spread potential

2. Consequences of establishment
    a. Economic damage potential
    b. Environmental damage potential
    c. Perceived damage potential

3. Estimate unmitigated pest risk potential. This estimate is developed from the compilation of risk values for the above seven elements.

Site Visit

Five members of WIPRAMET visited Mexico for two weeks in mid-July 1996. Much of the time was spent in close collaboration with representatives of Sanidad Forestal and the University at Chapingo. In addition, we met with representatives of SEMARNAP, INIFAP (the Mexican government research branch), industry, and landowners at various locations.

Our focus was on the three areas most likely to be producers of export logs to the United States. This included central Mexico (states of Michoacan and Jalisco), areas around Durango and Oaxaca, and the port city of Manzanillo. In each of these areas we discussed local forestry issues and practices, and saw firsthand forest stands, sawmills, and log yards.

In general, the stands we observed were healthy and had few significant problems. A number of insects and pathogens were seen as was expected. The major problem they have is bark beetles in pines. Several species of *Dendroctonus* infest stands and trees in most of the country. It appears that stand and site conditions that create tree stress are important in initiating these infestations. Trunk decays were also commonly observed in log yards. Both white and brown rots were seen in pine logs. *Lentinus lepideus* was commonly fruiting from brown cubical rot columns on the ends of logs. The white rot appeared to be mainly because of *Phellinus pini.* Although not many *Abies* logs were seen, we did see what we thought was decay from *Heterobasidion annosum* infection. The insects present in logs included *Ips* spp., *Dendroctonus* spp., and *Gnathotrichus* spp.

SUMMARY

A pest risk assessment is being compiled by the WIPRAMET and will be issued to specialists for review and comment before submission to APHIS. This assessment will evaluate the biological risk potential of exotic pest introductions to the United States on logs from Mexico. Economic, ecological, and political consequences are being examined. The risk assessment is being developed without regard to available mitigation measures. Once the risks are identified, suitable mitigation measures may be formulated by APHIS to reduce the possibility that destructive pests will be introduced.

Identified quarantine pests are being assessed, partly based on the availability of biological information. The lack of biological information on any insect or pathogen should not be equated with low risk. By necessity, pest risk assessments focus on those organisms for which biological information is available. By developing detailed assessments for known pests that inhabit a variety of different locations on imported logs, effective mitigation measures can be developed to eliminate the known organisms and any similar unknown ones that inhabit the same niches.

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Sending Pathogens Abroad: Advising the People's Republic of China on Risks Associated with Importing Logs from the Pacific Northwest

Ellen Michaels Goheen
Southwest Oregon Forest Insect and Disease Technical Center
Central Point, Oregon

During April of 1995 Andy Eglitis, Entomologist, Central Oregon Area Office, Forest Insects and Diseases, and I visited the People's Republic of China (PRC) as consultants to the Forest Protection branch, Forest Resources Division, Food and Agriculture Organization of the United Nations. The purpose of our visit was to provide training to personnel of the Ministries of Forestry and Agriculture in the recognition and management of potential insects and pathogens associated with imported logs.

Background

In order to meet their needs for wood products, the People's Republic of China is currently importing wood from other countries in the Pacific Rim. A large portion of this imported wood arrives in China as unprocessed logs with bark intact.

During March 1991, living specimens of two insects, the Douglas-fir beetle, *Dendroctonus pseudotsugae* and the flat-headed fir borer, *Melanophila drummondi* were found on Douglas-fir logs in Anhui Province. These logs were imported from the United States for construction of a Buddhist temple and had been deposited along a road in a forested area in the Jiuhua Mountain region. Douglas-fir beetle is one of the most destructive insect pests of *Pseudotsuga* in North America. Its introduction into the People's Republic of China could threaten populations of the two native species of *Pseudotsuga*

The accidental introduction of destructive forest insects and diseases can be minimized through inspection of logs and other wood products at ports of entry and through the use of techniques such as fumigation to destroy pest populations. It is critical that plant inspection officers at ports of entry be capable of recognizing potential pests and evidence of infestations, and of taking appropriate action to prevent their establishment and spread.

The objective of our work was to train plant quarantine officers and foresters in recognizing potential insect and disease pests in logs imported into China, especially in logs imported from western North America. This would strengthen their national capacity to conduct monitoring and inspection and minimize potential of introductions of harmful insects and pathogens.

Training material prepared prior to our consultation included: 1) Overviews of the biologies of insects and pathogens associated with logs. Pathogens I covered included stem decay fungi, canker fungi, root disease fungi, wood inhabiting nematodes, and staining fungi. 2) Biologies of specific insects and pathogens likely to be associated with conifer logs from the northwestern United States. 3) Information on insects and pathogens likely to be associated with Monterey pine logs from Chile and New Zealand. 4) Coverage of organisms of potential concern to People's Republic of China. 5) Detailed information the Pest Risk Assessment process.

Prior to conducting the training, we spent two weeks traveling in China with hosts from the Ministry of Forestry. The study tour was designed to provide us with a better understanding of forest and port resources and conditions to increase the relevance of our lecture material and to provide a basis for recommendations. Our time was spent predominantly on the south central China Coast, near Shanghai, Hangzhou, and Ningbo.

We were particularly interested in: 1) Characterizing the forest resource in the People's Republic of China, both native and exotic species; 2) Research capabilities on forest pests within PRC; 3) Quarantine capabilities and procedures within PRC; 4) Taxonomic and diagnostic support for quarantine personnel; 5) Forest pest management capabilities within PRC; 6) Forest pests of greatest concern, both presently and for the future.

The native forests in China contain a wide variety of genera, many of which are common to North America as well (*Larix, Picea, Pseudotsuga, Abies, Pinus*). Most of the forests with native vegetation are remote and do not contribute significantly at this time to the country's needs for wood fiber.

The People's Republic of China has had an aggressive program of reforestation since the early 1950's. When the emphasis on forestry began at that time, China had little native forest remaining The most important species currently being planted include Masson pine (*Pinus massoniana*), Japanese black pine (*P. thunbergii*), slash pine (*P. elliottii*), China fir (*Cunninghamia lanceolata*), mou bamboo (*Phyllostachys pubescens*), tea-oil tree (*Camellia oleifera*), locust (*Robinia pseudoacacia*), and various poplars (*Populus* spp.).

Plantations near the southeast coast of China commonly consist of mixtures of pines (*P. massoniana, P. thunbergii,* and P. *elliottii*) together with China fir (*C. lanceolata*). In this part of the country, the growth rates of pines appear to be very good, with China fir growing almost as well. The future of forestry in the PRC will emphasize the establishment of fast-growing, high yield plantations rather than harvesting from natural forests.

Research on forest pests is conducted by the Research Institute of Forest Protection within the Chinese Academy of Forestry, centralized in Beijing. The Research Institute in Beijing currently investigates both native and exotic forest pests. Some native pests currently receiving attention include the pine caterpillar, (*Dendrolimus punctatus)*; gypsy moth, *(Lymantria dispar)*; poplar canker, Chinese hemlock adelgid, and diseases of *Paulownia.* Key areas of research include biological controls, applications of remote sensing, and development of forecasting models. Forest Research Institutes also operate at the provincial level, where studies are conducted on pests of local importance.

The pest quarantine responsibility within the People's Republic of China resides in the Ministry of Agriculture. Quarantine centers are found at the provincial and prefecture level. Counties have quarantine stations, which serve as checkpoints for pest quarantine purposes. There are 7,000 people involved in the quarantine function

The largest port facility for receiving logs is located in Shanghai. Logs have been brought into China through Shanghai for the past 20 years, and the facility managers believe that they have adequate resources to conduct inspection of imported material as it arrives. In 1995, most of the logs imported into China were from North America and Russia, with small amounts from New Zealand and Chile. Other important sources of logs include Burma and Malaysia.

We were told that inspections of logs are carried out aboard ship before the logs are unloaded. If insects are detected, fumigation of logs aboard ship is required. The logs may be inspected once again after unloading and are treated if necessary, either by fumigation or by placing them in the water. Infested logs may remain in water storage for several months before being released. Approximately half of the logs received in Shanghai are kept in water storage for up to six months. When logs are inspected and believed to be free of pests, they are moved rather quickly through the port. Most commonly, the inspected logs are transported upriver by barge.

Generally, quarantine stations rely on their own internal diagnostic collections for the identification of insects associated with logs. In terms of diagnostic support, there appears to be greater capability to deal with insects than with pathogens. Some taxonomic expertise exists in the Chinese Academy of Forestry. However, most of the systematists in the Academy specialize in groups not likely to be associated with raw logs.

In Shanghai, the diagnostic collection for insects was fairly impressive although it appeared to consist mostly of specimens intercepted at the port. Emphasis is mostly on the order Coleoptera (bark beetles, ambrosia beetles, and wood borers), since this group comprises the bulk of insects most likely to be found in association with raw logs. The pathology lab in Shanghai Port is staffed with 10 people, some of them specializing in mycology. Additional taxonomic support for the inspection effort can be provided by several institutions. These include the Shanghai Entomological Institute, the Science Academy at Guangzhoû, and the Beijing Mycological Institute.

The Ministry of Forestry manages the forest resources in the People's Republic of China. The major activities in the Ministry include various aspects of forest protection such as fire prevention, insects and diseases, and reduction of illegal harvesting. The Department of Wildlife and Plant Protection within the Ministry is the primary agency

responsible for management of forest pests. This work is done through the Division of Forest Pest and Disease Control. Each province within the People's Republic of China has a station for pest control, contained within the provincial Forestry Bureau. These stations serve as centers for reporting and forecasting of pests within the province. A similar organization is found at the prefecture and county level as well.

There are two important aspects of China's forest resource which must be considered in evaluating forest pests for the future. First, the wide variety of tree genera in native forests means that a broad array of organisms could potentially find suitable hosts in China's forests. Second, the heavy reliance on *Pinus* for plantations particularly in monoculture, may mean that certain pests, if established, could affect very large areas.

Much attention is currently focused on the pinewood nematode (*Bursaphelenchus xylophilus).* It is considered a very important pest of pine. The nematode was first detected in Nanjing City in 1982. It has spread rapidly and now also occurs in Anhui, Jiangsu, Zhejiang, Guangdong and Shandong provinces, Ningbo Area, and Shanghai. The primary hosts are *P. massoniana* and *P. thunbergii.* Large groups of trees are killed each year as the nematode continues to expand its range. No effective control exists at this time for the pinewood nematode. Current methods of dealing with the nematode include surveillance for early detection of new infestations and the harvest of all infected trees. The wood is removed, piled, and fumigated with methyl bromide to kill the wood borer larvae inside.

The pine caterpillar, *Dendrolimus punctatus,* is also considered very important. It defoliates large areas of plantations each year, sometimes affecting several million hectares in one season. Work related to this insect includes the development of predictive models to determine timing and need for control, and research on several biological control agents.

Scale insects are considered problems in the pine plantations of Guangdong Province and other areas in southern China. These insects have recently been introduced from other countries and as such, have no effective natural control agents in China.

Pests of hardwoods include wood borers (*Saperda populnea*) in poplar and a mycoplasma-like organism which affects Paulownia sp. Bamboo (*P. pubescens*) also suffers from a number of pests including an unknown fungus that causes a top dieback and several insects (*Algedonia coclesaris* and *Ceracris kiangsu).*

Organisms which could be of concern in the future include those associated with the genus *Pinus.* These include the engravers *Ips* spp., from North America and Australia, and the wood wasp *Sirex noctilio* from the southern hemisphere.

Many of the forest insects on the quarantine list for People's Republic of China are bark beetles and termites from Southeast Asia. The list also includes assorted bark and wood-infesting insects from the United States. Beetles such as *Dendroctonus brevicomis* and *D. ponderosae* are included on the list, primarily because they are important pests in North America, not because their potential importance to resources of China has been established.
Results and Conclusions

The training session was attended by 64 people representing the Ministry of Agriculture's pest quarantine function, and the forest pest management function in the Ministry of Forestry. Our students were attentive and interested. We encouraged class discussion during our lecture time and as the students became more at ease with us, lively discussion often took place.

We made the following recommendations to the People's Republic of China. These recommendations relate to various aspects of protecting the country's forest resource from potential exotic pests associated with imported logs.

Conduct periodic surveys of forests for suspicious symptoms, especially in those areas where foreign logs have already been taken.

The travel routes and destinations of foreign logs should be closely inspected to determine if damage from exotic organisms has occurred. Prompt identification of infection centers would still provide the opportunity for eradication of an introduced pest; an opportunity which would soon disappear as time goes on and infection centers expand. Forests along travel routes should be monitored in the fall when fresh tree mortality would be most apparent. In particular, forests of native *Pseudotsuga* should be examined closely for organisms such as *Dendroctonus pseudotsugae* which may have become established from past log imports. A specific survey for this organism could be aided by the use of the insect pheromone deployed through a trapping system.

Revise the quarantine list of forest pests to reflect organisms potentially important to the People's Republic of China

Many of the insects and pathogens on the current list of quarantine organisms for PRC are only listed because they are important within the country of origin. Since the quarantine list provides the basis for inspection efforts, this list should be made as carefully as possible so that appropriate diagnostic tools can be developed to aid inspectors, and so that no effort is wasted searching for organisms with little or no likelihood of being encountered or of being significant to the forest resource. The foundation for the updated quarantine list must be the forest resources of China. The foreign organisms affecting these hosts would then be evaluated for placement on the quarantine list.

Follow the Pest Risk Assessment methodology described in the training session to assess the potential for introductions of organisms from the USA, Chile, New Zealand, and other countries with which China deals for logs (e.g., Malaysia, Burma)

It is important that PRC carry out a risk assessment to identify organisms of potential concern which currently do not occur in the country but which could be introduced through the importation of logs. Those organisms identified as non-indigenous to China should be evaluated for their pest potential based on a combination of the existing literature and expert opinion, and appropriate protocols could be developed for inspection and treatment of infested material to prevent unwanted introductions of these organisms into the country.

Evaluate alternative tree species to plant in environments affected by pinewood nematode.

Pinus massoniana appears to be extremely susceptible to the pinewood nematode despite being planted on sites which produce vigorous growth. The dangers of monoculture, from a pest standpoint, are very well-documented throughout the world, and are now confronting PRC by virtue of the country having committed vast areas to plantations of *P. massoniana exclusively*. If China is to continue to depend on exotic species for wood fiber, then a strong commitment should be made to test seed sources of other tree species from similar climates in the world. The diversification of species will provide a safeguard not only against the pinewood nematode, but against other introduced organisms which could otherwise devastate a resource founded on one or few closely related tree species.

Carry out studies to determine the efficacy of water soaking as a means of controlling organisms found in logs.

This method is commonly used now in China for treating logs obviously infested with bark or wood-inhabiting beetles. Logs are kept in water storage for up to six months and then released to the marketplace. Studies should address the time period required for control, the completeness of the control, and the variety of organisms that can be controlled this way. Along these lines, it was also recommended that logs be debarked, either manually or mechanically prior to water treatment, when they are found to be infested.

Develop a strong program of international cooperation where Chinese experts are able to visit other countries and exchange information on managing forest pests.

Many countries are facing similar challenges to their forest resources and as such, many different approaches have been developed globally to deal with exotic pest problems. Countries such as Chile and New Zealand have developed rigid quarantine procedures to limit the introduction of exotic organisms. Other countries have been managing resident populations of insects and pathogens which could find their way into PRC. Exchanges with these countries could lead to great benefits for PRC for accumulating state-of-the-art knowledge on the assorted organisms and their management.

Panel - Forest Fungi

WILLIS LITTKE - MODERATOR

Introduction:

Willis Littke
Weyerhaeuser Forestry Research
Centralia, WA

Today's special panel on forest fungi will present several new perspectives for WIFDWC participants. Normally, we are concerned with the biology, epidemiology and pathology of various fungal groups. As such, we work with relatively few of the 4,000-odd fungal species thought to be present in the PNW.

Until recently (last decade or so), interest in edible forest mushroom harvesting was left to local communities, and then mostly for personal use. The recent interest in Chanterelle and Matsutake harvesting has taken on the scale reminding one of the "gold-rush" days. However, with this increased commercialization of forest fungi has come renewed calls for more research to determine if it harms longer-term forest health?, is it sustainable?, what management prescriptions are needed to perpetuate the activity? Revolving around this are questions of conservation of forest fungi and the role these species play in long-term forest productivity and succession.

The following three presentations will illustrate some new approaches to the study of forest fungi. Each paper will present new learning's and challenges to the researchers in this group and should serve to stimulate further discussion.

Recent publications by Randy Molina, Dave Pilz and others (1993, 1996) are just two examples of this new perspectives in forest mycology.

Molina, R.,T. O'Dell, D. Luoma, M. Amaranthus, M. Castellano, and K. Russell. 1993. Biology, Ecology and Social Aspects of Wild Edible Mushrooms in the Forests of the PNW: A Preface to Managing Commercial Harvest. USDA Forest Service Publication PNW-GTR-309. 42 pages.

Pilz, D. And R. Molina (Editors). 1996. Managing Forest Ecosystems to Conserve Fungus Diversity and Sustain Wild Mushroom Harvests. USDA Forest Service Publication PNW-GTR-371. 104 pages.

Man and the Biosphere Research Project: Biological Component of an Integrated Study on the Biological, Socio-economic, and Managerial Aspects of Chanterelle Harvesting on the Olympic Peninsula.

David Pilz
Botanist, Harvested Forest Fungi
Pacific Northwest Research Station
Corvallis, OR 97331

Over the last decade, commercial harvesting of wild edible forest fungi has increased dramatically in the Pacific Northwest. Much of this harvest has occurred on federal forests that have extensive appropriate habitat, but many other forest landowners have also experienced interest in harvesting mushrooms from their lands. The Mycology Team at the PNW Research Station instituted a research program in the early 1990's to broaden our understanding of this resource, especially its abundance and the sustainability of harvesting. From the beginning it was recognized that the harvest of edible forest mushrooms entailed unique and fascinating social and economic dimensions that were important to developing appropriate means of managing this resource. This recognition lead to involvement of the Forest Mycology Team with the Man and the Biosphere Project because the framework for this research program emphasized a multi-disciplinary approach and interpreting results from varied managerial perspectives.

Objectives for the biological component of this study included:

- Pilot testing of sampling procedures (long narrow plots)
- Estimations of biological productivity (weight and numbers per unit area of habitat)
- Sampling a variety of habitats around the Olympic Peninsula
- Correlating fruiting with temperatures and moisture
- Determining typical moisture contents of chanterelles
- Estimating proportions of quality grades collected during field visits

The MAB chanterelle research project is unique not only in its multi-disciplinary approach but also in its range of cooperating land owners and organizations. The chart below lists field site locations, the landowners, and field personnel used for sampling.

Site(s)	Landowner	Field Personnel
Soleduck and Heart of the Hills	Olympic National Park	Puget Sound Mycological Society volunteers
Quinalt Ranger District (Three Sites)	Olympic National Forest	Local volunteers
Clallam Bay (Two Sites)	Washington Department of Natural Resources	Puget Sound Mycological Society volunteers
Shelton	Simpson Timber Co.	Washington DNR employee
East of Aberdeen (Three Sites)	Weyerhaeuser Co.	Weyerhaeuser employees

Site selection included the following criteria for forest types and stand age classes.

Forest Types Sampled	Age Classes Sampled
Coastal (Hemlock zone) moist forest	Young stands (~ 25 years of age)
Interior (Douglas-fir zone) drier forest	Harvestable stands (~ 50 years of age
	Mature stands (80-100 years of age)

We sampled eleven sites using elongated rectangular plots 8 meters wide by 100 meters long. Five such plots per site yielded a total sample area of 4000 m^2 or about one acre per site. Our field personnel sampled each site once every three weeks during the fruiting season (generally August through November). On all sites except the Olympic National Park, chanterelles were picked, sorted by grade, counted and weighed. Sub-samples were weighed before and after drying to determine moisture content.

On the Olympic National Park (where managers preferred that we not pick the mushrooms) we counted chanterelles and measured their cap diameters. Mushrooms collected off the transects were measured and weighed to develop correlations between size and weight. These regression equations were used to estimate the weight of the chanterelles left in our transects from the measurements of their cap sizes.

During each site visit, we measured soil temperatures, then estimated the wetness of the forest vegetation and soils using an artificial scale with descriptors.

Results are still being analyzed and will be published soon. Some of the highlights include:

- A large range in productivity was observed among sites in both 1994 & 1995
- 1994 production averaged better than 1995
- The harvest-aged Shelton site had by far the highest productivity
- We detected no significant differences among forest types or stand age with our limited survey
- Cap measurements worked well for estimating weights
- Moisture contents ranged from 75% to 95%, with an average of 88%
- We found no correlations between productivity and temperature or moisture data
- An acre (or more) must be sampled for reasonable estimates
- Sampling protocols are being revised; recommendations will be forth-coming

Future analyses will likely include comparisons of the value of timber and mushrooms on a given unit of land, and exploration of management options for producing and enhancing the value of both. We also will ask forest managers to interpret our research results from the perspective of their organization's land management objectives. Finally, we hope to provide preliminary estimates of the value of chanterelle harvesting to the regional economy.

Survey and Manage Fungi in the Northwest Forest Plan: New Challenges in Conservation Biology

Randy Molina
Team Leader, Forest Mycology
Pacific Northwest Research Station
Forestry Sciences Laboratory, Corvallis, OR 97331

A challenge within the FEMAT (USDA 1994a) process was protecting biological diversity for all species within the master plan for protecting the northern spotted owl. Protecting all species and their ecological functions is indeed a primary tenet of the new paradigm of ecosystem management. Taxa specialist panels were convened to examine mammals, amphibians, fungi, lichens, bryophytes, vascular plants, mollusks, and arthropods with the task of listing rare taxa within the range of the northern spotted owl and taxa that required late successional forest habitat. These taxa were then run through risk assessment screens in conjunction with the various options being considered for implementation. Under option 9, the risk assessment yielded 409 species and 4 arthropod communities whose viability failed to be protected. The Survey and Manage (S & M) guidelines were then developed as part of the Record of Decision (ROD) (USDA 1994b) and serve as the basic structure for ensuring the viability of these rare taxa.

The Survey and Manage guidelines were organized around four strategies, each of which had different objectives for protecting species viability and gaining new information for use in adaptive management. The taxa were placed into these various strategies in the C-3 list (pages C49-C61, ROD). The four strategies and their relevance to fungi are described below.

Strategy 1 - Manage known sites

Taxa in this category receive the highest priority for protection. The strategy calls for gathering information on all extant sites, developing a GIS data base for all species and using this information for preparing management recommendations. Management activities implemented in 1995 and later must include provisions for these known sites. In most cases this will involve protection of relatively small sites. "For rare and endemic fungus species, areas of 160 acres should be temporarily withdrawn from ground-disturbing activities around known sites until those sites can be thoroughly surveyed and site-specific measures prescribed. For one fungus species, *Oxyporus nobilissimus*, there are only six known sites and two of these do not currently have protected status. Management areas of all usable habitat up to 600 acres are to be established around these two sites for the protection of those populations until the sites can be thoroughly surveyed and site-specific measures prescribed. The actions to protect *Oxyporus* must be undertaken immediately" (ROD, page C-5). There are 147 fungal species listed under strategy 1.

Strategy 2 - Survey prior to ground-disturbing activities

This strategy was designed to address the high-risk species for which survey protocols exist or could be developed reasonably soon, and for which adequate searches could be conducted in a single year. Efforts to design protocols and implement surveys would be started immediately. The information gained from the surveys would be used to develop management strategies for species protection. For fungi, these surveys must be completed prior to ground disturbing activities that will be implemented in 1999 or later. Only two fungal species are listed under strategy 1, one being *Oxyporus nobilissimus*.

Strategy 3 - Extensive surveys

The objective of this strategy is to conduct surveys to find high-priority sites for species management. "It is recommended primarily for species whose characteristics make site and time-specific surveys difficult. For example, some fungi only produce fruiting bodies under specific climatic conditions, so finding their location may take several to many years" (ROD, page C5-C6). Surveys under this strategy must be underway by 1996. These surveys are likely to take several years to complete and to identify high priority sites for protection. All strategy 1

fungal taxa are also listed under strategy 3; 87 additional fungal species are also designated as strategy 3 species for a total of 234 species this strategy.

Strategy 4 - General regional surveys

The objective is to survey for the species to acquire additional information to determine necessary levels of protection. Although these species were not considered rare, there was only limited information regarding their abundance and distribution. The information gathered from these surveys would be used in adaptive management to refine the guidelines to better protect these species. These surveys were expected to be both extensive and expensive. They must begin in 1996 and be completed within 10 years. There are 20 fungal species listed in this strategy.

Current Work in Progress

A primary task in implementing the S & M guidelines was to gather all available information on extant collections of strategy 1 taxa. For fungi, collection records and ecological information were obtained from several mycological herbaria, literature searches, and from field botanists throughout the Pacific Northwest; approximately 1800 collections were discovered and reverified. These are now in a GIS database and available to the field. The database is managed and updated at the Regional Ecosystem Office.

From the known site data base and literature searches, full management recommendations were drafted for use by field personnel. The management recommendations include information on species descriptions, nomenclature, known sites and geographic range, ecology, reproductive biology, habitat requirements, impacts of past disturbances, specific recommendations to maintain species presence at known sites, and research and monitoring needs. These documents will undergo formal scientific and managerial reviews prior to final publication.

Future Directions and Challenges

Designing efficient survey protocols and conducting the extensive surveys called for under strategies 3 and 4 remain the greatest challenges in implementing the S & M guidelines. As part of a national effort to develop inventory and monitoring protocols for all fungal groups, Michael Castellano and Thomas O'Dell, members of the PNW's Forest Mycology Team at Corvallis, have written chapters on epigeous and sequestrate fungi. These chapters will be published in an upcoming book on international mycological survey protocols by the Smithsonian Institute and will serve as the foundation for developing specific regional protocols for S & M fungi.

A high priority is determining which S & M fungal species are at highest risk and so should be surveyed immediately. Another priority is to build simple habitat based models that will guide decisions on where to conduct surveys. For most known site records, little site specific habitat information was recorded. Revisiting known sites to determine whether the taxon is still present (many of the known sites have been disturbed since the original collections) and to gather specific habitat information are urgent tasks requisite to building habitat models.

Complimentary mycological research is needed in two new areas for building a comprehensive conservation strategy for fungi. First, because the overall goal is protecting species viability, we must develop an understanding of population dynamics for forest fungi. This includes information on geographic distribution, genetic structure, dispersal capabilities, reproductive biology, and habitat fragmentation effects on population structure. Population biology is poorly understood for fungi in general, largely because of the difficulty in defining what is an individual and how individuals interact genetically to yield distinct populations. Many traditional approaches for defining and measuring populations used for plants and animals simply do not work for fungi. This research will require use of both field biological sampling and molecular genetic approaches.
A second important research need is habitat modeling at the landscape and regional scale. Given the large number of S & M fungal species, it will be very difficult to assess viability for all species across the range of the northern spotted owl. Also, because known sites occur on a variety of public and private land holdings, it will be necessary to integrate how all available habitat will contribute to maintaining species viability. To do so will require development of predictive GIS and statistical models that examine the current and future forest conditions that will

affect fungal species persistence. The end product would be a working model that resource managers could use to examine how management practices on their land base will affect viability of S & M species. This effort will take considerable effort between mycologists, statisticians and land managers to develop a usable habitat model for decision making.

Two conditions are necessary for the long-term success of Survey and Manage strategies. First, communication and coordination with field units are needed to develop management recommendations and survey protocols that are attainable and efficient. Field managers are key members in the adaptive management process. They must be involved in gathering new information from the surveys and in deciding how best to use the information to refine management strategies. Second, monitoring the results of our recommendations and management decisions is essential to determining species viability. These monitoring efforts must be carefully coordinated with other Northwest Forest Plan effectiveness monitoring activities across the region.

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Olympic Peninsula Man and the Biosphere Mushroom Project: Ethnographic Methodology and Results

Thomas Love
Dept. Anthropology
Linfield College
McMinville, OR
and
Eric Jones
Univ. Mass/Amherst

(This overview presented and abstracted for Dr. Love and E. Jones by Will Littke at Hood River, OR September 1996)

The following overview of the 1st year study results will provide insight to the methods used in the sociological part of the MAB project. A more comprehensive report will be forthcoming in the final document.

Qualitative Research Methods: A major part of the field work was conducted using interviews and observations of people involved in the harvesting of Chanterelles. In these ethnographic interviews, the researcher is directing in a formal way a question-answer process to drive out certain facts. Prior to doing any interviews, all methods and questionnaires had to be previously reviewed by the Human Subjects Committee (Linfield College). All informant information throughout the project was considered strictly confidential.

This methodology provided a broad profile of Chanterelle harvesters, their behavior, attitudes and relationships to other pickers. Through 1995, some 800+ hours of interviews were conducted, consisting of formal and informal interviews:

Formal Interviews #	Additional Interviews #
Harvesters 22(55)	Buyers non-special forest products 7
Buyers SFP 4 (18)	Native Americans 8
Law Officers 2(7)	Land Managers 8
	Scientists 8
	Misc. 6

Sample questionnaires listed some of the following: A small sample of the questions asked for a buyer are shown below.

* How long buying specialized forest products?
* What areas, seasons and products do you work?
* What % of your yearly income is derived from SFP, and mushroom harvests?
* What buyers or markets do you supply?
* What type of interactions have you had with other pickers, buyers, land managers and law officers?
* What % of your customers are local, exclusive and why?
* What motivates you to do this work?
* How should mushroom harvesting be regulated, permitted, etc.?
* What improvements needed?

A more in-depth set of questionnaires can be found in the final published report due in November 1996.

In addition, other methods of information gathering were tried. A written survey was distributed to mycological clubs for members who pick on the Olympic peninsula. To date, 272 forms sent out with 49 returned (18% response). Survey forms left in USFS offices for pickers signing up for permits did not result in much of a voluntary response. Publication of information requests in local senior citizen newsletters were tried to elicit long-term information on mushroom harvest practices. And lastly, notices placed in five high school papers resulted in a 35% response; some 80% of these indicating that mushroom harvesting was done for fun.

Although the complete data set has yet to be analyzed, some preliminary results can be drawn.. Let's cover the non-commercial elements of the study first.

The data shows that on the Olympic Peninsula of Washington State, the non-commercial volume of Chanterelle harvest is less than the commercial volume. The strong non-commercial interest is seen in the amateur mycologist and Caucasian pioneer families. Pioneer community use is mainly for eating, canning, and drying. Many harvesters cite "being in the woods" is the most important part of the mushroom hunting experience. Chanterelle's make up the bulk of the harvest. There is a general sense that non-commercial values are being displaced and overlooked by commercial harvest interests.

The culture of the commercial harvest community is difficult to penetrate without expending the effort to become acquainted with pickers and buyers. This has required spending time camping, eating, and getting to know and being introduced to people involved in the harvest. Patience and flexibility of schedule and mobility are essential to break into the commercial harvest culture.

Some of the early findings show, that harvesters would like lower permit prices and to self-administrate picking areas. Weekend periods are the busiest with the largest mushroom harvest volumes. Few pickers carry weapons, feel unsafe in the woods, or have negative confrontations with others.

Although the MAB project covered the Peninsula down to Aberdeen, Washington, much of the ethnographic data centered on areas of current picking/buying intensity. The Hoodsport region is mostly private forest land, while Quilcene, Quinalt, and Soleduck regions are representative of mostly public forest lands. Land closure and gating are increasing competition for mushroom patches; more opportunistic harvesting and less patch stewardship being practiced. Circuit picking, is declining due to the regulatory hoops, gating, and increased harvest pressure. Timber harvest is cited as practice which results in loss of picking lands and destruction of known patches.

