

PROCEEDINGS OF THE 38th ANNUAL WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

**Redding, California
September 17-21, 1990**



Proceedings of the 38th Annual Western International Forest Disease Work Conference

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CHAIRMAN'S WELCOME

Welcome one and all to the 38th WIFDWC! There are several persons who are responsible for bringing this meeting to fruition.

Greg DeNitto for local arrangements
Greg & Bob Mathiasen for pre-meeting field trip
Melissa Marosy for the program; and
Jim Hoffman for mail announcements

I think that we all have to agree that Bob James probably can do the ½ hour in 25 minutes after his speedy production of the Proceedings of the joint meeting held in Bend, OR.

Next year's conference will be partially a joint affair with the Western Forest Genetistic Association in and out of Vernon, B.C. Hadrian Merler of the B.C. Min. of For. is making joint arrangements with the genetists. The meeting will probably be held the 1st week in August, thus permitting families to holiday the last week in July during B.C.'s traditional week of excellent weather. This will also permit the genetists to pick ripe cones later in Aug. and through Sept. I am soliciting suggestions for the program.

To my knowledge none of our members have during the past year gone to that great diseased forest in the sky.

At the 36th meeting Jim Byler as WIFDWC chairman stated, "It is customary for someone in my position to offer words of wisdom or a perspective on WIFDWC" and then proceeded to go on for three more paragraphs. Which was an increase of 300% over the immediate previous WIFDWC chairman John Muir. Last year Don Goheen stated "It is customary --- for WIFDWC chairman to pontificate." And, like the Queen giving her annual state of the Commonwealth address, he went on for a 500% increase over Jim Byler. Thus, for me to continue this so called custom, which these Berkeley graduates seem to be embellishing over time, I should produce about 2800 mm of text or about 1200% more wisdom than John Muir produced 3 short years ago. For me to get out of this dilemma I'd like to go back to another Berkeley graduate, who was chairman in 1978 and quote from his opening remarks. However, our quiet and very wise Dick Smith in that year said absolutely nothing.

As a compromise I'd like to make two points: First, our governments are in such debt that we are faced with many of our tax dollars going to pay interest and only a few real dollars to carry out the governments' agenda. The governments are continually forced to reduce and rearrange their agenda. Most of us need government dollars to carry out our programmes. Besides encouraging debt reduction, we have two avenues to pursue a) change our programmes to fit the governments' agenda and b) encourage the governments to have us on their agenda. The latter is the more palatable. To do this we must catch the governments' eye frequently and successfully compete with others who are doing exactly the same thing. We must attract the news media and hold its attention, we must lecture to

the lay public through night courses, we must actively pursue support from environmental groups, we need to patent a super video game where Blutto Cobb kicks the spinach spores out of the forest, etc. etc. We need to ask ourselves if we have a true perspective of society and the ways of government when over the history of WIFDWC none of the officers have been black or red, and of the 141 positions 2% have been held by females. Look around the room, are we not largely a group of upper class WASP males and thus a group the government seems to be trying to make extinct?

The second point I'd like to make was made by another chairman, who also was a Berkeley graduate. And from Bob Scharpf I quote

"I would like to stress, particularly for you newcomers, the air of informality and openness that prevails during this conference, both in and out of the sessions. By all means do not hesitate to ask questions, put forth your ideas and comments, and probably the hardest to do, toss out constructive criticism about any of the topics or presentations. Please do not be afraid to put yourselves in harm's way."

I believe the "air of informality" is not as strong as it used to be at WIFDWC. So, please, please do not hesitate to call a spade a spade. We must advance science through truth and knowledge, hence we need to put all the pieces of the cards on the table for everyone to evaluate.

I will now turn the program over to Melissa Marosy.

R.S. Hunt

38th WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE
Redding, California

Tentative Agenda

Monday, September 17, 1990

4:00 - 8:00 p.m. Registration

7:00 - 10:00 p.m. Get-together/mixer

Tuesday, September 18, 1990

7:30 a.m. Registration

7:30 a.m. Root Disease Committee Breakfast Greg Filip

8:30 a.m. Chairman's Welcome Rich Hunt

8:45 a.m. Keynote Address: New perspectives,
biodiversity, sustainability,
and forest health? Phil Aune

10:00 a.m. Break

10:30 a.m. Update on Old and New Projects All

12:00 p.m. Dwarf Mistletoe Committee Luncheon John Muir

1:30 p.m. Panel: Forest Health Monitoring--
Can These Rumors Be True? Bob Loomis, moderator

The Forest Health Monitoring Program Bob Loomis
The New England Experience Margaret Miller-Weeks
The Southern Experience Bob Anderson

3:00 p.m. Break

3:30 p.m. Forest Health Monitoring (continued)

Pest Effects Plot Project Bob Mathiasen
National Forest

Management Plan Monitoring Beth Willhite

Discussion: Let's sort this out,
ventilate, and see where we're
likely to go from here All

5:00 p.m. Adjourn

Wednesday, September 19, 1990

8:00 a.m. Field Trip to Mount Shasta and McCloud
Flats: Black stain and annosus root
diseases, white pine blister rust,
Elytroderma, bark beetles, and other
miscellaneous creatures in the woods

5:00 p.m. Return to Redding

Wednesday, September 19, 1990 Continued - Evening Session

- 7:30 p.m. Update on Introduced Diseases Melissa Marosy, moderator
- 7:30 p.m. The Canadian Situation: Scleroderris canker, pine wood nematode, Colletotrichum seedling blight John Muir
- 7:50 p.m. The Washington Situation: Unusual abiotic tree problems; whitebark pine, an endangered species? Ken Russell
- 8:10 p.m. White pine blister rust in New Mexico Frank Hawksworth and Dave Conklin
- 8:25 p.m. Pitch canker in California Mark Schultz
- 8:40 p.m. Dutch elm disease in California Alleah Haley
- 9:00 p.m. Adjourn

Thursday, September 20, 1990

- 7:00 a.m. Disease Control Committee Breakfast John Schwandt
- 8:00 a.m. Business Meeting Rich Hunt
- 9:00 a.m. Panel: Armillaria as an Ecosystem Component GERAL McDONALD, moderator
- Armillaria, habitat types and system behavior GERAL McDONALD
- Armillaria--A role for long-term stability of natural inland western forests Al Harvey
- Recent advances in taxonomic perspectives Hal Burdsall
- 10:00 a.m. Break
- 10:30 a.m. Armillaria (continued)
- An experiment in shade stress of Douglas-fir Anita Koehn
- A forester's perspective and action Leo Torba
- Preliminary results of a blind-blind test of a new procedure to identify diploid isolates of Armillaria Terry Shaw
- Discussion All
- 12:00 p.m. Rust Committee Luncheon Rich Hunt

Thursday, September 20, 1990 Continued - Afternoon Session

- 1:30 p.m. Special Papers Fred Baker, moderator
- 1:30 p.m. Hazard tree survey of the Ft. Lewis
Historical District, Washington David Shaw
- 2:00 p.m. Creating wildlife trees with
inoculation of decay fungi Catherine Parks
- 2:30 p.m. Break
- 2:45 p.m. Managing forest diseases
in recreational areas Ernest Del Rio
- 3:15 p.m. Comparison of sampling methods for
Armillaria root disease Stephan Zeglen
- 3:45 p.m. Adjourn
- 6:00 p.m. No-host Happy Hour
- 7:00 p.m. Banquet

Friday, September 21, 1990

- 8:00 a.m. Special Papers (continued)
- 8:00 a.m. Status of the annosus/bark beetle
variant of the western root
disease model Bov Eav, John
Kliejunas, Pete
McNamee, and Terry
Shaw
- 8:30 a.m. Management of Port-Orford-cedar
in the face of its related root
disease, Phytophthora lateralis Mel Greenup
- 9:00 a.m. Panel: New Perspectives and Forest
Health--An Ecosystem Perspective Jim Byler, moderator
- Coastal Forests Don Goheen
Eastern Oregon Forests Greg Filip
Montana and Northern Idaho Forests Jim Byler
Discussion All
- 11:00 a.m. Adjourn

Business Meetings Minutes
Thirty-eighth Annual Western International Forest Disease Work Conference

First Business Meeting - September 18, 1990

The work conference was called to order at 8:33 am on September 18, 1990 by the prolocutor, Rich Hunt. As the 1991 WIFDWC is a joint meeting with the Western Forest Geneticists in Vernon, British Columbia, and few Canadians were in attendance at the Redding Work Conference, Rich appointed himself as the interim program chairman.

"Round Robin" - Forest Pathology News as viewed and reported by attendees

Rich Hunt reported Forestry Canada is now a ministry rather than a part of the Canadian Agriculture Department. He also said Duncan Morrison is working on the interaction of mountain pine beetle with Armillaria to kill pines. Dr. Brenda Callum will replace Bill Bloomberg, which is amazing because she just replaced Al Funk according to last year's proceedings. Her next assignment? Well, Rich said Dick Smith will "phase out" into retirement.

Stefan Zeglen is back in Canada working on Armillaria surveys. Rhizina root disease in burned-over plantations has also kept him occupied.

Ken Russell, in Washington is working on simplified technology transfer reports for the public concerning aspects of Forest Health.

Someone from Oregon reported they are in the midst of a severe budget crisis and re-organization effort.

John Schwandt represented his old position as the State of Idaho forest pathologist and talked about continuing work with permanent plots to monitor and evaluate root diseases in northern Idaho.

Mike Shoemaker, Colorado State Forestry Service, said his time is spent working on Dutch Elm Disease, hazard tree rating systems, and other public pest inquiries associated with urban and community forestry.

Mike Albers, from Minnesota, is trying to standardize the insect and disease survey procedures and codes, in between working on aspen loss assessment work.

From the University of Washington, David Shaw, reported their graduate pathology program is declining. Not related to this decline are their current programs - sludge effects on forests, and root diseases of coastal forests.

Another un-named person from Oregon State reported Everett Hansen was on sabbatical in Sweden. Phil Hamm moved to Hermiston, Oregon to do agricultural pathology. Greg Filip, left Forest Service Research in LaGrande, Oregon to rejoin his old alma mater (OSU) as a research/extension specialist in Forest Protection.

Several important personnel changes are happening at the University of California in Berkeley. Field Cobb indicated he may be retiring by mid-1991. Dick Parmeter did retire in fall 1990. Art McCain continues to hold down the fort, working on charcoal root rot in nurseries. Tom Harrington, from the University of New Hampshire, is on sabbatical at UC Berkeley.

Bob Gilbertson is continuing his Ganoderma decay work. He has a graduate student, Kevin McCann, working on Armillaria.

Frank Hawksworth filled in for Bill Jacobi at Colorado State University and said Bill has an flourishing pathology program with three graduate students, and is looking for additional projects/funds.

Bob Tinnin, at Portland State, is working on the anatomy and ecology of dwarf mistletoes.

At Utah State University, Fred Baker, is working on several aspects of Armillaria.

From the Forest Service FPM regions, Jim Byler talked about their expanding program. Bob James continues to do nursery pathology studies in Couer d'Alene. John Schwandt joined the Forest Service during the year and will conduct root disease studies in northern Idaho. Sue Hagel, in Missoula, continues to expand and monitor her root disease plots. Jane Boyd also is installing permanent plots to provide better information for stand simulation models.

Mary Lou Fairweather of the Flagstaff, Arizona FPM Zone Office is mostly involved with Forest Service interdisciplinary teams and the concerns of dwarf mistletoe in ponderosa pine. In New Mexico, the new Albuquerque Zone Office pathologist, Dave Conklin, is trying to figure out the extent and etiology of white pine blister rust on southwestern white pine on the Lincoln National Forest. The new disease occurrence is at least 600 miles from any previously reported areas. Of note to old timers, the Lincoln National Forest has been the home, since the early 1980's, of former Region 5 pathologist, Ed Wood. Dave might want to check out Ed's field vest for old collections.

In Region 4, Leon LaMadeleine, of the Ogden Field Office, announced the transfer of Bob Mathiasen to the state of Idaho. Leon is looking for a replacement. Jim Hoffman, in the Boise Field Office, said he was working on the Lucky Peak Nursery EIS, and an evaluation of the effectiveness of pyrethrin insecticides to prevent attack by western pine beetle.

John Kliejunas, in Region 5, California, discussed their programs. They continue to monitor their long-term Fomes annosus and dwarf mistletoe plots to provide information for models. Air pollution studies are continuing, with emphasis on ozone monitoring. They are also standardizing their hazard tree ratings and procedures. Susan Frankel is conducting mulch studies to control Phoma in nurseries.

Up in the Pacific Northwest, Jerome Beatty reported on personnel changes. Paul Hessburg moved to a new zone office in Wenatchee, Washington. Sally Campbell transferred to timber management and is leading a team that is preparing environmental impact statements for all of the Forest Service nurseries and seed orchards in the country. Mel Greenup is the Port-Orford-Cedar

coordinator, responsible for Forest Service efforts to manage this valuable species which is declining in northern California and southern Oregon because of the fungus, Phytophthora lateralis.

From Washington DC, Bob Loomis said the big programs in pest management these days are western bark beetles, southern pine beetle, Gypsy Moth, Fusiform Rust, and dwarf mistletoes. Also, more flexibility was given to the Regions in terms of their budgeting priorities.

Bov Eav reported the Methods Application Group (MAG) in Fort Collins, Colorado is feeling some strain after losing Ross Pywell, who handled computer systems, and Andy Gillespe, the statistical services whiz. Fortunately the remote sensing department, run by Dick Myhre is flourishing. Dick is on the cutting edge of video camera applications for resource management, including pest effects.