Pickers average about $25/day and in peak times can make $50-$100/day. Matsutake mushroom command a higher value but are pursued by a more knowledgeable minority. Most harvesters eat a portion of the daily catch. The mix of harvesters is composed of roughly 50% local and non-locals. Most of the income generated stays in the local communities. Pickers tend to represent the poverty to lower middle class incomes.

Picking strategies vary, but most people harvest in older second growth (40-60+ years old), some in young (20-39 years) and old growth (100+ years). Picking is mostly concentrated on known patches, with a small portion of time spent in search of new patches. Harvesters are secretive about patch locations for economic stability reasons. Most pickers practice some crude patch stewardship, such as; stomping or throwing bad mushrooms back into forests, returning trimmings to forests, or experiment with other ways to increase productivity.

Mushroom harvesting is a ethnically diverse. Major stakeholders include; Caucasians, Cambodian, Laotians, Mexican and Guatemalan Hispanics, and other Asian language groups. The largest recent increase in numbers of pickers has taken place in the Hispanic groups.

These results presented here represent only the tip of the iceberg of the ethnographic study within the MAB project. Please feel free to contact the MAB group for a final project report.

Special Papers

RONA STURROCK - MODERATOR

Incidence of Armillaria Species in Precommercial Thinning Stumps and Spread of *A. ostoyae* to Adjacent Douglas-fir Trees

Mike Cruickshank
Canadian Forest Service
Victoria, BC

ABSTRACT

The frequency of Armillaria species in precommercial thinning stumps and the interaction at root contacts between Douglas-fir Pseudotsuga menziesii (Mirb.) Franco crop trees and stumps colonized by Armillaria ostoyae (Romagn.) Herink were investigated at sites in four biogeoclimatic zones along a transect from the coast through the southern interior of British Columbia. The frequency of stumps colonized by A. ostoyae and A. sinapina Bérubé and Dessureault varied among lower, mid and upper slope transects. On coastal sites, A. sinapina dominated fresh hygrotopes and A. ostoyae dominated slightly dry hygrotopes, and the frequency of both fungi was low on moist hygrotopes. On interior sites, A. ostoyae was found over all hygrotopes, but with lower frequency on the driest sites. The distribution of the two Armillaria species on sites is apparently determined by anoxia associated with periodic soil saturation, by drying of the soil, and by host response limiting spread of pathogenic species.

At root contacts between colonized stump roots and crop tree roots, transfer and infection by A. ostoyae occurred more frequently in moist biogeoclimatic zones than dry ones. Lesion size on crop tree roots was related to inoculum volume at some sites and to stump root diameter at others. The percentage of lesions on roots at which crop trees formed callus was associated with tree bole volume. The results indicate that there will be crop tree mortality following precommercial thinning, especially where inoculum levels are high in the Interior Cedar Hemlock and Interior Douglas-fir biogeoclimatic zones.

A Hazard Rating Model for Armillaria Root Disease in the Black Hills National Forest

Melanie A. Kallas and Robin M. Reich
Department of Forest Sciences
Colorado State University
Fort Collins, CO 80523

William R. Jacobi
Department of Bioagricultural Sciences and Pest Management
Colorado State University
Fort Collins, CO 80523

In 1991, Lundquist created the first hazard rating model for Armillaria root disease (ARD) in the Black Hills of South Dakota. The objective of our current study was to utilize advanced statistical techniques and a Geographic Information System to create an updated hazard rating system for ARD in the Black Hills National Forest. The data sources used in creating this hazard rating model include four studies of ARD in the Black Hills (Hinds *et al.* 1984, Holah 1993, Lundquist 1991). The studies performed by Hinds *et al.* (1984) and Holah (1993) provided us with the township, range and legal county section where ARD was found. In both of these cases, we digitized the center point of the sections with infection and used them as data points in our model. Lundquist (1991) provided us with sample points where the disease was found. The database for this model also included data from a 1995 field survey of Armillaria root disease in the Black Hills. This study provided us with UTM coordinates of the starting points of one-half mile transects on which ARD was found.

Because of the nature of the data we decided to model the probability of observing Armillaria root disease on a randomly located sample plot. In developing the model we took disease occurrence to be a discrete variable taking on the value of 1 if the disease is present and zero if the disease is absent. Next, a kernel density estimator was used to estimate the density of ARD based on the number of disease occurrences in a circular plot (10 km diameter) encompassing the point of interest (center point) and the relative distance of these disease points from the point of interest. This process results in a response surface of estimated density of ARD which we assume is proportional to the true density of the disease in the Black Hills.

Trend surface analysis was then used to model the large-scale variability in the estimated density of the disease as a function of geographical coordinates and independent variables that are spatially and linearly correlated with the estimated density of ARD. The trend surface models incorporated independent variables including elevation, average annual precipitation, percent slope, and aspect. A strong correlation between elevation and precipitation in the Black Hills was found, therefore, to avoid the effects of one variable masking the effects of another, we created two models. The first model (Model 1) incorporated elevation and percent slope as independent variables. The second model (Model 2) incorporated average annual precipitation, percent slope, and aspect as independent variables. Both models accounted for approximately 65% of the overall variability in the estimated density of ARD in the Black Hills. In both models, the residuals (error terms) of the trend surface analysis were spatially autocorrelated. It was also observed that the residuals were spatially cross-correlated with site index.

We used information regarding the spatial autocorrelation of the residuals and cross-correlation between residuals and site-index to help correct for the errors associated with the trend surface models. This was accomplished using cokriging. We used the four nearest neighbors of the point of interest to estimate the residual estimated density at the point of interest. In ordinary kriging, the residual values of the four nearest neighbors are used to estimate the residual value at the point of interest. Cokriging differs from ordinary kriging in that auxiliary information (site index) is also used in estimating the residual value at the point of interest. This procedure was used to obtain a response surface of residual errors in the trend surface model.

The surface of predicted residuals was added to the trend surface models to obtain the final surfaces depicting all of the variability in the estimated density of the disease. By modeling the residuals of the trend surface analyses we were able to account for approximately 32% more variability in the estimated density of ARD in the Hills.

Therefore, by modeling the small-scale variability in the estimated density of the disease and incorporating site index as an independent variable we improved the overall model performance to approximately 98%. The model incorporating elevation, percent slope and site index as independent variables (Model 1) had a slightly higher overall model performance than the model incorporating precipitation, percent slope, and aspect (Model 2).

Finally, the surface depicting estimated density of Armillaria root disease was rescaled to obtain an estimate of the probability of observing ARD on a randomly located sample plot, which we define as:

$$HAZARD = \frac{estimated \cdot density \cdot of \cdot ARD \cdot at \cdot a \cdot given \cdot \text{point}}{Maximum \cdot estimated \cdot density \cdot of \cdot ARD \cdot in \cdot the \cdot Black \cdot Hills}$$

The kernel density estimator, which was used to obtain the initial response surface, identified a continuous belt of extremely high hazard rating that ranged from the northwest corner (Spearfish Canyon) of the Black Hills to the area south of Deadwood/Lead (north central portion of the Black Hills). It also identified two peaks of high hazard just south of Deerfield Lake, a peak in the south-central portion of the Hills (just north of Jewel Cave National Monument) and one in the northwestern portion of Custer State Park. Areas where the disease was not observed had an extremely low hazard rating, close to zero.

The final model that incorporated elevation, percent slope, and site index as independent variables (Model 1) identified all of the same high hazard areas as the kernel density estimator model. However, by incorporating the independent variables into the model, we were able to estimate the density, and, therefore, the hazard rating for points or areas where we have no data. These estimates are based on the correlations between the independent variables and the estimated density of the disease. Incorporation of independent variables also allowed us to further define the hazard rating gradient. For example, where the kernel density estimator identified the continuous belt of extremely high hazard, Model 1 identifies some areas within that belt that are only moderately high hazard and other areas that are extremely high hazard. Model 1 also identifies some areas of low hazard rating that break up areas of high hazard rating.

These hazard rating models can be used by forest managers to aid in decision making processes. The techniques used in this study can be used to create hazard rating models based on the number of infected stems per acre if the sample size of points with accurate information is sufficient. The techniques used in this study can also be used to study the interaction between Armillaria root disease and other disturbances in the Black Hills such as fire, Mountain Pine Beetle attack, and timber harvesting. By including these other disturbances as independent variables in our model, we can determine the effect of other disturbances on the probability of observing ARD on a randomly located sample plot. After correlations between the estimated density of ARD and disturbances such as timber harvesting are determined, this information could be used to create predictive models based on management activity.

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Studies on Western Hemlock Dwarf Mistletoe at the Wind River Canopy Crane Research Facility.

David Shaw
Wind River Canopy Crane Research Facility
1262 Hemlock Road
Carson, Washington 98610

The Wind River Canopy Crane Research Facility is cooperatively managed by the University of Washington, USFS Pacific Northwest Research Station, and USFS Gifford Pinchot National Forest. The facility consists of a construction crane which was located in an old-growth (+/- 500 yr.) Douglas-fir/western hemlock forest in the spring of 1995. The crane is 75 meters tall with an access jib 85 meters long. Scientists access the forest canopy by stepping into a suspended personnel basket at the forest floor and ascending above the tallest trees, then being lowered to the desired position. The crane can reach 2.3 ha of forest, and access 340 individual tree crowns (150 western hemlock, 88 Douglas-fir, 43 western red cedar, 15 grand fir, 12 pacific silver fir, 1 noble fir, and 2 pacific yew). Top height in the stand is 62.5 meters.

A four hectare stem map, with the canopy crane near center, was developed in 1994. The map serves to aid researchers in the physical patterns of tree distribution. All trees > 5cm were mapped (total of 2168 trees). A western hemlock dwarf mistletoe infection center occurs over an area of about 1 ha of this four ha map. The infection center consists of many severely infected tree, with thousands of individual infection throughout the tall crowns (reaching up to 59 meters). The capability to access these crowns without climbing or felling trees provides a rare opportunity to study western hemlock dwarf mistletoe at the plant, population, and stand scale.

During summer of 1995 Elizabeth Freeman (with brief training from Bob Mathiasen, Jerry Beatty, and Diane Hildebrand) rated each western hemlock tree (916 trees) in the four hectare plot using the Hawksworth 6-class rating system. We then plotted this pattern on our stem map (Figure 1).

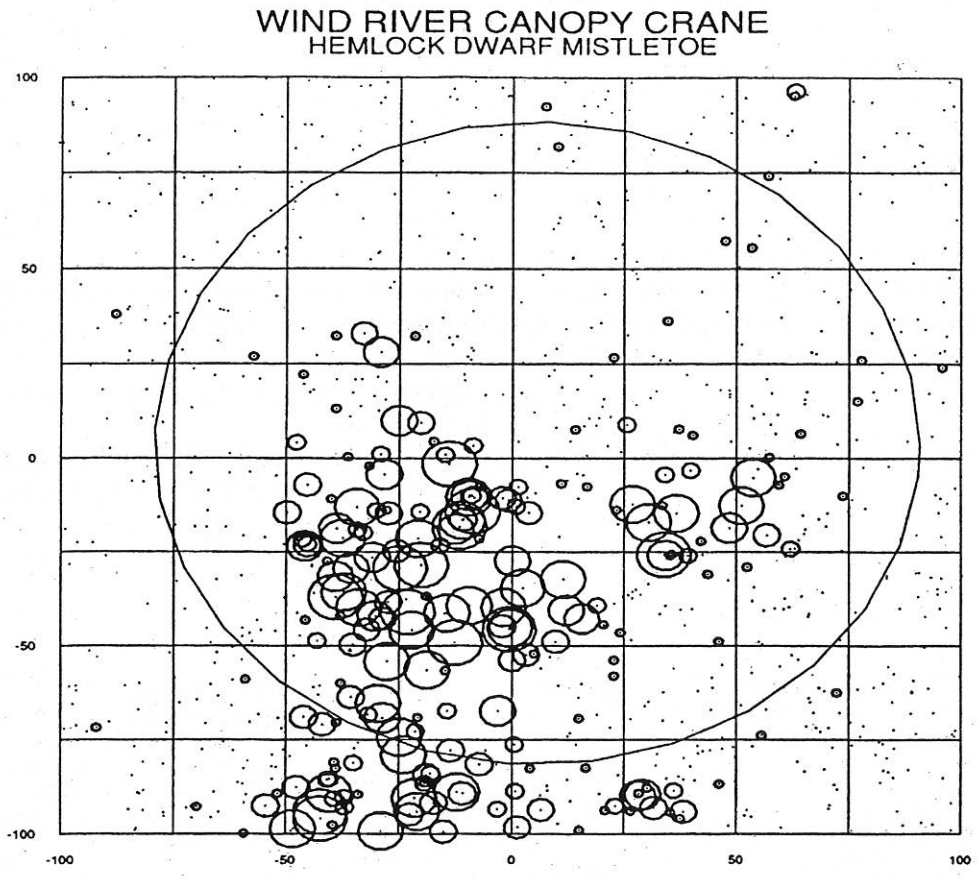


Figure 1. Uncorrected map of ground-based DMR survey of all western hemlocks on the 4 ha. Plot. The size of the circle corresponds to the DMR number; largest circles are 6's, black dots are western hemlocks rated 0.

The resulting pattern shows a very discrete infection center. I believe the pattern of the infection center is a result of the dynamic interaction of the distribution of western hemlock and non-host species, plus the pattern of stand development and succession.

The hypothetical origin of the forest is a stand replacement fire, or series of fires, that occurred approximately 500 years ago. Also hypothetically, some infected western hemlock trees survived the disturbance along with other trees that escaped mortality. The principle species that occupied the stand following disturbance, however, was Douglas-fir. The Douglas-fir still dominates the stand (in terms of height and basal area) but is slowly being replaced by western hemlock, western red cedar, grand fir, and Pacific silver fir. The infection center grew into the areas where non-host tree crowns (particularly Douglas-fir) did not block the dispersal of mistletoe seeds. As mortality of these non-host trees occurs, the mistletoe population moves into the uninfected areas if seeds can reach western hemlocks (or Pacific silver fir and noble fir). Currently, the population of dwarf mistletoe may be moving into uninfested areas by animal dispersal, as isolated infections with no readily apparent source have been observed.

Studies in intensification of western hemlock dwarf mistletoe can now be made with five year remeasurements. We anticipate remeasuring in 2000 and in 2005, after which time we hope to be able to say something about factors controlling the spread of this infection center.

At the suggestion of Bob Mathiasen, we initiated a study to evaluate the accuracy of our 6-class ratings. We were able to access 140 western hemlock trees with the canopy crane, to examine their crowns and to better estimate the dwarf mistletoe rating. We lowered the gondola along two sides of each crown examining individual thirds of the

crown. Then estimating the rating. We considered this a very accurate method to rate the tree crown. Of the 140 trees, 49% were accurately rated by the ground survey, but most of the correctly rated trees (85%) were non-infected. Only 14% of the 73 infected trees were accurately rated by the ground survey. Of the 73 trees with infections, 79% were underestimated, while 21% were overestimated by the ground survey. The structure of the forest stand, with the majority of foliage below 30 meters (stand height about 60 meters), makes it quite difficult to accurately rate the tree crowns. This suggests that great care should be taken when working in this type of tall stature forest. (a manuscript is in preparation).

I have begun initial work on the pollination ecology of western hemlock dwarf mistletoe here at the canopy crane site. The study will not begin in earnest until 1997. Initial observations indicate a wide variety of insects visiting both male and female flowers, including Vespid wasps, bumblebees, honey bees, Syrphid flies, Muscoid flies, Anthomyid flies, Tachinid flies, and even Pine white and Anglewing butterflies. As this is a huge project, anyone interested in collaborating is very welcome. Please contact me.

The canopy crane is ideally suited to a number of other studies of western hemlock dwarf mistletoe, and I hope any and all of you will consider coming to the site.

The Incidence of Infection and Decay Caused by Annosus Root Disease in Managed Second-growth Noble Fir

Kelly Sullivan
OSU College of Forestry

Background

Annosus root and butt rot is a major problem of true firs in the Pacific Northwest. Annosus root and butt rot increases with multiple stand entries because residual tree wounds and stumps serve as entry courts through which fungi can grow, spread, and cause disease. The presence and effects of annosus root and butt rot in noble fir are largely unknown. Thinned and wounded stands of second-growth noble fir on the Warm Springs Indian Reservation (WSIR) in Oregon may be affected by annosus root and butt rot resulting in substantial losses through decay, windthrow, and tree mortality. In 1994, OSU began a study to explore the incidence and severity of annosus root and butt rot in managed noble fir stands on the WSIR.

Study Objectives and Methods

1. **Determine the incidence of annosus in relation to tree wounding.** In two stands, 36 wounded and 11 unwounded noble firs were sampled to determine the amount of decay in relation to wound presence, size, and age.

2. **Develop a model that predicts and estimates infection and decay caused by annosus.** Existing true fir infection and decay models were tested and modified.

3. **Determine the intersterility group (ISG) of annosus that infects noble fir.** Cultures were collected and paired to determine the strain (P, S, or F) of annosus.

4. **Analyze the relative importance of primary (through wounds) and secondary (through stumps) spread of annosus.** Tree wounds and surrounding thinning stumps were sampled to determine if decay fungi are spreading primarily through wounds or stumps. This will determine what prevention strategies can and should be used (i.e. wound prevention or borax stump treatments).

Results

* **24 trees were sampled in the Wilson Ck. stand (thinned 20 yrs)**
* 18 of 24 trees had 1 or more trunk wounds from thinning
* 13 of the 18 wounded trees had annosus root and butt rot
* buttrot columns ranged from 4-60 ft.
* 6 of 24 trees were unwounded
* 5 of the 6 unwounded trees had annosus

* **23 trees were sampled in the Powerline stand (thinned 5 and 8 yrs)**
* 18 of 23 trees had 1 or more trunk wounds from thinning
* 17 of the 18 wounded trees had annosus root and butt rot
* buttrot columns ranged from 2-20 ft.
* 5 of 23 trees were unwounded
* 4 of the 5 unwounded trees had annosus

Decay Model

LOGIT (% Decay Volume) = -4.24 + 0.15 **(Wound Age)** + 0.10 **(Thinning Stump Dia.)** $R^2 = 0.35$

ISG Group

All of the annosus isolates sampled belonged to the S-group.

Conclusions

Annosus root and butt rot is extensive in noble fir stands thinned 8 to 20 years ago especially in wounded trees, but also in unwounded trees as well. This suggests that disease is spreading from adjacent thinning stumps as well as from trunk wounds. The size and number of trunk wounds is directly correlated with annosus infection.

Our recommendations would be to implement guidelines aimed at wound prevention both in the planning process and in the actual thinning operations. These have been published and are available. We also recommend treatment of thinning stumps with a protectant such as borax to prevent stump infection from airborne annosus spores. These recommendations if followed would protect the second-growth noble fir resource on the WSIR from unnecessary defect and decay resulting from wounding and harvesting.

Relating the Incidence of *Inonotus tomentosus* to Specific Site Series in Northern British Columbia

Daniel R. Bernier and Kathy J. Lewis
University of Northern British Columbia
Prince George, B. C.

INTRODUCTION

Inonotus tomentosus (Fr.) Teng is a basidiomycete that is the primary agent of root decay in the spruce dominated forests across Canada (Whitney *et al*, 1974). In British Columbia, *I. tomentosus* infects spruce stands as young as 30-years-old (Lewis & Hansen, 1990; Merler *et al.* 1988). Significant growth reduction and butt cull losses of 20% volume in severely infected trees occurs in mature spruce stands (Lewis, unpublished data). *I. tomentosus* can be active in a site for several years before any detectable symptoms are noticed and crown symptoms do not give a reliable indication of the extent of root disease in a stand (Lewis, unpublished data; Merler *et al.* 1988; Myren and Patton, 1971). These characteristics make the disease difficult to diagnose and easy to miss when preparing Silviculture Prescriptions. Therefore, other potential indicators of diseased sites are useful tools.

This study analyzes the relationship between the site series and the incidence of Tomentosus Root Disease. The objectives of this study are to determine if Tomentosus Disease incidence is related to the site series of the surrounding ecosystem, and to relate these findings to the development of a series of disease indicators.

BIOGEOCLIMATIC ZONE CLASSIFICATION

When analyzing the relationship between disease distribution in British Columbia and ecosystem factors, it is necessary to understand the basis for site classification in British Columbia. The biogeoclimatic ecosystem classification, as summarized by Meidinger and Pojar, (1991), was developed for use in British Columbia by V.J. Krajina and many of his students between 1950 and 1975 (Pojar *et al*, 1987). This ecosystem classification is unique and was developed from ecological forestry principles proposed and developed in Russia and Southern Europe (Pojar *et al*, 1987).

Biogeoclimatic units are organized in a hierarchy based upon zonal (climatic) classification, site (geologic) classification and vegetation classification. A biogeoclimatic zone, the largest unit of measure, is a large geographic area with a relatively homogenous macroclimate, such as the sub-boreal spruce (SBS) zone. A biogeoclimatic subzone is determined by the distinct climax plant association on the zonal site. An example of a subzone would be the wet and cool (wk) subzone. A biogeoclimatic variant distinguishes different regional climates (drier, wetter, colder, snowier, warmer) within the same subzone. The variant is denoted by a number after the subzone (wk1). A site series divides the subzone or variant into edaphically more uniform units. These units are derived using soil characteristics and plant associations and are given a two-digit numerical code; the zonal site being given the code 01. Subzones have varying numbers of site series depending on the variation in moisture regimes, as demonstrated by the edatopic grid.

The edatopic grid (**Figure 1**) is an important tool developed by British Columbia ecologists to help demonstrate relationships between plant associations and moisture and nutrient regimes. (Pojar *et al*, 1987). It incorporates relative soil moisture regimes along the Y-axis, ranging from very dry to very wet. The actual moisture regimes are different for each subzone and thus have to be considered relative to a specific subzone only. A soil moisture regime is defined as the average amount of soil water available annually, for evapotranspiration by vascular plants (Pojar *et al*, 1987).

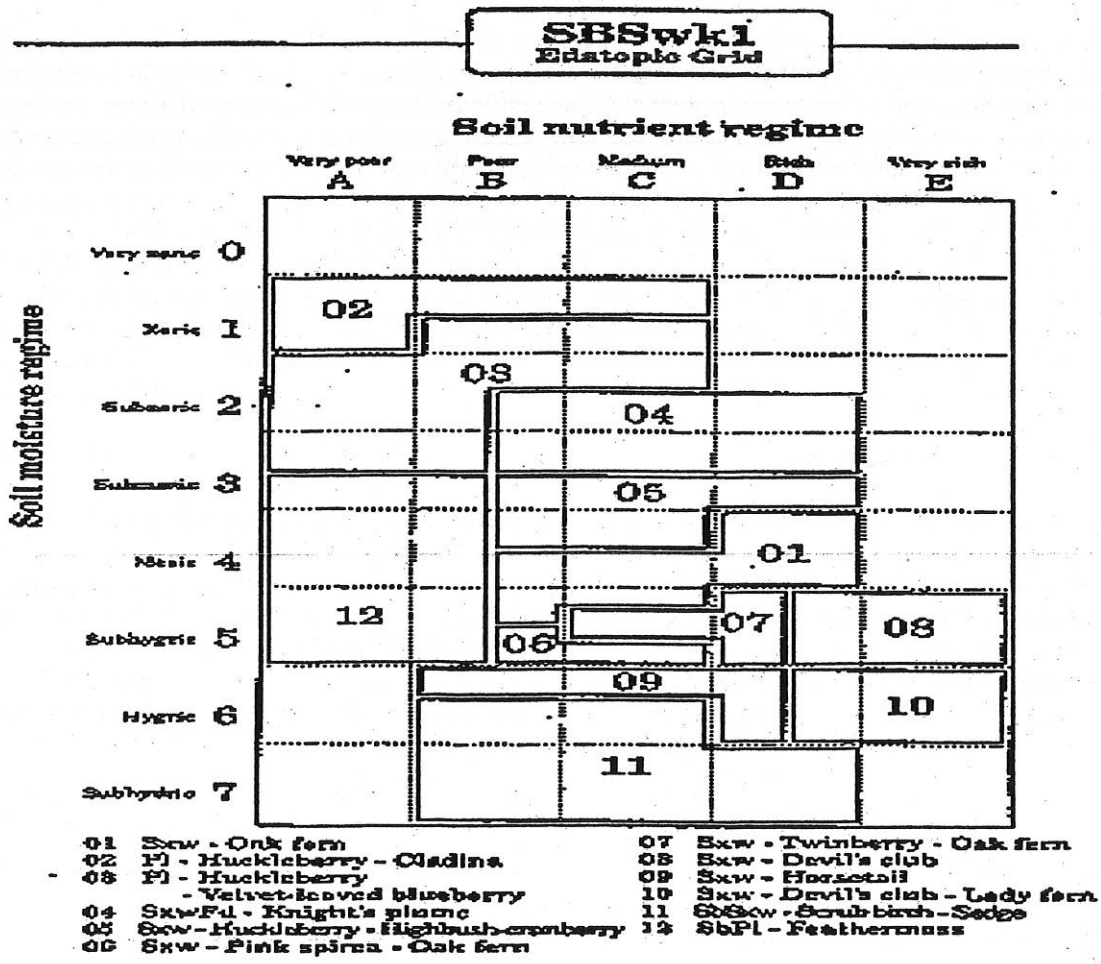
There are five actual soil nutrient regimes located along the X-axis of the grid, ranging from very poor (A) to very rich (E). Soil nutrient regimes are defined by the amount of essential soil nutrients available to vascular plants over a period of several years (Pojar *et al*, 1987). The classes of soil nutrients are determined by analyzing site

properties such as humus form, A horizon, soil depth, organic matter content, soil texture, coarse fragment content, parent material and seepage or flooding (Meidinger and Pojar, 1991).

METHODS

The study was confined to areas within the SBSwk1 subzone. This is a diverse subzone with 12 different site series. Much of the SBSwk1 is found just east and north of Prince George, British Columbia. Spruce trees are found in varying densities throughout each of

Figure 1. THE EDATOPIC GRID FOR THE SBSWK1 SUBZONE.



the site series. The criteria used to select study sites were: a minimum stand age of 100 - 120 years old, spruce as the dominant tree species, and accessibility. In addition, sites were selected from several different areas within the SBSwk1 classification. The 02 site series was not studied because these sites are extremely rare and have very few spruce.

After an area was determined to satisfy the criteria for study, transect lines were drawn on a forest cover map and plots were located every 100m along the transect. Transect lines were a minimum of 100m apart. In the forest, measurements between plots were made using a standard hip chain. Once the plot site was located, two criteria were used to maintain consistency between each site series. The area selected had to be the same site series throughout the entire plot and the site had to consist of a minimum of six spruce trees. If the area did not satisfy

these requirements, the plot would be relocated 5-10m in any direction to an area that could satisfy these requirements.

Plots were 25.2 meters (1/20 ha.) in diameter, measured outwards from a central tree using a 50m logging tape. Any tree with part of its trunk within the 25.2 m diameter was considered in the plot. Only trees with a Diameter at Breast Height greater than 15cm were studied, and all species of trees were counted for density estimates. A pulaski was used to chop into the roots of spruce trees to determine the presence of Tomentosus Root Disease. Fruiting bodies, deep purple/brown staining and pitting characteristic of infection by *I. tomentosus* were diagnostic features. If the cause of the root rot was uncertain, a sample of the root was brought to the lab and cultured to determine if the pathogenic agent responsible for the decay was *I. tomentosus* .

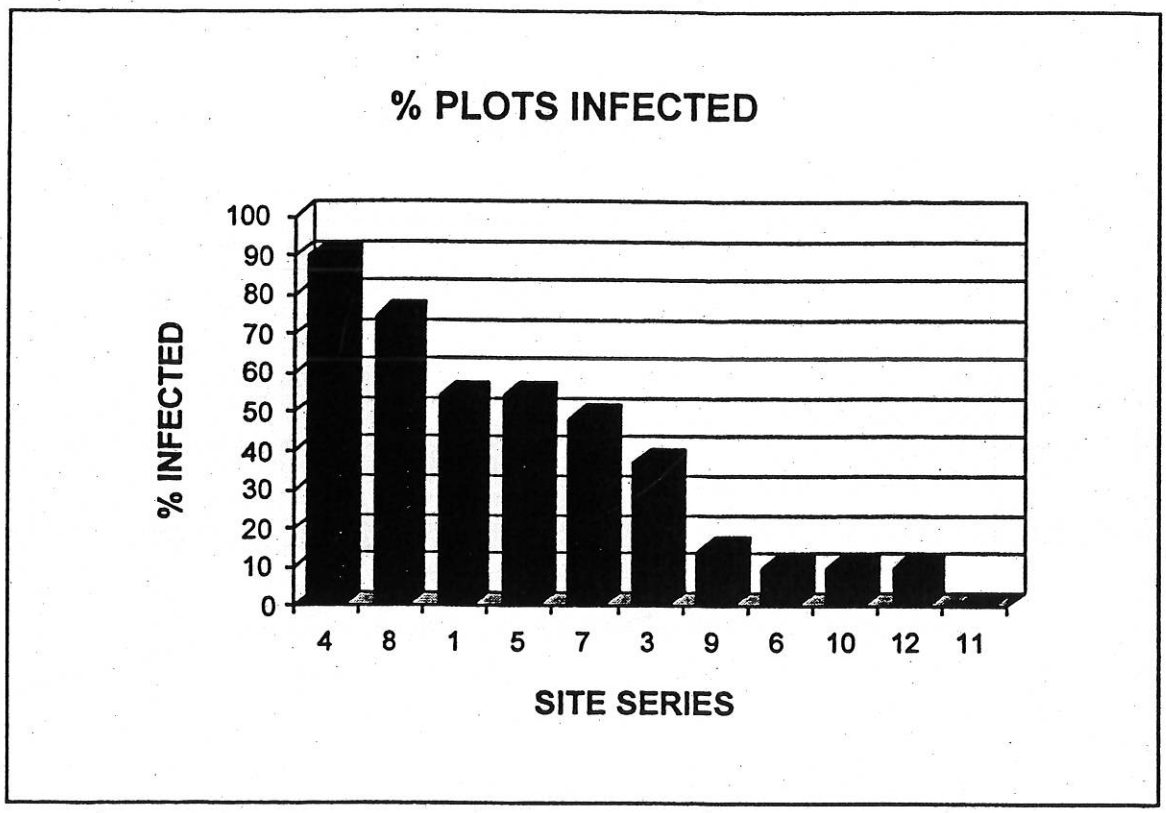
Classification of sites to specific site series was according to the standard ecosystem classification keys published by the British Columbia Ministry of Forests. A soil pit was dug at each site to determine humus form, soil texture, soil depth and coarse fragment percentage. Identifying moisture regimes incorporated slope, soil depth and soil texture whereas nutrient regimes were determined using soil texture, coarse fragments, soil depth and humus form. The indicator plants present at each site were used together with the moisture and nutrient regimes to specify the site series of the plot.

A minimum of twenty plots were studied per site series. After twenty sites were completed, the data was analyzed to determine the standard error of the percent plot infection. For site series 01, 03, 05, 07 and 08, the standard error was greater than 8% and an additional 15 plots were sampled for a total of 35 plots for these site series with highly variable levels of Tomentosus Root Disease. Thirty-five plots was sufficient to keep the standard error of all site series-plot infection under 8%.

RESULTS

A total of 295 plots were sampled from the eleven site series and 4035 spruce trees were examined for Tomentosus Root Disease. The percent of plots with at least one tree infected is plotted by site series in **Figure 2**. Percent plot infection varied widely with the highest levels in the 04 site series at 90% of plots infected. Site series 11 had no infection in any spruce trees studied. Relative to the edatopic grid, the highest level of infection was in the range of 3-5 moisture level and C-D nutrient level. The incidence of infected trees per site series is very similar to the percent of plots infected per site series, as shown in **Figure 3**. Once again, the 04 site series had the greatest infection intensity with 29% of trees infected with *I. tomentosus* per plot.

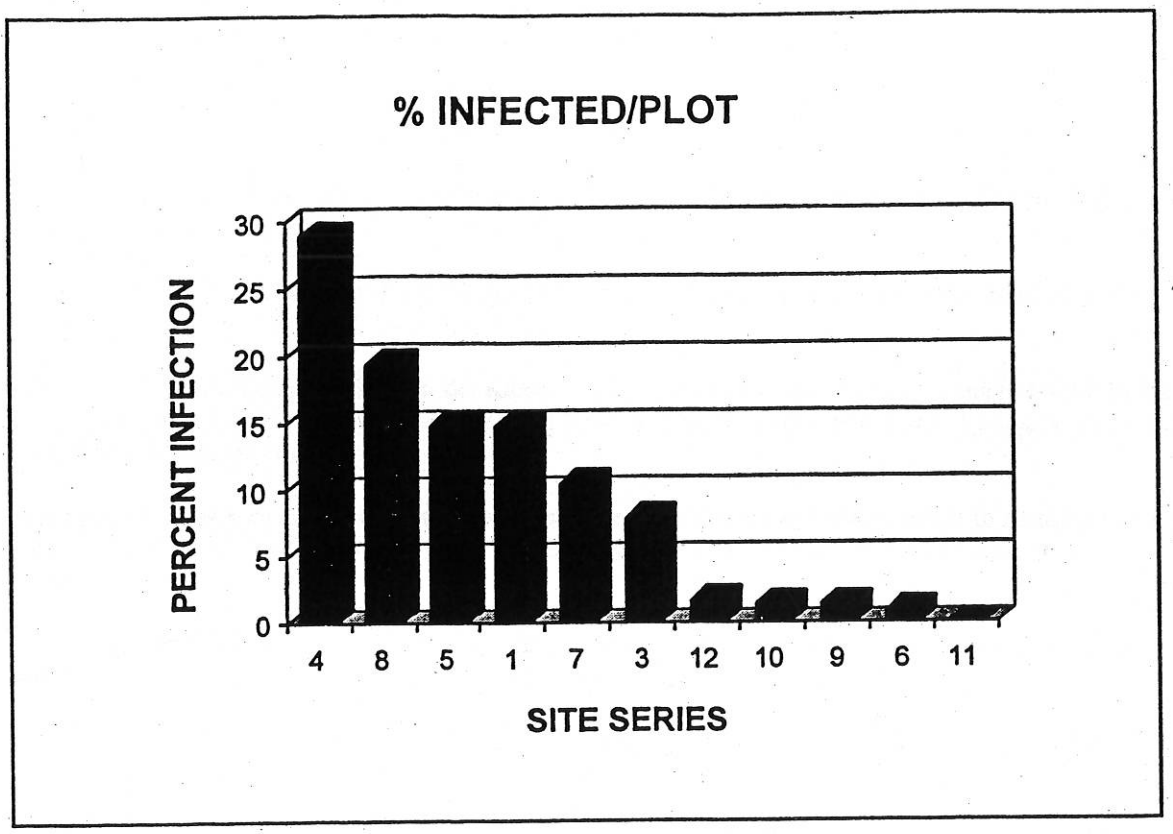
Figure 2. PERCENT PLOTS INFECTED / SITE SERIES



DISCUSSION

The 04 site series has significantly higher levels of Tomentosus infection than other site series. Sites that are classified as 04 are generally small in area and are quite uncommon compared to other site series (DeLong *et al* , in press). The vegetation common to this site series includes many species indicative of disturbed habitats or open-canopy forests. These indicator plants include *Acer glabrum* , *Amelanchier alnifolia* and *Spiraea betulifolia* (Klinka *et al*, 1989). Of the eleven different SBSwk1 site series studied, the 04 site series has the lowest density of spruce trees with an average of 200 spruce/hectare. Western hemlock (*Tsuga heterophylla*) regenerates well on acid organic substrates and decaying coniferous wood (Klinka *et al*, 1989) but it is rarely found in the wk1 subzone of the SBS, with an average of four hemlock/hectare. However, the 04 sites have an average of forty hemlock/hectare, indicative of an environment with large quantities of decaying coniferous wood. All of these characteristics suggest that this site series may develop in old Tomentosus Root Disease infection centers or areas disturbed by other biotic or abiotic agents. These areas may have been a different site series before *I. tomentosus* or another agent disturbed the habitat. The 04 site series may be considered a root disease climax ecosystem, defined by van der Kamp (1991) as a forest community created by the actions of pathogens. Analysis of other soil and site features should corroborate or negate this hypothesis.

Figure 3. PERCENT OF TREES INFECTED / SITE SERIES



The cells on the edatopic grid that show the heaviest levels of infection are submesic to subhygric moisture and medium to rich nutrients. These sites are abundant in the SBSwk1 subzone and are generally the best quality sites in the area. Past literature is inconsistent concerning whether *I. tomentosus* is found more extensively on poor or good quality sites (Merler, 1984; Oulette *et al*, 1971; Thomas & Thomas, 1954; Whitney, 1976). This study preliminarily suggests that mesic moisture levels and rich nutrient levels provide the best habitat for *I. tomentosus*. The 03 site series is not found in this type of habitat yet it still has moderate levels of infection by Tomentosus. Other site or soil features of these areas should help explain why infection levels are moderate in the 03 site series. Site series 11 represent the bogs and extremely high water table areas. The lack of oxygen available to *I. tomentosus* is the most probable explanation for the absence of this fungus in site series 11. These results suggest that Inonotus *tomentosus* is a disturbance agent that may change site series and appears to infect site series with differing intensities.

The results of this study are preliminary as several other site and soil features are still being analyzed for their relationship to the incidence of Tomentosus Root Disease. These features include relative moisture regimes, actual nutrient regimes, humus form, slope position, soil texture and coarseness of the soil. These factors, together with the information presented herein will provide a useful picture of the site and soil characteristics most frequently associated with Tomentosus Root Disease.

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Decline of Ponderosa Pine Near Burns, Oregon: an Interim Report

Walter G. Thies[a], Christine G. Niwa[a], Rick G. Kelsey[a], Mark Loewen[b], and Gladwin Joseph[c]

[a]USDA Forest Service, Pacific Northwest Research Station, Corvallis, Oregon 97331; [b]USDA Forest Service, Burns Ranger District, Hines, Oregon, 97738; [c]Department of Forest Science, Oregon State University, Corvallis, Oregon 97331.

Abstract: Black-stain root disease (BSRD) of ponderosa pine (Pinus ponderosa Dougl. ex Laws), has been associated with increasing losses in stands near Burns, Oregon. In 1995 and 1996 and effort was made to trap insects in stands with varying degrees of disturbance, to examine roots of diseased and healthy trees, and to correlate diseases found in the roots to volatile chemicals found in the bole of the trees. Significant differences were found in both frequency and species of insects captured in disturbed areas when compared to captures in undisturbed areas. Some species were more attracted to ponderosa pine stump-wood with stain typical of BSRD than to other attractants tested. Some volatile compounds from increment cores collected from the stem base showed quantitative differences and could be used to accurately separate diseased and healthy trees. Diseased trees were both clumped and scattered in distribution and there was a higher proportion of infected trees than estimated from crown symptoms. Most trees had multiple root diseases. Some lab work and data analysis remain to be completed.

Introduction

For at least 10 years, USDA Forest Service, Pacific Northwest Region (R6) pathologists, in particular Craig Schmitt and Don Goheen, have been calling attention to black-stain root disease (BSRD) of ponderosa pine (Pinus ponderosa Dougl. ex Laws) caused by the fungus Leptographium wageneri var. ponderosum (Harrington and Cobb) Harrington and Cobb in stands east of the Cascade crest in Oregon. Since initial identification of BSRD at the Burns Ranger District (RD), Malheur National Forest, in 1989, District personnel have been mapping locations of BSRD. As more BSRD has been identified, the District has questioned how their management practices may have affected the spread and impact of BSRD. In spring 1995, an informal road survey of part of the Burns RD by the authors confirmed that BSRD was both widespread and affecting a substantial portion of ponderosa pine stands in the southeastern part of the District. Cooperative work begun in summer 1995 focused on three areas: (1) a better understanding of potential vectors; (2) a better understanding of the belowground portion of diseased trees; and (3) a nondestructive disease detection-system based on volatile compounds found in the bole of suspect trees. Results from the 1995 examinations were used to plan additional efforts for summer 1996. The purpose of this communication is to present an overview of our activities and preliminary results.

Insect Trapping

The long term goal is to determine the role, if any, of insect vector(s) for BSRD and to develop a management strategy to reduce both their disease vectoring activity within stands and their spread of the disease into uninfected areas.

1995 Effort

The goals of the 1995 effort were to: (1) survey for the presence of insect species that were likely vectors of BSRD, (2) determine effectiveness of several specific semiochemical attractants that could be used in future trapping efforts, and (3) determine the candidate insect species and their frequency stands with particular disturbance histories.

The 1995 trapping study was designed as a test of attractants and conducted in ponderosa pine stands with BSRD and with recent disturbance. Relatively undisturbed stands, and those thinned with slash treated in various ways, including burning, also were included. The stands were distributed over a portion of the district 19 km east-west

and 11 km north-south. In each stand, trap sites were selected in tree clusters at least 100 m apart along a transect. At each trap site, a pitfall trap (for ground dwelling beetles) and a Lindgren funnel trap (for flying beetles) were installed and baited with the same attractant. Treatments were randomly assigned within each block (location): (1) alpha-pinene; (2) ethanol; (3) combination of alpha-pinene and ethanol; (4) stained wood (stain typical of BSRD) from ponderosa pine; (5) nonstained wood from the same level and tree as (4) but without stain; (6) stump wood from a ponderosa pine that showed no signs or symptoms of BSRD; (7) control, consisting of antifreeze in pitfall traps and a no-pest strip in Lindgren traps; (8) no-pest strip; and (9) combination of antifreeze and a no-pest strip. Treatments (8) and (9) were additional control treatments used with the pitfall traps only.

Pitfall traps were 13 cm in diameter with a 25-cm diameter rain shield lid suspended 2 cm above the ground. Below a funnel was a collection cup 5 cm in diameter by 5 cm deep containing 50% ethylene glycol (antifreeze) and water as a killing/preserving solution. Lindgren traps (16 funnel units) were suspended from twine between two ponderosa pines at least 3 m apart such that the collecting cup was about 0.5 m above the ground and anchored by twine to a piece of slash to reduce swinging. A piece of no-pest strip 3 cm square was placed in each collecting cup to kill trapped insects. Alpha-pinene was a jellied formulation contained in a 16 mil. sealed poly bottle. Ethanol was in a slow release polymer tube. Both were packaged to give a 100-mg/day release rate for 60 days and were purchased from Phero Tech Inc., Delta B.C. (Mention of a trade or firm name does not imply endorsement by the USDA). Wood used as an attractant was collected from the freshly cut stumps of several ponderosa pines at least 8 km from any of the trapping locations. The wooden pieces were approximately 15 cm long by 3 cm square in cross section. The three kinds of wood attractants (BSRD-stained, nonstained, and healthy) were kept in separate plastic bags and stored on ice until being placed in traps. Either pieces of wood, or the semiochemical releasers, were attached to the Lindgren traps by tying them outside the middle funnel of the vertical stack, or by placing them in the pitfall trap next to the collection cup. After 2 weeks, each piece of wood was refreshed by splitting it into four pieces and putting it back in the same trap. Wood was replaced by freshly cut pieces after a total of 4 weeks in the field.

Trapped insects were collected weekly from June 15, 1995, through July 26, 1995. Those beetles known to burrow into, or feed on, the lower bole or roots of ponderosa pine were identified to species. Additionally, trapping was done (without ethylene glycol or no-pest strip) to capture live insects for preliminary attempts to cage insects on ponderosa pine seedlings and for attempts to culture L. wageneri from insects.

1995 Results

Statistically significant results (P = 0.10) for Friedman's Test and orthogonal contrasts (attractant comparisons) or Duncan's Multiple Range Test (location comparisons) are reported. For each beetle species, analyses were run separately for pitfall traps, Lindgren traps and their combined captures.

1. Four species were collected in sufficient numbers (greater than 100 total specimens) for meaningful analysis: Hylastes longicollis Swaine, H. macer LaConte, Hylurgops porosus (LeConte), and Dendroctonus valens (LeConte). Other species recovered infrequently (30 or fewer total specimens collected for the entire trapping period) were Hylastes nigrinus (Mannerheim), H. ruber Swaine, H. gracilis (LeConte), H. tenuis Eichhoff, Hylurgops reticulatus Wood and H. subcostulatus Mannerheim.

2. Hylastes longicollis and D. valens were captured more frequently in Lindgren traps than in pitfall traps. Hylastes macer was captured in greater numbers in pitfall than Lindgren traps.

3. In general, there were no differences in the number of beetles caught in traps baited with nonstained or healthy wood and controls. Traps baited with wood stained by BSRD attracted more H. longicollis, H. macer, and D. valens than some of the other treatments.

4. Alpha-pinene and ethanol together attracted more insects to the traps than either compound separately for both H. porosus and D. valens.

5. Hylastes longicollis and H. macer were trapped significantly more often in the disturbed locations (burned and recently thinned) than in the undisturbed areas. Hylurgops porosus was trapped more frequently in the burned location. Dendroctonus valens was most abundant in the burned area, but there was no significant difference among locations for this species.

6. No feeding by live beetles caged on seedlings was detected and no BSRD was discovered in the seedlings.

7. Thirteen insects (12 D. valens, 1 H. porosus) yielded cultures that appeared to be a species of Leptographium. Representative cultures were examined by Tom Harrington (Iowa State University) and none was found to be L. wageneri var. ponderosum.

1996 Effort

The 1996 insect trapping was conducted with the same basic objectives and field approach as was used in 1995, but with a slightly different focus and based on results from 1995. Ten pairs of stands, disturbed and undisturbed, were selected in the same portion of the Burns Ranger District sampled in 1995. Four trap sites, each with a pitfall and a Lindgren funnel trap, were established along a transect in each stand. Four attractant treatments were tested, one at each site: (1) ponderosa pine stump wood stained by BSRD; (2) stump wood from a ponderosa pine that appeared to have a healthy crown and no evidence of BSRD or other root diseases on the freshly cut stump; (3) combination of alpha-pinene and ethanol; and (4) no attractant.

Live insects were collected in four of the disturbed stands from mid-May through mid-July. In each stand an additional transect (at least 100 m from other transects) was established with six trapping sites. The attractant used for each trap was a combination of alpha-pinene and ethanol. Each week the traps were first emptied and live beetles kept, then live insects were collected twice at 24-hr intervals. The insects were sorted by species, stored on ice, and transported to the J. Herbert Stone Nursery near Medford, OR. At the nursery, ponderosa pine (2-0 seedlings in citrus pots) were used to test insect transmission of BSRD. While still cool, five insects of a given species were placed on soil in a pot and a piece of fiberglass screen placed over the pot top and around the wounded stem of the seedling, then stapled to the edge of the pot and stapled closed. Stems were wounded by removing bark from approximately 20% of the circumference of the stem from the soil line up 2 cm. The pots were kept in a shadehouse. In an attempt to keep the insects active containers of alpha-pinene and ethanol were placed at 1.5 m intervals along the shadehouse benches holding the test seedlings. After at least 2 months exposure to the insects, seedlings were removed from the pots, potting medium removed, the roots examined for feeding, and the stems examined for stain typical of BSRD.

1996 Results

All trapping has been completed for the year and insect identification is proceeding but not complete. Trapping results are not yet available. In mid-August, the 91 seedlings caged with insects captured before mid-June were examined. Only a few seedlings showed any signs of root feeding and none showed internal signs of BSRD. More complete results will be available later.

Root examination

There were two objectives of the "BSRD-dig": (1) to provide an opportunity to examine the belowground portions of ponderosa pine that showed crown symptoms suggesting root disease; and (2) to identify diseases on the roots for correlation with volatile compounds identified in the bole.

1995 effort

The 1995 dig was conducted in a stand marked for thinning. Stand description: Driveway timber sale unit 16, Burns RD, Malheur NF. It is located 38 km northeast of Burns, Oregon (T20S, R33E, Sec.5; 43°52'15"N, 118°45'5"W). The following description is summarized from the stand management prescription for the unit available from the Burns RD: nearly all trees are ponderosa pine; ecoclass--CPS221 ponderosa pine - bitterbrush - Ross sedge; annual

rainfall - 63 cm; elevation 1690 m; aspect - E; slope - 6%; soil type is 41/81 (Malheur NF, soil resource inventory), a shallow loamy and clayey soil with some rock outcropping. This is a dry pine site with scattered overstory and overstocked understory. Prior to fire exclusion, it was an open ponderosa pine stand, but since fire exclusion a dense understory of ponderosa pine have become established and a thick litter layer has accumulated. Most trees are under 100 years old. Average growth, based on a 1987 stand exam, was 9 rings/cm. The area has been relatively undisturbed since a partial removal harvest in the 1930s.

A total of 42 ponderosa pine trees representing a range of root disease crown symptoms, from apparently healthy to dead, was selected for removal and examination. Each selected tree was measured for diameter at breast height (dbh, 19.5 to 46.0 cm), and the crown photographed. Seven diseased trees with severe crown symptoms and three healthy trees were selected for chemical analysis. Just prior to uprooting the tree, increment core samples of sapwood were collected, at the stem base in each of the four cardinal directions and one at BH. Cores were immediately frozen on dry ice for transport to the laboratory where they were processed and analyzed by using headspace gas chromatography. The BH increment core was used to determine the last 10 years of growth, measured to the nearest 0.1 mm. Trees were pushed over with a skidder and stems severed near their base. Stumps were lifted to free roots from the soil, and the root system cleaned for examination. To keep roots from drying, the trees were pushed over just before examination.

1995 results

1. Trees with BSRD were not limited to disease centers or openings. BSRD was also found on scattered isolated trees having no visible crown symptoms.

2. There was a higher incidence of trees with root disease than would be suspected from crown symptoms.

3. There was little indication of insect activity on the roots. Even where there was some incidence of ambrosia beetles and blue stain, the crowns still looked relatively good.

4. Heterobasidion annosum (Fr.) Bref was wide spread and present on many excavated trees.

5. Most trees had combinations of blue stain, annosus root disease, and BSRD.

6. Ponderosa pine on this site survived in some cases with an amazingly small number of functional roots. In some cases, only 10-15% of the cambium was still alive as tallied on roots near the stumps of trees having a green crown. In some cases, trees with healthy appearing crowns had only 20% of their roots alive.

7. There was some evidence of active defense mechanisms. Some trees appeared to have "calloused off" infected roots so that the fungus never reached the root collar. Other trees had stained wood on most roots and root collars with no evidence of callous tissue being formed.
From lab analysis:
8. Some volatile compounds from increment cores collected from the stem base showed quantitative differences and could be used to accurately separate diseased and healthy trees.

9. Annual increment growth was unrelated to whether the trees were diseased or healthy. Among the "most diseased" trees were both the largest and smallest annual increment for the last 5 or 10 years.

1996 effort

The 1996 and 1995 digs were conducted in the same stand. Twenty- nine live trees with BSRD, representing a range of crown symptoms, and 10 healthy trees were tagged. Each selected tree was measured for dbh (16.0 to 55.5 cm), and the crown photographed. An increment core was removed from the north face at BH to measure growth; four cores were removed at the stem base in the cardinal directions for chemical analysis of volatiles. These samples were collected the day before tree removal, and stored on dry ice for transport to the laboratory. Diseased trees were initially selected based on crown symptoms and then confirmed to have stain typical of BSRD at the base

of the stem. Healthy trees were initially selected based on healthy appearing crowns and each was selected from an area with no apparent BSRD. During root examination healthy trees were confirmed to be free of BSRD or other disease at the base of the stem and in the roots. Immediately after the trees were pushed over the terminal and two dominant laterals from the second whorl were clipped and bagged for later measurement of growth and needle densities. The trees were then carried by a grapple skidder to a landing where the stems were severed and the roots cleaned and processed.

Root systems were cleaned of soil and roots were clipped at intervals beginning from the distal end and examined to detect any root disease. Each major root (>5 cm diameter) was cut approximately 30 cm from the root collar and evaluated. If the root appeared either 100% functional or 100% diseased, the circumference was measured and noted; alternatively, a disk 2-6 cm thick was collected for measuring later. Notes were made on disease incidence on whole root systems as they were cleaned and cut.

1996 results

The analysis of the volatile compounds is yet to be completed, but we can address frequency of specific diseases in the diseased trees (Table 1). Of 28 diseased trees (selected based on probability of having BSRD) 27 had BSRD. All 27 trees with BSRD had some other recognizable root disease; 20 had annosus root disease. Of 21 trees with annosus, 20 had BSRD. All 16 trees with blue stain in the roots also had BSRD. There was very little evidence of current or past insect activity to be found.

To provide some example data, photos were used to select three trees with different crown symptoms, one healthy and two diseased (moderate and severe), representative data were then summarized (Table 2). Based on these three trees, there were some surprises: (1) Viable roots--The biggest surprise was that the severely diseased tree was still alive and making good increment growth with only 18% of its root system functional. This is consistent with observations made in 1995. (2) Diameter growth--The two diseased trees historically grew faster than the healthy tree. Even the diseased tree with the fewest viable roots grew almost twice as fast as the healthy tree. (3) Needle retention--Diseased trees held their needles as long as the healthy trees. The characteristic "lion tail" symptom of diseased trees may be best explained by limited shoot growth rather than by needle retention or low needle numbers. These data should be very interesting when they are complete.

Summary

We went to the Burns Ranger District knowing there was blackstain root disease present. We discovered that blackstain root disease is more widespread and at a much higher frequency than we previously thought. The root disease situation is not simple. Trees with blackstain have other root diseases as well. Crown symptoms are only an indicator of tree condition. At present it appears there is no one disease responsible for decline and death of ponderosa pine on the Burns Ranger District. What is the role of the insects in this problem? What is the role of fire, or lack of it, in this decline of ponderosa pine? We have more questions now than when we started, and we invite you to grab a shovel, pick or pulaski and join us to help solve this mystery.

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Table 1. Percent of diseased trees with various disease symptoms and insect boring activity. Total number of diseased trees = 29.

Diseases and beetle incidence	% of diseased trees
Black stain	96%
Blue stain	57%
Annosum decay	75%
Resinosis	82%
Black+Annosum	71%
Fresh beetle frass	13.8%

Table 2. Root and shoot characteristics of ponderosa pine with different degrees of crown symptoms (June 1996).

Root and shoot characteristics	Severe crown symptoms (#38)	Moderate crown symptoms (#45)	No crown symptoms (#24)
DBH (cm)	23.5	26	29
5 yr annual increment (mm/yr)	0.60	0.12	0.77
25 yr annual increment (mm/yr)	1.74	1.2	0.66
Root cross-sectional area (sq.m)	0.19	0.09	0.12
Functional root (%)	18	34.1	100
Terminal shoot characteristics			
Needle retention (yr)	5	4	5
Stem length (cm) y_0	1.3	1.1	3.5
y_1	2.5	2.5	10.7
No. needles y_0	38	22	99
y_1	41	23	104

y_0 = current year; y_1 = last year.

Molecular Systematics of *Rhabdocline* and Closely-related Foliar Pathogens.

David S. Gernandt and Jeffrey K. Stone
Department of Botany and Plant Pathology
Oregon State University
2082 Cordley Hall, Corvallis, Oregon 97331-2902

INTRODUCTION

Numerous ascomycetous fungi are abundant and widespread as pathogens, neutral symbionts, and commensal saprobes of twigs and leaves of conifers. The inoperculate discomycete orders Rhytismatales and Helotiales are comprised of many such pathogens and inconspicuous, asymptomatic endophytes. The host specificity, distribution, and ecological and morphological diversity of foliar fungi make them an excellent model system for studying cospeciation between plants and fungi.

Although many genera of foliar fungi are pathogens of economically important conifers, the framework of their systematic relationships at the ordinal level and below remains tenuous and based on few reliable morphological characters. Currently, the majority of genera of inoperculate discomycetes associated with conifer foliage are disposed in two orders, Helotiales and Rhytismatales. The Helotiales is a large and ecologically diverse order that, besides foliar fungi, includes ground-inhabiting, fleshy members of the Geoglossaceae and Helotiaceae, and lichenized forms of the Baeomycetaceae and Icmadophilaceae. The Rhytismatales is comprised of parasites and saprophytes primarily on foliage but also on bark and wood. Many members of these orders are endophytes--generally asymptomatic colonists of live tissue. The two orders are defined by characters that overlap in several respects. Most notably, fungi in these two orders possess sheathed or unsheathed ascospores, the ascus tips of some turn blue in iodine, and they include both pathogens and innocuous endophytes.

Hemiphacidiaceae was erected in 1962 by Korf to include plant parasites and saprophytes with a poorly developed excipulum, with ascomata that rupture overlying host tissue, and that lack a stromatic layer above the asci. The ascospores of several members of the Hemiphacidiaceae form septa and become pigmented late in development, sometimes following discharge from the ascus. All members are known exclusively from conifers, however it should be noted that this trend may be artificial, for Korf (1994) remarked that the Hemiphacidiaceae is more of an ecological than a phylogenetic group. This sentiment is controversial, yet ecological role and variability with respect to the ascus tip are characters also cited as justification for the transfer of genera from the Hemiphacidiaceae to the Rhytismatales (Minter 1994). Genera originally included in Hemiphacidiaceae are considered by some workers to belong to either the Rhytismataceae or Rhytismatales *incertae sedis*. These include *Rhabdocline*, *Cyclaneusma*, and *Darkera* (Hawksworth et al. 1995). Genera retained in the Hemiphacidiaceae include *Didymascella, Fabrella*, *Hemiphacidium*, *Korfia*, and *Sarcotrochila*. The tenuous systematic framework for Helotiales and Rhytismatales makes it difficult to identify the closest relatives to *Rhabdocline.*

Rhabdocline is characterized as having immersed fruit bodies with little or no stromatic or excipular tissue, capitate paraphyses, and ascospores that become one-septate with one brown cell and one hyaline cell upon germination. Asci either possess an apical pore that turns blue in Meltzer's iodine reagent (*R. weirii*, *R. parkeri*), or lack it (*R. pseudotsugae*). The genus presently contains five subspecies of two species which are pathogens of a single species of *Pseudotsuga* (Parker and Reid 1969) and a single endophytic species on the same host (Sherwood-Pike et al. 1986). Although all these fungi are found on the same host, niche separation is achieved through differences in geographic distribution, anatomical location and by symbiotic role. The anamorphic state of *Rhabdocline parkeri*, given the form-name *Meria parkeri,* bears a strong morphological similarity to the needle cast pathogen, *Meria laricis,* a (presumed) obligately asexual species that has been reported on three species of *Larix.* The connection between *M. laricis* and *Rhabdocline* has been demonstrated based on nucleotide sequence evidence from the ITS region (Gernandt et al. in review). The most recent Dictionary of the Fungi (Hawksworth et al. 1995) is equivocal on the placement of *Rhabdocline*. While the main entry places *Rhabdocline* in Rhytismatales *incertae sedis*, the systematic arrangement towards the back places it in Rhytismataceae.

Nucleic acid sequences for the internal transcribed spacer region (ITS-1, 5.8S, and ITS-2) of nuclear ribosomal DNA have been gathered for *Rhabdocline* species and several other inoperculate discomycetes. Recently, we have used phylogenetic analysis to demonstrate that *M. laricis* forms a monophyletic clade with *Rhabdocline*. In an effort to generate a robust phylogeny for the genus *Rhabdocline*, we have undertaken the search for a close relative. Substitutions in the internal transcribed spacer region accumulate quickly enough to allow its use in reconstructing phylogenies at the approximate level of genus and species. However, across longer evolutionary time scales, point mutations and insertion-deletion events along the ITS region accumulate until sites become saturated, making the region unsuitable for comparisons of more distantly-related groups. Keeping this potential problem in mind, we have attempted to use the ITS region to make a preliminary evaluation regarding the ordinal placement of *Rhabdocline* and to identify candidates for its sister genus.

MATERIALS AND METHODS

Genera included in the analysis have been disposed variously in the families Hemiphacidiaceae, Helotiaceae, Phacidiaceae, Sclerotiniaceae, and Rhytismataceae. Sequences for *Sclerotinia sclerotiorum* and *S. trifoliorum* were obtained from Genbank (M96382 and U01218, respectively). *Rhabdocline parkeri, M. laricis, Chloroscypha seaveri* and *C. chloromela* were isolated from needles surface-sterilized in 95% ethanol for 60 s followed by 5 min in 2% NaOCl and 60 s in 95% ethanol. Isolates were maintained on potato dextrose agar (Difco) supplemented with 0.1% malt extract and 0.1% yeast extract, (PDMYA). Because isolates of *R. pseudotsugae* and *R. weirii* are difficult to obtain in culture, DNA was extracted directly from apothecia dissected from diseased Douglas-fir needles. Needle segments bearing apothecia were ground in liquid nitrogen and the fungal ITS region was selectively amplified by the use of primers specific to fungi and not to plants. Whole apothecia of *Mitrula elegans* and *Chloroscypha enterochroma* were used. The remaining specimens were provided as cultures from other institutions. Cultures were either grown for 7-21 d in potato dextrose broth (Difco), or were scraped from PDMYA plates prior to DNA extraction. DNA was extracted from either pure fungal cultures or needles bearing apothecia using the CTAB method of Doyle and Doyle (1987).

Primers used for amplification and sequencing of the internal transcribed spacer region of nrDNA were ITS5, ITS4, ITS3, and ITS2 (White et al. 1990). Presence of an intron in the small subunit necessitated the use of an additional forward primer for sequencing. The primer, SSUEND (5'GAACCTGCGGAAGGATCATTA3'), was designed to anneal to a site on the last 21 bases (3' end) of the small subunit. Sequences were assembled and edited using Genetic Data Environment (GDE) (Smith et al. 1994). Sequence data for the ITS region were aligned using the PileUp option in Genetics Computer Group (GCG 1991) (GapWeight = 1.0, GapLengthWeight = 0.1) and further adjusted by eye in GDE. Sequences were analyzed using PAUP v. 3.0s+4 (Swofford 1993). Tree-bisection reconnection and random sequence addition were used in a heuristic search with 50 replicates. Bootstrap values were generated using 100 replicates.

RESULTS

The taxa sampled formed three main clades in the analysis (Figure 1). One clade comprised the three species of *Chloroscypha*. The three species sampled had a region of 21-120 base pairs in the ITS-1 regions that was not homologous to sequences of other taxa included in the analysis. Sequence divergence within the genus was high relative to that found in *Lophodermium, Sclerotinia,* and *Rhabdocline*. The second clade comprised the three genera of Rhytismataceae, *Lophodermium, Colpoma,* and *Tryblidiopsis*, The third clade, supported by a 71% bootstrap value, comprised all the *Rhabdocline* taxa, including *M. laricis*, and the Helotialian taxa *Sclerotinia sclerotiorum, S. trifoliorum, Fabrella tsugae, Phacidium infestans,* and *Mitrula elegans*. Also in the clade and grouped together at a node supported by a 95% bootstrap value were *Darkera parca*, and *Cyclaneusma minus*. Slight adjustments in the sequence alignment resulted in three taxa, *Mitrula elegans, Darkera parca,* and *Cyclaneusma minus,* migrating out of this clade and occupying a position that was basal to the Helotiales and Rhytismataceae clades (data not shown).