From Forest Service Research, the pathology picture is far from rosy. Retirements and budget cuts have drastically reduced the work force and programs. The remnant scientists, however, continue to plug along with staunch fervor.

Al Harvey, briefly mentioned the pathology research in the Intermountain Station in Moscow, Idaho. They are working closely with the national forest system to better define pathological concerns that relate to stand productivity, especially with regard to root disease and soil management. Geral McDonald is continuing his Armillaria and habitat typing studies, as well as wrapping up some old studies to provide information for the white pine blister rust hazard model.

At the Pacific Northwest Station in Corvallis, Oregon, Walt Theis reported he is getting some of the information together from his long-term root disease plots. Earl Nelson is doing some biological-control studies. They are also in the midst of a re-organization effort.

From PNW in LaGrande, Greg Filip announced his recent defection from Forest Service Research to Oregon State University. Nevertheless, he will continue his silvicultural control of Armillaria studies. In Greg's absence, Catherine Parks will finish her doctorate (from OSU - must be a requirement to work in Oregon!) and return to LaGrande to work on the politically controversial decline of the forests in the Blue Mountains caused by a Gordian knot of stress factors that include drought, defoliating insects, and root diseases. Good luck, Catherine!

At the Pacific Southwest Station, Bob Scharpf announced he would join the rest of the "Berkeley boys" in retirement soon. In the meantime, he would work on a revision of the classic, "Diseases of Pacific Coast Conifers." Bob is also finishing up some manuscripts on the resistance of Jeffrey pine and ponderosa pine to dwarf mistletoe infections. Bill Ostrasina, is starting to wind down his Fomes annosus work. He's working on a new project with George Ferrell on black stain root disease and insect associations, as well as working with the Chico Nursery on mycorrhizae inoculation of container grown sugar pine.

In the absence of Terry Shaw, the Rocky Mountain Station report was delivered by Frank Hawksworth. Frank said his revised Dwarf Mistletoe Monograph is

finished and is ready for the printer. Terry finished "The Armillaria Book," and it too will be one of 1991's best sellers. Brian Geils is the Stations GIS coordinator.

From Wisconsin and the home of the Forest Products Lab, Harold Burdsall said he was looking into speciation of Armillaria. Karen Nakasone is doing Phlebia classification. Mike Larsen is working on the speciation of Phellinus. And Frances Lombard indicated she might give up mycology in deference to retirement - in about 10 years! Keep up the great work, Frances.

Finally, Willis Littke of Weyerhaeuser gave us a list of activities that keep the industrial pest management specialist from getting into trouble: seed/cone gall midge; Ambrosia beetle monitoring; Ips pini recruitment; F. annosus and thinning; fertilizer interaction with black stain root disease; Poria mapping; Botrytus control; and inputs to "New Forestry."

Second Business Meeting - September 20, 1990

The chairman of the 38th annual WIFDWC, Rich Hunt, called the meeting to order at 8:04am.

1. Old Business

The chairman requested revision of the WIFDWC subcommittee of the National Committee on Forest Health Issues. He nominated Dave Johnson as the tentative representative and Don Goheen as the alternate representative. (In phone calls subsequent to this meeting, Bill Jacobi was confirmed as the WIFDWC representative, with Bob Edmunds as the alternate. Gregg DeNitto, Fred Baker, and Dick Smith are consulting committee members).

While he had the floor, Rich Hunt gave a brief report of the "Future of Forest Pathology," based on discussions at the APS meeting in Grand Rapids.

Update on the common name list of forest diseases: the Hawksworth - Burdsall list has been approved by forest pathologists in both the United States and Canada.

2. Treasurer's Report

Ken Russell said WIFDWC is embarrassingly flush with funds, having \$2,828 at the start of our 1990 meeting (see treasurer's official report). Thereupon a discussion was initiated on what we could and should do with our funds. Some thoughts - funding to WIFDWC for: graduate students; graduate students from eastern US universities; and/or international forest pathologists. Without motions or resolutions, we decided to allow next years' secretary and treasurer some latitude on the implimentation of our vague notions, at least on a trial basis.

3. Committee Reports

- a) See detailed reports elsewhere in proceedings.
- b) An effort is being made to contact the Honory Life Members (HLM's) through a committee consisting of Jim Hoffman and Earl Nelson.

4. Announcements on Staffing

- a) See comments under first business meeting.
- b) Retiring Canadians are Bill Bloomberg, Dick Smith, and Roy Whitney.

5. Announcements on Meetings

International Plant Pathology Congress is in Montreal, Canada from July 28 to August 5, 1993. Contact Rich Hunt or Lou Shain.

Canadian Phytopathology Society meeting is in Banff, from June 24-26, 1991.

American Phytopathology Meeting is in Portland, Oregon in 1992.

1991 WIFDWC Meeting is in Vernon, British Columbia during the first week in August. This is a joint meeting with the Forest Geneticists. The interim chairman received suggestions for the following topics: biological control of forest weeds; stem rust panel; media presentation workshop; foliage disease update; and forest health monitoring techniques.

6. New Business

Frequency of WIFDWC meetings - despite tight budgets and frequent travel restrictions there was overwhelming support for the annual rather than biennial meetings.

We decided to allow the local arrangements committee for future WIFDWC's to decide on the time of the meeting. Better rates can often be had at certain times of the year.

After short debate we decided that all had a great time at our joint meeting with the entomologists in Bend, Oregon in 1989. Consequently, we proposed to institute a tradition of joint forest pathology/entomology meetings every 5-years. As the entomologists met in the fall with us at our designated meeting place in Bend, we decided to accommodate their schedule and location for the next meeting. This likely means that prior to our joint meeting we will have an 18-month gap between our meetings.

Secretary Hoffman was instructed to respond to WFIWC and accept their invitation. He did, for a meeting in 1994. By word of mouth secretary Hoffman heard that the entomologist received another invitation from someone in WIFDWC for a joint meeting in the year 1995. We hope someone straightens this out at the 1991 WIFDWC meeting! One additional suggestion for a joint meeting--start and finish the two conferences on different days so that both groups can have part of the meeting on their own.

If you think the joint meeting business is goofed up, you haven't seen anything yet! Ok, the 1991 meeting is locked into Vernon, B.C. Now for the far future. We agreed to meet at a resort in Durango, Colorado in 1992. However, in a phone call from Rich Hunt in March 1991, secretary Hoffman was informed that the resort might be too costly for us. Also, since the 1992 APS meeting is in Portland, Oregon we might want to have a concurrent or adjoining meeting. If this occurred, then we could have the

1993 meeting in Durango (presumably at an affordable place). This sounds ok, except WIFDWC member, Jim Hoffman invited the WIFDWC members to Boise, Idaho for the 1993 meeting and they accepted. So if 1994 or 1995 is a joint meeting with entomologists, at their place and time, the proposal for a Boise meeting is annulled. Member Hoffman is comfortable with this decision.

The nominating chairman, John Muir, put forward Art McCain as chairman for the 1991 meeting and this was confirmed. The secretary position was turned down by Earl Nelson, because of commitments which will become apparent during the year. Consequently, John Muir became secretary for the 1991 meeting.

The meeting was adjourned by chairman, Rich Hunt.

FOREST PATHOLOGY TRIVIA II

Frank G. Hawksworth, Charles G. Shaw, III, and Robert L. Gilbertson

1. Which WIFDWC Secretary has the honor of getting the Proceedings out the fastest? the slowest?
2. What forest pathologist was as well known for his rag-time piano playing at the Soapy Smith Saloon in Skagway as for his pathology endeavors?
3. What forest pathologist has a mountain named for him?
4. Who was the first State Forest Pathologist west of the Mississippi?
5. Name a third generation forest rustologist.
6. What forest pathologists were confined to quarters by the Santa Fe Sheriff?
7. Which forest pathologist became a university president?
8. Which forest pathologist received his Ph.D. and retired at the same time?
9. Which forest pathologist made permanent changes in the internal microflora of several WIFDWCers by feeding them beans for 3 days?
10. What forest pathologist included descriptions of fungi from the Sonoran Desert and from Interior Alaska in his series of publications on the "Fungi of the Great Lakes"?
11. Which forest pathologists published a paper on red POT of ponderosa pine?
12. Which forest pathologist always starts his stories with, "Well, to tell the truth, . . . "?
13. And another who starts, "You know, I remember once. . . "?
14. Which forest pathologist would you not trust to clear your driveway with a snow blower?
15. What are some famous father-son forest pathologists?
16. How about some husband-wife forest pathologists?
17. Brother forest pathologists?
18. Who were the heads of the old USDA Division of Forest Pathology?
19. What forest pathologist was also an accomplished musician, linguist, and gourmet cook?
20. What forest pathologist teaches biochemistry, quantum mechanics, Greek,

music theory, philosophy, Great Books, etc.?

21. What is the most colorful forest pathology literature title?
22. Who was the first woman forest pathologist in the US? in Canada?
23. Who were the participants in the great fossil wood decay caper?
24. Who first discovered white pine blister rust on sugar pine?
25. What introduced tree disease was successfully eradicated in the West?
26. Which forest researcher, now well known for his tireless efforts to establish Research Natural Areas in Idaho, first discovered "pole blight" of western white pine?
27. What forest pathologist published Part I for a series of articles in Forest Science in 1965 for which Part II has not yet been started?
28. Who first determined that blue stain fungi were involved in tree killing by bark beetles?
29. Who had this statement in the acknowledgment in his Ph.D. dissertation - "I wish to that my mentors, . . . and my tormentors."?
30. What forest pathologist is better known as a loranthological deltiologist?
31. What wood decay fungus was first described in a forest pathology textbook?
32. What is polygonal parasitism?
33. Which WIFDWC member claimed to be the "Real" Dick Smith?
34. Which squeaky clean-cut forest pathologist was once a 1960's style Berkeleyite and known for having the longest beard since John Muir?
35. Which forest pathologist's first publication was on the economics of milk barn production?
36. What is the most widespread genus of forest pathogens throughout the world?
37. How many forest pathologists did it take to find white pine blister rust in South Dakota?
38. What US states or Canadian provinces have the most kinds of mistletoes?
39. What forest pathologist was a catcher for the Boston Red Sox?
40. What forest pathologist has a non-relative, namesake in plant pathology?
41. Which western forest pathologist sails to WIFDWC meetings?
42. What forest pathologist was director of antibiotic research for Parke-Davis & Co. during World War II?
43. What forest pathologist became an internationally known specialist on the

Gasteromycetes after he retired from the USDA?

44. Which states or provinces have no reports of Dutch elm disease?
45. What forest pathologist who was head of the National Fungus Collections, became involved in a controversy with his superiors in the USDA and absconded with the collections to the Brooklyn Botanic Gardens?
46. What forest pathologist helped develop fire retardants for the Monsanto Chemical Co.?
47. What forest pathologist first reported collection of fungus spores by honey bees?
48. What new WIFDWC member has investigated baboon damage to pines?
49. By what name is "tall silver western white fir" better known?
50. What do Lew Roth and Geoff Marks have in common?
51. What infamous US forest pathologist claims to have published papers on all the major types of forest diseases (fungi, bacteria, viruses, insects, nematodes, mistletoes, mycorrhizae, abiotic agents, anthropogenic perturbations, and bears)?
52. What famous Canadian forest pathologist can make a similar claim?

IN MEMORIAM - THOMAS S. "BUCK" BUCHANAN

Buck passed away on January 5, 1990 at his retirement home in Asheville, North Carolina. Buck was born in Tacoma, Washington on June 8, 1908, and obtained his a B.S. in forestry from the University of Idaho (1935) and a M.S. in forestry from the University of California (1937). Buck then went on to Yale to work with Dr. J. S. Boyce where he received his Ph.D. on littleleaf disease of southern pines in 1943. Buck began with the Portland, Oregon office of the old Division of Forest Pathology in 1928, and worked there, mainly on white pine blister rust in the Pacific Northwest and British Columbia, until 1939. Soon after he finished his Ph.D. at Yale he served as a Captain in the Marine Corps in the South Pacific from 1944 to 1946. After the war, he became the first forest pathologist for the Weyerhaeuser Timber Co. in Centralia, Washington, from 1947 to 1948. He then moved on to the University of Idaho where he was forest pathologist in the School of Forestry from 1948 to 1951. He then joined the US Forest Service on a cooperative aid project in Liberia where he served as the Director of the National Agriculture-Forestry Experiment Station from 1951 to 1954. In 1954 he returned to the US and served as Assistant Director of the US Forest Service Division of Forest Disease Research until 1964. He then became an Assistant Director for the Southeastern Forest Experiment Station in Asheville, a position he held until his retirement in 1972.

During his distinguished career in the West, Buck made important contributions to the understanding of many forest diseases, including white pine blister rust, decay of windthrown timber, decays of Douglas-fir, and pole blight of western white pine. Buck was a member of the early Division of Forest Pathology group that made pioneering studies on the epidemiology of white pine blister rust on pines and Ribes in the Pacific Northwest and British Columbia. He was also the first to discover white pine blister rust on sugar pine. At the University of Idaho he was not only a very successful teacher but he also led a productive research team (consisting of E. E. Hubert, George Harvey, Bill Ferrell, and one F. G. Hawksworth) on the then-mysterious pole blight of western white pine. Buck also encouraged other students, including such notables as Tom Laurent and Don Graham, to pursue careers in forest pathology.