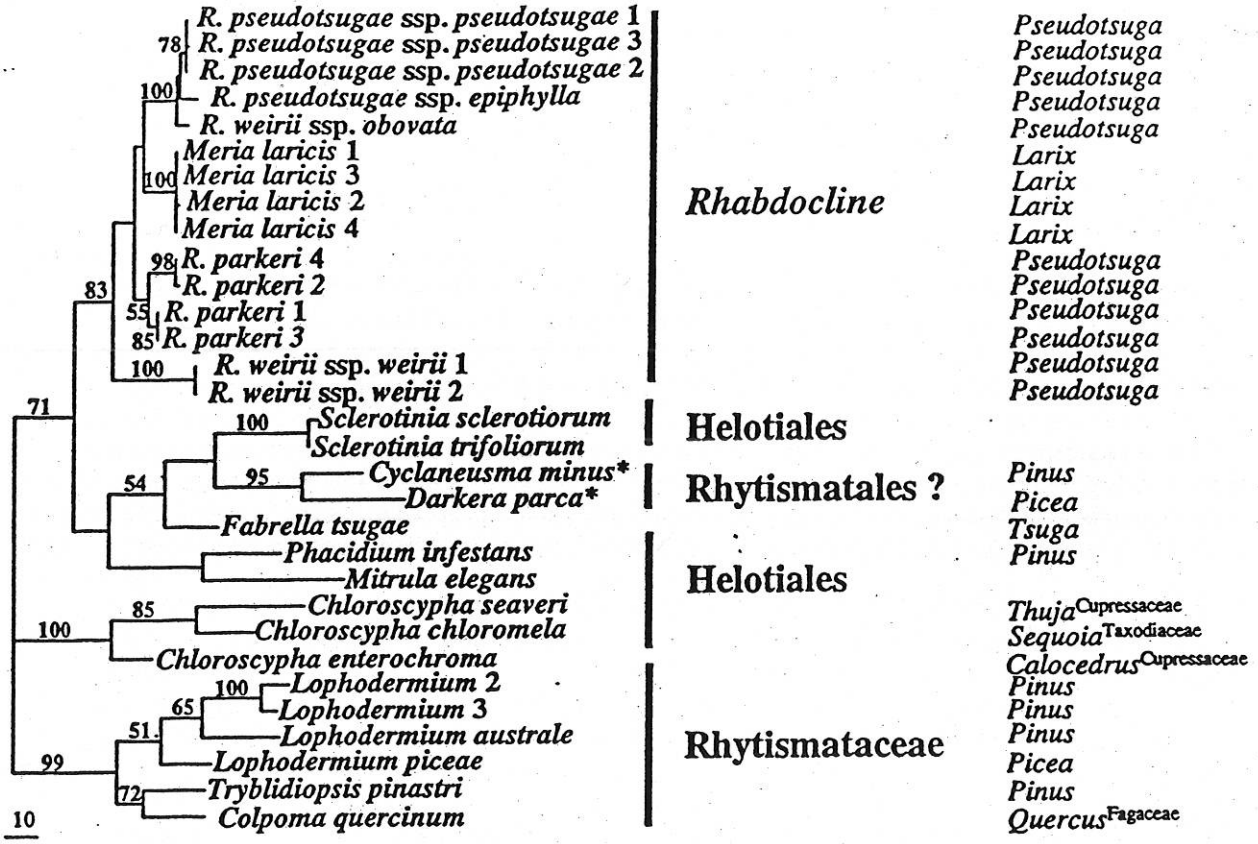

Figure 1. ITS region phylogeny of inoperculate discomycetes. One of six most parsimonious trees (737 steps, CI=.574, RC=.464). Small nucleotide differences in taxa represented by multiple isolates (*M. laricis* and *R. pseudotsugae*) explain variation in the other five trees. *Rhabdocline* is monophyletic and includes *Meria laricis*. Moderate bootstrap values (71%) support a sister relationship with Helotialian fungi. Rhytismataceae is monophyletic, and the two taxa with asterisks, together with *Rhabdocline* are considered by Hawksworth et al. (1995) as either members of Rhytismatales *incertae sedis* or placed in the Rhytismataceae. These two taxa occupy a position basal to the Rhytismataceae clade in other analyses (Gernandt et al., in review).

Two species of *R. weirii* ssp. *weirii* had identical sequences. The two occupied the basal position in the *Rhabdocline* clade, but bootstrap support was less than 50%. Two ITS types of *R. parkeri* were encountered, one type (*R. parkeri* 2 and *R. parkeri* 4) was encountered with isolates taken from Wyoming, and the other type (*R. parkeri* 1 and *R. parkeri* 3) was encountered with isolates from Oregon. *Meria laricis* isolates from the northwestern U.S. larches, *L. lyallii* and *L. occidentalis* formed a monophyletic group. There is a single substitution in *R. pseudotsugae* ssp. *pseudotsugae* 3 from Pennsylvania that separates it from the *R. pseudotsugae* ssp. *pseudotsugae* isolates from Oregon. *Rhabdocline weirii* ssp. *obovata,* represented by only one sample, occupied a position basal to the two subspecies of *R. pseudotsugae* that was supported by a 100% bootstrap value.

DISCUSSION

Unpublished notes, camera lucida drawings, and correspondence to Dr. T. R. Peace by Dr. T. Childs (1938) showed that he collected the fungus later designated *R. pseudotsugae* ssp. *epiphylla* Parker & Reid from diseased Douglas-fir trees at Mt. Hebo, Oregon, and that he recognized this fungus as a unique taxon. In addition to the epiphyllous habit, this taxon is distinguishable from *R. pseudotsugae* ssp. *pseudotsugae* by its distinctly clavate paraphyses. This fungus was collected earlier by J. R. Weir (1923) and later by us (1996) on young, naturally regenerating Douglas-fir from the same locality. Thousands of acres in the Mt. Hebo area burned in the 1930's and were replanted with *P. menziesii* seed from an unknown source. All or part of the seed used could have been from the interior variety of *P. menziesii,* but it seems more likely that it was from a nearby, coastal source. This subspecies is

apparently locally endemic and may specialize on certain host genotypes, since it is not as widespread in occurrence as *R. pseudotsugae* ssp. *pseudotsugae*. Nearly all collections of *R. pseudotsugae* ssp. *epiphylla* described by Parker and Reid (1969) were made from the Coast Range in western Canada and the northwestern U.S. We have also made another collection of this subspecies near the Molalla Watershed in the west Cascades of Oregon.

The biogeography of the *Rhabdocline* taxa associated with Douglas-fir suggests that the fungal parasites are undergoing host-mediated isolation and speciation. *Pseudotsuga menziesii* is the most abundant and widely-distributed *Pseudotsuga* species. The range of the coastal variety extends from British Columbia south to California, and the interior variety is further divided into northern and southern forms that extend inland along the Sierra Nevada Mountains, and from British Columbia to central Mexico along the Rockies. The pollen of *Pseudotsuga* (and *Larix*) is nonsaccate and disperses poorly by wind. This morphological feature has been used to explain the restricted gene flow between and among populations that maintains the three host varieties (Li and Adams 1989). Varieties of *P. menziesii* are differentially susceptible to "*Rhabdocline* needle cast". When progeny from the three host varieties are grown in humid environments favorable to infection by the pathogenic *R. pseudotsugae* ssp. *pseudotsugae*, the southern form is most susceptible, the northern form is slightly less susceptible, and the coastal form has a high level of resistance (Stephan 1980, Hoff 1988). Within each region, susceptibility among siblings varies, and seems to increase in drier or colder high elevation locations unfavorable for ascospore infection of flushing buds.

The distribution of *Rhabdocline* throughout the range of *P. menziesii* varies according to species and subspecies. The distribution of *R. pseudotsugae* ssp. *pseudotsugae* has been documented on all varieties of *P. menziesii* Parker and Reid (1969) and is also found in the eastern United States and Europe, where *P. menziesii* has been introduced. Other pathogenic *Rhabdocline* taxa appear to have a more restricted range. *Rhabdocline pseudotsugae* ssp. *epiphylla* has only been reported from the coastal region, *R. weirii* ssp. *weirii* and *R. weirii* ssp. *obovata* have mostly been reported from northern interior hosts, and *R. weirii* ssp. *oblonga* has been reported primarily from the southern interior hosts (Ellis and Gill 1945, Parker and Reid 1969). Weakly-supported topological features of the *Rhabdocline* clade (Figure 1) suggest that the northern interior *Rhabdocline* taxon, *R. weirii* ssp. *weirii*, represents the oldest extant line. We have not determined the ITS region sequence for *R. weirii* ssp. *oblonga*, which is known primarily from the southern interior region and shares the most morphological similarity with the northern interior taxon.

Although taxonomists have recognized that the iodine ascus pore reaction can be variable (Baral 1987, Kohn and Korf 1975), it is still relied upon in various instances. Parker and Reid separated the species *R. pseudotsugae* and *R. weirii* based on the I^+ ascus pore reaction. The grouping of *R. weirii* ssp. *obovata* with the two subspecies of *R. pseudotsugae* rather than with *R. weirii* ssp. *weirii* in our analysis provides preliminary evidence that this character has been overemphasized in *Rhabdocline*.

Support for monophyly of the *Rhabdocline* taxa, including *M. laricis*, was upheld in our analysis. Another *Meria laricis*, from European *L. decidua*, while exhibiting slight differences in its ITS region, was monophyletic with this group in other analyses (data not shown). The phylogenetic placement of *Rhabdocline* remains unresolved. *Rhabdocline* occupied a basal position of a Helotialian clade in our analysis, but this placement had only moderate support. Two promising directions of research are the sampling of additional specimens, including *R. weirii* ssp. *oblonga*, and the use of another locus to resolve questions regarding the evolutionary relationships of Helotiales and Rhytismatales on conifer hosts.

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A Destructive Epidemic of Swiss Needle Cast in Coastal Forest Plantations

Lori Winton, Bryan Cappitano, Pablo Rosso, Wendy Sutton, and Everett Hansen
Department of Botany & Plant Pathology
Oregon State University
Corvallis, OR 97331

History & Background

Ten years ago, few people were aware of a foliage disease problem in the scattered Douglas-fir plantations in the Tillamook area of western Oregon. As damage became visible in more and more plantations the problem came to be called the Tillamook decline or disorder. Two years ago this was recognized to be an epidemic of Swiss needle cast, a largely historical disease. In the 1920's, Swiss needle cast and the fungus that causes the disease, *Phaeocryptopus gaeumannii*, were described as devastating Swiss Douglas-fir plantations with the characteristic symptoms of chlorotic needles, low needle retention, and poor height and diameter growth. From Switzerland the disease spread to Germany and the rest of Europe. The disease has since limited the use of Douglas-fir in New Zealand, the eastern United States, and Christmas tree plantations, wherever Douglas-fir has been grown far from its native range. A survey conducted in Oregon and Washington in 1938 found the fungus to be present throughout the Douglas-fir range, but never damaging. So what then, has changed? The two main hypotheses addressed by this study are: 1) that the environment in the Spruce-Hemlock zone, where the disease is most prevalent, favors the pathogen. and 2) that there is a new, more virulent strain of the fungus

Experiments in Progress

1. Epidemiology of SNC in the Tillamook area.

Tests designed to determine environmental conditions associated with spore release and needle infection address the hypothesis that conditions in more severly diseased areas favor spore infection.

a) **Weather and Spore Release.** The correlation between microsite weather and spore release is being tested at nine field plots through weekly weather records and spore trapping data. Nine plots have been installed in three clusters. Each cluster includes one plantation with moderate or severe disease, one with visible but not obviously damaging disease, and one healthy plantation. Disease level is estimated by needle color and retention. Each plot has spore traps and a weather station recording temperature, relative humidity, and rainfall. In each plot 10 or 20 trees are measured weekly for budburst and elongation of lateral branches.
Preliminary Results: Lower elevation plots with more serious disease were generally warmer and drier through the months of April, May, and June. Budburst occurred 1-2 weeks earlier at these sites. *Phaeocryptopus* spores were trapped before budburst at all sites.

b) **Exposure period and infection levels.** The correlation between the length of time needles are exposed to inoculum and subsequent level of infection is being tested at the six test plots with visible symptoms. Branch tips were bagged before budburst to prevent contact with airborne spores. Bags were removed at intervals through the growing season and shoots will be evaluated to determine periods of infection.

c) **Soil, weather, and Exposure.** Potted 2-year-old Douglas-fir seedlings are used for a three factor test (environment, inoculum exposure, and soil) on infection and disease development. Seedlings are potted in soil from a severely diseased plantation or in soil from a healthy area inland in the Coast Range. Fertilizer amendments provide additional treatments. Seedlings are moved back and forth between a Corvallis site with little or no inoculum and a heavily infected Tillamook site.

2. Impact of *Phaeocryptopus* infection on growth and needle retention of Douglas-fir.

Although the fungus is constantly associated with diseased trees, it is also present on trees with minimal symptoms. These experiments are designed to test the relationship between infection and actual damage.

a) **Needle Retention.** The correlation between pseudothecia and needle retention will be tested. At 8 of the test sites branches were collected and pseudothecia counted on a sample of needles from each needle complement. On this sample, measured before budburst this spring, the proportion of stomata occupied by the fungus on 1995 needles was positively correlated (R^2=.73) with needle retention. Trees holding only 1995

needles had a high proportion of those needles occupied by the fungus. Trees holding 2, 3, or 4 years of needles showed progressively fewer pseudothecia on 1995 needles, and increasing numbers on older needles, Apparently needles are retained on the tree until about 50% of the stomata are occupied.

b) **Growth.** Height growth increment for each of the last 5 years and spring wood/summer wood ratio is measured. In this sample, there was a negative correlation ($R^2 = .66$) between the number of years needles were retained and the summer/spring wood ratio. In general, trees from severely and moderately infected plantations possessed disproportionately large amounts of summer wood. Trees from healthy plantations retained up to 5 years worth of needles and possessed more normal ratios. Mildly infected plantations were intermediate.

3. Conditions of infection and development of *Phaeocryptopus gaeumannii* in Douglas-fir.

Clarification of the conditions and mechanisms of spore infection and subsequent development of the fungus on and within needles are addressed by the following experiments.

a) To determine conditions for infection of Douglas-fir needles through artificial inoculation under controlled environmental conditions an inoculation chamber has been constructed and tested using naturally infected Douglas-fir, as well as macerated mycelium as inoculum sources.

b) A time course developmental study of the fungus using surface visualization and needle clearing techniques will be undertaken this fall to check the validity of the reported asexual stage. Needles were collected and preserved weekly throughout the growing season for analysis of fungal development within needle tissues.

c) Measure vegetative growth of the fungus on and within needles to assess the importance of this method of increase as an explanation for varying levels of disease severity under various environmental conditions.

4. Detection of *Phaeocryptopus gaeumannii* in Douglas-fir needles.

At present there is no way to determine infection of current year needles before late December. However, many of the experiments underway as well as immediate concerns in the field could be greatly facilitated by early detection and quantification of the fungus in needles.

a) **Needle Clearing.** Of the many needle clearing and staining protocols tested, needle clearing in KOH and fungal staining with trypan blue allows microscopic visualization of hyphae within and on the needle surface.

b) **Surface Visualization.** Epifluorescence microscopy of needle surfaces stained with DAPI and microscopic examination of epidermal peels are quick and efficient and will be useful in identifying infection points..

d) **Fungal Isolation.** Direct isolation from needles and culture of the fungus on selective media is presently the best approach for surveys requiring assesment of infection in needles.

e) **DNA Probes.** We have amplified *Phaeocryptous* DNA from a bulked sample of 10 visibly infected needles. Quantitative DNA amplification or probe development from amplification products could be developed to detect and perhaps quantify the fungus in needles.

5. Genetic variability in *Phaeocryptopus*

Although less likely it is possible that the Tillamook epidemic is the result of a new, more virulent strain of the fungus. We are addressing this question using DNA and pathogenicity markers.

a) **Population Structure.** A preliminary study using DNA fingerprinting as a means to estimate genetic variabiltiy within *P. gaeumannii* has been completed. We used a small subset of over 200 isolates cultured from populations throughout western Oregon and Washington and a population from Pennsylvania. Although initial sample size was too small for conclusions it is evident that there is significant genetic variability in *P. gaeumannii*. There are suggestions of geographical clustering with Oregon, Washington, and Pennsylvania isolates each grouping separately, although as yet without strong support.

b) **Phylogenetics.** *Phaeocryptopus* is a member of the Venturiaceae, an ascomycete family consisting of12 genera including *Venturia*. *Venturia inequalis*, causal agent of apple scab, is the closest relative causing a well-studied disease. Comparisons of ribosomal DNA sequences of *P. gaeumannii* with other loculoascomycetes have not placed *P. gaeumannii* in either of the proposed orders of the Venturiaceae. We are searching for other members of the Venturiaceae as well as the other 4 species of *Phaeocryptopus* to investigate familial and ordinal evolutionary relationships of the Venturiaceae.

Panel - Natural And Prescribed Fire---Burning Issues For Pathologists?

CATHERINE PARKS - MODERATOR

Overview

Catherine Parks
Research Plant Pathologist
USDA Forest Service
Forestry and Range Sciences Laboratory
La Grande, OR

Wildfire--Already this year, as of the end of August, nearly five million acres of forested land have burned from wildfire in the Western states. During the last few weeks, large fires have continued to burn suggesting the acreage burned in 1996 will exceed records of over 125 years.

The large numbers of acres burned in just this year seem impressive, yet the acreage burned was only a fourth of the average acreage historically burned by wildfire across the west. Estimates by Jim Agee in "Fire Ecology of Pacific Northwest Forests" report 800,000 acres burned annually in prehistoric Oregon. In ponderosa pine type, fire scars display evidence that fires burned in stands every nine to 15 years.

Until recently we have considered forest fires nature's way of stealing timber. Now we have come to realize that by our pervasive prevention we have assured any near-future fires to burn hotter than ever possible before.

Prescribed fire--Beyond the acreage burned in wildfire, prescribed fires will be ignited across the landscape. Largely, in an so-called effort to "fight fire with fire", public land managers had an additional 750,000 acres of prescribed fire planned for this year. This amount is projected to increase annually to equal three million acres in 2003. The U.S. Forest Service wants to undo what 80 years of fire suppression has created: dense, fuel-filled forests ripe for devastating fires.

This abrupt change in paradigm for forest management is not without controversy. Some see the reintroduction of fire as simply a social issue. They feel that biologically speaking, forests of the west should be returned to a more natural fire regime...after all the West's forest ecosystems have adapted and coevolved with fire. The ecosystem is actually dependent on fire--one of the most important agents of change--to stress populations and eliminate those individuals that are poorly adapted. Still other biologists and ecologists disagree as to whether the change can be implemented without disastrous ecological consequences.

Stands that once burned on regular intervals now have 10 to 20 times as much above-ground biomass as they supported under more natural conditions. Fire resistant tree species have been replaced with dense stands of fire susceptible species. To burn or not to burn? The questions that follow the controversy to managers are...What is the proper use of fire in managing forests? What will a fire do to long term productivity? Is there even a choice to "not burn" anymore? In the last few years, report long-time fire experts, fires are burning hotter, have the ability to move faster, and are harder to extinguish, than in previous fire-suppression history.

What are some issues that face forest pathologists? Some factors are those that affect disease susceptibility and future productivity of forests. Other issues, such as salvage, deal with the value of the timber commodity.

- Tree Stress
  short term (wounds) and long term.
- Stand Stress
  short term (soil erosion) and long term
- Salvage
- Suppression

Tree and stand stress and disease susceptibility--Little evidence suggest that there are direct effects of fire on forest pathogens. Years ago there was some thought that Rhizina root rot (*Rhizina undulata*) may become a major seedling killer of Douglas-fir when fire was included in site preparation. This relationship has remained unsubstantiated.

Well documented is the relationship of dwarf mistletoe and fire---stand replacement fires have been a limiting factor of dwarf mistletoe spread throughout Western stands.

Largely the only obvious direct relationship between fire and pathogens is the potential effects of wounding of the bole or root system. These wounds not only stress the tree but provide infection court for heart-rot fungi. Stress from root loss may also make an individual trees more susceptible to root disease and decay pathogens.

Conversely, tree and stand stress may actually be reduced if high stocking conditions are reduce due to diffuse tree mortality in the stand. Weak, fire-intolerant, or mistletoe infected trees are more susceptible to mortality and may improve the over-all vigor and condition of the remaining trees. The trees surviving fire are often those best adapted to the growing conditions of the stand.

Salvage--In burned stands what is the value of the timber commodity? What is the window for harvest? Our first speaker Jim Hadfield will review data collected from timber burned in Southeast Washington.

Suppression--What are the changes in species composition, and successional processes that alter the risk of disease in stands where fire is excluded? Paul Flanagan will use subalpine ecosystems to model that association in his discussion.

After our speakers we will have a "mop-up" discussion. Any questions to the speakers will be appropriate and also perhaps a general session on the questions: Will reintroduction of fire improve the disease related conditions of the wests forests? Or can silviculture replace the role of fire?

Wood Changes in Fire-killed Eastern Washington Tree Species - First-year Progress Report

J. Hadfield
Area Forest Pathologist
Wenatchee National Forest
Wenatchee, WA

A study was established in eastern Washington in 1994 to measure wood changes in trees killed by fires. The study is planned to last five years, with annual sampling of trees. Tree species include Douglas-fir, ponderosa pine, lodgepole pine, grand fir, subalpine fir, Engelmann spruce, and western larch.. A sample of trees is felled and cut into log lengths each year. Measurements are made on location and frequency of cracks, stain, saprot, char, insect holes and several other wood changes.

One year following death by fires numerous changes had taken place in all tree species sampled. Wood changes varied greatly by tree species. Detailed accounting of the wood changes by tree species is provided in a progress report. A very low percentage of wood volume was affected by charring for all seven tree species. A high percentage of the sapwood of ponderosa pine, lodgepole pine, western larch, grand fir, and Englemann spruce was stained at the end of the first year. There was minor staining in Douglas-fir and subalpine fir. There was very little saprot present in any tree species at the end of the first year. Saprot was beginning in several of the grand firs sampled, but wood volume affected was less than one percent. Cracking was most common in subalplne fir, grand fir, Englemann spruce, and western larch. Ponderosa pine had almost no cracks. Most trees had been attacked by several species of wood boring insects. All western larch had numerous attacks by these insects. Douglas-fir was the least altered tree and grand fir was the most altered one year after tree death.

Ecological Relationships Among Disturbance Agents in a Subalpine Forest

P. Flanagan
Area Forest Entomologist
Wenatchee National Forest
Wenatchee, WA.

Methods--Eighteen polygons with similar aspect and slope were randomly selected in the upper Entiat valley. Within a polygon, several stand types were identified from aerial photographs. Five transects, 30 feet wide, were drawn across each polygon, oriented to cross each stand type. All mortality within a transect was recorded. Vegetation and fuel data were taken from plots in each stand type. About 93 miles were traversed, and over 800 cores were taken. Fire history was determined from a variety of sources.

Variables Groups--
(1) disturbance agents: animals, beetles, weather, root disease
(2) silviculture: conifer species, stand type, layer
(3) abiotic: distance from Cascade crest, elevation, aspect, slope
(4) fire: time since last fire, percent burned in last fire, fuel load

Preliminary Results--Chi square analyses of contingency tables show aspect/slope differences for the following variables:

Beetles. South slopes and steeper aspects have more trees killed by beetles.

Root disease. Most of the root disease found was caused by Armillaria. Armillaria was found more frequently associated with tree mortality on south aspects than north.

Animal girdling (porcupine and bear). There were too few observations for contingency table; a Wilcoxon test found more animal girdling occurred on south than north aspects.

Weather (wind and snow): More mortality occurred on moderate slopes, north aspects.

Ongoing Analysis--Similar tests will compare variables or groups of variables. Two examples, 1) animals, white pine blister rust, and wind and snow killed codominants preferentially while bark beetles killed dominants most often; and 2) subalpine fir and lodgepole pine were killed most often overall, although NO recent mountain pine beetle had occurred.

A satellite study that exclusively evaluates **Mortality of whitebark pine** and specifically looks at white pine blister rust (WPBR) was also conducted this year. Data from this study supports other published information reporting that Cascade whitebark pine populations appear to be less affected than populations in the northern Rockies. WPBR can be found in all areas where whitebark pine occurs but mortality appears to be significantly lower and reproduction higher than in some of the studies conducted in the Northern Rockies. Whitebark pine, based on the sites we've seen so far, has quite a lot of bole feeding by black bears. Some trees are girdled in one season, others are girdled in successive seasons.

Panel - Forest Pathology and Wildlife

DONALD GOHEEN - MODERATOR

Management Implications of Maintaining Douglas-fir Dwarf Mistletoe Brooms for Wildlife Use

Katy Marshall
Southwest Oregon Forest Insect and Disease Technical Center
Central Point, Oregon 97502

WHY MAINTAIN BROOMS FOR WILDLIFE?

On federal lands covered by the Northwest Forest Plan, the Record of Decision mandates that we maintain late successional and old growth species habitat and ecosystem processes and characteristics. The focus is in Late Successional Reserves, but even on land that is managed to produce timber (the matrix) we need to provide habitat refugia for late successional-associated species so that there will be connectivity of habitat between late successional reserves. Early on the focus was on the size and structure of the trees, but more recent studies have increased awareness of the importance of other habitat elements such as Douglas-fir dwarf mistletoe (DFDM) brooms.

WHAT IS UNKNOWN

Most dwarf mistletoe research in the past focused on how the disease affected the trees and how to reduce the impacts of these effects. When we start planning to maintain DFDM in stands as well as trying to control it, it turns out that there is very little specific information about how wildlife use DFDM brooms and how the brooms develop. For example:

* How much DFDM is enough? Could we leave the nest tree and sanitize the rest of the stand, or leave one clump of infected trees around the nest, or do we need to leave brooms scattered around the entire stand?
* Would brooms in the lower crown be sufficient (where they have less impact on the host) or do they need to be throughout the tree?
* Would some species use other structures such as cavities or fir broom rust brooms with equal success?
* How do brooms develop in individual trees and stands over time? How did large trees with large brooms develop? How long does it take?
* At a larger scale, how many infected stands are necessary across the landscape?
* How do the levels of DFDM infection and wildlife use of brooms today compare with the levels that existed prior to fire exclusion?

CURRENT RESEARCH

A number of people have started researching these questions, especially those dealing with specific information about what animals are using. Spotted owls are a major emphasis right now because of their legal status and their use of DFDM brooms as nest platforms in several areas of their range.

* One of the earliest studies was done by Sandy Martin, Jerry Beatty, and Frank Hawksworth. They characterized spotted owl nests and nest stands in the Eastern Washington Cascades by broom size and dwarf mistletoe rating (DMR). They also compared stands with and without nests. Some preliminary results were presented in 1992 but the final results of this study have not been published yet.
* Catherine Parks is currently working on a proposal for a study of wildlife use of DFDM brooms in northeastern Oregon. She hopes to look at the amount and type of use and whether it is different in brooms that are in isolated trees versus trees in groups.

* A study by Oregon State University and the National Biological Survey will relate demographic performance of spotted owls in southwestern Oregon with structural characteristics of their habitat, including dwarf mistletoe brooms.
* Mario Mamone (Wildlife Biologist, Applegate Ranger District, Rogue River National Forest) and I are planning a study that will characterize DFDM and other elements of owl nest trees and nest stands in the Siskiyou Mountains in southwestern Oregon.

Once we know what animals are using the next question is whether we can recreate these patterns of infection to provide adequate amounts of habitat over time and space without creating stands that are so impacted by dwarf mistletoe that they have little potential for growth and development that will meet any objective.

CONFLICTS

Past research and management has made us well aware of the potential for creating these severely impacted stands. We know DFDM has significant effects on the growth and survival of infected trees, especially those that are heavily infected or infected while they are small and that the potential for extremes of fire behavior are much greater in heavily infected stands.

Over the years we have gotten a lot of unintended experience in maintaining and enhancing levels of DFDM by leaving infected overstory trees in shelterwoods and then deciding to retain them for large tree structure and by practicing uneven-aged management in infected stands. Unfortunately, this haphazard sort of management is unlikely to produce the range of infection levels that yield both brooms and acceptable tree vigor because the regeneration that becomes infected will have poor growth and high levels of mortality. At the same time, managing dwarf mistletoe, especially for spotted owl habitat, is complicated by the fact that owls nest in stands with multi-layered canopies.

We need to have specific guidelines for managing the spread and intensification of DFDM so we can predict the outcome of measures to maintain it. Otherwise we may end up increasing it to levels that cause unacceptable fire hazard, or such reduced growth and increased levels of mortality that other aspects of the habitat are no longer functional.

AN ATTEMPT TO MAINTAIN DFDM

Mario Mamone and I recently devised a plan to maintain some of the DFDM in two infected stands on the Applegate District that were going to be thinned. One stand was adjacent to a critical habitat unit for spotted owls and the other was in a dispersal corridor. The goal of thinning was to increase tree vigor, open up growing space for pines and reduce the fire hazard. Thus, in most of the two stands it was desirable to minimize the amount of DFDM that would remain after treatment. We developed the following guidelines for selecting mistletoe-infected areas in each stand that would be left untreated:

* A few, large areas would be better than many, small ones because there would be less perimeter from which the mistletoe could spread into the surrounding stand. Similarly, round areas would be better than elongated ones because they have less perimeter area.
* Riparian areas would be best because they are heavily used by owls and because mistletoe would spread more slowly from the bottom of the slope into the stand.
* Areas with a range of DMR classes would be preferable, but the majority of the trees should be vigorous so they would survive for a long while.
* Mistletoe and snags in the same area would be ideal because it would meet the needs of several species at once.
* We would cut heavily around the leave areas where necessary to minimize mistletoe spread into the surrounding stand.

The areas we selected were 1/2 to 3 acres in size and totaled about 10% of each stand. They will maintain some of the broom structure that was in the stand. However, leaving these infected areas hasn't addressed how much DFDM

is really necessary, how it will change over time and whether the areas will still provide adequate habitat in the future.

FUTURE POSSIBILITIES

Using the concept of 'target stands' might be one means to assess and manage DFDM in the future. The purpose of target stands is to quantify the description of a stand that meets a desired condition at a specific time in the future. The existing stand is compared to the 'target' and treatments applied, if appropriate, that will move the stand toward the desired state. This would provide a framework for describing in a quantitative manner how much DFDM we want in the future stand. Then, if we could develop simulation models such as Prognosis (FVS) so they account for dwarf mistletoe spread in a satisfactory way, the models could be used to project the development of the dwarf mistletoe in the existing stands after hypothetical treatments are applied. These simulations would provide data to determine whether the level of DFDM that develops by the target year is what was anticipated, and whether this level of DFDM can be achieved while maintaining conditions (growth, stocking, survival, cover, etc.) that meet the target.

CONCLUSION

To meet the challenge of maintaining DFDM as habitat for wildlife successfully, pathologists, wildlife biologists and silviculturists will need to work closely together in the future. Pathologists should share the existing data on the effects that DFDM has on infected trees so managers will understand the consequences of maintaining it. Simulation models like FVS should be improved so they can be used to develop quantitative information with which to judge whether management decisions will lead to the desired conditions in infected stands. We should suggest and participate in studies that will help us understand more about how wildlife use brooms and how DFDM develops, and we should monitor treated and untreated stands where DFDM is maintained for habitat.

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Wildlife Use of Douglas fir Dwarf Mistletoe

Mario S. Mamone
Wildlife Biologist
Rogue River National Forest, Applegate Ranger District

Douglas Fir Mistletoe Brooms as Wildlife Habitat

Before I begin, I want to thank Don Goheen for his invitation to address your group. I also want to thank Katy Marshall with whom I've collaborated on this presentation. My talk today has three parts: First I'll speak about the role of Douglas fir mistletoe in creating wildlife habitat; second, I'll speak about specific wildlife species that use habitat created by Douglas fir dwarf mistletoe (*Arceuthobium douglasii*); and finally I'll conclude with some summary comments.

The forests of the Pacific Northwest provide an array of habitats for forest wildlife. There are old-growth forest habitats, young-forest habitats, high elevation and low elevation habitats, and there are riparian habitats. At a finer scale we can look at specific forest structures and the habitats they provide. For example, the role of large woody material as habitat for deer mice, or the role of snags as maternity roosts for silver-haired bats, or as we are doing today looking at the role of Douglas fir dwarf mistletoe in creating habitat for wildlife.

Mistletoe booms serve similar ecological functions in the forest canopy as woody material serves on the forest floor. Mistletoe brooms create and enhance structural diversity in the forest canopy. Mistletoe brooms create structural roughness and more edges in what otherwise is a rather uniform forest canopy. For arboreal wildlife species (animals that live in the forest canopy and rarely come to the ground), mistletoe brooms provide nesting, resting, and hiding habitats. A large dense mistletoe broom provides a dry, warm or cool environment for wildlife, and protection from predators.

The abnormal growth of branches infected with dwarf mistletoe creates platforms large enough and strong enough to hold the nest of any wildlife species that can access the broom. Mistletoe itself is a food source of some wildlife, and possibly, for some arboreal species, mistletoe brooms may serve as safe-avenues of travel through the forest canopy.

Wildlife that use Mistletoe Brooms

There are three groups of wildlife associated with Douglas fir dwarf mistletoe that I will speak about: Insects, Mammals, and Birds. I want to preface the next portion of my talk by stating that very little is known about wildlife species use of Douglas fir dwarf mistletoe.

Insects

Although considerable work has been done in the area of insect and dwarf mistletoes, very little of this research has centered on Douglas fir dwarf mistletoe. From what we know, it appears that the insect life associated with Douglas fir dwarf mistletoe is not as highly developed as has been reported for the dwarf mistletoes associated with pine species.

Mammals

In a current, PNW fisher (*Martes pennanti*) telemetry study, fisher were observed in Douglas fir dwarf mistletoe brooms. Fisher are adept at climbing through trees and chasing down arboreal small mammals. Two different fisher, on two separate occasions, were observed in the mistletoe broom shown in this slide. It is easy to see the safety a fisher finds in this dense broom.
Marten (*Martes americana*) and weasels (*Mustela spp.*), relatives of the fisher, very likely also use mistletoe brooms. These small carnivores are also adept at climbing through trees in search of prey. Bushy-tailed woodrats

(*Neotoma fuscipes*) are known to build stick nests in the deformed branches caused by Douglas fir dwarf mistletoe. The northern flying squirrel (*Glaucomys sabrinus*) is also know to build nests in mistletoe brooms. Both the flying squirrel and the woodrat are important prey of the northern spotted owl.

Chipmunks (*Eutamias spp.*), have not been reported using mistletoe brooms, but these arboreal rodents very likely use brooms for some aspect of their lives. The arboreal red tree vole (*Phenacomys longicaudus*) builds nests in the canopies of Douglas fir (*Pseudostuga menziesii*) trees, but has also been reported using mistletoe brooms for nest sites. This vole is a U.S. Forest Service, Region-6 Survey and Manage species. The red tree vole is also preyed upon by the northern spotted owl.

Bats are a group of wildlife we often over-look, but they may have some ties to Douglas fir dwarf mistletoe. No studies I am aware of have shown bats to use mistletoe brooms, but I wouldn't be surprised to learn that one or more of our forest bats, such as the silver-haried bat and the long eared myotis, utilize mistletoe brooms for roost sites and even as maternity sites.

Birds

More is known about use of witches brooms by birds than any other group of wildlife. This is understandable because birds are easier to study than insects and mammals. Birds are diurnal and those that are not can be observed during dawn and dusk.

The northern spotted owl (*Strix occidentalis*) within portions of their range, i.e., southwestern Oregon, utilize Douglas fir dwarf mistletoe almost exclusively for nest structures. Spotted owls do not construct their own nests, so they must find suitable nest structures. Often these nests are in cavities in live trees or sometimes in snags. However, the forests of southern Oregon generally do not develop structurally to provide suitable cavity nests for the spotted owl. Mistletoe brooms provide an excellent alternative to cavity nests. They provide platforms to safely hold eggs; they are large enough and strong enough to house a family of spotted owls; and brooms are dense enough to protect owls from the elements and from predators.

The great gray owl (*Strix nebulosa*), a U.S. Forest Service, Region-6 (R-6) Survey and Manage species, also utilizes Douglas fir mistletoe brooms for nest sites. In a northeast Oregon study, long-eared owls (*Asio otus*) nested exclusively in Douglas fir mistletoe brooms. The northern Goshawk (*Accipiter gentilis*), a U.S. Fish and Wildlife Service species of concern, will also use mistletoe brooms as places to construct stick nests.

Other birds that have been identified as having some association with dwarf mistletoe include: American robin (*Turdus migratorius*), Townsend's solitaire (*Myadestes townsendi*), Stellar's jay (*Cyanocitta stelleri*), blue grouse (*Dendragapus obscurus*), pygmy owl (*Glaucidium gnoma*), saw-whet owl(*Aegolius acadicus*), hermit thrush (*Catharus guttatus*), and chipping sparrow (*Spizella passerina*). Other birds that I believe may use mistletoe brooms, and I base this on observations or on the species foraging strategies, include: red-breasted nuthatch (*Sitta canadensis*), chestnut-backed chickadee (*Parus rufescens*), black-capped chickadee (*P. atricapillus*), mountain chickadee (*P. gambeli*), golden-crown kinglet (*Regulus satrapa*), and ruby-crowned kinglet (*R. calendula*).

Woodpeckers also use Douglas fir trees weakened by dwarf mistletoe and that have been attacked by beetles. These include the pileated woodpecker (*Dryocopus pileatus*), downy woodpecker (*Picoides pubescens*), and the hairy woodpecker (*P. villosus*).

Summary

The forests of the Pacific Northwest are a shinning example of the adage, "The whole is greater than the sum of it's parts." We, in our limited human ways, only see parts of the forest ecosystem. We study trees, we study wildlife, and we study forest diseases and insects. Yet, we don't see the whole forest. We don't see all the interconnections; layers of interconnections flowing through the forest. After all, forests are nothing if they are not the embodiment of the elaborate interconnections, ecological functions, that are like threads of a spider's web which connects together all parts of the forest.

Douglas fir dwarf mistletoe is an important component of our forest ecosystems. Dwarf mistletoe is a thread within the web of forest ecological functions. Dwarf mistletoe may be a keystone species because dwarf mistletoe infections create forest structures used by, or that are essential for many wildlife species. In essence, Douglas fir dwarf mistletoe positively influences biological diversity.

Although we do not have all the answers, we know enough about the importance to wildlife of Douglas fir dwarf mistletoe that consideration should be given to managing mistletoe within our forest landscapes. This is quite difficult considering our lack of knowledge about the ecological roles of Douglas fir dwarf mistletoe. For example what makes a suitable spotted owl nest broom? How do we grow such brooms? How do we grow a stand of such brooms? Or for that matter, how do we manage dwarf mistletoe at the landscape level? These and many other questions about dwarf mistletoe need answering as we move into the future with forest management.

Artificially Created Snags for Cavity Nesters - What's Working?

Catherine Parks
Research Plant Pathologist
USDA Forest Service
Forestry and Range Sciences Laboratory
La Grande OR

Background

The importance of cavity nesters--why are forest managers interested in habitat management for woodpeckers?

Woodpeckers excavate nest cavities in decayed wood in standing trees, annually. Their vacated cavities are subsequently used by a myriad of other birds and mammals for nesting, roosting, and shelter. About 25 percent of the bird species nesting in the northern Rocky Mountain forests are cavity nesters (McClelland and others 1979). Many of the primary and secondary cavity-nesting birds are insectivorous and play an important role in regulating populations of forest insects. Machmer and Steeger (1995) provide a thorough review of the effect these birds have in reducing numbers of forest insects that feed on trees.

Wood Decay Characteristics of Cavity Nest Trees

Some woodpeckers select living trees colonized by heart-rot fungi because they can penetrate through the sound layer of sapwood and excavate the nest chamber in the softened heartwood. The sapwood remains relatively intact for a long period forming a shell surrounding the decaying heartwood. Thus, the excavated interior may retain a desirable shape for nesting for many years.

For some cavity-nesters, living trees with heart-rot form a necessary habitat component. One widely known example from the southern United States is the red-cockaded woodpecker (Picoides borealis), which selects pines over 80 years old that are infected with the heart-rot fungus Phellinus pini to excavate their cavities (Conner and Locke 1982; Hooper and others 1991).

Dead trees that are selected for cavity placement also tend to be those trees that have relatively sound outer core of sapwood and with decayed heartwood.

Most tree species have a narrow cylinder of sapwood, the exception is ponderosa pine. Woodpeckers sometimes excavate cavities in the decayed sapwood of ponderosa pine. Ponderosa pine is the only tree species in interior forests to have this thick sapwood to heartwood ratio (up to 50 percent). Furthermore, unlike the other species which decay "from the outside-in" very quickly, dead ponderosa pine, seems to loose, or at least loosen it's bark rapidly, and often develops a hard out shell under the bark. This rigid shell may provide structure and allow the sapwood to be excavated without the concomitant outer decay associated with other tree species, such as Douglas-fir.

Creating Wildlife Trees,

Over the last year I have been evaluating techniques to create suitable cavity nesting habitat. The techniques that are being tested include topping, with chainsaws and dynamite, basal-burning and -girdling, top girdling, killing trees with silvicides, pheromone baiting for bark beetles, and fungal inoculations, using drilled dowels and rifle and shotgun delivered inocula. The history behind many of the older trials that were imposed in the 1980's is that they were not set up as research projects per se, but as wildlife managements projects under the Knutson-Vandenberg Act (know among federal land managers as "KV"). This act allows for "protecting and improving the future productivity" of forested lands associated with timber sales. I have located some of the better documented projects and plan to analyze and publish the results.
The oldest designed study was conducted in Oregon by Bull and Partridge (1986) to investigated six methods of killing trees. They determined that topping trees with either a chainsaw or explosives produced snags that stood the longest and received the greatest nest use by woodpeckers. In this study, girdling, fungal inoculation, and insects

attracted by pheromone did not consistently kill the tree. Trees killed by girdling or silvicides fell over too quickly to provide wildlife structure. This year I reviewed the plots installed by Bull and Partridge, now 17 years old, and plan to document these results.

In a study located in New Mexico, all of the ponderosa pines killed by girdling were used for foraging by woodpeckers. Most of the trees greater than 16 inches d.b.h. were standing after 7 years, and about 30 percent contained woodpecker nest sites (Parks and others, unpublished data). Because the climate in the New Mexico sites is drier than in the Oregon study area used by Bull and Partridge (1986), basal decay of killed trees may have been less, and therefore trees stood longer.

Recent work by Parks and others (1996a, 1996b) has yielded a new method of inoculating live trees with decay organisms found in living trees that are used by woodpeckers for nesting. In one stand 6 years after inoculation of living trees, 14 percent of western larch contained woodpecker cavities near the point of inoculation. These trees may remain alive for decades with a pocket of decay that woodpeckers can use for nesting. Logging activity may occur next to these trees without safety concerns, and trees are less likely than dead trees to be lost to fuel-wood cutters. These preliminary results for western larch suggest that inoculation produces desirable wildlife trees at a lesser cost than other methods of killing trees. Rifle delivered inoculum is also being tested (Baker and others, 1996).

Another trial, now eleven years old, located on the Deschutes National Forest in Central Oregon, used dynamite topping of ponderosa pine to create nesting habitat. Preliminary results show that ponderosa pine killed by topping (i.e. no living branches left) were used heavily by woodpeckers but began to fall somewhere between year 6 and 11 (Parks and Milano, unpublished data).

Conclusions

In managed stands, the retention of existing snags is the most ecologically sound and most economical approach. However, if stands are devoid of snags, an option is to alter or kill living trees. Depending on the method used, killing trees can be costly and ineffective in producing the desired decay conditions. In addition, it may take years before decay is sufficiently advanced to promote cavity-nester excavations.

Ponderosa pine seems to be the best tree species for topping. Other tree species are being evaluated in wildlife tree creation trials that combine various levels of, crown retention, inoculated decay organisms, and silvicultural prescriptions.

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Application of Hierarchy Theory and Disturbance Profiles for Assessing Impacts of Forest Insects and Pathogens on Wildlife and Its Habitat

Brian W. Geils, John E. Lundquist, and J. Patrick Ward, Jr.
USDA Forest Service
Rocky Mountain Forest and Range Experiment Station
240 West Prospect, Fort Collins, CO 80526

The panel on disturbance ecology at the 1995 WIFDWC, Whitefish, MT included papers by Hoekstra and Allen (1995) on scale in ecological systems and by Lundquist and Geils (1995) on measuring natural disturbances. Hoekstra and Allen (1995) argued that a framework for describing the roles of forest insects and pathogens in an ecological system required explicit descriptions of the system's hierarchical structure and the observer's perspective. Specifically, they felt that forest diseases and insects were disturbance agents if they were external to the focus system, and regulatory agents if they were internal to the system's identified boundaries. Lundquist and Geils (1995) described a metric using spatial and non-spatial statistics for vegetation plus insects and pathogens to describe the effects of small-scale disturbances on forest resources. We illustrate here a specific example how these two concepts can be reconciled and applied to the problem of assessing forest insect and pathogen impacts on the Mexican spotted owl (MSO).

We use the ecosystem of the Sacramento Mountains in southern New Mexico as our example. This ecosystem contains at least three interacting systems: (1) forest insects and pathogens, (2) a food web including the Mexican spotted owl (MSO-prey system), and (3) the vegetation that constitutes habitat for animals of this food web (Figure 1A). These three systems affect each other both directly (pathogen kills a tree) and indirectly (dead tree influences animal distribution). The insects and pathogens are therefore disturbance agents relative to the vegetation or MSO-prey system but regulatory agents within the forest ecosystem. Viewed at a deeper level (Figure 1B), each of these three systems is composed of elements that interact directly and indirectly with other elements. Some of the important forest insects and pathogens in the Sacramento Mountains are mistletoes, root disease fungi, and bark beetles. The MSO-prey system includes the owl itself, the small mammals it consumes, and its predators and competitors (Northern goshawk). Although the forest vegetation and animal habitat could be described in numerous ways, we focus on the canopy, live trees, and coarse woody debris as necessary and sufficient elements for relating forest pathogens and MSO prey.

Within the framework of a forest ecosystem in the Sacramento Mountains (Figure 1), we need also to describe the temporal and spatial scales of the various systems (Figure 2A). Small mammals live 1 to 3 years and usually forage 100 to 500 m from their burrow, depending on the species (Figure 2A, a). Mexican spotted owls live an average of 9 years and forage up to several kilometers from the nest (Figure 2A, b). A population of MSO has probably occupied the Sacramento Mountains for thousands of years (Figure 2A, c). (See USDI 1995 for data on MSO.) Insect outbreak cycles in these forests tend to persist for only a few years but extend over much of the forest (Figure 2A, d). Mistletoe and root disease fungi are enduring but also localized into discrete centers (Figure 2A, e and f respectively). Processes of tree gap formation, tree group mortality, stand replacement, and landscape development determine several common scales at which forest vegetation is organized (Figure 2A, g-j). The positions of the various objects on the scale map (Figure 2A) reveal how these objects relate: more enduring objects are seen by less persistent objects as constant, and the distribution of smaller units determine the heterogeneity perceived by larger units. To a small mammal, for example, a large mistletoe center would appear to be a constant habitat feature extending across its entire landscape. Although slow expansion of that mistletoe center may not be apparent to an owl, differences between infested areas and uninfested areas would be quite evident.

The dimensional analysis described in the previous paragraph provides a guide for determining the appropriate scales at which the various systems should be studied. In our work, the critical factors for determining the resolution, extent, and replication of the study are set by the activity scales of small mammals and owls. Canopy gaps and tree mortality groups caused by mistletoe, root disease, and bark beetles (and other agents) most closely overlap the spatial and temporal scales of individual small mammals and owls. Populations of prey and owls are

distributed across a mosaic of forest stands on the Sacramento landscape (a pattern resulting from geologic and climatic factors interacting with successional trends and disturbance regimes). Our study design, therefore, consists of a series of plots 200 m x 200 m (on edge) replicated across the landscape on a environmental gradient (xeric, transitional, mesic). On each plot, prey are trapped on a 20 m grid; trapping is repeated for 3 years to account for year-to-year variation in population levels (Ward and Block 1995). Live trees are sampled on a 20 m grid; canopy density measured on a 5 m grid; and insects, pathogens, and coarse woody debris are inventoried by canopy gap. Although 12 plots are established (Lundquist, Geils, and Ward 1995), we are reporting here only the results from 3 plots each representing a typical xeric, transitional, or mesic site. The analysis presented here illustrates how to relate the distribution of MSO prey to small-scale vegetation patterns resulting from the activity of forest insects, pathogens, and other tree-killing agents.

Disturbance profiles are constructed from data for live trees, canopy density, coarse woody debris, and various small-scale disturbances (for details see Lundquist and Geils 1995 or Lundquist and Ward 1995). Table 1 displays a portion of disturbance profiles for vegetation features of 3 sampled sites and illustrates some site differences.

Table 1. Vegetation Profile for 3 selected sites in the Sacramento Mountains.

Component	Site		
Statistic	Xeric	Transitional	Mesic
Live Trees			
stems/ha	624	657	478
basal area, m^2/ha	13	23	33
Canopy Closure			
percent closure (SD)	20 (29)	52 (31)	76
number of gaps	32	54	23
mean gap area, m^2	2351	2983	927
Coarse Woody Debris			
logs/gap	6	6	13
logs/m^2	0.005	0.003	0.031
median log class	2	3	3

Both the xeric site, dominated by pinyon and juniper, and the transitional site, dominated by ponderosa pine and Douglas-fir, had similar stems/ha, but basal area was nearly double on the latter. Fewer, but much larger trees occurred on the mesic site, dominated by Douglas-fir and white fir. Relative to each other, gaps on the xeric site were few but large; the canopy was most closed and dense on the mesic site. Well-decayed logs were most common on the mesic site.

Five species of small mammals were captured on the three sites (Table 2).

Table 2. Total number of individual animals captured over 3 seasons on 3 selected sites in Sacramento Mountains.

Species	Xeric	Transitional	Mesic
Deer mouse	29	57	92
Brush mouse	103	45	0
Mexican woodrat	12	22	10
Long-tail vole	0	0	80
Mexican vole	0	12	10

Although the brush mouse was the most frequently captured species on the xeric site and one of the most common species on the transitional site, it was never captured on the mesic site. In contrast, the Mexican vole was restricted to the transitional and mesic sites. The trend in these data suggested that species differ as either habitat generalists (such as the deer mouse) or specialists (such as the long-tail vole). The spatial distribution of captures could be determined with regards to canopy gaps, gap edges, gaps and edges combined (Table 3). Significant association determined by the Goodness of Fit test indicated either affinity or avoidance of gaps, edges of gaps, or gaps plus their edges (against the hypothesis that captures were unrelated to canopy structure). Examinations of maps with gaps and captures represented revealed if the association was for affinity to gaps (and therefore avoidance of edges and closed canopy regions) or for avoidance of gaps (and therefore affinity for other regions).

Table 3. Association of small mammal captures with canopy gaps and edges.

Species	Xeric			Transitional			Mesic		
	Gap	Edge	Both	Gap	Edge	Both	Gap	Edge	Both
Deer mouse	-	-	-	-	-	-	-	**	-
Brush mouse	*	-	-	-	-	*			
Mexican woodrat	**	-	-	-	-	-	-	-	**
Long-tail vole							*	-	-
Mexican vole				-	-	-	**	**	-

Note: A gap occurs where canopy closure is less than -1 SD of mean crown density; an edge where closure is -1 to 0 SD of mean density; and both (gap or edge) where closure is less than mean density.
Association evaluated with X^2 Goodness of Fit (pooled over 3 years data)
* = significant, $P < 0.10$, ** = highly significant, $P < 0.01$,
- = not significant, blank = species absent.

These data illustrate that species varied in response to canopy structure and those responses varied by site. On the transitional site, most species are indifferent to canopy structure. Deer mouse are found abundantly on all three sites (Table 2), but only on the mesic site does it demonstrate a significant affinity for gap edges or avoidance of regions with low canopy density or high canopy density (Table 3). Further analysis with Classification and Regression Tree Analysis – CART (Breiman and others 1984) is required to identify other vegetation features (those listed in Table 1) which might be related to prey distribution. Although most species are influenced by the interactions of several factors, the Mexican vole demonstrate a simple response to gap size.

On the mesic site, Mexican voles have a highly significant affinity for gaps and gap edges (Table 3); 76% of captures are located in gaps larger than 50 m (CART analysis). Although the Mexican vole is a less common prey item than other species, its presence increases the diversity of foraging opportunity which is important where populations can vary greatly from year to year (Ward and Block 1995).

Many of the vegetation features which influenced prey capture frequencies and distributions were determined by the activity of various tree-killing agents. The relation between forest pathogens and wildlife has been examined in

other studies at several different scales. Bennetts and others (1996) demonstrated that the abundance and diversity of bird communities in 4 stands of ponderosa pine increased with stand DMR and number of snags present. Martin and others (1992) reported that trees with large, dense dwarf mistletoe brooms were preferred for nesting by northern spotted owls. Rather than averaging disease severity over a stand or characterizing individual trees, we mapped canopy gaps and identified the various predisposing and killing agents associated with each gap. These data allowed us to estimate the scale at which forest insects, pathogens, and other gap-forming agents were operating. The most frequently tallied agents were wind, fire, tree harvest, mistletoe, and bark beetles; these agents were associated with gaps of various scale, expressed as the square root of gap area (Figure 2B). For example, bark beetles were implicated in the formation, maintenance, or expansion of gaps ranging from 36 to 81 m (mean 56 m).

A spatial measure of vegetation heterogeneity such as scale provides a means for relating specific forest insects and pathogens (which kill trees) to individual small mammal species (including those not directly dependent on trees) In our example, Mexican voles appear to prefer wetter sites (transitional and mesic), but within those sites avoid regions of dense forest canopy (i.e., they are indifferent to gaps on the open transitional site but are attracted to gaps and edges in closed mesic site). Where gaps are significant to the Mexican vole, gaps larger than 50 m are preferred. The only agents associated with these larger gaps are mistletoe and bark beetles (Figure 2B). These agents appear to be capable of creating the kinds of canopy openings which are the preferred habitat of the Mexican vole. Whether more habitat for the Mexican vole would increase the abundance or viability of the Mexican spotted owl in the Sacramento Mountains are questions that would require study at a larger scale. The disturbance profile (Lundquist and Geils 1995) includes measures of spatial scale and complexity and permits examination of multiscale questions such as the effects of natural disturbances or silviculture on wildlife resources.

The study and analysis described here develops the ideas that various disturbance agents (as viewed from the perspective of creating small-scale, canopy gaps) have distinctive effects on forest vegetation and therefore wildlife habitat. We observed variation in species sensitivity to large-scale plant association and to small-scale vegetation composition and structure. We also observed a selectivity by at least one species, the Mexican vole for canopy gaps of a relatively large and uncommon size. Gaps of this size in these sites were associated with mistletoe and bark beetles and not associated with the smaller gaps created by wind, fire, or tree harvest. Although results presented here are preliminary, they demonstrate how the concepts of scale and disturbance profiling can be applied to a specific issue involving forest pathology and wildlife biology.

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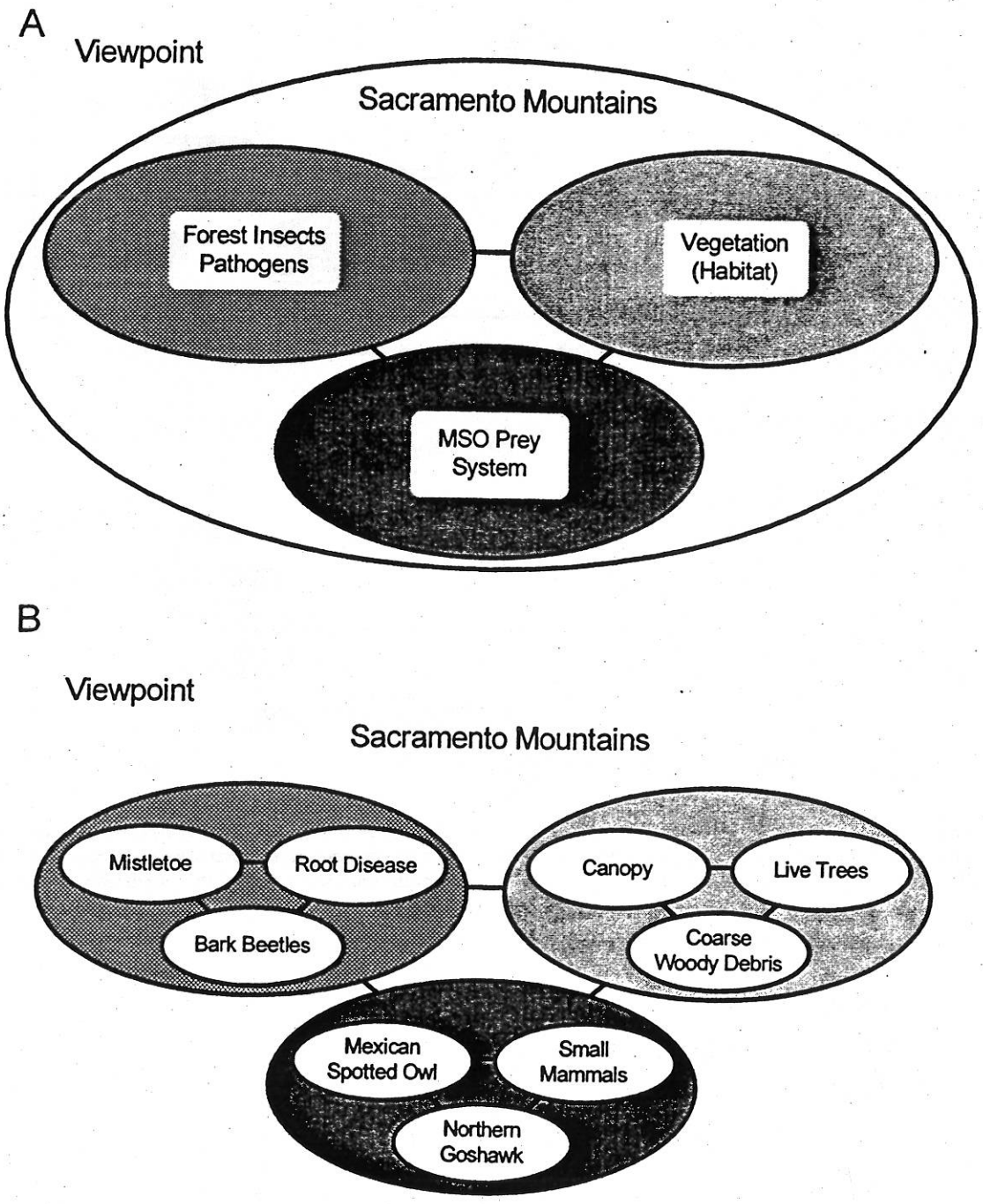


Figure 1. General and detailed viewpoints (**A, B**) of the forest ecosystem in the Sacramento Mountains, New Mexico; viewpoints illustrate the concepts of boundaries, hierarchical nesting, and interactions. **A**, forest insects and pathogens affect the Mexican spotted owl prey system directly and indirectly through vegetation. **B**, more generalized systems such as forest insects and pathogens, contain more specific and interacting systems.

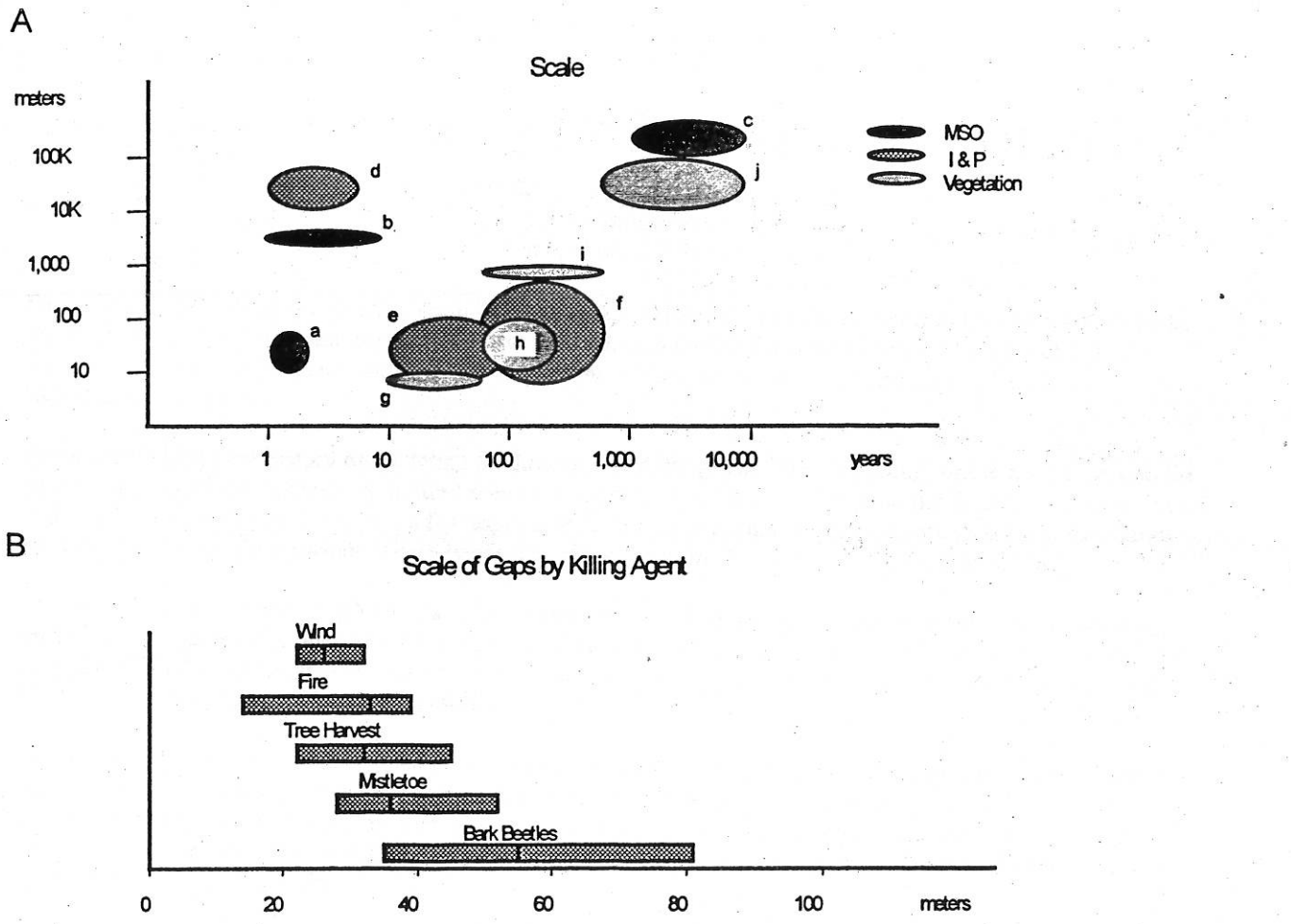


Figure 2. A, spatial and temporal scale for the Mexican spotted owl-prey system (MSO), forest insects and pathogens (I&P), and vegetation. B, scale for gaps associated with various agents causing tree mortality in their respective gaps; scale is computed as square root of gap area; bar length represents extent of gap scale observed in sample plots; dividing line within bar indicates mean gap scale.

Posters

The 4 C's of Modeling and Analysis.

USDA Forest Service
Forest Health Technology Enterprise Team
3825 East Mulberry
Fort Collins, CO 80524

Forest Health Technology Enterprise Team in Fort Collins (FHTET-FC) has been involved cooperatively with the regions in the development and support of insect and pathogen models for over 10 years. Throughout this time many changes have taken place both with the models themselves, as well as opportunities resulting from technological advances.