Although most of Buck's later career was spent "down East", western forest pathologists will be forever indebted to him for his monumental historical account of "Forest Disease Research in the Western United States and British Columbia, Canada", which was published by the Southeastern Forest Experiment Station in 1976.

Buck will be long remembered as a thorough and meticulous forest pathology researcher and teacher, a top-flight research administrator, a good friend, and a devoted family man. He is survived by his wife Ann, a son Jerry, an engineer with the U. S. Forest Service in Virginia, and a daughter Patricia, a physical therapist in Denver, Colorado.

Frank G. Hawksworth and C. Gardner Shaw

38th WIFDWC
Forest Health Monitoring Panel
Redding, CA September 17, 1990

Panel Chairman: Bob Loomis

Panel Members by order of presentation:

Bob Loomis, USDA FS Forest Pest Management (FPM), Washington D.C. Office
Margaret Miller-Weeks, USDA FS Forest Pest Management, Northeastern Area
Bob Anderson, USDA FS Forest Pest Management, Southern Region (presented by
Bob Loomis)
Bob Mathiasen, Idaho Department of Lands (formerly FS FPM Intermountain
Region)
Beth Willhite, USDA FS Forest Pest Management, Pacific Northwest Region
(presented by Jerry Beatty)

Panel Introduction:

The panel's purpose is to describe, explain, and provide a forum to discuss:

- o National and regional perspectives on the Forest Service Forest Health Monitoring Plan (FHM),
- o FHM implementation progress and expectations,
- o Relationship of FHM to (1) an FPM technology development project for pest model validation and (2) National Forest management plan monitoring.

National Perspective of Forest Health Monitoring: (Loomis)

The health of the Nation's forests is increasingly in the news. The public is concerned about air pollution, global climate change, management activities, and a variety of forest insect and disease problems. The USDA Forest Service, U.S. Environmental Protection Agency (EPA), and other Federal and state agencies find it difficult to respond adequately to these concerns. One reason is that much of the resource data now collected by various public and private organizations can not be compiled, analyzed, and interpreted to evaluate forest health.

The FS, EPA, and cooperating states have responded to this problem by initiating a national forest health monitoring program designed to describe current forest conditions and to detect changes, determine causal relationships, and predict consequences. FHM design includes recommendations from the FS Forest Response Research Program (part of the National Acid Precipitation Assessment Program), the FS Forest Health Strategic Plan, and the EPA Environmental Monitoring and Assessment Program.

Forest Health Monitoring builds on existing FS programs and will be implemented in cooperation with other Federal and state agencies. The FS programs initially most involved are Forest Inventory and Analysis, Forest Pest Management, and several long-term ecological and hydrological research programs. The cooperating agencies most involved with the FS are EPA and state forestry agencies.

Forest Health Monitoring is a three-tiered, long-term process in which each successive tier requires progressively more detailed and costly information. The tiers are:

- o Detection monitoring to detect unexpected deviation of key monitoring elements from established baseline conditions or trends. This is the first and most extensive level. It consists of a geographically-based network of permanent plots distributed throughout the nation's forested areas coupled with pest surveys.
- o Evaluation monitoring to identify likely causal relationships. This is the second level and is activated by detection monitoring results and reports received from other sources. When detection reports identify areas or problems of concern, FS Forest Pest Management will assess the situation and as appropriate will convene a multidisciplinary team to determine specific evaluation responses. Responses could include additional surveys, site or area specific evaluations, more detailed monitoring, and specific research studies,
- o Research monitoring to define basic relationships sufficient to predict consequences. This is the third level and provides the most detailed, long-term data for ecosystem research to better determine causal relationships and to predict rates of change in forest conditions.

Forest Health Monitoring began this year in New England. With adequate funding, monitoring will gradually expand during the next 5 years to other areas in the Northeast, the South and the West.

For additional information, contact:

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FOREST HEALTH MONITORING

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The term "forest health" describes forest ecosystem resilience and productivity relative to public values, needs, and expectations. A healthy forest can be described by different standards, each related to differing management objectives for particular forested areas. The first step toward evaluating forest health is describing forest condition. Currently, the USDA Forest Service gathers data about the forest resource and its health in various ways. The two most notable activities are the periodic Forest Inventory and Analysis (FIA) surveys and specific insect and disease surveys the State and Private Forestry division of Forest Pest Management (FPM) coordinates through the state forestry agencies or conducts on federal lands. During the past five years the Forest Service has been developing a forest health monitoring program. It will be an integral part of the Forest Service's Forest/Atmosphere Interaction Program proposed under the Forest Ecosystems and Atmospheric Pollution Research Act of 1988 (PL 100-521) and involves coordination with the US Environmental Protection Agency's Environmental Monitoring & Assessment Program (EMAP).

Monitoring is the repeated recording or sampling of pertinent data for the comparison of that data to a reference system or identified baseline. Monitoring always involves the determination of changes over time and usually also involves interpretation with respect to the reference or baseline. Forest Health Monitoring (FHM) will be a multi-tiered, long-term process to (1) detect unexpected deviation from established baseline conditions or trends, (2) identify cause, and (3) define basic relationships sufficient to predict consequences. Each successive tier requires progressively more detailed and costly information. Currently, three increasingly detailed monitoring levels are planned:

Detection monitoring is the first and most extensive level. It will consist of a geographically-based network of permanent plots coupled with remote sensing pest surveys distributed throughout the forests of the United States. The spatial basis for these permanent plots will be the forest inventory (FIA) augmented with additional plots to represent all forest lands. From this augmented network, a subset of "sentinel plots" will be selected and routinely visited at intervals ranging from several times per year to biennially. The amount of information collected will be greater than on the normal forest inventory plots.

Information from the sentinel plots will be supplemented by information collected during routine forest pest surveys (by Forest Service FPM and by state agencies) and other specifically focused monitoring

activities. This information will be spatially linked (through use of GIS) to the network of sentinel plots, thus providing a more complete annual estimate of forest condition. The objectives of this level of monitoring are to:

1. Enable systematic observation of key monitoring elements that "describe" forest condition and assist in the early detection of change "signals" calling for more detailed evaluation.
2. Provide data for annual forest condition (health) statistics.
3. Activate evaluation monitoring (level two) in a planned and coordinated manner.

Data obtained from these plots and other sources of detection-level information will be managed and evaluated by a staff of experts within the Forest Service. Monitoring results may be reported in several ways including: time series of the basic observation variables; synthetic "indices" of condition, and appropriate summaries for use by the states, other federal agencies, cooperators and the research community. This level of monitoring will be the primary linkage to EPA's proposed EMAP.

Evaluation monitoring, the second level, is activated by detection monitoring results. When detection results identify areas or problems of concern, a multidisciplinary team will determine specific evaluation needs and undertake activities such as additional surveys, site or area specific evaluations, and more detailed monitoring. The objectives of these detection-activated evaluations are to:

1. Clarify concerns raised by detection monitoring, delineate problem extent, identify cause (if possible), and make control recommendations as appropriate.
2. Identify research hypotheses if cause can not be identified.
3. Provide the additional data needed to link evaluation of these relatively broad problems with the detailed, site-specific research monitoring (third level) undertaken to define and predict causal relationships and effects.

Research monitoring is the third level of this system. Monitoring at this level provides data for ecosystem research undertaken to better understand causal relationships and to predict rates of changes in forest condition. The goal of research monitoring is more complete understanding of the mechanisms of change in forest ecosystems. Research Monitoring sites will represent key forest ecosystems throughout the United States. We envision about 20 such sites distributed among forest ecosystems. These sites will be the centers for collecting very detailed information on all components of the forest ecosystem. The purpose of these sites is to supplement detection and evaluation monitoring and to support mechanistic research to identify, describe or model tree, stand and forest processes in ways that 1) increase basic understanding of causal relationships and (2) enable explanations or projections of observations in the other levels of this monitoring system.

We plan to fully implement this Forest Health Monitoring effort over the next 5 to 10 years. Implementation began this year in New England where the Forest Service and the six State Forest agencies are jointly developing procedures and collecting the first year's data for the approximately 250

Detection monitoring "sentinel" plots. The State Foresters are providing the field cadre for this effort. In 1991, we desire to expand the monitoring into the South. Our purpose in meeting with the State Foresters is to inform them of this effort and to invite their participation as partners in this effort.

Specifically, the Forest Service wishes to have each state provide the forestry personnel for the Detection level plots each year in that state. The long-term background and familiarity of state personnel with local forest situations will provide a desired consistency and stability to the field observations. A state would provide the forestry component of each field crew (2 people and their transportation with at least one person being a forestry graduate). The data collection activities are limited to one day per plot and the field season will be approximately 50-working days between July and mid-September. As a rule of thumb, there will be 9 FIM plots per 1 million acres of forest land in a state; thus in a state with 10 million acres of forest we would expect to visit 90 plots during the 50-day period. In addition to the field work, we would provide one week of intensive training and review for all state personnel involved in the activity. We want to jointly develop the particulars of this effort with interested states and are prepared to begin the technical planning and implementation efforts in the near future.

NEW ENGLAND FOREST HEALTH MONITORING PROJECT
SCOPE AND PURPOSE

Prepared by
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The USDA Forest Service, in cooperation with the six New England States, and with assistance from the US Environmental Protection Agency has implemented a Forest Health Monitoring Project in 1990. The purpose of the project is to characterize various forest conditions and potential forest stressors and over time to quantify changes in forest condition and determine the relationship to the forest stressors. The various forest conditions include: growth rates; tree vigor; soil and site; and stand composition. Potential forest stressors are factors such as: insect and disease pests; weather and climate; atmospheric deposition; and other anthropogenic activities (such as harvesting).

The New England Forest Health Monitoring Project was designed along the goals of the National Forest Health Monitoring Program, which is part of the USDA Forest Service Global Change Research Program. The main emphasis of the monitoring program is to detect changes from baseline conditions and annually report on forest condition. There are two other phases including evaluation and research that will be implemented when unexpected changes are detected. The plot network is one component of forest health monitoring. The other major component is the forest pest conditions; an assessment of the distribution and impact of forest pests throughout the region.

PLOT NETWORK

Organization:

The Northeast Forest Experiment Station, Forest Inventory and Analysis Unit (FIA) in Radnor PA has been given the lead responsibility for establishing the plot network in the Northeast. The Northeastern Area, State and Private Forestry, Forest Pest Management Staff (FPM) in Durham NH has been providing assistance with various elements of the project such as workplan and manual preparation, training, and electronic data recorder and data transmittal support. There are designated State Project Coordinators for Maine, New Hampshire, Vermont, and Southern New England. They are responsible for coordination of data collection, which is being conducted by State field crews, in their respective States. Quality assurance support for data collection protocols and quality control is supplied by the US EPA Environmental Monitoring Assessment Program (EMAP). A Technical Committee made up of various Forest Service and State personnel was appointed to plan, implement, and evaluate the project. The Executive Steering Committee, composed of the NEFES Director, NA S&PF Director, State Forester Representatives, US EPA-EMAP Representative, and the National Forest Health Monitoring Coordinator, provides general guidance to the project. The project is funded through the Northeastern Forest Experiment Station via cooperative agreements with the individual New England States.

Methods:

a. Sampling and Design - The FHM plots were selected using the EPA-EMAP grid, to insure comparability with the National Forest Health Monitoring design. There is one plot in each of the 263 40km² polygons (hexagons) within New England, located at an FIA photo point closest to the hexagon center. However, by using this design it was impossible to initially stratify the plots by forest type. A new plot is being established at each location. Non-forested points are also included in the sample in order to make area estimates. Each plot is a cluster of four 1/24th acre fixed radius points, with a 1/300th acre regeneration microplot located at each point.

b. Indicators and Measurements - The first year of measurements will serve as baseline information to compare to future assessments. Some measurements are taken annually, others periodically, and others only once. The field measurements are collected from mid-June to the end of August. Most of the measurements are taken on the plot, however individual tree sampling will be done adjacent to the plot. Basic site condition information is being collected. Measurements on plot trees include tree data, crown condition, and obvious presence of insect and disease damage. Regeneration on the plot and condition of air pollution indicator species will also be assessed. The sample trees will be used for foliar sampling, root sampling, and increment core collection. The soil profile at each plot will be determined and soil samples will be collected.

During the first year of implementation, plot establishment and obtaining baseline tree condition data on all plot trees has been emphasized. Techniques for sample collection from sample trees and soils are being tested on several research plots by the USDA Forest Service and EPA-EMAP. The results of those tests of the various techniques will help determine how and when those measurements will be taken on established FHM plots.

Data Analysis and Reporting:

Electronic data recorders are being used to insure more efficient and accurate data collection. The FIA software program "TALLY" has been modified for the NEFHM Project. The data recorders were provided to the State field personnel by the USDA Forest Service and the US EPA. The data was downloaded to disks which were then forwarded to the FIA unit for input and analysis.

The principal report will be an annual statistical summary reporting on the status of the current year's forest health indicators and any change from previous measurements. The FIA group will generate the summary tables that will be incorporated into the annual reports. The tables will include information on forest area, forest-type, stand and tree condition, and regeneration. A quality assurance/ quality control report will also be prepared annually, providing information from check crews and field crew evaluations. Annual Executive Summaries will be prepared to inform the general public of the results presented in the annual statistical summaries. Periodically, interpretive reports will be prepared which will further analyze annual data sets to assess changes in forest health in relation to current conditions in forest stressors.

The plot network provides for detection of change in forest condition. When unexpected changes occur, then evaluation and research projects will be conducted in an attempt to describe and determine the cause of the changes.

FOREST PEST CONDITIONS

The USDA Forest Service in Durham NH in cooperation with the New England State Cooperators will plan and implement the forest pest component of the forest health monitoring program. The forest pest component includes detection and evaluation surveys. Detection surveys and damage assessments will be standardized and minimum standards will be prepared for outbreak detection, pest damage, and reporting. Surveys will include the use of aerial photography, sketch mapping, satellite imagery, and ground surveys. Impact and trend assessments will also be standardized. Procedures for integration of information on forest pest activities with the NEFHM plot network will be established.

Survey information from all the States will be entered onto a Geographic Information System at the USDA Forest Service Forest Pest Management Forest Mapping Lab. Regional maps and acreage tables will be prepared annually for the major forest pests in New England. Forest pest population data will also be input onto the GIS to determine spatial distribution trends. Historical data will be input in order to determine long term trends.

Funding for this portion of the forest health monitoring program is provided through the Cooperative Forest Pest Action Program and FPM Technology Development Project dollars.

FUTURE PLANS

A debriefing for this field season, which ended on August 31, will be held in early October. As a result of the evaluation of the field activities, methods and techniques may be slightly modified. Following an assessment of the measurements which were tested on the research plots, decisions will be made on which soil and foliar sampling techniques will be incorporated into the plot network next year. Plans are to visit the New England plots annually and to expand forest pest detection and assessment activities. It is envisioned that within the next few years, depending on the funding levels, all the states in the Northeast will be involved in the Forest Health Monitoring Program.

FOREST HEALTH MONITORING AND FOREST
PEST CONDITIONS REPORTING - REGION 8

Presented at
Western International Forest Disease Work Conference
Sept. 17-21, 1990
Redding, California

by
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In the late 1970's and early 1980, Germany was reporting a major decline in forest health. Subsequent surveys throughout Europe reported similar findings. At the same time, FIA data suggested the southeastern United States was suffering a major growth loss in its pine forests, and high elevation spruce-fir forests were showing symptoms of decline similar to those observed throughout Europe. The National Vegetation Survey was started about the same time. Forest Pest Management in Region 8 has been involved in the process from the start (including SARRMC). The Region has participated in the spruce-fir surveys using ground, aerial and GIS techniques. Forest Pest Management produced, in conjunction with the National Vegetation Survey and Penn State University, a color illustrated manual on air pollution damage and mimicing symptoms titled "Diagnosing Injury to Eastern Forest Trees". FPM has also participated in a specialist review of the reported pine growth loss, and in a number of forest health projects, such as the "Near Term Survey", "Forest Health Pilot Study", and the 1989 operational forest health survey in the south.

In 1990 the National Forest Health Monitoring program was started in the northeastern United States. The program design is for FPM in Region-8 to start a similar forest health monitoring and pest status reporting system in 1991. This would coincide with the establishment by FIA of the permanent plot forest health EMAP network system in the south. The 1991 implementation and continuation into 1994 would be consistent with the national forest health monitoring nationwide program. The project will start in six southern states in 1991, and is projected to expand to all 13 southern states by 1993, in support of the national program.

Forest Pest Management Activities - will concentrate in two areas: 1) Plot support - FPM will provide training to the FIA crews on pest and crown evaluation techniques. Intensive training for about two weeks will be given to a few select Forest Inventory and Analysis, personnel. FPM will serve on a steering committee and help identify pest data needs. The states or other personnel will revisit the plots in May each year to check for damage such as defoliation. This is needed to identify pest damage that may occur when the FIA crews are not on the plot and the damage is not detectable year round. FPM will photograph at (1:12000) each plot each year, interpret the photographs, and enter the data into a GIS system. This is to look for pest damage not visible on the plot such as dieback and mortality in the general area. FPM & FIA will jointly use these photographs. 2) Reporting Pest Conditions - FPM

will collect regional pest data on southern pine beetle, gypsy moth, oak decline, dogwood anthracnose, littleleaf disease, fusiform rust, annosus root rot, ozone, weather, and crown condition. A lead person has been assigned to each pest to provide the needed data. These data will be entered into a GIS system to produce maps and supporting data tables.

The primary use of the data will be to record and report local, state, and regional pest conditions for evaluations and annual pest reporting. In addition, a set of core tables and maps will be produced that help explain abnormal conditions on FIA and EMAP plots. The analyst will be able to match the table and map products to the FIA plot data for comparison purposes.

Responsibilities

Forest Inventory and Analysis has the lead responsibility for the Forest Health Monitoring plots in the SE and SO. Each state forester or designed personnel have the responsibility to revisit each plot in the spring to check for pests that are not present year round. FPM activities are described in this paper and include input from various FPM professionals in training, data collection, data analysis, and monitoring quality control.

FOREST PEST MANAGEMENT WEST-WIDE PERMANENT PLOT PROJECT

WHO, WHY, WHAT, AND WHERE

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The Forest Pest Management (FPM) west-wide permanent plot project is a cooperative effort between all of the western Regional offices of FPM, the Methods Application Group (MAG), Forest Insect and Disease Research (FIDR), and the National Forest System (NFS). The primary objective of the project is to establish a centralized data base consisting of information from permanent plots located in pest-infested forest stands throughout the western United States. Permanent plots measured at specific time intervals provide a more reliable record of pest effects and pest population dynamics than can be obtained by other mensurational techniques. The principle use of the data base will be for validation of several pest models which have been developed by the U. S. Forest Service, but the data could be used for assessing pest effects and possibly as a means of monitoring forest health conditions. However, it was decided early in the development of the project that the main objective is to provide a standardized permanent plot data set for pest model validation.

The FPM west-wide permanent plot project originated in the Intermountain Region as a FPM special project (now termed technology development projects), but FPM personnel from all the western Regions have been involved in planning and implementing the project. In December, 1989 representatives of FPM, MAG, FIDR, and NFS met in Denver, CO to discuss the objectives of the project and how to proceed in 1990. At that meeting we agreed to concentrate on: 1. pest model validation, 2. four major pests - dwarf mistletoes, root diseases, western spruce budworm, and mountain pine beetle, 3. locate and examine existing permanent plot systems which already have pest information available, 4. develop and field test procedures for establishing new permanent plots where needed to fill in gaps in existing permanent plot data, 5. create a centralized data base consisting of data from existing permanent plot systems and new permanent plots, and 6. work closely with research to insure that we are collecting the information needed for pest model validation.

The December meeting participants divided into four working groups representing the four major pests listed above. Each working group chose a coordinator and discussed what specific data would be needed for model validation efforts related to their pest. Each pest working group developed a proposal which detailed what they planned to accomplish during 1990. In addition to appointing coordinators for each pest working group, regional coordinators were designated to facilitate the process of determining what permanent plot systems already existed in each Region. MAG and the regional coordinators agreed to develop a permanent plot questionnaire and

disseminate it to any groups or individuals that might have knowledge of existing permanent plots containing pest information. Results of the questionnaire were to be used for compiling a catalog of existing permanent plots for the western United States. The catalog would then be used by the pest working groups for locating and evaluating existing permanent plot systems in relation to their usefulness for pest model validation.

Data from appropriate systems was to be evaluated on the basis of a listing of minimal criteria needed for model validation developed by each pest working group. For example, the dwarf mistletoe working group developed a list of nine criteria which needed to be met by a permanent plot system, including items like remeasured tagged trees with tree species, diameter breast height, total height of each tree, and dwarf mistletoe rating (6-class system) recorded for each tree. Permanent plot systems which contained all or most of the selected criteria would then be ground-checked to determine the reliability of the data set. Eventually we hope to summarize the data by stand attributes such as density, site potential, habitat type, forest type, etc. and determine where additional plots are needed for pest model validation. Individuals involved in pest model development from FIDR and Timber Management Research units of the Forest Service have been assisting our efforts and they have agreed to use our centralized data base for improving the existing pest models when enough data becomes available.

The permanent plot questionnaire was developed by MAG and it has been disseminated by the regional coordinators. Results have been coming in slowly and this has delayed the completion of a permanent plot catalog. However, several Regions have been able to start examining and evaluating existing permanent plot systems during 1990. Many of these systems appear to contain useful and reliable pest data, but some will require that additional pest data be collected. In any case, the use of existing permanent plot systems should greatly reduce the number of additional permanent plots needed. Some Regions will need to continue working on evaluation of existing permanent plot systems in 1991 because of the large number of systems they identified as potentially useful. Other Regions have completed this task.

Field manuals describing specific procedures for establishing new permanent plots have been developed by the dwarf mistletoe and root disease working groups. Field testing of the procedures has been completed and a meeting will be held in early 1991 to discuss needed revisions of the field procedures and standardization of data collection methods (data codes, tree measurements, etc.). Therefore, the root disease and dwarf mistletoe working groups will be ready to start establishing new permanent plots in 1991. Each Region has chosen which pests it feels are highest priority in relation to their individual needs. Some Regions are concentrating their efforts on one pest, while others are attempting to work on all four of the pests listed above.

While the FPM west-wide permanent plot project has accomplished most of its tasks for 1990 and will be ready for 1991, there are a few areas that could use additional attention or improvement. We need to encourage the individuals working on the insect pests to become more involved in the project. Right now there does not appear to be a strong interest in using

permanent plots for insect model validation. This may be because permanent plots are less useful for documenting insect activities over long time periods or we have not invited enough interested entomologists to participate in the project. Whatever the reason, we should make a greater effort in the future to involve more entomologists who feel permanent plots are a useful tool for insect model validation. If we have not contacted enough interested entomologists in the past we should try to find out who we have missed and get them involved.

A second area for attention is standardization of data codes. Right now each Region has different data codes for mensurational as well as pest damage information. The efforts of MAG and regional coordinators in charge of developing a standardized set of pest codes should be completed quickly and these codes should be adopted by the FPM west-wide permanent plot project. We must also agree on standardized codes for tree species and other mensurational data.

Another problem is related to the organizational structure of the project. Although the project originated in Region 4, it is designed to be a cooperative FPM project between each of the western Regions. It has not been clear to many of the regional cooperators who is coordinating the overall project. The Washington Office should appoint one person, with an adequate level of interest and authority, to coordinate the entire project. However, the pest working groups seem to function fairly well and could be maintained under the supervision of the project coordinator. In addition, each cooperating Region should identify individuals that are keenly interested in the success of the project and assign them to it. Personnel that do not feel the project is worthwhile will not devote the time or energy required to make a project of this magnitude succeed.

We should have allowed more time for locating and cataloging existing permanent plot systems. Some Regions did not have many systems in place and were able to complete the task of finding and evaluating them quickly. However, other Regions had many permanent plot systems to locate and evaluate. Although we could all see the value and importance of locating and using existing permanent plot systems as much as possible, it has proven to be a very large project in itself. We still need to summarize the existing data sets to determine where gaps are present. This will hopefully be completed during the winter months of 1990-91.

Finally, we need to make sure that once we have established a series of new permanent plots we allocate the time and money required to maintain them. This potential problem should be addressed now. If we wait until the plots are established and then find that there is inadequate time or funding to maintain them, we may be wasting our current efforts. The original proposal calls for each Region to maintain the plots they establish, so let's not forget this major responsibility. We need a continuing strong commitment from each cooperating Region as well as the Washington Office.

If you would like more information on the FPM west-wide permanent plot project please contact Dave Holland or Bob Mathiasen, FPM, Intermountain Region, USDA Forest Service, 324 25 th St., Ogden, UT 84401 (801) 625-5458.

MONITORING OF FOREST PLAN IMPLEMENTATION

Beth Willhite
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INTRODUCTION

Monitoring can be generically defined as the repeated recording or sampling of similar, pertinent information for comparison to an established frame of reference or an identified baseline. Forest Plan Implementation (FPI) monitoring is the activity of gathering data for use in evaluating 1) the effectiveness of the Forest Plan and 2) environmental effects of management activities. It is part of the process through which Forest Plans will be amended, revised or affirmed as adequate. Legal provisions for monitoring are found in the National Forest Management Act regulations. These regulations require monitoring to determine how well Forest Plan objectives have been met and how closely management standards and guidelines have been applied during implementation. Regulations specific to pests require monitoring to ensure that "...destructive insects and disease organisms do not increase to potentially damaging levels following management activities." In practicable terms, FPI monitoring means monitoring a tremendous range of activities, plans, prescriptions, guidelines, and assumptions across many functional areas such as wildlife, range, recreation, timber, soils, hydrology, fisheries, etc., for the purpose of ultimately achieving the stated "desired future condition" contained in each Forest's Plan.

LEVELS OF MONITORING

There are three "levels" of FPI monitoring:

- 1) Implementation monitoring - Did we do what we said we would?
- 2) Effectiveness monitoring - Did it work?
- 3) Validation monitoring - Are our basic assumptions O.K.?

Implementation monitoring ascertains whether plans, prescriptions, projects, and activities are implemented as designed and are in compliance with the Forest Plan objectives, standards, and guidelines. Effectiveness monitoring determines whether plans, prescriptions, projects and activities are effective in meeting management direction, objectives, standards, and guidelines. Validation monitoring is validation of the assumptions used in Forest Plan development and analysis, e.g. wildlife habitat relationships, forest growth and yield, insect and disease effects. Validation of these assumptions requires carefully designed and controlled data collection and will frequently be conducted as research projects, independent from ongoing "everyday" monitoring activities.

STATUS OF MONITORING

The first of the National Forest Plans were signed and went into effect in 1986. Experiences with monitoring have varied. Some forests are well into their monitoring program, while others have not done much monitoring due to appeals of the Forest Plan. Monitoring is a big task that is still being defined; the process is evolving. Forest Plans are complete and signed in every Region but Region 6.