The poster displays the history of modeling on three panels starting with 'The Beginning' or the early stages on the panel to the far left, the 'Current Activities' scene is in the center and 'Future Opportunities' is portrayed in the panel to the right. In our attempt to capture a few aspects of the model development and support, four horizontal bands run through all three time periods. These bands are referred to as the "4 C's of Analysis and Modeling":

Capability: The upper most band illustrates the increased capabilities of the modeling systems. There has been growth in the number of models and the geographical area they encompass. The Forest Vegetation Simulator (FVS) is functional in the eastern areas shown on the map, so the natural progression will be for the insect and disease models to follow wherever a need is identified.

Confidence: The models are developed utilizing data sets from a very few locations or based solely on expert opinion. It is a continuous process to calibrate and validate the models for different areas. In the past this was accomplished by a small group of people. However, the more confidence there is in using the models the more individuals become involved with these activities. They lead efforts to ascertain that the model will function properly for their particular area.

Comprehension: he next band down portrays ways user comprehension has improved through various types of technology transfer that have been or are still being utilized. The evolution of the modeling interface has been from a file editor to an ASCII submittal system and is now evolving into a 'point and click' GUI. In the future we can expect a fully integrated GUI/GIS/Modeling system. Documentation has always been a priority for any model development effort. Information exchange has continued through the years, but the media has evolved with the advances made in technology. Where documents were once hard copy only, we now see them in a number of different electronic formats.

Cooperation: he ovals at the bottom indicate our cooperators throughout the years. These individuals and groups have grown at a steady rate and represent a wide variety of backgrounds. The geographic areas they represent are often in direct correlation to the model development sites. Initial modeling workshops strive to include everyone that is currently, or could be in the future affected by the insect or pathogen under consideration for model development. The far right panel has a number of ovals with question marks. These unidentified circles show the potential, but yet unknown cooperators of the future.

Forest Health Technology Enterprise Team

USDA Forest Service
Forest Health Technology Enterprise Team
3825 East Mulberry
Fort Collins, CO 80524

The Forest Health Technology Enterprise Team poster portrays the merging of separate technical development locations, projects and ideas. The National Center for Forest Health Management in Morgantown, West Virginia, the Pesticide Application Program in Davis, California and the Methods Application Group in Fort Collins, Colorado were functioning independently until February 1995. At that time, these three groups along with the RSAC and MTDC forest health support programs were consolidated under one direction, but still maintaining a level of autonomy within each group.

The projects shown are in no way all inclusive, but merely represent a cross section of the major areas. The layout is not in any particular order nor priority arrangement.

INFORMS is a decision support system for project planning that was moved from the Data General ported to the 615 platform. It is currently being tested in a few locations within Regions 8 and 6. Implementation will soon be expanded to include a larger geographical area.

SpraySafe Manager is a decision support system developed jointly between the FHTET-Davis and the New Zealand Forest Research Institute. SpraySafe Manager provides land managers with an-easy to use tool to support safe, efficacious, and economical application of pesticides.

Biopesticide and biological control are two program areas of FHTET-Morgantown, WV. Morgantown will take a leading role in stimulating the development and adoption of environmentally acceptable technologies and methodologies to sustain or enhance all forest resource values.

Analysis and modeling comprise the development and technology transfer for insect and disease models linked to the Forest Vegetation Simulator model. Development has primarily been concentrated in the western half of the United States until recently. Now that FVS is based in the east, we will assess the need for developing models in this area.

Data and information needs include projects associated with remote sensing, GIS and data management systems.

Developed for Washington Office and Regions, the nontarget impact studies determine how pesticides are affecting animals, birds or any living thing that is directly or indirectly in contact with pesticide.

The results from model simulation runs are in a tabular format and difficult to use as a communication tool. A preferred method is to use a graphic that will assist the public in visualizing possible management alternatives. The examples depicted here are for Western Spruce Budworm in Region 6.

Value determination is a system that will account for nontimber items such as privacy or aesthetic appeal. These are important to people and often play a role in deciding recreation sites when one location is compared to another. These items should also be identified and prioritized when management alternatives are considered.

Informs-R8: the Utility of Rulebase Technology in a Decision Support System.

Stephen B. Williams
USDA Forest Service
Forest Pest Management/Methods Application Group
3825 E. Mulberry, Fort Collins, CO 80524

Ron Perisho
USDA Forest Service
Ouachita National Forest/Jessieville Ranger District
Hot Springs National Park, AR 71949

David R. Holtfrerich
Texas A&M University
Department Of Rangeland Ecology and Management, STARR Lab
College Station, TX 77843

Integrated Forest Resource Management System in Region 8 (INFORMS-R8) is a decision support system designed to aid in project-level planning and in the development of environmental assessments on US Forest Service managed land. Components integrated in this tool include a geographic information system (GIS), a relational database management system (RDBMS), a user interface system (UIS), various simulation models, and an assortment of rulebases. Rulebase technology is represented in INFORMS-R8 using CLIPS, a public domain software package. Rulebases are used to capture natural resource management knowledge that is needed to manage Forest Service lands. This display demonstrates how rulebase technology can benefit resource managers in effectively evaluating land management issues in a consistent manner and in reaching optimal and defensible decisions. Sample rulebases developed by subject area experts from the Ouachita National Forest in Arkansas are depicted. These rulebases include a rulebase to analyze forest land areas that may need prescribed burning, a rulebase to highlight foraging areas for the scarlet tanager, and a rulebase to locate areas that have a high probability of containing significant prehistoric resource sites.

The WIFDWC Forest Pathology Family Tree: A Work in Progress

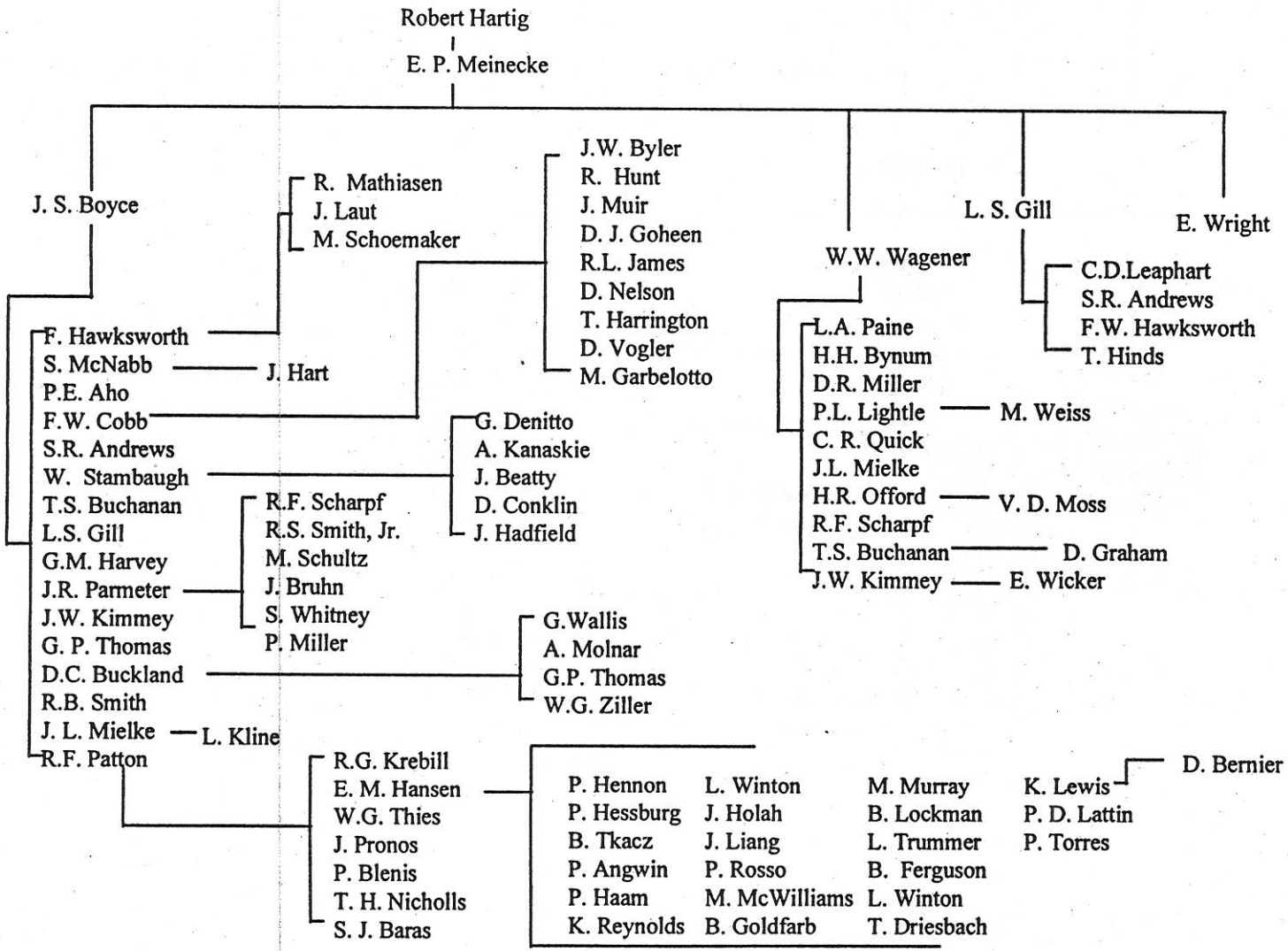
Ellen Michaels Goheen

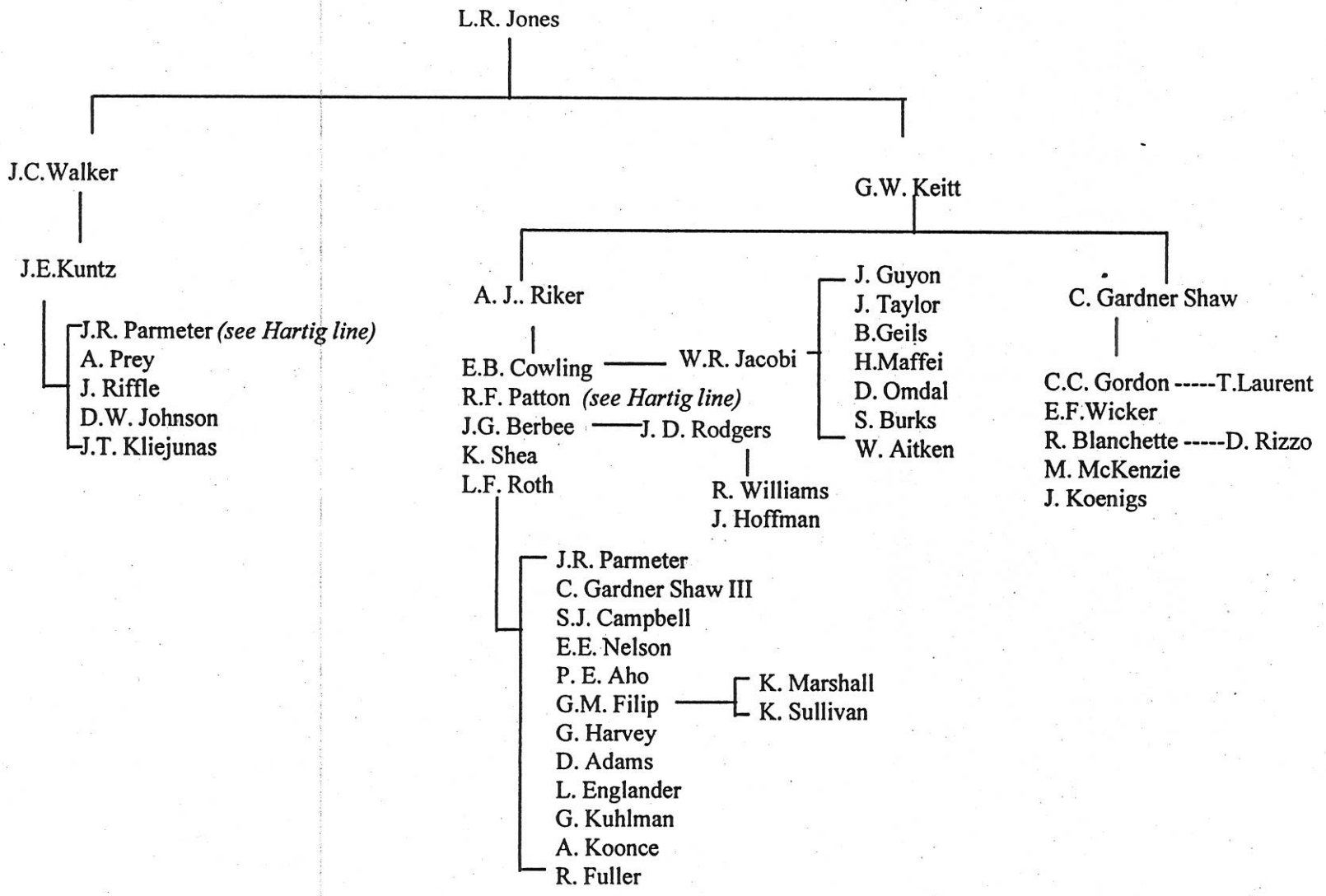
The information used to build the following family tree(s) comes from attendees at the 1995 WIFDWC meeting held in Whitefish, Montana, the 1996 WIFDWC meeting held in Hood River, OR, the University of Wisconsin publication "A Foot in the Furrow" edited by P. Williams and M. Marosy, and the USDA publication "Forest Disease Research in the Western United States and Canada" by T. S. Buchanan.

Lineages are based on identification of mentors and/or major professors or on work relationships. Field assistance outside of graduate school links many early WIFDWCers to our founding fathers.

Our family tree is by no means complete. Many current members of WIFDWC were not at the 1995 or 1996 meetings. There are gaps and omissions for several Honorary Life Members. Connectivity of some branches is lacking. Undoubtedly there are mistakes. Research must be done and information collected to get to the roots of many members. WIFDWC members are encouraged to add to and revise this information at future meetings.

But, it is a start.....


Robert Hartig
E. P. Meinecke
J. S. Boyce
F. Hawksworth
S. McNabb
J. Hart
P.E. Aho
F.W. Cobb
S.R. Andrews
W. Stambaugh
T.S. Buchanan
L.S. Gill
G.M. Harvey
J.R. Parmeter
J.W. Kimmey
G. P. Thomas
D.C. Buckland
R.B. Smith
J. L. Mielke
L. Kline
R.F. Patton
R. Mathiasen
J. Laut
M. Schoemaker
R.F. Scharpf
R.S. Smith, Jr.
M. Schultz
J. Bruhn
S. Whitney
P. Miller
J.W. Byler
R. Hunt
J. Muir
D. J. Goheen
R.L. James
D. Nelson
T. Harrington
D. Vogler
M. Garbelotto
G. Denitto
A. Kanaskie
J. Beatty
D. Conklin
J. Hadfield
G.Wallis
A. Molnar
G.P. Thomas
W.G. Ziller
R.G. Krebill
E. M. Hansen
W.G. Thies
J. Pronos
P. Blenis
T. H. Nicholls
S. J. Baras
P. Hennon
P. Hessburg
B. Tkacz
P. Angwin
P. Haam
K. Reynolds
L. Winton
J. Holah
J. Liang
P. Rosso
M. McWilliams
B. Goldfarb
M. Murray
B. Lockman
L. Trummer
B. Ferguson
L. Winton
T. Driesbach
K. Lewis
D. Bernier
P. D. Lattin
P. Torres
W.W. Wagener
L.A. Paine
H.H. Bynum
D.R. Miller
P.L. Lightle
M. Weiss
C. R. Quick
J.L. Mielke
H.R. Offord
V. D. Moss
R.F. Scharpf
T.S. Buchanan
D. Graham
J.W. Kimmey
E. Wicker
L. S. Gill
C.D.Leaphart
S.R. Andrews
F.W. Hawksworth
T. Hinds
E. Wright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J.C.Walker
J.E.Kuntz
J.R. Parmeter (see Hartig line)
A. Prey
J. Riffle
D.W. Johnson
J.T. Kliejunas
G.W. Keitt
A. J.. Riker
E.B. Cowling
R.F. Patton (see Hartig line)
J.G. Berbee
K. Shea
L.F. Roth
W.R. Jacobi
J. D. Rodgers
R. Williams
J. Hoffman
J. Guyon
J. Taylor
B.Geils
H.Maffei
D. Omdal
S. Burks
W. Aitken
C. Gardner Shaw
C.C. Gordon -----T.Laurent
E.F.Wicker
R. Blanchette -----D. Rizzo
M. McKenzie
J. Koenigs
J.R. Parmeter
C. Gardner Shaw III
S.J. Campbell
E.E. Nelson
P. E. Aho
G.M. Filip
G. Harvey
D. Adams
L. Englander
G. Kuhlman
A. Koonce
R. Fuller
K. Marshall
K. Sullivan

H.N. Hansen
R.V. Bega

L.O. Overholtz
C. L. Fergus
F. W. Cobb
(See Hartig line)

J. Rishbeth
D. Morrison

Anton Debary
W.R. Dudley
J.C. Arthur
G. Cummins
Y. Hiratsuka
E. Allen

H.W. Ward &
C. MacMillan
E.M. Freeman
E.C. Stakeman
C. Christensen — M. F. Kernkamp
D. French — B. Woodruff
F. Baker — K. Russell
S. Zeglen
J. L. Harris
D. Rabin

J. E. Bier
W. J. Bloomberg
D. J. Morrison
E. A. Van Sickle
R.B. Smith
R. Robinson
T. Pentland

E. Edgerton
H.E.Wheeler
C.Driver
R. Edmonds — J. Browning
E. Wood — D. Shaw
W. Littke
S.. Frankel

J. Lowe
R.Gilbertson — J. Ginns
R. Mathiasen
M.L. Fairweather

B. van der Kamp
|
J. Beale
R. Reich
H. Merler
A. Woods
D. Rusch

F. Roth
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D. Baxter
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R. Peterson

S. Shushan
|
D. Hildebrand

N. Oshima
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G. Hudler

E.E. Wilson
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J. Ogawa
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G.A. Chastagner
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E.M. Goheen

A. Partridge
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J. Laut
E. Wood
E. Canfield
J. Schwandt
W. Livingston
D. Kulhavy
S. Hagle
B. Geils

R. Sacinas
|
D. Cibrian
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J. Guerra

Genetic Variation in Blister Rust of Sugar Pine Families at Six Sites in Southern Oregon: 10-year Results.

Richard A. Sniezko, Jude Danielson, USDA Forest Service, Dorena Genetic Resource Center, Cottage Grove, OR 97424, and Harvey Koester, USDI Bureau of Land Management Medford District, Medford, OR 97504

The use of artificial inoculation for screening sugar pine and western white pine trees for resistance to blister rust has been done at the USDA Forest Service's Dorena Genetic Resource Center for more than 30 years. Seedlings have been inoculated and evaluated for a range of organizations, but most screening has involved BLM or U.S. Forest Service trees. However, only a few field plantings have been established in Oregon to validate the screening at Dorena and to monitor rust infection over time. The most comprehensive of these field plantings with data available are the 1982/1983 outplantings of 52 families at five BLM sites and one Forest Service site. Five-year and 10-year data were collected from these six sites and is being used to examine how the incidence of the disease varies among sites and among families, and to provide guidelines for a 15-year assessment that will be done later this year. Many of the 52 wind-pollinated families originated from parents that were phenotypically selected in the forest for rust resistance. In addition, these families were evaluated in short-term tests following artificial inoculation at Dorena (depending on the family being tested, inoculation occurred between 1971 and 1978). Percentage of trees with rust infection varied widely among sites (from 15% to 75% at age 10).

Screening for Blister Rust Resistance at Dorena Genetic Resource Center.

Richard Sniezko and Jude Danielson R.A. Sniezko and J. Danielson, USDA Forest Service, Dorena Genetic Resource Center, Cottage Grove, OR USA

The USFS has been screening sugar pine (Pinus lambertiana) and western white pine (Pinus monticola) trees for resistance to white pine blister rust (Cronartium ribicola) for nearly 40 years in the Pacific Northwest Region (Oregon and Washington). The rust resistance program at Dorena has been patterned after work done at the USFS Intermountain Research Station. Progeny of over 10,000 selections from a range of land ownerships have been evaluated for this exotic disease. Generally, over 95 percent of seedlings develop needle lesions, and seedlings are examined for up to five years after inoculation for a variety of resistance mechanisms. Species diversity issues and timber value have stimulated high interest in rust-resistant seed. Seed orchards have been established by the USFS and/or the BLM for many breeding zones; seed is now available for some zones. Validation runs indicate a dramatic increase in resistance in one generation, particularly in the percentage of trees free of cankers. Also, the first field validation plantings indicate good progress has been made in increasing resistance. To facilitate advanced-generation planning, further information is needed on the inheritance of the resistance mechanisms, the frequency of occurrence of these mechanisms within breeding zones, and strategies for seed deployment.

Wood Discoloration of *Chamaecyparis obtusa* and *Cryptomeria japonica* Caused by Japanese Horntail and *Amylostereum sp.* in Shikoku District, Japan.

Masanobu Tabata

Wood discolorations of *Chamaecyparis obtusa* and *Cryptomeria japonica* caused by Japanese horntail (*Urocerus japonicus*) and *Amylostereum* sp. have become a serious problem in the Shikoku District. The author cut *Ch. obtusa* and *Cr. japonica* trees naturally infested with the horntail and investigated the characteristics and size of wood discoloration etc. to understand the actual state of the damage. Furthermore, inoculation with *Amylostereum* sp. isolated from the mycangia of horntail was conducted to examine the pathogenicity of this fungus in *Ch. obtusa* and *Cr. japonica* trees. Wood discoloration of *Ch. obtusa* was reddish brown, but that of *Cr. japonica* was dark brown. The tone of wood discoloration of the former was lighter than that of the latter. The wood discolorations were triangular in transverse section and spread from the center of an oviposition site of a Japanese horntail in longitudinal, tangential, and radial directions. The average size of wood discoloration of *Ch. obtusa* was 18.1cm in the longitudinal direction, 0.4cm in the tangential direction, and 1.1cm in the radial direction. That of *Cr. japonica* was 25.5cm in the longitudinal direction, 0.4cm in the tangential direction, and 1.6cm in the radial direction. The average number of oviposition sites was 60 in *Ch. obtusa* and 56 in *Cr. japonica.* Oviposition sites in *Ch. obtusa* and *Cr. japonica* were observed at heights of 5~473cm and 8~587cm respectively, and were concentrated from near the ground to a height of 400cm. Two *Ch. obtusa* and 3 *Cr. japonica* trees were inoculated with the isolate (AL-1)

of *Amylostereum* sp. All inoculated trees were discolored. Wood discolorations of *Ch. obtusa* and *Cr. japonica* by the inoculation of *Amylostereum* sp. were spindle-form in transverse section and spread from the center of an inoculation point in longitudinal, tangential, and radial directions. The average size of wood discoloration of *Ch. obtusa* (1 month later) by the inoculation of *Amylostereum* sp.was 12.8 times in the longitudinal direction, 2.7 times in tangential direction, and 1.2 times in radial direction larger in contrast to the inoculation by sterilized toothpick. That of *Cr. japonica* (1 month later) was 10.7 times in the longitudinal direction, 1.7 times in tangential direction, and 1.6 times in radial direction larger in contrast to the inoculation by sterilized toothpick. When inoculated with AL-1, the fungus reisolated from the discoloration area was mainly *Amylostereum* sp.

Creating Wildlife Trees in Managed Forests Using Decay Fungi.

Catherine Parks, Greg Filip, and Evelyn Bull

A method to provide internal wood-decay conditions needed by cavity excavators is being tested in six stands in northeastern Oregon. Preliminary results find that after five years 50 percent of artificially inoculated trees in one stand are being used by cavity nesters. All inoculated trees remain alive with viable crowns. Because of the biology and natural abundance of airborne spores of the decay fungi used, there is no likelihood of spread into non-target trees. These preliminary results suggest that inoculation may be a viable tool to create suitable habitat for snag-dependent wildlife in coniferous forests in greater abundance or at younger ages than would naturally occur.

Committee Reports

Dwarf Mistletoe Committee

Jerome S. Beatty and Robert Mathiasen

I. TAXONOMY, HOSTS, AND DISTRIBUTION

a. Limber pine dwarf mistletoe was found heavily parasitizing limber pine on the northeast slopes of Spruce Mountain in eastern Nevada. This is the first report of limber pine dwarf mistletoe from this mountain range. Although this report does not significantly extend the range of limber pine dwarf mistletoe, the population is noteworthy in that many Great Basin bristlecone pine growing next to heavily infected limber pine were not infected. This is perplexing because Great Basin bristlecone pine is considered to be a principal host of limber pine dwarf mistletoe. (R. Mathiasen, IDL)

II. PHYSIOLOGY AND ANATOMY

III. LIFE CYCLES

a. Because hemlock dwarf mistletoe is reported to have a skewed sex ratio of approximately 3:2 in favor of the females, we examined a total of 1364 infections throughout the crowns of 7 heavily infected western hemlock within the Wind River Canopy Crane site near Carson, WA. Using the canopy crane we examined the north and south sides of each tree and determined the sex of each reproductively active infection we could easily observe or reach. Because most of the reproductively inactive infections observed were in the lower part of the crown, we plan to conduct a survey from the ground throughout the canopy crane site to see how the results compare to the survey conducted using the crane. (R. Mathiasen, IDL and D. Shaw, Univ. of WA, WRCC)

IV. HOST-PARASITE RELATIONS

a. Quantitative data are being collected on the host relationships of mountain hemlock and western hemlock dwarf mistletoes in Oregon and Washington. Temporary circular plots (6 m radius) are placed around heavily infected hemlocks in mixed conifer stands and the following data recorded for each tree larger than 2 cm in diameter at breast height: species, dbh and DMR. This information will be used to better evaluate the natural host susceptibility classifications for hemlock dwarf mistletoe in the Pacific Northwest. (R. Mathiasen, IDL)

b. Additional quantitative data were 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. (R. Mathiasen, IDL)

V. EFFECTS ON HOSTS

a. One hundred and forty large, infected western hemlock within the Wind River Canopy Crane site were carefully rated from the ground using the 6-class dwarf mistletoe rating system. These trees were then carefully examined and rated again using the canopy crane to access their crowns. A short note comparing the two ratings is being prepared for publication. (D. Shaw, Univ. of WA, WRCC)

b. Growth of 450 Douglas-fir in thinned stands was assessed over a period of 20 years. Many of the trees were infected with dwarf mistletoe to various degrees. Our objective was to assess tree growth at all levels of dwarf mistletoe infection. We measured bole diameter, height, and infection level over the course of the

study, and sampled radial growth, and tree vigor at the conclusion of the study. The effect of dwarf mistletoe on host growth at any one site depended on which measure of growth was used. Trees on the Malheur National Forest showed somewhat different responses to infection than trees on the Okanogan National Forest. A significant reduction in radial increment was observed at an infection class rating (ICR, range: 0 to 6) as low as 3. Diameter growth at breast height was affected more on the Malheur, whereas height growth was affected more on the Okanogan National Forest. Sapwood area measurements suggested a significant reduction in vigor at ICR 3. Dwarf mistletoe did not affect cylindrical form factor. Less than 3% of our sample trees died in 20 years with no clear indication of increased mortality owing to dwarf mistletoe. The ICR increased on average one class in about 11 years, but intensification appeared to accelerate as ICR increased. (R. Tinnin, PSU; C. Parks, PNW; D. Knutson).

VI. ECOLOGY

a. A total of 449 ponderosa pine trees in three rectangular plots are being monitored in a prescribed burn area on the Santa Fe National Forest. Plots were established in 1994; the area was broadcast burned in October 1995; and the plots were re-inventoried in 1996. Some degree of crown scorch occurred on 84% of the sample trees; 16% of the trees had complete crown scorch and are presumed dead. There was a tendency for greater crown scorch and mortality on DM-infected than on uninfected trees. For example, while 81% of the sample trees were visibly infected prior to the fire, 89% of the trees directly killed by the fire were visibly infected. Crown scorch appeared to have killed at least 80% of the DM plants on over one-third of the surviving trees. Eighteen percent of the surviving trees appear to have been completely "sanitized." (D. Conklin, FHP, NM Zone, R3).

VII. GENETICS

a. Work continues on the selection, propagation and testing of both ponderosa and Jeffrey pines in California. Criteria and guidelines for locating and selecting resistant candidate trees have been developed. In 1994-95, 65 candidate and 10 highly susceptible ponderosa pines were selected. Wild seed has been collected from 40 candidates and all 10 controls. Location and selection of candidate Jeffrey pines began in 1995 and continues in 1996. More inoculations were made in 1995 on the 6 resistant and 6 control ponderosa pines made from grafts in 1965. Inoculations made on these trees in 1993 and 1994 will be evaluated in the Summer of 1996.

Tests were established on susceptible ponderosa pines in 1995 to determine the efficiency of using patch grafts of infected tissue as a method of inoculating pines, with the intent of speeding up the infection process. Progress of the project was reported at the Sixth Parasitic Weed Symposium in Cordoba, Spain, May 1996. Edited by Moreno, M.T., Cubero, J.I., Berner, D. Musselman, L.J. and Parker C.; Junta de Andalucia. Consejeria de Agricltura y pesca. "Dwarf Mistletoe Resistance in ponderosa pine; Selection and testing protocols. D.B. Ringness and P. Stover, USDA Forest Service, Pacific Southwest Region, Central Zone Genetic Resource program, 2375 Fruitridge Road, Camino, Ca. 95709, USA.; R.F. Scharpf, USDA Forest Service, Pacific Southwest Research Station, retired, Institute of Forest Genetics, 2480 Carson Road, Placerville, Ca 95667. (RF Scharpf, PSW ret.)

VIII. MANAGEMENT

a. To mitigate for the loss of wildlife habitat caused by cutting trees infected with Douglas-fir dwarf mistletoe in the Beaver/Palmer Timber Sale on the Applegate R.D., Rogue River N.F., Mario Mamone (District wildlife biologist) and I laid out Douglas-fir dwarf mistletoe leave areas in two commercial thinning/pine release units. One unit is adjacent to a Critical Habitat Unit (CHU) for the Northern Spotted Owl, the other is in a dispersal corridor for the owls. We decided that the leave areas should total 15% of each unit area to be consistent with the Northwest Forest Plan Record of Decision guidelines for green tree and snag retention. We agreed on the following guidelines for selecting the leave areas:

- Fewer, large areas would be better because they have less perimeter to spread mistletoe than more, smaller areas. Areas that are round in shape would be better than elongated areas for the same reason.

- Riparian areas would be the best location because mistletoe would spread uphill into a stand more slowly from the bottom of the slope.

- We would prefer areas where mistletoe-infected trees were in a range of DMR classes but still looked vigorous.

- Mistletoe and snags in the same area would be ideal.

- We would mark to cut heavily around infected leave areas where needed to reduce mistletoe spread to the surrounding stand.

The resulting leave areas were 1/2 to 3 acres in size and totaled about 10% of each unit. We felt they met the objective of maintaining concentrations of dwarf mistletoe in the two stands. Monitoring of the spotted owl population in the area will show the extent to which they are utilized. What is yet to be addressed is the management of dwarf mistletoe in these two stands and across the surrounding landscape over the long term. (Katy Marshall, SWOFIDTC)

b. This report updates the presentation entitled "Can Dwarf Mistletoe Be Eliminated From Recreation Areas?" given at the 43rd Annual WIFDWC in Whitefish, Montana in September, 1995. In the Whitefish report, results from 3 separate dwarf mistletoe control entries in each of 4 campgrounds in the Cedar Grove area of Kings Canyon National Park, CA were described. At that time, the 4 campgrounds had not been surveyed for dwarf mistletoe infections remaining after the third entry/treatment. In May, 1996, the campgrounds were inspected and the results are listed in the last column of the table below.