Region 6 is in the process of finishing its Plans; all Forest Plans are due to be signed by September 30, 1990. Those forests with signed plans are currently dealing with appeals and beginning to develop detailed monitoring plans.

With regard to pests, most Forests simply list aerial survey, and sometimes stand exam and reforestation surveys, as their sampling methods for monitoring insects and disease. This is a good start, but there is a definite need to develop a more comprehensive program of pest monitoring strategies, criteria and methodology.

WHERE TO GO FROM HERE

Pest monitoring is important. Insects and disease can profoundly affect the volume and scheduling of timber harvested, quality and availability of wildlife habitat, visual resources, quality of recreation experiences, etc. The relationships between uneven-aged management and pest incidence and severity can be documented and clarified through monitoring activities. Pest monitoring is integral to pest model verification.

As previously stated, there is a need for development of a comprehensive program of pest monitoring for application by National Forests as they implement their Forest Plans. Specific needed items include 1) efficient, cost-effective ways to monitor that are integrated with other FPI monitoring activities, 2) guidelines for monitoring pests, e.g. identify which pests to monitor for each management area, sampling methods and reporting systems, thresholds of concern for remedial action and 3) greater interaction between pest specialists and Forest managers/planners.

We in Region 6 Forest Pest Management are in the initial stages of developing a comprehensive program of pest monitoring for our Region. We plan to incorporate pest considerations into the Forest Planning process by participating in the next revision of our Regional Guide, due in 1991. We are also currently involved in a pilot project on the Okanagan National Forest; working with them as they develop a vegetation-based forest inventory system to incorporate methods of collecting reliable insect and disease data. We also hope to work closely with their Forest Planning Team to help them develop the pest monitoring portion of their FPI monitoring plan. We have plans to develop guidelines for monitoring pests in our Region, and are working with Region 4 (Southern Idaho, Utah, and Nevada) to present a workshop this winter on Forest Plan Implementation Monitoring of Insects and Disease.

ACTION ON NEW PESTS OR PEST THREATS IN BRITISH COLUMBIA.

J.A. Muir

The forest health program in British Columbia(B.C.) has two general objectives: to develop and incorporate appropriate treatments in forest management for preserving timber and increasing productivity of young forests; and to initiate control programs for pest epidemics, and new pests.

I would like to briefly discuss our concerns as an operational forest health organization about some new pests: pinewood nematode, that is not a pest but affects export of forest products, and scleroderris canker that might become an important new disease in B.C.

Pinewood nematode. The pinewood nematode Bursaphelenchus xylophilus is important for British Columbia wood products exports particularly to the European Economic Community. Results of several surveys and research indicated that the nematode is widespread in wood chips and some green lumber products that have been colonized by wood borers(Monochamus spp.). The wood borers carry the nematode, and commonly attack dead or dying trees.

In North America there is no evidence that the nematode is a pathogen. In native forests it does not affect healthy trees or cause any tree killing. It lives in trees that have been killed by various agents, and feeds on saprophytic fungi.

The widespread occurrence of the nematode in certain forest products in B.C. and elsewhere appears related to recent outbreaks of the mountain pine beetle, and other insects or events that have killed or weakened trees, and made them attractive to wood borers.

The European Community(E.C.) restricted imports of North American forest products because of the nematode, and fears that the nematode could affect European forest trees. However, there is no scientific evidence that the nematode could spread from wood chips, nor from infested green lumber without the insect vector. It is also improbable that the nematode would be pathogenic in European or Scandanavian forests. Nevertheless, the EC has required kiln drying of forest products, and some countries such as Ireland have banned all North American forest products.

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An interim exception to the kiln-dried rule was negotiated with the United Kingdom, an important customer for B.C. wood exports. A certification procedure to ensure that green lumber is free of bark and wood borer holes has been developed by the B.C. forest industry in co-operation with the Canadian and United Kingdom Plant Health regulatory agencies. The principle is to prevent transport of the wood borer that can transmit the nematode. Industry experience has shown that green lumber can be inspected and certified free of wood borers at the mill sites by the industry associations.

Imposition of the kiln drying restriction in 1991 will have severe economic consequences for some coastal B.C. mills. Green lumber and sawn timbers are a mainstay of several European industries, such as the Italian window and door industry, and kiln drying of large timbers is practically impossible. Coastal B.C. mills that now ship only green lumber will face considerably higher costs as the result of these restrictions, and probable loss of customers for certain exported forest products.

The pinewood nematode is thus an anomaly as it is not a pest in the usual meaning of the term, but it has had extremely important implications for our forest industry. We are monitoring the situation, but it is evident that the main emphasis of a "control" program for the nematode is on continuing negotiations by the federal government agencies, and by the industry associations, to defer or rescind import restrictions by the importing countries.

Scleroderris Canker. In B.C. we are in a position to prevent introduction of an important pathogen from eastern North America into our nurseries and plantations.

The pathogen Gremmiella abietina is well known in eastern Canada, the United States, and Europe, as the cause, in association with frost injury, of a damaging canker disease of young trees.

In North America several strains of the pathogen have been identified, including a weakly pathogenic strain endemic to North America, and a more virulent strain, apparently endemic to Europe. The virulent strain was introduced by unknown means to eastern North America, and was identified approximately 15 years ago.

The pathogen occasionally severely damaged young plantation trees, and is believed to pose a threat to B.C. plantations. In western North America and elsewhere, several tree species are susceptible to the disease, including lodgepole pine, Douglas-fir, and Sitka spruce. Recently in northern Scandinavian plantings of lodgepole pine that were from seed that originated from a B.C. provenance, an outbreak of the disease occurred, and plantings of lodgepole

pine were suspended. In North America the pathogen has apparently been established in plantations by transportation and planting of infected seedlings.

In British Columbia there have been only a few collections of the endemic North American strain of the fungus, and the fungus has not been found in several subsequent re-inspections at these localities. Forestry Canada Forest Insect and Disease Survey (FIDS) staff are re-examining the previous B.C. locations this year. For several years in B.C. they also have conducted a program to examine young plantation trees for disease and insect damage with no findings of the pathogen. We assumed that the virulent strain of the fungus is not yet established in B.C., but outbreaks of the endemic strain can be expected. Regardless of the strain of the fungus, and because of the practical difficulty in identifying the strain quickly and reliably, we intend to take appropriate action to control any outbreaks of the disease that appear to threaten young trees.

Control programs for the disease have been relatively successful. The province of Ontario required that any outdoor nursery beds of red pine bare-root planting stock must be sprayed with a fungicide to prevent spread of the disease, which might explain the relatively few outbreaks have been reported in that province. In Quebec and in other localities, where preventative measures were not taken, several outbreaks of the disease were reported. However the provincial agencies, particularly Quebec, have aggressively dealt with outbreaks, and most have been contained and possibly eradicated by destroying, or branch pruning, infected trees.

In B.C. there are good prospects for early detection and quick action on any new or suspected outbreaks. Nursery seedlings are monitored by growers, B.C. Forest Service, and Forestry Canada technicians and scientists. Representative seedlings from each nursery and seedlot are planted and monitored for two or more years for any disease or insect occurrences. Plantation trees are inspected, and any suspicious conditions are reported. We do not believe that many susceptible horticultural plants are brought into B.C., but several of the growers also grow ornamental plants, and these also are inspected.

In B.C. a key element of dealing with any new or suspected outbreaks will be an interagency-industry committee of the B.C. Plant Protection Council that has been concerned with the disease for several years. The scleroderris committee functions to keep participants informed of the disease status, and in the event of an outbreak, to seek consensus of all affected parties, and to recommend control actions. When action is undertaken, the committee will also provide coordination. The committee also played an important role in recommending the development of a federal regulatory policy to control disease outbreaks, and prevent spread of the fungus.

We have used a similar interagency action committee for several

years to deal with gypsy moth, and have very successfully eradicated several new outbreaks.

Our concerns with the pinewood nematode and scleroderris canker are the most urgent, but there are several other similar issues such as:

- 1) Blackstain root disease of Douglas-fir and lodgepole pine. Will the disease in B.C. in young spaced (pre-commercially thinned) plantations increase as it has done in Oregon?
- 2) Annosus root disease. Will the pine strain that kills trees spread to B.C. from Washington or Oregon?
- 3) Trisetacus mites. Will the recent B.C. nursery infestations affect pine plantations?
- 4) Pitch canker disease. Will it spread from California?
- 5) New strains of white pine blister rust. Will the occurrences in California spread?
- 6) European larch canker. Will it spread from eastern North America to western larch?
- 7) Hemlock seedling blight. Will the fungus spread from infected strawberry transplants that are imported into B.C. from California to nursery seedlings?

These and similar concerns are no doubt shared by many of the resource management agencies in western North America. Our challenge is to avoid another white pine blister rust situation. Warnings alone are not sufficient. Pathologists warned about the potential spread and effects of the blister rust for several decades before the pathogen was introduced, but the disaster was not prevented. Hopefully with our forest health organization, with our proactive committees and procedures in place, and with our recent experiences in dealing with new outbreaks, we will deal expeditiously with the next new outbreak to protect our forest resource.

ACKNOWLEDGEMENTS

The programs to deal with new pests in British Columbia are based on information and scientific expertise provided by Forestry Canada, Agriculture Canada, other agencies and individuals, and on co-operation and resources provided by these and other groups, particularly the B.C. Council of Forest Industries.

WHITE PINE BLISTER RUST IN NEW MEXICO.

Frank G. Hawksworth and David Conklin

White pine blister rust (Cronartium ribicola J. C. Fisch.) was found in March 1990 on southwestern white pine (Pinus strobiformis Engelm.) in the Lincoln National Forest near Cloudcroft, Otero County, New Mexico (Hawksworth 1990). The closest known populations of this rust are about 1,000 km north in southern Wyoming on Pinus flexilis James (USDA For. Serv., 1985, p. 28) and 1,400 km west in the southern Sierra Nevada of California on Pinus lambertiana Dougl. (USDA For. Serv., 1985, p. 51). Although greenhouse inoculation tests in Idaho have shown that P. strobiformis is very susceptible to white pine blister rust (Hoff et al. 1980), this is the first discovery of the fungus in natural stands of this tree. The extreme isolation of the outbreak suggests that it may have been a separate introduction rather than a result of spread from previously known affected areas. Perhaps it was brought in on infected cultivated Ribes in the private lands which are intermixed with National Forest lands in this area.

The oldest infected area appears to be a small area about 3 miles NE of Cloudcroft where the rust has apparently been established for at least 15 years. Here, trees of all sizes are infected and some small trees up to 4 feet tall have been killed. The majority of branch flagging, top-kill, and seedling mortality are associated with cankers 5-6 years old. A more recent wave of infection occurred 2-3 years ago. Scattered infected trees occur essentially throughout the 100 plus square mile range of southwestern white pine on the Cloudcroft District of the Lincoln National Forest. Infected pines have been found up to 19 miles south and 12 miles east of the Cloudcroft center; and also about 5 miles north on the adjacent Mescalero Apache Reservation. Infections some distance away from the presumed center are typically only 3-5 years old, which suggest that the rust incubated in the original area for several years, but has "blown up" relatively recently. Thus it appears that Peterson and Jewell (1968) may have indeed been prophetic when they suggested that the rust might "explode" in the Southwest once the xeric stands of limber and bristlecone pines to the north had been slowly penetrated or bypassed, and the inoculum reached the relatively moist stands of southwestern white pine.

The orange gooseberry (Ribes pinetorum Greene) and the southwestern black current (R. mescaleirum Cov.) are the most common alternate hosts in the vicinity of the outbreak. While the rust is commonly found on both species, the former carries more inoculum, sustains more damage, and generally appears to be more susceptible to the rust (at least in mid-August). Both species are commonly found along drainages and stand edges, and less frequently within stands.

Rust-infected Ribes were also found in the White Mountains, 30 miles north, and in the Capitan Mountains, 50 miles northeast of the Cloudcroft center. However, we have not yet determined whether these are C. ribicola or the native pinyon blister rust (C. occidentale Hedgc., Bethel & Hunt). We have not observed infected pines in these areas.

Southwestern Region Forest Pest Management and the Lincoln National Forest have established two permanent plots to monitor damage caused by the rust, one near the oldest infected area, and one 15 miles away. Additional plots may be set up on the Lincoln National Forest and on the Mescalero Apache Reservation.

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PITCH CANKER IN CALIFORNIA

Mark E. Schultz and Thomas R. Gordon

ABSTRACT: Pitch canker was probably recently introduced into California and was first diagnosed in 1986 in Santa Cruz County. Most of the new infections of radiata pine (Monterey pine) occurred at cone whorls that were infested primarily with cone or twig beetles. There was a difference in the susceptibility of radiata pine to the pitch canker fungus. There was also a difference in susceptibility due to the physiological age of the plant tissue inoculated. There was a relationship between the date of inoculation and the rate of lesion development.

INTRODUCTION

Pitch canker was first reported in 1946 from the southeastern United States (Hepting and Roth, 1946). Occasionally an epidemic phase occurs resulting in stem cankers, resin streaming, shoot dieback and increased pine mortality in certain situations (Barrows-Broadus and Dwinell, 1985; Kuhlman and Cade, 1985). The pathogen damages pine plantations and seed orchards where mechanical cone harvest creates wounds which serve as infection courts for the fungus (Barrows-Broadus, 1987; Blakeslee et. al., 1981).