TABLE 1. Number of trees pruned or removed during 3 entries in 4 campgrounds at cedar Grove, Kings Canyon National Park, 1984-1992.

Campground	Entry 1	Entry 2	Entry 3	Still Infected in 1996
Sheep Creek	640	58	36	22
Sentinel	837	118	23	13
Canyon View	465	84	35	23
Moraine	586	81	32	18
TOTAL	2,528	341	126	76

While the number of residual pines with infections decreased following each entry, it seems excessive to require or recommend that dwarf mistletoe control efforts in recreation sites include 3 or more entries. Based on the results from Cedar Grove, the long standing recommendation that suppression projects include 2 entries seems most reasonable and efficient. The answer to the question posed in the title of the Whitefish presentation appears to be NO.

c. Plans are to treat 608 acres of dwarf mistletoe infested stands on the Arapaho and Roosevelt; Medicine Bow/Routt; and Pike and San Isabel National Forests; and on the Southern Ute Reservation. (P. Angwin, D. Johnson, USFS, R-2).

d. In R-4 we accomplished 2,192 acres of DM treatment (mostly overstory removal); 7,217 acres of pre-suppression survey; and 2,132 acres of post-suppression survey in 1996. (J. Hoffman, FHP, R-4).

e. R3 FHP provided input to the Mexican Spotted Owl Recovery team, who were solidifying management recommendations. We have and are continuing to provide assistance in a number of Ecosystem

Management Analyses. However, due to the injunction which is now over 1 year old these projects have not been implemented. The threat of budget-cuts to the DM suppression program could be devestating to some of the BIA agencies. (ML Fairweather, FHP, AZ Zone, R3).

IX. SURVEYS

a. Surveys were conducted in 1996 in several ponderosa pine stands on the Carson National Forest that had been seed-tree harvested in the mid-1980's. The information gathered will be used to encourage small timber sales in some of these stands to remove infected seed trees in order to protect young regeneration from infection. (D. Conklin, FHP, NM Zone, R3).

b. According to the Northwest Forest Plan (see 1995 WIFDWC ecology report), the US Forest Service Pacific Northwest Region is required to "conduct general regional surveys" for mountain hemlock dwarf mistletoe, Arceuthobium tsugense subsp. mertensianae, in the State of Washington.

Summary of 1995 Survey

The 1995 portion of the general regional survey for mountain hemlock dwarf mistletoe in Washington consisted of two parts: 1) revisiting the old forest inventory plots (1974 to 1986) that reported dwarf mistletoe on mountain hemlock on Gifford Pinchot, Mt. Baker-Snoqualmie, and Olympic National Forests in Washington; and 2) surveying from many roads in the mountain hemlock zone, and/or roads in vicinity of plots from old timber inventory that reported dwarf mistletoe on mountain hemlock. We found that the dwarf mistletoe information from the old timber inventory was not particularly reliable, and that occurrence of mountain hemlock dwarf mistletoe is unpredictable in Washington. The survey will probably continue in 1996 and 1997.

On the Gifford Pinchot National Forest in south-central Washington, we found mountain hemlock dwarf mistletoe on the east side of Mt. St. Helens National Volcanic Monument. On the Mt. Baker-Snoqualmie National Forest in north-central Washington, mountain hemlock dwarf mistletoe occurred in six different areas. On the Olympic National Forest, we found mountain hemlock dwarf mistletoe only near Three Peaks.

Gifford Pinchot National Forest (Surveyed by Bob Mathiasen, Jerry Beatty, and Diane Hildebrand, July 1995).

Mt. Adams Ranger District. Plot 454, south of Mt. Adams Wilderness (T.7N, R.11E, S.6): Lodgepole pine dwarf mistletoe (Arceuthobium americanum) on lodgepole pine and subalpine fir; mountain hemlock present; no mountain hemlock dwarf mistletoe observed. Plot 565, east of Indian Heaven Wilderness (T.6N, R.9E, S.19): Mountain hemlock and Pacific silver fir infected with larch dwarf mistletoe (Arceuthobium laricis).

Wind River Ranger District. Plot 1031, west of Indian Heaven Wilderness (T.6N, R.8E, S.8): Mountain hemlock and Pacific silver fir present; no mountain hemlock dwarf mistletoe observed. Plot 1033, west of Indian Heaven Wilderness (T.6N, R.7 1/2E, S.13): Mountain hemlock and Douglas-fir present; no mountain hemlock dwarf mistletoe observed. Nearby stands had heavy western hemlock dwarf mistletoe (Arceuthobium tsugense subsp. tsugense) on western hemlock and Pacific silver fir. Plot 561, west of Indian Heaven Wilderness (T.6N, R.7 1/2E, S.24): Plot had been clearcut prior to 1987. Adjacent stand had western hemlock and Pacific silver fir with no dwarf mistletoe.

Packwood Ranger District. Plot 922, west of Goat Rocks Wilderness (T.11N, R.10E, S.4): Mountain hemlock, Douglas-fir, and true fir present; no dwarf mistletoe observed.

Randle Ranger District. Bob Mathiasen and Diane Hildebrand surveyed from the road in mountain hemlock zone on east side of Mt. St. Helens National Volcanic Monument. On both sides of Forest Road 99, 3.4 miles west from the junction with Forest Road 25, a large mountain hemlock dwarf mistletoe infection center was found at 3800 ft elevation, near Wakepish Creek (T.10N, R.6E, S.26, southwest quarter section). Large, heavily infected mountain hemlock stood next to large, uninfected western hemlock. In the understory, small mountain hemlocks were infected while western hemlocks were not infected. Small mountain hemlocks had large witches' brooms. Mt. Baker-Snoqualmie National Forest (Surveyed in June and September, 1995, by Bob Mathiasen and/or Diane Hildebrand and Jerry Beatty).

Mount Baker Ranger District. Bob Mathiasen surveyed in the vicinity of Mt. Baker Wilderness. Mountain hemlock dwarf mistletoe infection was heavy on mountain hemlock in vicinity of the Mt. Baker ski area, northeast of Mt. Baker (T.39N, R.9E, S.17). South of Mt. Baker, within Mt. Baker Wilderness, mountain hemlock dwarf mistletoe occurred north of Schreibers Meadow at 3600 ft elevation (T.37N, R.8E, S.7). Mountain hemlock dwarf mistletoe was common on mountain hemlock, occasional on Pacific silver fir, and rare on subalpine fir. A large population of mountain hemlock dwarf mistletoe occurred north of Blue Lake, south of Mt. Baker Wilderness, along Forest Road 1230, at 3300 ft elevation (T.37N, R.8E, S.28, 29, 33). Another population of mountain hemlock dwarf mistletoe was found west of Baker Lake, southeast of Mt. Baker Wilderness, on Forest Road 1124 (to 1127), about 6 miles northwest of Forest Road 11, at 3700 ft elevation (T.37N, R.8E, S.2).

Bob Mathiasen, Jerry Beatty, and Diane Hildebrand did not find mountain hemlock dwarf mistletoe near Sauk Mountain, along Forest Road 1030, north of Rockport State Park (T.35N, R.9E, S.11, 14). No mountain hemlock dwarf mistletoe was visible from road to Suiattle Mountain (T.34N, R.10E, S.27,34).

Darrington Ranger District. Bob Mathiasen, Jerry Beatty, and Diane Hildebrand surveyed roads in the mountain hemlock zone. On Segelsen Ridge (T.33N, R.8E, S.13, 19, 24, 30), no mountain hemlock dwarf mistletoe was found. Along Forest Road 49 above Sloan Creek, mountain hemlock dwarf mistletoe occurred uphill from the road at an intermittent creek, across from the gravel pit between Sloan and Bowser Creeks; and past Bowser Creek (T.29N, R.12E, S.9, 15, 16). Mountain hemlock dwarf mistletoe was found on mountain hemlock and Pacific silver fir, in both the overstory and understory. Western hemlock dwarf mistletoe was also present on western hemlock and Pacific silver fir. Along Forest Road 2550 east of Lime Creek, no mountain hemlock dwarf mistletoe was found (T.32N, R.12E, S.29).

North Bend Ranger District. Approximately one half mile north of the public parking lot at Alpental Ski Area, north of Snoqualmie Pass (T.23N, R.11E, S.29), Bob Mathiasen found a population of mountain hemlock dwarf mistletoe on a steep slope at 3900 ft elevation.

Olympic National Forest (Bob Mathiasen and Diane Hildebrand surveyed from roads in the mountain hemlock zone, in October 1995. Many areas were inaccessible due to washouts, landslides, and road closures).

Hood Canal Ranger District. North of Three Peaks, along Forest Road 2270, mountain hemlock dwarf mistletoe was common and heavy on mountain hemlock and occasional on Pacific silver fir in fragmented patches of very old trees at 3300 ft elevation (T.23N, R.7W, S.15,16). In the Mt. Tebo area, along Forest Roads 200, 210, and 230 (T.23N, R.5W, S. 19,20,29; and T.23N, R.6W, S.23,24,25), few mountain hemlock were seen, although western hemlock was abundant with western hemlock dwarf mistletoe, especially in section 25.

Quinault Ranger District. Near the headwaters of Matheny Creek (T. 24N, R. 9W, S. 17), in the vicinity of old timber inventory plot 1094, western hemlock dwarf mistletoe had crossed over to a few mountain hemlock trees. Along Forest Road 2170 on Matheny Ridge (T. 24N, R. 10W, S. 11,13,14; and T.24N, R.9W, S. 7,8,9), a small number of mountain hemlock were observed, but only western hemlock dwarf mistletoe was found on western hemlock. Near Higley Peak (T. 23N., R. 10W, S. 1), no mountain

hemlock were seen. In the vicinity of Moonlight Dome and old timber inventory plot 1041 (T. 23 N, R. 8W, S. 14, 24), no dwarf mistletoe was seen on the mountain hemlock.

Soleduck Ranger District. In the Pine Mountain area (T. 29N, R. 10W, S. 35,36) although mountain hemlock was abundant, no dwarf mistletoe was observed. (D. Hildebrand, USFS Pacific Northwest Region)

c. Presuppression surveys for dwarf mistletoe are planned for 12,042 acres on the Arapaho and Roosevelt; Medicine Bow/Routt; Pike and San Isabel; and White River National Forests. (P. Angwin, D. Johnson, USFS, R-2).

X. MODELING

XI. MISCELLANEOUS

Special Projects:

a. A project was undertaken in spring 1996 by Karsten Dufft, Philipps University, Fachbereich Biologie, Marburg, Germany to determine the continued spread and development of European mistletoe (Viscum album) on trees in the Santa Rosa - Sebastopol areas of Northern Caifornia. Results of the study will be published in English. (R.F. Scharpf)

b. Microbial Control Strategies for Dwarf Mistletoe. This is a new research project which was established in June, 1996. A research grant was awarded to Canadian Forest Service by B.C. Forest Renewal to conduct research on the feasibility and potential use of hyperparasitic fungi as candidate biocontrol agents for dwarf mistletoe. At this stage our research efforts have been focused on collection and identification of the hyperparasitic fungi from western hemlock dwarf mistletoe (Arceuthobium tsugense). Also, our research activities are focused on: 1. Production of a literature review on the occurrence, effect and efficacy of the biocontrol agents on dwarf mistletoe. 2. Generate a collection of microbial control agents for dwarf mistletoe and preserve them under liquid nitrogen or -80 C for further testing. 3. Assay, in the laboratory (using in vitro tissue culture techniques), the greenhouse and shade house (using seedlings grafted with branches infected with dwarf mistletoe) for potential microbial control agents. 4. Conduct and follow-up on the efficacy of the application of the lead biocontrol agent (Our field observations has lead us to use Nectria fuckeliana var. macrospora which shows the most promising biocontrol agent for westren hemlock dwarf mistletoe) under operational silvicultural harvesting methods. 5. The results will be communicated to: Principal clients through reports, newsletters, discussions and meetings; to foresters via extension publications; and to scientific community via journal papers and conference presentations.

Project Leader: Dr. Simon Francis Shamoun, Research Plant Pathologist, Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, 506 West Burnside Road, Victoria, B.C. V8Z 1M5, CANADA. Phone: (604) 363-0766/Fax (604) 363-0775/Email: SSHAMOUN@A1.PFC.FORESTRY.CA

Research Team: 1. Dr. Alan J. Thomson- Research Scientist, CFS-Victoria. 2. Ms. Carmen Oleskevich- Research Technician, CFS-Victoria. 3. Dr. Harry H. Kope- Visiting Scientist & Head, Contact Biologicals, Victoria. 4. Ms. Shannon Deeks- M.Sc. student at Simon Fraser University, B.C. 5. Dr. Zamir K. Punja- Associate Professor & Director, Centre for Pest Management- Phytopathology & Biotechnology. 6. Dr. Richard B. Smith- Consultant, Grand Forks, B.C.

Major Clients: 1. B.C. Ministry of Forests, Victoria, B.C., C/O Dr. John Muir. 2. MacMillan Bloedel, Nanaimo, B.C., C/O Dr. Glen Dunsworth. 3. Riverside Forest Products, Williams Lake, B.C., C/o Mr. George White. 4. Lignum Ltd., Williams Lake, B.C., C/O Mr. Kim Peel.

Pest trend/impact plots system plots

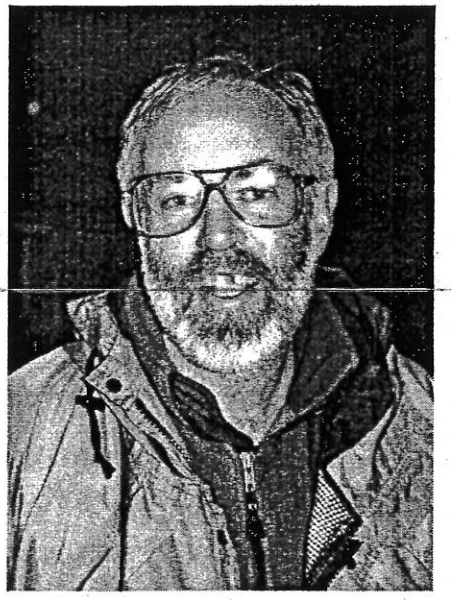
a. Region 3 has begun 5 year remeasurements of the permanent plots established for model validation. The majority of these plots are in areas infected with Southwestern dwarf mistletoe of ponderosa pine. (ML Fairweather, FHP, AZ Zone, R3).

Poetry:

The Squeaky Wheel and Larch Dwarf Mistletoe - A Match Made in Heaven.
A Poem by Bob (with apologies to E.A. Poe)

Squeak, squeak, squeak goes the wheel
Hear it squeak
What is it saying?
Squeakkkkkklarchdmfidllarchdmfidllarchdmfidl
It hurts my ears
It strains my brain
But I can't seem to get it out of my head
Squeakeeeeeee Squeakeeeeeeee wheel

There it goes again
Squeakkkkkkcallrebeccacallrebeccacallrebecca
Squeakkkkkkgetthefidlformatgetthefidlformat
It's driving me mad, mad, mad!
But what can I do?
I'm going crazy!
No wait, I hear it clearly now
It's giving me good advice
Squeakkkkkkeeeeeeee wheel, how can I thank you?



Hazard Tree Committe

John Pronos

The Hazard Tree Committee met for lunch at Hood River, Oregon on September 17, 1996. Twenty-six people attended. Mike Schomaker began by summarizing a meeting held in May, 1996, in San Francisco to plan strategies for an International Tree Failure Reporting Program. The meeting was sponsored by the International Society of Arboriculture and organized by Larry Costello, University of California Extension; Nelda Matheny, Hortscience, Inc.; and Alison Berry, University of California-Davis, Environmental Horticulture. A summary of that meeting is included below. In short, this project is widely supported but still lacking funding to get started. The Hazard Tree Committee recommended that we help submit a Technology Development Proposal for USDA Forest Service funds for fiscal year 1997.

The rest of the meeting was spent discussing the proposed second Hazard Tree Workshop. Results of a questionnaire sent out last spring were presented. In general people were in favor of a 3-day meeting in the spring of 1997. Region 6 would host the meeting in Hood River. A wide variety of topics were suggested to be addressed at the workshop with the most frequent including: legal issues; case studies; vegetation management and hazard trees; an update on the national tree failure reporting system; computer data bases; new tools, technologies, and innovations; and wildlife trees vs. hazard trees vs. worker safety. Dave Shaw volunteered using the Wind River Canopy Crane site to focus on hazard trees and worker safety. Bob Mathiasen and Keith Sprengel suggested looking at trees in the field with specific defects, evaluating them, and then returning to the site a day or two later to view the same trees after they had been dissected. A slight majority of individuals returning the questionnaire felt that providing abstracts of presentations was preferable to publishing complete papers in a proceedings.

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International Tree Failure Report Program

Advisory Committee Meeting
San Francisco, CA
May 18, 1996

MEETING SUMMARY

The inaugural meeting of the Advisory Committee was held on May 18, 1996, in San Francisco. Committee selection was based on professional experience and interest in tree failure monitoring, professional areas represented (urban and forested recreation), and geographic distribution (see "Participants"). (Note: five members were unable to attend this meeting, but all expressed interest in future meetings and activities of the Committee.) Meeting objectives were: 1) to identify the operational elements of an International Tree Failure Report Program (general organization, participants, reporting system, etc.), 2) to identify funding needs and sources, 3) to evaluate the costs and benefits associated with an ITFRP, and 4) to determine the future role and composition of the Advisory Committee.

After background information was presented, discussions focused on the elements of an ITFRP: participants, regions, data management, duration, and budget/funding sources. It was decided that a full-time program manager would be essential: the program will likely be only as good as the program manager. The program manager establishes and maintains the database, oversees the budget and maintains relations with funding sources, coordinates reporting regions, and provides technical and training support for regions.

Six regions (5 US/Canada and 1 European) were envisioned, likely consisting of various reporting units (ISA Chapters, SAF units, professional groups, etc.) which are coordinated by a Regional Coordinator. As appropriate for the region, the Regional Coordinator may be a state forester, ISA officer/member, academic (e.g. Cooperative Extension Advisor or faculty member), or private sector individual. Regional Coordinators recruit and train cooperators, provide technical support, maintain mailing lists, and report to the Program Manager. In order to participate in the program, cooperators in each region would be trained and certified by the Regional Coordinator.

Data management was discussed as a key element of an ITFRP. The application of new communications technologies will be essential to the success of this project. All data entry and output needs to be simple, convenient, and cost-effective. A World Wide Web Site containing a user interface for data input and an information delivery system with data analysis, publications, photos, and related topics should be established. A conference call from Jim Skiera during the meeting helped the committee understand the potential of linking an ITFRP Web Site with the existing ISA Site.

A preliminary budget was established: $47,000 for startup expenses (computer, fax, scanner, database development, training materials, regional support, etc.) and $66,000 for annual expenses (program manager salary and benefits, data entry assistant, travel, advisory committee expenses, phone, postage, printing, and supplies). No expense for office space was included.

Over 20 possible funding sources were listed, including federal and state agencies or organizations, professional societies or associations, and private enterprises (including utilities and insurance companies).

The meeting concluded with member assignments to one of three subcommittees (*Subject to acceptance by the individual):

1) Organizational Development: L. Costello (chair), Jim Cooney, Mike Schomaker, Ralph Zentz*, Bob Mathiasen, John Pronos, and Ken Meyer*.

2) Data Management: A. Berry (chair), Phil Synder, Jim Cooney, Kim Coder, Geoff Kempter, Bruce Fraedrich, and Joe O'Brien*.

3) Funding: N. Matheny (chair), Ralph Sievert, Geoff Kempter, Brian Fisher*, Jim Skiera*, Ed Macie*, and Rita Schoenman*.

The subcommittees will add detail and propose action in each of the focus areas. After subcommittees have completed their work, findings and recommendations will be used to develop a complete strategy for establishing and implementing an ITFRP. Provided that funding can be secured, a second meeting of the Advisory Committee (possibly in Fall, 1996) will focus on the development of this strategic plan.

Rust Committee

R.S. Hunt

White pine blister rust: validation plantations: A. Kanaskie and E. Goheen reported that western white pine plantations are being established, or are established, but no results are in. R. Sniezko reported that 10 year data is in and the 15 year data will be gathered next month for sugar pine.

White pine blister rust: failure of resistant materials: R. Hunt reported that a plantation originating from the Moscow arboretum (needle shed resistance) growing on northern Vancouver Island had more rust in 5 of 6 blocks than a local unselected source. This makes a total of three failures in coastal BC. A "rust races" trial has not demonstrated a genetic reason for the failure of these plantations. A gene X environment experiment had a failed inoculation in 1995. All surviving seedlings are being re-inoculated and re-planted at two Coastal and one Interior site. J. Schwandt reported that G. MacDonald has been investigating six similar failures in ID and canker aging supports the hypothesis that the resistance fails under particular environmental conditions. Some plantations have gone from 0 to 98% infection in 10 years. G. De Nitto reported that major gene resistance in sugar pine had now failed at Mountain Home state park.

White pine blister rust and pruning: J. Schwandt reported that pruning is continuing and seems successful. R. Hunt reported that in general little gain has been realized 10 years after pruning, because operationally pruned stands were too late. Stands must be pruned early to achieve notable pruning benefits.

White pine blister rust distribution and intensity: J.J Smith and J. Hoffman are investigating the possible spread of rust to NM via white bark pines through Utah and Nevada. Incidence data has been gathered on 50 trees/plot in 60-70 plots to date. G. De Nitto reported that white pine blister rust was not moving farther south in CA. B. Geils reported that it was moving in NM. B. Jacobi reports that some ornamental white pines imported into CO are infected and, as yet, the rust is not established in CO.

White pine blister rust on white bark pine: Besides the above, J. Taylor has been working with K. Kandall, and the former reports that D. Decker and R. Hoff are looking for candidate trees. J. Harris is surveying WY and SD (including limber pine).

White pine blister rust: miscellaneous: (ignoring bark beetles) E. Goheen is hoping to hazard rate SW OR. The sugar pine symposium proceedings are available from Davis for $20.

Limb rust: F. Baker reported that trees rated 11 years ago now have "hardly any mortality" = this disease is not a problem. However, this was quickly followed-up by a statement that growth loss may be important. B. Geils et al. are going to resolve the taxonomic questions regarding limb rust.

Melampsora: E. Hansen reports that a student, S. Strauss, is attempting to move "resistance genes" ; e.g., chintanase into hybrid popular.

Root Disease Committee

Ellen Michaels Goheen

The Root Disease Committee met for breakfast on Thursday, September 19, 1996. Thirty people attended.

We discussed recent changes and improvements to the Western Root Disease Model (WRDM). The Annosus Root Disease/Bark Beetle Model has been joined with the original WRDM; improved spread and mortality functions developed for the annosus model have been incorporated into the WRDM. Bark beetle functions have been increased and refined. With the availability of the model on the PC through the USDA Forest Service Forest Health Technology Enterprise Team (Fort Collins) Bulletin Board System, the need has surfaced to train model users. Many people who were involved with the development of the original WRDM have not been involved with the improvements. The PC format offers the model to those outside the USDA Forest Service. The WRDM cold be a valuable tool in University classes.

Action Item: The Root Disease Committee agreed to sponsor a workshop centered around using the new WRDM, with emphasis on "training the trainers" and "training the western pathologists" rather than silviculturists or planners who might be interested in using the model as well. This workshop would be held either spring 1997 or in conjunction with the 1997 WIFDWC Meeting in Prince George, BC. Ellen agreed to get a small group of workshop planners together to begin discussing details.

The remainder of the meeting was spent discussing annosus root disease and wetwood occurrence in western hemlock. Charlie Driver showed slides from a city park in western Washington where cleanup of hemlock blowdown from a winter storm revealed wetwood and stain associated with *H. annosum*.

The following reports were submitted this year:

Colorado State University: *submitted by W. Jacobi*

In cooperation with the USDA Forest Service Region 2 FHM and the Rocky Mountain Forest and Range Experiment Station we are utilizing a GIS to study the distribution of Armillaria root disease in the Black Hills National Forest. We are looking at relationships between root disease occurrence and soils, site characteristics, stand characteristics, past disturbance, and meteorological data. The study is aimed at determining general relationships over the entire Black Hills region.

Results to date:

1) Hazard rating models for the Black Hills National Forest are completed. These models use known points of root disease occurrence to predict the density of Armillaria root disease for any point of interest in the Black Hills. Three models were constructed, one used a kernel density estimator and the other two used trend surface analysis and cokriging of the residuals of the trend surface analysis. The model that best depicts the hazard is the trend surface model which incorporates elevation, slope, and site index as independent variables.
2) A survey of ponderosa pine in the Black Hills for incidence of Armillaria root disease is in the second summer of data collection. Data from the first summer indicates that most diseased trees are not in pockets but occur as scattered infection. We will determine if root disease incidence is related to any site and stand features on the small scale of the survey transects. We have to finish this summer's survey and enter the data before we can report the findings. We are also recording incidence of mountain pine beetles and so far have not found enough beetle trees to test any relationships with root disease.
3) A survey of Armillaria clones and species on ponderosa pine, aspen, and spruce in the Black Hills confirmed reports of all isolates being *Armillaria ostoyae* with many clones. On clone in the survey covered approximately 1280 feet of the transect.

USDA Forest Service, Rocky Mountain Region: *submitted by P. Angwin*

Project Title: GIS-based Landscape Scale Root Disease Hazard Rating System

Investigators: Jeri Lyn Harris Judy Pasek, and Dave Johnson, Forest Health Management, Rocky Mountain Region

Cooperators: William Jacobi, Dept of Bioagricultural Sciences and Pest Management, Colorado State University (CSU), Robin Reich, Dept. of Forestry, CSU and Melanie Kallas, Graduate Student, Dept. of Forestry, CSU.

Years: Begun 1995; End 1997

Project Description: Existing data on Armillaria root disease occurrence, supplemented with new field data, will be coupled with SCS soil classification, stand inventory, site disturbance, habitat type, and meteorological data in a GIS data base. Utilizing spatial statistical analysis, an Armillaria root disease hazard rating system will be developed for the Black Hills National Forest.

Project Title: Pest Trend Impact Plots in the West- Rocky Mountain Region

Investigators: Pete Angwin, Tom Eager, Jeri Lyn Harris, Dave Johnson, and Bernard Benton, Forest Health Management, Rocky Mountain Region

Cooperators: Bov Eav, Renee Platz, Julie Williams-Cipriani, Judy Adams, Forest Health Technology Enterprise Team; Jim Friedley, BIA Southern Ute Agency; Don Brake, BLM Gunnison Resource Area Office; Elizabeth Stiller, Randy Rick, Jim Allen, and Steve Pische, Black Hills NF; Sam Schroeder, White River NF; Gary Roper, Mike Morrison, and Mike Westfahl, Routt NF; Paul Langowski and Steve Johnson, Roosevelt NF; Jon Morrissey, Grand Mesa, Uncompahgre and Gunnison NFs; Phil Kemp and Bob Vermillion, San Juan NF.

Years: Begun 1990; End indeterminate

Project Description: For the past 6 years, Region 2 Forest Health Management has been actively involved with the westwide technology development project, "Pest Trend Impact Plots in the West". The objective of the project is to establish a series of permanent plots to provide data for the validation and calibration of various insect and disease computer simulation models. In 1994, the installation of plots to monitor the spread of root diseases was completed. In all, Gunnison Service Center personnel have established plots in 35 ponderosa pine, white spruce, spruce/fir, mixed conifer, lodgepole pine, and pinyon pine/ juniper stands throughout the Region. During the 1995 field season, the ponderosa pine, mixed conifer, and lodgepole pine plots were remeasured. In 1996, the white spruce, spruce/fir, and pinyon/juniper plots were remeasured. In addition, 98 plots to track the impacts of western spruce budworm along the Front Range of Colorado were remonumented and remeasured.

Project Title: Ski Area Vegetation Management: Biology and Impacts of the Armillaria Root Disease/Western Balsam Bark Beetle Complex

Investigators: Pete, Tom Eager, and Dave Johnson, Forest Health Management, Rocky Mountain Region; Jose Negron, Rocky Mountain Forest and Range Experiment Station

Cooperators: Jim Stark, Aspen RD, White River NF; Jon Morrissey, Taylor River/Cebola RD, Grand Mesa, Uncompahgre and Gunnison NF; Dick Myhre and Barry Russell, Forest Health Technology Enterprise Team
Years: Begun 1993; End 1998

Project Description: For the past three years, the staff of the Gunnison Service Center has been working with the Aspen Ranger District, White River National Forest, to improve vegetation and forest health conditions at Aspen Mountain, Aspen Highlands, Snowmass, and Buttermilk Ski Areas. Similar efforts, described in the 1995 WIFDWC proceedings, have taken place at Crested Butte Mountain Resort (Taylor River/Cebola RD, Gunnison

National Forest). The activity at Aspen Mountain was originally triggered by observations of widespread subalpine fir mortality in the forested leave strips between the ski runs. During a visit to the mountain in 1992, it was confirmed that the mortality was due to the disease/insect complex of Armillaria root disease (*Armillaria ostoyae*) and western balsam bark beetle (*Dryocoetes confusus*). In 1993, a color infrared aerial photo mission was flown over Aspen Mountain, Aspen Highlands, and Buttermilk Ski Areas. An additional photo mission was run in 1995. In 1994, a ground survey of Aspen Mountain was conducted in which individual and groups of off-color trees that were identified on the infrared photos were located and inspected. Symptoms typical of the Armillaria root disease/western balsam bark beetle complex were observed in 33 spruce/fir stands on the mountain. Positive identification of *A. ostoyae* and *D. confusus* were made in 20 and 32 stands, respectively. Results of the aerial and ground surveys are summarized, together with specific management recommendations in Biological Evaluation R2-95-3. Removal of red and dead firs from selected stands, as recommended in the evaluation began in 1995.

In 1995, walk-through assessments were made at Aspen Highlands, Snowmass, and Buttermilk Ski areas, and an additional visit was made to Aspen mountain. The impacts of the root disease/bark beetle outbreak at Aspen Mountain continue to increase. Many dead were identified that were alive in 1994. Dead and fading trees were also noted in a number of leave strips that last year appeared to be healthy. Western balsam bark beetle was readily found under the bark of the affected trees, but *A. ostoyae* was not found on the roots. It is thus evident that bark beetle populations have increased to the point that non-root diseased firs are also being attacked.

At Aspen Highlands, only minor amounts of Armillaria root disease/western balsam bark beetle complex were found. However, a large infestation of lodgepole pine dwarf mistletoe (*Arceuthobium americanum*) was identified midway up the mountain. At Snowmass, a number of older diseased aspen stands were observed and winter burn has affected large numbers of Engelmann spruce and subalpine fir. Scattered patches of subalpine fir mortality probably due to the Armillaria root disease/western balsam bark beetle complex were observed along the headwall near the top of the mountain. The root disease/bark beetle complex does not appear to be a problem at Buttermilk Ski Area. However, high degrees of animal damage was found in all coniferous species and moderate levels of mountain pine beetle was found in older lodgepole pines.

In general, the pest problems at the four ski areas are typical of mature, non-managed stands. To minimize the effects of these pests in the future, vegetation management efforts need to concentrate on the gradual replacement of the older stands with younger, more vigorous stands. This can be accomplished by the application of a series of thinning and regeneration cuts throughout the ski areas. Treatments to address specific pest management situations may be integrated into this overall vegetation improvement effort.

To gain public support, understanding and acceptance of the necessary vegetation management measures, opportunities for interpretation need to be explored and implemented. In December, 1995, Pete Angwin and Tom eager provided training to the staff and interns of the Aspen Center for environmental studies (ACES) who give interpretive ski tours at the Aspen ski resorts. The training included both a slide presentation and a first-hand look at the insect and disease situations on Aspen Mountain.