Pitch canker propagules may be able to infect wounds by wind blown or rain splashed spores (Blakeslee and Oak, 1979). Since insect exclusion studies were not done it is difficult to determine whether the primary means of infection involves insect vectoring of the fungus to wounds or by other mechanisms. The sporadic infection of wounds due to cone harvesting and the observation that infected trees (*Pinus taeda*) can recover from the disease is evidence that insects may be attracted to wounded or stressed trees and that there must be continual inoculation of susceptible trees resulting in serious injury or death. Insects may also be vectoring the fungus to areas distant from infected stands.

Recently pitch canker has been contributing to radiata pine (*Pinus radiata*) (commonly called Monterey pine) mortality in the Santa Cruz region of California. The susceptibility of radiata pine to pitch canker was reported by Hepting in 1961. It was discovered in Santa Cruz County, California in the fall of 1986, primarily on radiata pine, but also on Bishop pine (*P. muricata*), Italian stone pine (*P. pinea*), and Aleppo pine (*P. halepensis*) (McCain et al., 1987). Since then it has also been found on

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Coulter pine (*P. Coulteri*) and Ponderosa pine (*P. ponderosa*). The disease has recently been reported in Guam, Mexico, and Japan.

In California the fungus is vectored by insects and has not been shown to infect wounds by windblown or rain splashed spores (Correll, et al., unpublished). Without insect vectors, pitch canker may die out quickly. This insect-fungal relationship has already altered the distribution and abundance of each of these organisms and may threaten replanting efforts using off-site pines.

Planted radiata pine are more susceptible to infection than radiata pine in the native stands. Host physiology and the amount of tissue susceptible to insect infestation are additional factors that may be involved in the amount of disease that develops in any particular tree.

There are three distinct California mainland radiata pine populations (Año Nuevo, Monterey, and Cambria) and two island populations (Cedros and Guadalupe). Fossil cones have been found from Carpentaria to Tomales Point California, suggesting that radiata pine was widespread. The mainland trees usually have needles in fascicles of three whereas the island trees have a majority of needles in fascicles of two. Crosses between these populations have been planted as a landscape and crop trees.

MATERIALS AND METHODS

Host tissues infected

A total of 107 and 266 infections were examined on 23 and 37 recently infected radiata pine in 1989 and 1990, respectively, at 4 locations in Santa Cruz and Monterey Counties, California.

Disease resistance in Pinus radiata

Three sets of inoculations (11/89, 1/90, and 6/90) were made both for potted clones and branch clones of radiata pine. Radiata pine from three California populations (Año Nuevo, Monterey, and Cambria) and two island populations (Cedros and Guadalupe Islands) were inoculated. Inoculations were done by removing the bark and phloem with a 1/16" drill, 5 cm proximally from the branch tip. A 5 µl distilled water suspension of 25 microconidia of Fusarium subglutinans was placed in the wound. A previous inoculum-concentration study showed that 25 microconidia per inoculation was the minimum inoculum needed to consistently get infection. We included two controls in each inoculation test: water with no spores, and a rice isolate of F. subglutinans, previously determined to be weakly pathogenic on pine in a previous test.

RESULTS

Host tissues infected

Most of the new infections examined in both 1989 and 1990 occurred at cone whorls. Only a few infections occurred at branch tips or wounds in either year. Overall, the greatest number of infections occurred at cone whorls. The frequency with which different insects were found at each point of initial infection was recorded (Table 1). Though the largest number of infections originated at cones infested with C. radiatae other cone insects such as Ernobius could be involved in infecting cones and cone whorls with F. subglutinans.

Table 1: The number and percent for each of the four types of infection points were insect infestation was found.

INSECTS	INFECTION POINTS			
	Cone Whorl (%)	Branch Whorl (%)	Between Whorls (%)	Multiple Points (%)
<u>Conophthorus radiatae</u>	77 (49)	0 (0)	0 (0)	5 (11)
<u>C. radiatae</u> alone	34 (21)	0 (0)	0 (0)	1 (2)
<u>Pityophthorus carmeli</u>	54 (34)	20 (57)	7 (26)	19 (41)
<u>P. carmeli</u> alone	11 (7)	15 (43)	6 (22)	11 (24)
<u>Ips</u> sp.	18 (11)	9 (26)	3 (11)	5 (11)
<u>Ips</u> sp. alone	5 (3)	3 (9)	3 (11)	2 (4)
<u>Synanthedon sequoiae</u>	10 (6)	7 (20)	3 (11)	3 (7)
<u>S. sequoiae</u> alone	0 (0)	4 (11)	2 (7)	2 (4)
no insects	19 (12)	2 (6)	6 (22)	12 (26)
test feeding	16 (10)	2 (6)	0 (0)	0 (0)
TOTAL INFECTIONS	158	35	27	46

Disease resistance in Pinus radiata

There was a difference between populations in their susceptibility to F. subglutinans for the 11/89 and 1/90 dates of inoculation (Table 2). A Chi Square test showed that fewer than the expected

number of infections developed from pine-isolate inoculation of clones from the Año Nuevo, Cambria, and Cedros Island populations. Conversely, more than the expected number of infections developed from the pine-isolate inoculation of clones from the Monterey, Guadalupe Island, Crosses (mainland x island), and Selects (Año Nuevo x unknown-origin superior-growth selection) populations. There were no differences in the percent infection for the 1/90 and 6/90 potted clones or for the 6/90 branch clone inoculations.

The mean lesion length for Año Nuevo, Monterey, and Crosses clone 35 to 44 days after inoculation was 1.5 to 3.5 times larger for 6/90 inoculations than for 11/89 or 1/90 inoculations (Table 3). This may reflect the longer day length and higher temperatures following the 6/90 inoculations, which apparently are more favorable for growth of the pathogen. These conditions, may have allowed the pathogen to overcome resistance mechanisms which were effective after the 11/89 and 1/90 inoculations. In locations where native stands of Monterey pine are found, temperatures are unlikely to be as high as those during our greenhouse test in 6/90.

Table 2: Greenhouse inoculations and the number that resulted in lesions.

Population	Date					
	11/89		1/90		6/90	
	%+	Total	%+	Total	%+	Total
Potted Clones						
Año Nuevo	65	20	52	31	82	175
Cambria	88	16	75	40	--	---
Cedros Is.	64	14	42	31	--	---
Guadalupe Is.	100	19	57	14	--	---
Monterey	100	11	64	14	--	---
Crosses	86	14	36	11	--	---
Selects	100	18	68	22	--	---
Chi-square	20		12		13	
Probability	.002		.060		<.000	
Branch Clones						
Año Nuevo	3	32	10	58	11	159
Cambria	27	22	7	27	--	---
Cedros Is.	33	24	11	45	--	---
Guadalupe Is.	81	27	45	95	--	---
Monterey	100	20	90	10	17	94
Crosses	59	49	73	15	--	---
Selects	73	30	66	64	--	---
Chi-square	73		77		2	
Probability	<.000		<.000		0.15	

Table 3: Mean lesion length for the potted-clone inoculations 35 to 44 days after inoculation. T-test and probabilities for all date-of-inoculation comparisons within each population.

Population	Lesion Length Means(cm)		
	Dates of inoculation		
	11/89	1/90	6/90
Año Nuevo	1.4	1.6	4.2
Monterey	1.7	2.2	3.1
Crosses	1.3	1.9	3.6

Population	T-test(T) and Probability(P)					
	11/89 x 1/90		11/89 x 1/90		1/90 x 6/90	
	T	PT	T	PT	T	PT
Año Nuevo	0.6	0.290	8.2	<.0000	9.1	<.0000
Monterey	1.4	0.100	3.1	.001	2.2	.015
Crosses	1.0	0.180	6.1	<.0000	2.9	.004

The percentage of inoculations resulting in lesion development was generally much greater for branch-clone inoculations than for potted-clone inoculations. The physiologically older tissue (branch clones) were less susceptible than the physiologically younger tissue (potted clones).

CONCLUSIONS

A large number of recent infections of radiata pine at 3 sites occurred at cone whorls. Most of the cone whorl infections were associated with Conophthorus radiatae and Pityophthorus carmeli infestation of cones. P. carmeli could be found at other points of infection whereas C. radiatae was seldom found at other points of infection. Ips sp. were found at much lower frequency at all the sites of infection. There were a few infections for which (more for the cone whorl infections than the other infection sites) no insect feeding or insect test feeding occurred.

Two out of the three dates of inoculation of potted and branch clones of P. radiata resulted in differences in susceptibility between the populations. The branch clones were less susceptible than potted clone indicating that physiologically more mature tissue was less susceptible than younger tissue. Thus, pitch canker may remain as an important problem in areas that have high summer temperatures and in younger trees. Though very little disease has been found in native stands disease severity may increase as the older stands are replaced by younger stands.

ACKNOWLEDGEMENTS

This work was supported by the California Division of Forestry grant 8CA95531.

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ARMILLARIA, HABITAT TYPES AND SYSTEM BEHAVIOR

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Introduction

The Intermountain Research Station initiated the investigation of ecosystem aspects of Armillaria/conifer interactions in 1983. A series of randomly located plots were installed on 15 National Forests of the northern portion of the Rocky Mountains (McDonald et al. 1987). Armillaria samples (McDonald and Martin 1988) and lists of habitat type indicator plants (Pfister et al. 1977, Steele et al. 1981, and Cooper et al. 1987) were collected at each plot. In addition, one dominate or codominate tree of each species on the plot or within 10 meters of a plot boundary was girdled to serve as an Armillaria trap. Revisitation of plots to inspect the girdled trees was initiated in 1988 and will be completed in 1991. Pure isolates of Armillaria were obtained from rhizomorphs, fans, and rotten wood. The ecologic situation of each isolate was recorded. Pathogenicity was recorded as presence of fans or rotten wood in a living host or in a dead host that had visible resin flow. Occurrence as an epiphytic rhizomorph on the roots of healthy conifers and hardwood was also recorded.

Habitat type connection

Data from the 1983 plots revealed a pattern of occurrence for the genus Armillaria that was associated with habitat types. Very cold-dry and warm-dry habitat types appeared not to support Armillaria in any form even though adjacent more mesic plots always did support the fungus (McDonald et al. 1987a). Incidence of disease seemed to be associated with climax series, site disturbance, and host species (McDonald et al. 1987b). These interpretations were based as much on ecologic principles as on the small number of plots available per habitat type. If the emerging picture of Armillaria behavior is true, then a theory of host ecophysiologic maladaptation would explain the observed distribution of disease expression (McDonald, in press a) rather than distribution of pathogenic races of Armillaria (Morrison et al. 1985). The theory is a specific statement of the familiar disease triangle. First, I assume that Armillaria spp, even so-called pathogenic species, are recyclers of misfit and/or dead woody plants. Second, Armillaria spp. are composed of genetically stable clones that can occupy up to 75 ha and can be thousands of years old. Third, hosts have adapted to various environments and to the behavior of various Armillaria spp. Fourth, both parties exhibit inter- and intraspecies variation of acclimative and adaptive physiologic tolerances. The result is disease expression at suitable junctions of Armillaria occurrence, environment, host traits, and Armillaria traits. If the system is working in this fashion, then microadaptation of host populations to environmental

clines (Sowell and Spomer 1986, Steiner and Berrang 1990) will be an important aspect (McDonald in press a). Harvey (this workshop) also discusses adaptational factors. In addition, this theory predicted the occurrence of pathogenic and saprophytic clones of A. ostoyae on the same site (McDonald et al. 1987b).

Clone and species identification

In order to test the ecophysiologic maladaptation hypothesis or to effectively apply any management alternatives, we must understand the distribution and ecology of Armillaria clones and species. If basidiocarps and single basiospore cultures are available, mating tests using archived and identified haploid test cultures are a reliable identification tool (Watling 1987). A serious problem exists because most field collected isolates are vegetative and the mating of haploid testers to such isolates gives unreliable identifications (McDonald unpublished data). Connection of isolates to clones is easily done by looking for fusion between vegetatively derived isolates (McDonald and Martin 1988), and the method is not too controversial. There is still some confusion about the separation of full sibs, however. This same methodology is being extended to identify clones belonging to the same species, as well as to the identification of species of vegetative clones (see T. Shaw and H. Burdsall this workshop). We are in the final stages of developing a routine system of field-isolate-challenges to identify vegetative clones (McDonald, Burdsall, and Shaw unpublished data). Additional questions about taxonomy and other methods of identification are treated by Burdsall (this workshop). In the meantime, I have conducted preliminary identification of many clones growing on the randomly located plots discussed above, which I will treat below.

Classification of habitat types and Armillaria behavior

The maladaptation hypothesis indicates that certain Armillaria and host attributes should be important modifiers of disease expression by habitat type. Important fungal attributes are clone size and age, species and clone geographic overlap, species and clone ecophysiology, and species and clone pathogenicity. Important host attributes are those dealing with annual photosynthate production and allocation. Individual and species variation in adaptation and acclimation of photosynthesis, respiration, water use, nutrient use, and carbon allocation to growth, maintenance, reproduction, and defense should be highlighted.

We expect to make the link between the above factors and Armillaria behavior through classification of habitat types based on annual air temperature, annual precipitation amount and pattern, annual radiation profiles (McDonald, in press c), soil water availability profiles, soil temperature profiles, decomposition profiles, and nutrient cycling profiles. The individual random plots will be characterized by initializing and running a series of ecosystem process models and a correlative mountain climate model. We are adapting an existing model, FOREST-BGC, (Running and Coughlan 1988)

to our needs (Koehn and McDonald, in press). Model calibration and stress relationships are covered in more detail by Koehn (this workshop). We are also adapting soil temperature and nutrient process models. Output from these models will be incorporated into a spacial display environment to facilitate mapping of productivity index, probability of occurrence of pathogenic Armillaria, probability of host species susceptibility, impact of management options on risk, and impact of global change on risk.

The site-specific climate profiles will be established through use of a correlative mountain climate simulator -- MTCLIM (Hungerford et al. 1989). This model requires daily maximum and minimum temperature, daily precipitation, and 24-hr average dewpoint, if available, from two weather stations in the general vicinity of the target site. Also required is the average annual precipitation isohyet for the location. Site-specific data are east and west horizon, slope, aspect, and leaf area index. Output specific to the site is daily minimum and maximum air temperature, daily average relative humidity, daily radiation, and daily precipitation.

These site attributes will be used to verify the placement of individual habitat types into the annual temperature and moisture matrix based on climax species, presence of indicator shrubs and forbs, and knowledge about site-specific soil water-holding capacity and soil thermal conductivity (McDonald, in press b, and Figure 1). Once the classification system has been properly verified, indicator plants found on specific sites should suffice to give adequate placement. In the meantime, to illustrate how the system could work, several plots have been classified by habitat type and then placed in the temperature/moisture matrix (Figure 1).

Armillaria behavior patterns

About one-third of the plots in habitat types falling into the Douglas-fir climax of the dry-forb group would be expected to support one species, A. ostoyae, and if it is present, it can be expected to be pathogenic (Figure 2). In the next cooler cell, three species were found with all plots having at least one clone. Two species appear to be pathogenic, and one clone of A. ostoyae was saprophytic.

As the classes become more warm and wet (Figures 2,3, and 4), the proportion of saprophytic A. ostoyae clones increases. The number of plots are small and the geographic coverage is restricted, but the pattern is consistent with the ecophysiological hypothesis. If we continue to fill in the blank cells of Figures 2,3, and 4 with data representative of all our western forests, the result should be sufficient ecological understanding of Armillaria root disease to formulate effective west-wide management responses. Then forest pathologists can adequately address ecosystem level questions about root disease posed by silviculturists (see L. Torba this workshop) and others.

AVAILABLE WATER INDEX IN CM	AIR TEMP IN DEGREES C				AVAILABLE WATER INDICATOR PLANTS
	+8	5 TO 8	2 TO 5	-1 TO 2	
50 TO 75	NO TREES	PSMEG PIPO PIFL	ABCO PIEN	ABLA PIEN PIAL	JUCO PUTR RICE
		DRY SHRUB HABITAT TYPES			
75 TO 100	NO TREES	PSMEG PSMEM	ABGR ABCO	ABLA	DITR CHUM PAMY
		DRY FORB HABITAT TYPES			
100 TO 125	THPL	TSHE	ABGR ABCO TSME	ABLA TSME	CLUN COCA TITR
		MOIST FORB HABITAT TYPES			
125 TO 175	THPL	TSHE	ABGR TSHE	ABLA TSME	ASCA VIGL GYDR
		WET FORB HABITAT TYPES			
175 TO 225	THPL TSHE	THPL TSHE	ABGR TSME	ABLA TSME	ADPE ATFI
		WET FERN HABITAT TYPES			
225 +	THPL TSHE	THPL TSHE	ABGR TSHE	ABLA TSME	OPHO
		WET SHRUB HABITAT TYPES			

Figure 1. Classification of habitat type by annual precipitation and temperature on the basis of climax conifer species and moisture indicating shrubs and forbs.

DRY SHRUB GROUP OF HABITAT TYPES				
CLIMAX	HARDWOOD	PSMG-PIPO	ABCO-PIEN	ABLA-PIEN
# PLOTS	0	8	0	0
BEHAVIOR	O P S ¹	O P S	O P S	O P S
N A B S	I V VII IX X UNK	NO DATA	0 ² 0 0 0 0	NO DATA NO DATA
DRY FORB GROUP OF HABITAT TYPES				
CLIMAX	HARDWOOD	PSMG-PSMM	ABGR-ABCO	ABLA
# PLOTS	0	8	5	14
BEHAVIOR	O P S	O P S	O P S	O P S
N A B S	I V VII IX X UNK	NO DATA	8 8 0 0 0 0 1 0 1 5 1 4	4 8 1 0 0 0 0 0
¹ O - OCCURRENCE P - PATHOGENIC S - SAPROPHYTIC ² NUMBER OF CLONES DATA FROM McDONALD UNPUBLISHED				

Figure 2. Armillaria behavior on plots preliminarily assigned to dry-shrub and dry-forb groups of habitat types.

MOIST FORB GROUP OF HABITAT TYPES					
CLIMAX		THPL	TSHE	ABGR-ABCO	ABLA-TSME
# PLOTS		2	6	2	3
BEHAVIOR		O P S ¹	O P S	O P S	O P S
N A B S	I	2 2 0 ²	7 2 5	1 1 0	2 2 0
	V	1 0 1	0	0	0
	VII	0	0	0	0
	IX	0	0	0	0
	X	2 0 2	5 0 5	3 0 3	1 0 1
UNK	0	1 0 1	0	0	
WET FORB GROUP OF HABITAT TYPES					
CLIMAX		THPL-TSHE	THPL-TSHE	ABGR-TSME	ABLA-TSME
# PLOTS		4	5	2	0
BEHAVIOR		O P S	O P S	O P S	O P S
N A B S	I	0	2 0 2	0	NO DATA
	V	0	0	0	
	VII	1 0 1	0	0	
	IX	0	0	0	
	X	5 0 5	5 0 5	3 0 3	
UNK	2 1 1	0	2 0 2		
¹ 0 - OCCURRENCE P - PATHOGENIC S - SAPROPHYTIC ² NUMBER OF CLONES DATA FROM McDONALD UNPUBLISHED					

Figure 3. Armillaria behavior on plots preliminarily assigned to moist-forb and wet-forb groups of habitat types.

WET FERN GROUP OF HABITAT TYPES					
CLIMAX		THPL-TSHE	THPL-TSHE	ABGR-TSME	ABLA-TSME
# PLOTS		0	2	0	0
BEHAVIOR		O P S ¹	O P S	O P S	O P S
N A B S	I	NO DATA	1 0 1 ²	NO DATA	NO DATA
	V		0		
	VII		0		
	IX		0		
	X		2 0 2		
UNK	1 0 1				
WET SHRUB GROUP OF HABITAT TYPES					
CLIMAX		THPL-TSHE	THPL-TSHE	ABGR-TSHE	ABLA-TSME
# PLOTS		0	0	0	0
BEHAVIOR		O P S	O P S	O P S	O P S
N A B S	I	NO DATA	NO DATA	NO DATA	NO DATA
	V				
	VII				
	IX				
	UNK				
¹ 0 - OCCURRENCE P - PATHOGENIC S - SAPROPHYTIC ² NUMBER OF CLONES DATA FROM McDONALD UNPUBLISHED					

Figure 4. Armillaria behavior on plots preliminarily assigned to wet-fern and wet-shrub groups of habitat types.

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ARMILLARIA: A ROLE IN LONG-TERM STABILITY OF NATIVE, INLAND WESTERN FORESTS

Alan E. Harvey

ABSTRACT: The potential for native forest pests to act as recycling agents for fixed carbon and associated nutrients in forest vegetation is well recognized, if unappreciated, in typically infertile, Inland Western forests. Tree mortality is a requisite process that provides both structural and species diversity as well as nutrient release. Native pests are well situated to respond to high tree or stand stress caused by a myriad of common factors, even in developing stands not subject to human intervention. Efficiency in attacking high stress hosts provides an opportunity for pests to proactively remove unsuited genotypes, particularly with hosts that require close adaptation to local environments. This process may be required to permit rapid adaptations to typically changing environments. Armillaria's broad distribution, wide host range, sometimes aggressively pathogenic behavior, and apparent ability to selectively attack stressed hosts suggests it is ideally suited to such a role. Its extensive activities on both Douglas-fir and the white firs of the Inland West indicate this process may be particularly active on these highly site-adapted species. It is likely that successful management systems for this disease will require close attention to host genecology and site treatment as well as to pathogen-based epidemiological biology.

NATURE OF THE ECOSYSTEMS: Frequent, often catastrophic, natural disturbances on varying time scales (e.g., climate change, glacial encroachment, volcanic activity, and wildfire) have been and are typical in Inland Western forests. Since the appearance of humans, natural fire frequency has been grossly altered--first increased by native populations, then decreased by aggressive fire control from European settlers (Weaver 1974). Additionally, 20th century timber harvesting and related practices have resulted in significant host genecological (Millar and Libby 1989) and site perturbations (Harvey et al. 1989).

Despite a constantly changing native environment, Douglas-fir and white firs are predominating species throughout much of the this region. Typical of these species is a highly site-adapted nature with a general inability to thrive in "off-site" situations (Hamrick 1976, Rehfeldt 1979). Also typical of these species throughout the Inland West are high mortality rates and pest damage, particularly in disturbed and off-site stands (Fellin 1979, McDonald et al. 1987a, Baker 1988, McDonald 1991). Armillaria is especially conspicuous under these circumstances (Wargo 1980, McDonald et al. 1987b). On the other hand, Armillaria and other root rot pathogens are conspicuously uncommon on broadly site-adapted species such as western white pine and western larch (Minore 1979).

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The interaction between natural wildfire, biological decay, and geneecology of trees in highly disturbed, temperature-moisture limited, and/or infertile environments is likely to be quite different than that commonly encountered in well-buffered, fertile, and more stable ecosystems. The development of a typically pathogen-resistant population, as is normal in buffered, stable ecosystems, does not appear as common in marginal forest ecosystems.

Typical of marginal forest ecosystems are temperature, moisture, and nitrogen limitations to growth, gradual tie-up of most nutrients in woody materials, limited decay rates, high vegetation stress, and periodic fire recycling. In such ecosystems two things are paramount to generating a stabilizing, productive vegetative component: (1) bound nutrients, including carbon, must be recycled to the soil (Olsen 1963, 1981, Harvey et al. 1989) and (2) the vegetation must be well adapted to the site (Langlet 1971, Millar and Libby 1989). Aggressive biological decay and frequent, low-intensity fire are critical to the former (Harvey et al. 1979), and rapid removal of maladapted vegetation is critical to the latter (Langlet 1971, Millar and Libby 1989).

Host stress is a common predisposing factor for native forest pests (McDonald 1985, Waring 1987, Stoszek 1988, Smith 1990). These pests are well suited and situated to remove maladapted hosts. It is evident, however, that this removal process is likely to cause localized fuel accumulations and result in frequent, high intensity fire where the process is active. Thus, fire may sanitize those host populations most subject to pest pressures, thereby removing genotypes most likely to be resistant (Roth 1966, Harvey et al. 1987). However, in these environments, high resistance to pests may not be beneficial over the long run, and fire sanitizes the pest population as well (Hardison 1976, Harvey et al. 1976, Parmeter 1977, Fellin 1979).

Armillaria, due to widespread occurrence, wide host range, aggressive pathogenicity on stressed hosts, and ability to decompose, is ideally suited to recycle as well as remove maladapted genotypes. These capabilities appear highly beneficial to constantly changing, marginal ecosystems where off-site situations are likely to be common. It appears that susceptibility to Armillaria and other pests is much more the norm in such ecosystems than in more stable ones.

The activities of humans, when superimposed on balanced, constantly changing systems, can easily cause these forces to become greatly imbalanced (Waring 1985). Fire exclusion and the resultant dense stands of mid- and late-seral or climax, shade-tolerant, pest-susceptible species are only one example (Parsons and DeBenedetti 1979, Baker 1988). The latter has assuredly forced high level pest activities and/or intense, site-damaging wildfire into becoming dominant recycling agents. Perhaps more subtle but no less important are several generations of forest harvesting where removal of the best adapted genes by selective cutting, and/or reforestation with inappropriate species or genotypes (as can be associated with other means of cutting) may have led to reduced fitness of postharvest conifer populations (Millar and Libby 1989). This is particularly important in light of evidence suggesting genetic change in conifers as a response to localized environmental conditions (Fryer and Ledig 1972, Linhart et al. 1981).

Such a scenario has been and is being experienced in other forested ecosystems throughout the world (Langlet 1971, Millar and Libby 1989). Even more subtle is the potential for soil disturbance and degradation to accentuate this problem. It is becoming more and more evident that even modest changes in the soil system can bring about substantial (up to 25%) reductions in site productivity potential (Harvey et al. 1989, Powers et al. 1989). Even a single round of genetic selection, e.g., thinning or "high-grading," can cause a 12 to 17% genetic change in the regenerated stand (Orr-Ewing 1967, Wilusz and Giertych 1974, Ledig and Smith 1981). Also, genes can contribute more to the expression of site index than environment (Monserud and Rehfeldt 1990). It would not be unreasonable to combine more than one round of fitness-related productivity changes with any (or several) of the common site-related natural or human-caused problems described. A sobering probability!

From a pathological point of view--so what! Well, many aspects of site and vegetational history may well be as important as population density or inoculum potential for the spread and intensification of pest problems. Thus, the stage may be set, even prior to a current disturbance, for major alterations in pest hazard. Worse--conditions that might lead to substantial alterations in hazard may well not be as easy to identify as pest population densities, inoculum potential, or species susceptibilities in a postdisturbance stand. Influence of site history and soil factors on pest "damage" is particularly appropriate to a widespread, stress sensitive, soil-borne organism such as Armillaria. We now know that both Armillaria and at least one of its major hosts, Douglas-fir, are directly influenced by subtle soil and soil-related factors (Blenis and Mugala 1989, Page-Dumroese et al. 1989).