Because of the relatively low economic value of subalpine fir, little is known of the basic biology of the western balsam bark beetle. One of the most crucial pieces of information that is lacking is the flight periodicity of the beetle. At the beginning of the 1995 field season, five flight traps were placed along an elevational transect on the Aspen Mountain. The traps were emptied weekly by volunteers from ACES. Counts of the beetles revealed an extremely discrete flight pattern. The peak of the flight occurred during the week of July 30, and the greatest number of beetles were captured at an elevation of 10, 745 feet. A repeat of the trapping study for 1996 is currently underway. In addition, Tom Eager has begun a study in conjunction with Jose Negron to determine the effects of elevation on bark beetle development. Other long-term projects include lab studies on the effects of temperature on beetle development as well as investigations on the insect associates of *D. confusus*.

Disease Control Committee

R. L. James

The Disease Control Committee met for lunch on Tuesday, September 17, 1996. There were six people in attendance. Several topics were discussed during the meeting which dealt with current important diseases and control approaches. A summary of the discussion topics follows:

1. Meria needle cast (*Meria laricis*): this disease occurred in epidemic proportions during 1996 throughout the Pacific and Inland Northwest. Damage was extensive on trees of all age classes with some infected trees having their entire foliage affected. The problem was especially severe on 2-0 nursery stock and attempts to reduce damage by spraying affected seedbeds with chlorothalonil (Bravo) were only successful after clear, warm weather prevailed. Chemical applications seem to keep the disease within tolerable limits only when weather conditions are not very conducive to disease buildup. However, when cool, wet conditions prevail for extended periods in the spring and early summer, disease occurrence may be high despite repeated fungicide applications. Fortunately, most affected seedlings reflushed their foliage and appeared healthy by the end of the second growing season prior to lifting.

2. Swiss needle cast (*Phaeocryptopus gaeumannii*): this disease has occurred at epidemic proportions the last several years along the Coast Range of the Cascades. Damage has especially been severe about 15 miles inland and near the Tillamook area. Some work has been done on effects of fertilization and funigicides on disease severity. Although fungicides can be effective, infected trees generally show little growth reponse resulting from fungicide applications. Less disease has been shown to occur in some fertilization trials. The disease is cyclic and related to extensive wetness during the summer (during the 1970s most summers were very wet, resulting in greater than normal disease levels). The current outbreak may also be the result of a large representation of young age class trees which are not only more susceptible, but in stand locations where the right environmental conditions for infection occur. Affected trees have smaller proportions of springwood compared to summerwood. Affected trees also have reduced root growth due to lower photosynthate surfaces resulting from premature needle loss. Cultural control includes removal of Douglas-fir from severely affected areas.

3. Root diseases of bareroot conifer nurseries: some innovative techniques for reducing impact of root disease in nurseries without soil fumigation with biocides were discussed. Two possibilities include steam treatment of soil to kill pathogen propagules while allowing potential antagonists (such as spore forming bacteria) to live and using a "beach cleaner" to remove the extensive amounts of root material left in soil after seedling lifting. Since much of the pathogen population resides within residual organic matter, including roots left in fields, inoculum reductions can occur if much of this material is removed before sowing a new crop of seedlings. Trials with steam treatment and beach cleaners are currently underway at several nurseries in the Pacific Northwest and the South. Biological control also offers promise in controlling soil-borne diseases in forest nurseries. Several commerically-available sources of biological agents are available; some have been tested, usually with varying results. Mike McWilliams indicated that he had a "super" *Trichoderma* strain that was very effective against *Phellinus weirii* and other Basidiomycetes. This strain not only produces antibiotics, but is a mycoparasite on many soil fungi. It is possible that this strain may effectively control soil pathogens such as *Fusarium*, *Pythium*, and *Phytophthora*

Regional Reports

Northern Region, USDA Forest Service, Coeur d'Alene Field Office

R. L. James

Current Projects:

1. Alternatives to soil fumigation for control of diseases in Idaho bareroot forest nurseries (James). Work includes investigating alternative cropping practices such as fallowing, crop rotation, organic compost amendments, mustard or no cover crops, biological control amendments (bacteria, Actinomycetes, *Trichoderma harzianum*), steam treatment, and dazomet as a replacement for methyl bromide.

2. Biological control of Botrytis blight in container forest nurseries (James); using a mixture containing *Trichoderma hamatum, Rhodotorula glutinis* (yeast) and *Bacillus megaterium* (bacterium).

3. Control of Fusarium root disease in container forest nurseries using selected cultural and biological control approaches to replace common use of chemical pesticides (James).

Recent Publications:

Dumroese, R. K., R. L. James and D. L. Wenny. 1995. Interactions between copper-coated containers and Fusarium root disease: a preliminary report. USDA Forest Service, Northern Region, Insect and Disease Management. Report 95-9. 8p.

James, R. L. 1995. Fungi on Douglas-fir and ponderosa pine cones from the USDA Forest Service Nursery, Coeur d'Alene, Idaho. USDA Forest Service, Northern Region, Insect and Disease Management. Report 95-5. 8p.

James, R. L. 1995. Root diseases of western white pine transplants - USDA Forest Service Nursery, Coeur d'Alene, Idaho. USDA Forest Service, Northern Region, Insect and Disease Management. Report 95-8. 10p.

James, R. L. 1996. Root disease of 1-0 bareroot seedlings - USDA Forest Service Lucky Peak Nursery, Boise, Idaho. USDA Forest Service, Northern Region, Forest Health Protection. Report 96-4. 9p.

James, R. L. 1996. Technique for quantifying virulence of Fusarium and Cylindrocarpon spp. on conifer germinants. USDA Forest Service, Northern Region, Insect and Disease Management. Nursery Disease Notes No. 132. 8p.

James, R. L., R. K. Dumroese and C. J. Gilligan. 1996. Western white pine seedling mortality - USDA Forest Service Nursery, Coeur d'Alene, Idaho. Report 96-6. 10p.

James, R. L., R. K. Dumroese and D. L. Wenny. 1995. Botrytis cinerea carried by adult fungus gnats (Diptera: Sciaridae) in container nurseries. Tree Planters' Notes 46(2):48-53.

James, R. L., R. K. Dumroese and D. L. Wenny. 1995. Fusarium prolifera - tum is a common, aggressive pathogen of container-grown conifer seedlings. Phytopathology 85:1129.

James, R. L., R. K. Dumroese and D. L. Wenny. 1995. Management of fungal diseases of western larch seed and seedlings. In : Schmidt, W. C. and K. J. McDonald (compilers). Ecology and Management of Larix Forests: A Look Ahead. Proceedings of an international symposium. USDA Forest Service, Intermountain Research Station, General Technical Report GTR-INT-319. pp. 300-306.

James, R. L., R. K. Dumroese and D. L. Wenny. 1996. Western larch seed - contaminating fungi and treatments to reduce infection and improve germination. USDA Forest Service, Northern Region, Forest Health Protection. Report 96-7. 14p.

James, R. L., D. S. Page-Dumroese, S. K. Kimball and S. Omi. 1996. Effects of *Brassica* cover crop, organic amendment, fallowing, and soil fumigation on production of bareroot Douglas-fir seedlings - USDA Forest Service Nursery, Coeur d'Alene, Idaho. USDA Forest Service, Northern Region, Forest Health Protection. Report 96-5. 16p.

Stone, J. K., D. M. Hildebrand, R. L. James, S. M. Frankel and D. S. Germandt. 1995. Alternatives to methyl bromide for control of soil- borne diseases in bare root forest nurseries. In: Proceedings: Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions, November 6-8, 1995, San Diego, CA. Methyl Bromide Alternatives Outreach, U. S. Environmental Protection Agency and U. S. Department of Agriculture.

Rocky Mountain Region, USDA Forest Service

1. New and Continuing Projects

D. Root and Soil Diseases or Relationships (including Mycorrhizae)

95-D-1 GIS-based landscape-scale root disease hazard rating system. (W. Jacobi, M. Kallas, R. Reich, J.L. Harris).

95-D-2 Ski area vegetation management: biology and impacts of the Armillaria root disease/western balsam bark beetle complex. (P. Angwin, T. Eager, J. Negron).

90-D-2 Root disease impact monitoring. (P. Angwin, D. Johnson)

79-D-1 Surveys of root diseases in managed conifer stands in R-2. (P. Angwin).

79-D-5 Spread of Armillaria spp. disease centers in managed pine. stands (P. Angwin).

F. Stem Diseases: Malformations, Witches'-Brooms, Dwarf Mistletoes, Etc.

85-F-5 Silvicultural control of dwarf mistletoe in young lodgepole pine stands. (B. Geils, D. Johnson).

K. Miscellaneous Studies

92-K-1 Effectiveness of fire for site preparation in seral aspen in western Colorado. (P. Angwin, W. Shepperd).

90-K-1 Vegetation management planning in developed recreation sites. (D. Johnson, P. Angwin, T. Eager).

2. Terminated Projects

93-D-1 Survey of biological species of *Armillaria* and *Heterobasidion* in Region 2. (P. Angwin, D. Johnson).

RECENT PUBLICATIONS (as of August, 1996)

Angwin, P.A. 1995. Pest conditions at Amphitheater, Silverjack, Beaver Lake and Big Cimmaron Campgrounds, Ouray Ranger District, Uncompahgre National Forest, Colorado. USDA For. Serv., Renewable Resources, Rocky Mountain Region Biol. Eval. R2-95-4. 31 p.

Angwin, P.A. 1995. Pest conditions at Aspen Mountain Ski Resort, Aspen Ranger District, White River National Forest, Colorado. USDA For. Serv., Renewable Resources, Rocky Mountain Region Biol. Eval. R2-95-3. 16 p.

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Southwestern Region, USDA Forest Service

White Pine Blister Rust Monitoring

The New Mexico Zone has joined efforts with the Lincoln National Forest to gather stand exam data on the 14,000 acre Sacramento River Ecosystem Management Area. White pine blister rust (WPBR) data will be collected on about 1,100 of the 2,750 stand exam points that will be established. Since information will be collected on the full elevational range of Southwestern white pine, the only coniferous host in this mountain range, the current distribution of the WPBR relative to habitat type will be determined. Also, seventy-five rust-free trees are being monitored in an area of heavy infection as resistant candidates. Finally, permanent plots have been established in 10 locations thoughout the Sacramento Mountains to monitor the impact and long-term development of the outbreak.

Development of Cavity Nesting Habitat

In April of 1995, Catherine Parks, Pathologist, Pacific Northwest Research Station, gave a talk on the use of decay fungi for creating cavity nesting habitat in live trees. Wildlife biologists and other resource specialists from throughout the Region attended the talk. Personnel from the Coconino NF and Kaibab NF began setting up similar projects on their forests. They will be inoculating trees with fungal cultures derived from local sources (decayed trees) in the fall of 1996. We will continue to help with implementation and monitoring of these projects.

Wood Import Pest Risk Assessment and Mitigation Evaluation Team

In September, 1995, the Chief of the Forest Service and the Administrator for the Animal and Plant Health Inspection Service chartered a national standing team titled the Wood Import Pest Risk Assessment and Mitigation Team to provide a permanent source of technical expertise on the assessment of pest risks associated with importation of wood products into the United States. Borys Tkacz, Arizona Zone Leader, was appointed team leader for the eight-member team. The first report issued by the team was a review of the Pest Risk Analysis (PRA) for the territories of the European Union (as PRA area) on Bursaphelenchus xylophilus and its vectors in the genus Monochamus" completed in October, 1995. The team is currently conducting a pest risk assessment for the importation of Pinus and Abies logs from Mexico.

Pest Trend Impact Plots in the West

Since 1990, we have established permanent plots across the Region as part the technology development project: "Pest Trend Impact Plots of the West". In Region 3, we have established and monitored permanent plots in areas affected by dwarf mistletoe, root disease, and western spruce budworm. This information will be used to validate the pest subroutines of the Forest Vegetation Simulator Model, otherwise known as FVS.

BIOLOGICAL EVALUATIONS AND FUNCTIONAL ASSISTANCE LETTERS

Diagnosis of Alder decline along the Hassayampa River, Bradshaw Ranger District, Prescott National Forest. 2/95.

Biological Evaluation of Dwarf Mistletoe Suppression Project on the San Carlos Indian Reservation. 7/95.

Functional Assistance to De Motte Campground. 11/95

Review of European Union Pinewood Nematode Pest Risk Assessment. 11/95.

Interim post-treatment evaluation for Potato Knob and Sixteen Springs dwarf mistletoe control projects, Lincoln National Forest. 3/95.

White pine blister rust scouting, Gallinas Peak, Cibola National Forest. 6/95.

Pest Impact at Proposed Cayete Pumice Mine Site. 6/95.

Valle Grande and Borracho dwarf mistletoe control projects, El Rito RD, Carson National Forest. 7/95.

Dwarf mistletoe control projects, Tres Piedras RD, Carson National Forest. 7/95.

Cerro Pavo dwarf mistletoe control project, Coyote RD, Santa Fe National Forest. 7/95.

Lamy Peak dwarf mistletoe control project, Tres Piedras RD, Carson National Forest. 7/95.

Proposed dwarf mistletoe control project, Jemez Indian Reservation. 7/95.

Alamitos Mesa restoration/dwarf mistletoe control project, Espanola RD, Santa Fe National Forest. 8/95.

Forest insect and disease conditions, Ceremonial Canyon, Picuris Pueblo. 10/95.

Proposed Board Tree and Lower Sixteen Springs dwarf mistletoe control projects, Sacramento RD, Lincoln National Forest. 10/95.

Dwarf mistletoe control projects, Mescalero-Apache Indian Reservation. 10/95.

Tree decline and death on the Quemado RD, Gila National Forest. 10/95.

Mount Taylor Ranger District Campground Evaluations. 10/95.

Monitoring of the Stand 100 dwarf mistletoe control project. 11/95.

Monitoring of the Acoma Pueblo dwarf mistletoe control projects. 12/95.

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Anonymous. 1995. Forest Insect and Disease Conditions in the Southwestern Region 1994. USDA Forest Service, Southwestern Region. R-3-95-3. 19pp.

Fairweather, Mary Lou. 1995. Post-treatment Biological Evaluation of the 1981 Tusayan Dwarf Mistletoe Control Project. USDA Forest Service, Southwestern Region. R-3-95-1. 8pp.

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Oregon State University

RECENT PUBLICATIONS

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Stone, J. K., M. A. Sherwood, and G. C. Carroll. 1996. Canopy microfungi: function and diversity. Northwest Science 70: 37-45.

Stone, J. K. and O. Petrini. 1997. Forest endophytes. In: The Mycota, Volume 6, Plant Relationships. K. Esser and P.A. Lemke, editors, Springer-Verlag, Berlin. (in press).

Stone, J. K., D. Hildebrand, R. James, and S. Frankel. 1996. Alternatives to methyl bromide for control of soilborne diseases in bareroot nurseries. Third IUFRO working party on diseases and insects in forest nurseries. May 19-24, 1996, Gainseville, FL.

Filip, G.M. 1995. Forest health decline in central Oregon: a 13-year case study. NW Science 68(4):233-240.

Filip, G.M. and D.J. Goheen. 1995. Precommercial thinning in *Pseudotsuga, Tsuga*, and *Abies* stands affected by armillaria root disease: 10-year results. Can J. For. Res. 25(5):817-823

Filip, G.M., C.A. Parks, B.E. Wickman, and R.G. Mitchell. 1995. Tree wound dynamics in thinned and unthinned stands of grand fir, ponderosa pine, and lodgepole pine in eastern Oregon. NW Science 69(4):276-283.

Filip, G.M., A. Kanaskie, and A. Campbell III. 1995. Forest disease ecology and management in Oregon. Manual 9, Oregon State University Extension Service, Corvallis. 60 p.

THESES

Murray, M. 1995. Susceptibility of Pacific Yew to *Phytophthora lateralis*. MS.

Rosso, P. 1995. Tree vigor and the susceptibility of Douglas-fir to Armillaria root disease. MS.

Trummer, L. 1996. Spread and intensification of hemlock dwarfmistletoe in forests of SE Alaska. M.S.

Tuininga, A. R. 1996. Interactions between western hemlock mycorrhizal fungi and wood rotting fungi in a system simulating douglas-fir nurse logs in Pacific Northwest forests. M. S.

Marshall, K. 1995. The relationship of Douglas-fir dwarf mistletoe (*Arceuthobium douglasii*) to environmental and stand conditions and plant communities in the Southern Oregon Cascades. MS.

Rhatigan, R.G. 1995. Toxicity of methyl bromide to fungi inhabiting Dahurian larch wood. MS.

Yang-Erve, L. 1995. The effects of prescribed burning on the viability of *Armillaria ostoyae* in the soil of a mixed-conifer forest in the Blue Mountains, Oregon. MF.

NEW AND CONTINUING PROJECTS (1996)

Hansen

(1996-97) --Biology of Swiss needle cast on Douglas-fir. Oregon Department of Forestry

(1995-97) --Hazard evaluation for blackstain root disease. USDA Forest Service Technology Development Program

(1996) -- Testing for Resistance to Port Orford cedar root disease. USDA Forest Service

(1996-98) -- Screening Port-Orford cedar for resistance to *Phytophthora lateralis.* USDA Forest Service, BLM
(continues) -- Silvicultural strategies for management of laminated root rot.
(continues) -- Species concepts and population biology of *Phellinus weirii*

Stone
(1993-1997) --Alternatives to Methyl Bromide in bare-root nurseries. Technology Development Program.
(Continues) --Ecology and evolutionary biology of parasitic fungi in conifer needles.

Filip
(1990-continues) USDA Forest Service -- Can silviculture reduce damage caused by Armillaria root disease in a white fir forest on the Winema National Forest?

(1993-continues) USDA Forest Service -- Effects of silvicultural practices on forest productivity and protection in the Blue Mountains of Oregon

(1994-96) Warm Springs IR -- Effects of commercial thinning and subsequent tree wounding on the incidence of *Heterobasidion annosum* in second-growth noble fir stands

(1994-continues) -- Comparison of snag creation techniques and artificial inoculation of decay fungi into Douglas-fir to produce wildlife trees

(1966-continues) USDA Forest Service -- Precommercial thinning in conifer stands affected by Armillaria root disease

(1985-continues) USDA Forest Service -- Effects of simultaneous infestation by dwarf mistletoe and western spruce budworm on growth and mortality of Douglas-fir in eastern Oregon and Washington

(1989-continues) USDA Forest Service -- Effects of *Heterobasidion annosum* infection in stumps of grand fir on mortality of surrounding regeneration in northeastern Oregon.

(1988-continues) USDA Forest Service -- Species susceptibility, disease intensification, and loss predictions in an entered and unentered mixed-conifer stand infected by Armillaria in northeastern Oregon.

(1989-continues) USDA Forest Service -- Effects of fertilizer on grand fir infection by Armillaria and diameter growth of larch with dwarf mistletoe in northeastern Oregon.

BUSINESS MEETING MINUTES

Prepared by Jerome S. Beatty

Chairman John Kliejunas called the meaning to order at 10:30 a.m. on Friday, September 20 in Hood River, Oregon. The business meeting minutes for both the 1994 combined WIFDWC/WIFIWC meeting in Albuquerque, NM, and the 1995 WIFDWC meeting in Whitefish, MT were approved as written. Ken Russell and John Sutherland were proposed and recognized as Honorary Members; it was noted that Allen Van Sickle would retire later in 1996 and would be eligible for HM induction during the 1997 meeting.

Committee Reports

Bob James, disease control committee chair, reported that 6 people attended their meeting. The major topic of discussion was the probability of dissolving the committee if attendance does not increase at future meetings

Bob Mathiasen, dwarf mistletoe committee chair, reported that 27 people attended their meeting and gave some highlights of the 1996 report: Diane Hildebrand updated the committee on the mountain hemlock dwarf mistletoe survey in the Pacific Northwest; Jim Hoffman and Dave Johnson reported on the future of dwarf mistletoe suppression funding; John Pronos reported on the results of pruning trees in California campgrounds; Jerry Beatty gave an update on the publication of the larch dwarf mistletoe FIDL.

John Pronos, hazard tree committee chair, reported that 30 people attended their meeting. They discussed the possibility of starting a national tree failure reporting system and hosting another hazard tree workshop in the near future.

Ellen Michaels Goheen, root disease committee chair, reported that 30 people attended their meeting. They discussed holding a workshop on the "new" root disease model and Charlie Driver gave a slide show.

Rich Hunt, rust committee chair, reported that 20 people attended their meeting.

Future Meetings

The 45th WIFDWC will be held in Prince George, British Columbia, 15-19 of September, 1997. A pre-meeting field trip in Dawson Creek, will be coordinated by Jeff Beale. The 1998 meeting will be most likely be somewhere near Reno, Nevada, possibly in September. Carson City was no longer in the running but Jim Hoffman said he would check on Las Vegas as another possible site and report at the next meeting.

John Kliejunas noted that in 1999 we were scheduled for our next joint meeting with the entomologists. Every five years our meeting are joint meetings with the time and location selections alternating between groups; 1999 is our year to choose. John proposed that we so meet. This motion was seconded and passed unanimously. Dave Johnson offered Colorado as the site of the joint meeting, possibly at the Keystone resort, in mid- to late- September. This offer was accepted, moved, seconded, and passed unanimously. Dave also volunteered to contact the executive committee of WIFIWC to begin planning the meeting until WIFDWC officers for the 1999 meeting are selected.

Kathy Lewis, interim program chair, reported on program suggestions made so far and urged members to continue. Comments so far included:

Special paper session should be scheduled earlier in the week to reduce stress on graduate students.

Committees continue to meet for one and one-half hours with no concurrent meetings.

We need more ideas for the program

The Railroad committee reported on it's selection of officers for the 1997 meeting: Walt Thies, chairman, Rona Sturrock, secretary and Kathy Lewis, program chair. These selections were approved, seconded, and passed unanimously.

Old Business

Honorary Life Members discussion. Bob Mathiasen attempted to lead a long, meandering, and ultimately inconclusive discussion on the nature of HLM, after which the membership decided that, while HLM's did indeed exist, no one knew exactly what they were, who they were, nor how they got there. It was agreed that the basic requirement necessary for HLM-ism was to have been an active member of WIFDWC; which lead to a discussion on what constituted membership in WIFDWC. It was agreed by all present that membership required attendance at one meeting every five years. Pete Anguin asked if the organization had by-laws; John Laut offered to find them. John Schwandt reported that a questionnaire had been mailed to all 48 HLM's and 23 responded; of those, 22 requested copies of the proceedings. John Laut proposed that the current treasurer send another letter to those HLM's that did not respond to the first and that each year a mailing be made to all living HLM's asking if they want proceedings. Mike Schomaker added the proviso that only those who responded would get copies. The motion was seconded and passed. A retrospective analysis of the HLM story, conducted through the WIFDWC archives by John Kliejunas, is included in these proceedings.

New Business

John Schwandt brought up the subject of reports. Region 2, USDA Forest Service is the only organization now submitting regular reports for the proceedings and John wanted to know if all organizations should be required to do so. It was decided that reports would be welcome but voluntary. Pete Anguin commented that reports were an easy way to update members.

Walt Thies asked about the timing of preparing and mailing the proceedings. During this discussion the following points were made: Walt suggested that we require copies of papers to be submitted before meetings and that proceedings be prepared and handed out prior to the meeting; Diane Hildebrand suggested that the previous year's proceedings be handed out during the present meeting, (one year later). Diane also, proposed that papers for the proceedings be submitted by November 1st the year of the meeting. This proposal was seconded and passed unanimously.

Norm Alexander, commenting on the lack of attendance by Canadians, proposed that a letter be sent to the BC Ministry of Forestry encouraging that Canadians be allowed to attend WIFDWC meetings. This proposal was seconded and passed unanimously.

The meeting was adjourned at 11:36 a.m.

Respectfully submitted by,
Jerome S. Beatty
WIFDWC Secretary

TREASURER'S REPORT
44th WIFDWC

The following is a summary of transactions for the 1996 WIFDWC meeting in Hood River, Oregon. Submitted by John Schwandt, Treasurer.

Meeting Participants: There were a total of 107 participants at the 1996 meeting; 71 regular members, 9 students, 9 retirees, 7 guest speakers, and 11 spouses/children.

TRANSACTION	AMOUNT	BALANCE
Balance reported at close of 43rd meeting in Whitefish, Mt.		3,608.25
INCOME:		
Interest paid to account from 1/1/96 through 9/30/96	102.22	3,710.47
Reimbursement from 1994 joint insect and disease meeting in ABQ.	400.00	4,110.47
Gross registrations receipts for 1996 meeting (minus $138 refunds)	9317.00	13,427.47
Sales of Proceedings	160.00	13,587.47
PAYMENTS:		
Adjustment to costs for 1995 meeting in Whitefish , Mt. (orig. estimate was $8238.51, final costs were $8389.17)	-150.66	13,436.81
Printing costs for 1995 (43rd) proceedings; estimated at $1500, actual cost was only $587.94 (A SAVINGS of $912.06)	912.06	14,348.87
Motel/meeting rooms/meals/breaks/etc.	-3900.99	10,447.88
Field trip transportation (including cost for emergency bus and rebate)	-1529.90	8,917.98
Banquet (95 meals @ $17.00 each)	-1615.00	7,302.98
Canopy crane (2.5 hours @ $185/hr)	-462.50	6,840.48
Travel expenses for special speaker	-780.00	6,060.48
Other expenses (refreshments, photos, PA rental, registration supplies)	-796.03	5,264.45
CURRENT BALANCE (as of 11/1/96)		**5,264.45**
Printing and mailing costs for 1996 proceedings will be subtracted from this balance and reported in next years proceedings.	???	

The WIFDWC account now resides at the Coeur d'Alene Teachers Credit Union in Coeur d'Alene, Idaho. (This is one of few places that would give us an interest bearing account without any service charges or checking costs.) It also happens to have an office about a block from our office, so is a convenient place to have it.

Although I don't promise the longevity of Ken Russell (20 years), I will do my best to keep the account in good order and provide annual updates on the account activity.

Note: The account includes $1874.83 from the May, 1995 Hazard Tree Conference held in Visalia, CA.

WIFDWC Honorary Members Report

As a result of concerns regarding rising costs of sending complimentary copies of the WIFDWC proceedings to Honorary Members, and because of confusion as to the history of how Honorary Members are designated, a committee was formed after the 1995 Whitefish meeting to summarize the process. The objective was to gather historical information in one place for current and future members. Accounts from previous meetings are presented, followed by a summary and conclusions

Past Proceedings

1960, 8th meeting, Centralia: "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, retire from active continuous employment in forest pathology. Carried..." Because the nine listed motions involved changes in policy, the membership agreed to postpone action on the motions until the next meeting.

1961: The 9 policy amendments introduced in 1960 were re-introduced for consideration. A motion to table the motions was carried by voice vote.

1964, 12th meeting, Berkeley: a resolution was made by Andrews and Hawksworth that, "The classification 'honorary member' be bestowed on members of the conference who retire from continuous employment in forest pathology. Further, that this policy be retroactive to include all past members of WIFDWC who have retired. Also that registration fees be paid by the conference for honorary members. Further benefits to be decided by the officers on an individual meeting basis." The resolution was passed by a voice vote.

1965: The term "honourary life member" was used when referring to those eligible. Five individuals were eligible.

1966: It was agreed that a list of honorary life members should be maintained and kept up to date. Eight new honorary life members were recognized, and indicated with a (+) in the membership list.

1967: Honorary life members (13) were listed separately after the membership list.

1968: Three names were added to honorary life member list.

1969: No mention, or designation in membership list, of honorary life members.

1970: One honorary life member (Reed Miller) was selected and approved. No listing of honorary life members was in the proceedings.

1971: Honorary life members were listed separately. Two new honorary life members were accepted. The following motion was passed unanimously by voice vote: " With the exception of the Mexican delegation, a membership requirement of attending at least one conference during a consecutive five year period is hereby established. The current (1971) membership list, with some possible exceptions, is to be revised by the Secretary on this same basis. 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."

1972: Honorary life members (16) were listed separately.

1973: Three individuals were "voted" honorary life members. This is the first reference to actual voting. Nineteen honorary life members were listed separately before the membership list.

1975: The proceedings contained one page with honorary life members (20 names) and new life members (5 names). "The guidelines state that if such persons (those who retire since the last meeting) are no longer practicing forestry that they be made honorary members of WIFDWC."

1976: "Issuance of proceedings of WIFDWC meeting contributions are according to rules formulated during the 3rd meeting. Distribution of proceedings should be made to all persons known to be qualified for membership and who have an active interest in WIFDWC." Four honorary life members were added with unanimous vote.

1977: "It was pointed out that since the 12th conference, and confirmed at later meetings, honorary membership is automatically bestowed on members when they retire from principle employment as pathologists and that no election is necessary. Neil MacGregor and Ed Andrews have therefore been 'promoted' to 'honorary life members'." Thirty honorary life members, and 2 new life members, were listed separately.

1978: No mention of honorary life members; no list of active members either.

1979: Lew Roth "graduated" to an honorary life member. A list of 30 honorary life members was included.

1980: Three individuals were "elevated" to honorary life member status. Thirty three honorary life members were listed separately.

1981: A list of 33 honorary life members was contained, separate from the membership list. "The secretary-treasurer (Terry Shaw), according to instructions, used his discretion in revising the mailing list. A basic guideline provided in the bylaws was followed: anyone other than a life member who has not attended a meeting within the last 3 years can be dropped from the mailing list." (This 3 year requirement disagrees with the 5 year requirement in the 1971 approved motion.)

1982: A list of honorary life members was included. "The membership agreed that life members should receive a free copy of the proceedings. The cost of these can be covered by higher charges to others or hopefully from interest on our balance."

1983: Honorary life members (35) were listed separately.

1984: As there were concerns over the last several years of raising cost of producing the proceedings - "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 others at cost". A list of honorary life members (38) was included just before the member listing; a symbol (!) before the name indicated those who desire to receive proceedings.

1987: A separate list of honorary life members (41) was included.

1988: Honorary life members were indicated by (H) after name in membership list.

1989: "Walt Thies proposed that honorary life members be sent a questionnaire regarding their activities so that members of WIFDWC could be kept informed. These will be done by this year's secretary and reported during the next meeting." Honorary life members were indicated by (+) after their name in the membership list.

1990: "An effort is being made to contact the Honorary Life Members (HLM's) through a committee consisting of Jim Hoffman and Earl Nelson." Honorary life members were indicated by a (+) after their name in the membership list.

1992: Charlie Driver was recognized as a new honorary life member. No listing of honorary life members was included, anywhere.

1993: Five new honorary life members were recognized. No listing , or any indication of, honorary life members in the proceedings.

1994: "Norm Alexander was unanimously voted as a new Life Member (note reference to voting, and non-use of "honorary") of WIFDWC."

1995: Several names were "nominated" for honorary life membership. Because "no one knew for sure if any of these individuals were already approved as life members, all the names were approved unanimously by a vote of the membership. A committee (Kliejunas, Frankel, Mathiasen) agreed to "look into the process of selecting individuals for honorary life membership, whether or not any of the individuals approved for HLM had already been approved during past WIFDWC meetings, and to send letters to the newly approved HLM's. (Bob Mathiasen has prepared a listing of living and deceased Honorary Life Members for inclusion in the 1995 Proceedings)." Bob updated the existing honorary life member list and included it in the proceedings. Bob also send a letter to honorary life members, requesting their response if they desired a complimentary copy of the proceedings.

Summary and Conclusions

The definition of an honorary member, and of a member, is clear. Honorary members are entitled to a complimentary copy of the Proceedings. Voting or approval of new honorary members is not necessary. Those who meet the requirement stated in the 1964 proceedings automatically become honorary members. Recognition of new honorary members is appropriate during the member status portion of the business meeting. Costs can be reduced by sending copies of the proceedings only to honorary members who have indicated a desire to receive it. Some effort on the part of the Secretary and Treasurer (who now maintains the membership list) is required to maintain the honorary member list, including keeping track of those who desire to receive a copy of the proceedings.

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