CONCLUSIONS: There may be many instances where pest problems are the symptoms and not the disease. These could be quite common. With badly impaired sites and/or depleted or inappropriate gene pools or species, it is easy to visualize rampant problems with pests, particularly one of the nature of Armillaria. In such cases, the "obvious" inciting agent would have little to do with the basic problem. Pathogens now represent a natural solution for the problem! Attempts to control the disease, which is now only an indicator of a larger problem, would have little overall benefit, even if successful (very unlikely). If successful, the site would likely remain highly vulnerable to reinvasion by the same or other pest organisms.

Failure to balance silvicultural approaches, timber harvest/site preparation methods, tree species, and genetic fitness with soil and site conditions, in addition to pest biology, will likely negate what otherwise might be effective methods for pest control (Norris 1988). Such failures will certainly set the stage for nature to arrange the succeeding balance in her own way. She has alternatives! Forest declines, mountain pine beetle-Armillaria/Phellinus epidemics, and Yellowstone-type fires come to mind as current examples.

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A SHADE STRESS STUDY WITH ARMILLARIA AND PROCEDURES FOR CALIBRATING THE PHOTOSYNTHESIS PORTION OF ECOLOGICAL PROCESS MODELS.

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Abstract. Douglas-fir (Pseudotsuga menziesii) seedlings were exposed to four different levels of shade in the greenhouse and inoculated with Armillaria ostoyae. The inoculum apparently did not remain viable so there was no infection in the seedlings.

Methods for calibrating parameters for the photosynthesis portion of a detailed process-based ecological model are also discussed, as well as a procedure for using chlorophyll fluorescence for detecting environmental stress.

Introduction

Armillaria is the most common root pathogen encountered in coniferous forests in northern Idaho and western Montana. Apparently there is a relationship between the vigor of host species and Armillaria infection. In hardwood roots under stress there is an increase of glucose, fructose, and free amino acids and a decrease in starch and sucrose concentrations. Armillaria growth is enhanced by carbohydrates and amino acids. Concurrently, reduced carbohydrate reserves diminish the host's ability to preserve its defenses. Environmental stresses also seem to perturb the photosynthetic electron transfer chain of photosystem II in the photosynthetic process. The functional state of the chloroplast thylakoid membranes is altered which, in turn, results in changes in chlorophyll fluorescence.

This study is designed to measure the physiological response of Douglas-fir to various levels of light intensity and the interaction with Armillaria infection. Physiological parameters from this study may be used in assimilation models, similar to the one developed by Steve Running at the University of Montana (Koehn and McDonald in press, McDonald in press, and Running and Coughlan, 1988). This model is driven by climate and vegetation structure and calculates key processes involved in carbon, water, and nitrogen cycles for forests. This, in turn allows, one to evaluate the productivity and health of a forest stand.

The objectives of this study are to test the hypotheses that photosynthesis characteristics may be used to measure stress in Douglas-fir, chlorophyll fluorescence may be used to detect

environmentally stressed Douglas-fir, and physiological changes take place which result in Douglas-fir becoming more stressed and consequently more susceptible to Armillaria infection.

Methods

Douglas-fir seed was collected in the fall of 1987 from the Pete's Creek area near Elk River, Idaho. The seed was sown in May 1988 and grown for 10 months before inoculation with Armillaria ostoyae. Light intensity treatments also began at the time of inoculation. The Armillaria ostoyae clone used for inoculum in this study is a pathogenic isolate from Pete's Creek. It has been identified by haploid mating as a member of Korhonen's 'Species C' group (McDonald and Martin, 1988 and McDonald, unpublished). The stressors, levels of light intensity, were 70%, 40%, and 20% of the control. The control is the fourth treatment that has no shade except for what the greenhouse structure provides. The 20% light level should have been low enough to stress the seedlings according to Redfern (1978). Beginning in August 1989, five trees from each treatment were sampled for oxygen evolution, chlorophyll fluorescence, dry matter, and Armillaria infection each month for one calendar year. Sampling was intended to measure the physiological changes during budburst, growth, and dormancy. The experimental design was a randomized block design with four treatments and four replications, two of the replications were inoculated with Armillaria.

Photosynthesis was measured via oxygen evolution from Douglas-fir needles using the LD-2 leaf photosynthesis cell which contains a Clark-type electrode (Walker, et al., 1983). The system measures oxygen concentrations at temperatures controlled by water baths. The temperature for this study was 20°C. The light source was low heat lamps which emit a photon flux density of approximately 1400 $\mu\text{mol}/\text{m}^2/\text{s}$. Oxygen evolution was measured at nine light intensities including dark respiration. The light intensity was regulated by using three neutral density filters (10%, 25%, and 50%) in combinations. This allows for accurate determinations of photon yield. The carbon dioxide concentration of the sample chamber was saturated at about 5%. Oxygen concentrations were recorded by the Polycorder data recorder.

A fluorescence detector designed to be used with the LD-2 photosynthesis system was used to measure variable chlorophyll fluorescence. It is a nylon probe inserted at an angle of 40 degrees into the side of the upper jacket of the LD-2 apparatus which allows fluorescence to reach a photodiode protected by filters which exclude blue actinic light.

The procedures for preparing plant material were as follows. Needle samples were taken from the leader of the seedling and placed on moist filter paper in petri dishes. The needles were attached to tape and cut to fit into the photosynthesis cell chamber. Before being placed in the chamber, the needles were dark adapted for 1 hour.

Chlorophyll fluorescence readings were taken for 2 seconds at 1-millisecond intervals and then for 5 minutes at 1-second intervals. Oxygen evolution measurements were taken on the same needles at the nine different light intensity levels. Ten readings were taken every 15 seconds for 3 minutes at each light level.

Results

These procedures allow us to calculate various photosynthetic parameters using linear regression and Michaelis-Menton enzyme kinetics. These parameters are: maximum photosynthesis (P_{MAX}), the Michaelis-Menton constant for light (K_m), dark respiration, light compensation point, and quantum yield (Figure 1).

These parameters are used in the following photosynthesis model:

$$\text{umoles CO}_2/\text{m}^2/\text{s} = (\text{ICC} \cdot \text{MCC} \cdot \text{LMCS}) / (\text{MCC} \cdot \text{MMC} \cdot \text{LMCS}).$$

The definitions for the equation are: umoles CO₂ = .75 O₂ evolved, ICC = the internal CO₂ concentration (5% CO₂ in the O₂ measurement cells = 59259 ubars), MCC = maximum stomatal conductance (= .008 m/s from Lohammer, et al., 1980), MMC = maximum mesophyll conductance (= P_{MAX}/ICC from Landsberg, 1986), LMCS = Light dependent mesophyll conductance scaler ((current light - light compensation point)/(current light + Michaelis-Menton constant)).

P_{MAX} and chlorophyll fluorescence will be the only variables presented here. The data in the graphs are from 5 trees in the 20% of the control treatment (shade trees) and 5 trees in the control treatment (sun trees). The results for P_{MAX} are shown in Figure 2. The values for both treatments are very similar except for the month of February when the trees were in full dormancy.

The result from a chlorophyll fluorescence measurement is shown in Figure 3. The value used for comparative purposes is F_v, variable fluorescence. F_v is calculated by $F_v = (F_m - F_o) / F_m$. The parameters F_o and F_m are shown in Figures 4 and 5. F_o is taken as the first data point after the light is turned on by the Polycorder. F_m is the average of the data points at the peak of the graph. F_v is a ratio that corresponds to the efficiency of the electron transport system to transfer electrons between photosystem II and photosystem I. The value for non-stressed plants is between .75 and .85 (Bjorkman and Demmig, 1987). Both shade and sun treatments are in this range except during dormancy; the sun trees drop below this value.

The *Armillaria* inoculation was a complete failure. At the end of the experiment, 60 trees from the four treatments and two replications were checked for *Armillaria* infection; no trees were infected. Only 6 inoculum pieces out of 480 showed active fan growth.

Conclusion

The procedures developed here provide the necessary parameters for calibrating the photosynthesis portion of an ecosystem process model. The data at this point also shows a clear difference between the nature of the photosynthesis apparatus of the sun and shade trees during dormancy. Since the shade trees are photosynthesizing as efficiently as the sun trees, one cannot say at this point the shade trees are stressed; rather they have adapted to the conditions and are producing to their capacity given their environmental conditions.

Acknowledgments

This doctoral research is supported by Stillinger Funds from the University of Idaho and the Intermountain Research Station.

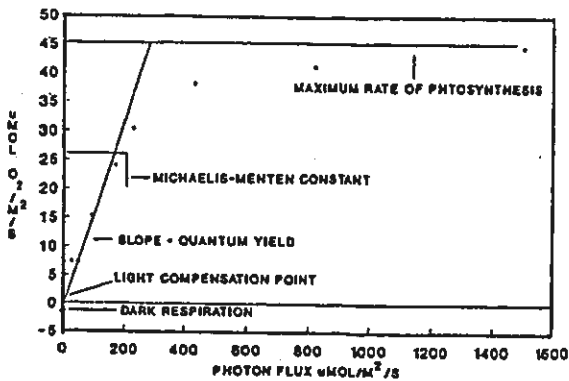


Figure 1. Photosynthetic parameters for calibrating models using enzyme kinetics analysis.

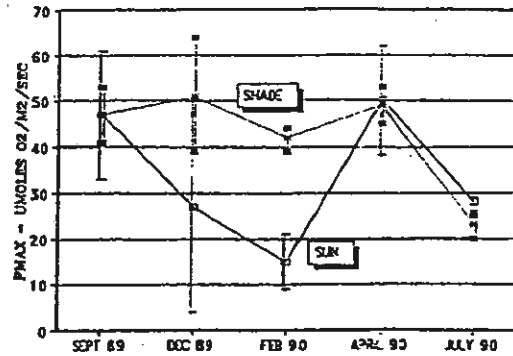


Figure 2. Maximum photosynthesis (Pmax) for 5 trees from a sun and shade treatment.

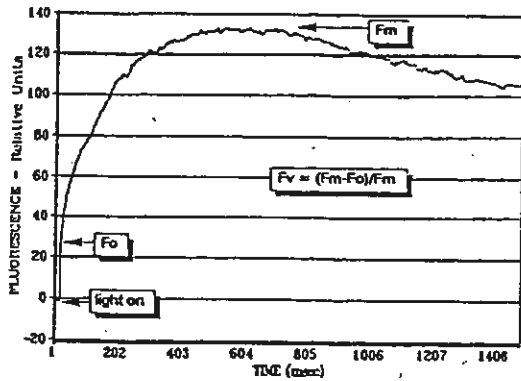


Figure 3. Chlorophyll fluorescence curve from an individual tree showing the parameters used for analysis.

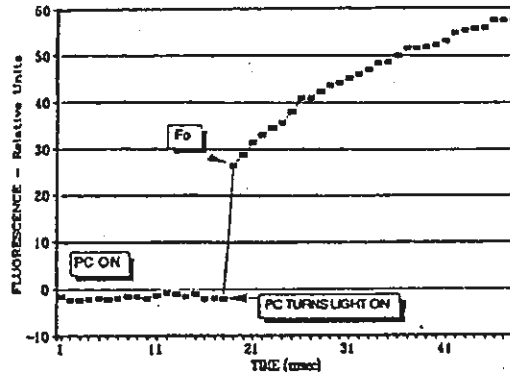


Figure 4. Initial part of the chlorophyll fluorescence curve used to derive Fo.

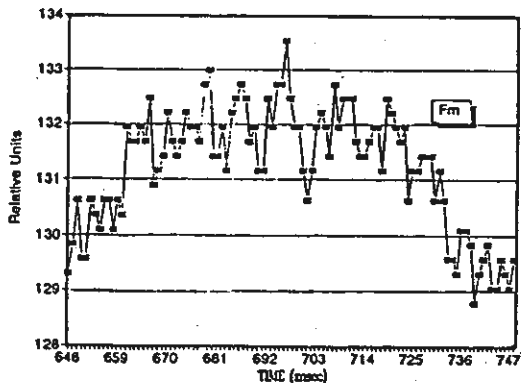


Figure 5. Maximum portion of the chlorophyll fluorescence curve used to calculate Fm.

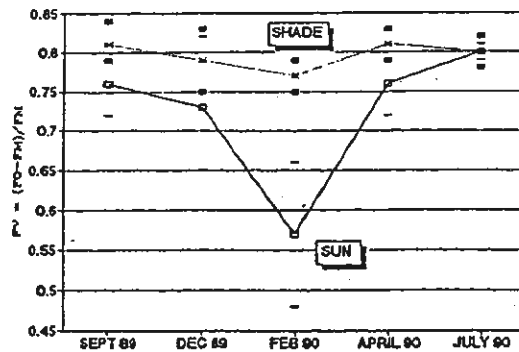


Figure 6. Chlorophyll fluorescence for 5 trees from a sun and shade treatment showing changes in photosynthetic efficiency during dormancy.

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PRELIMINARY RESULTS OF A BLIND-BLIND TEST OF A NEW PROCEDURE TO IDENTIFY DIPLOID ISOLATES OF ARMILLARIA

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Introduction

A test of the diploid x diploid challenge method of identifying vegetative isolates of Armillaria was constructed of known isolates obtained from various sources around North America. All the known North American biological species (NABS) were included. In the initial test, a group of 54 isolates (3 isolates/clone x 2 clones/NABS x 9 NABS) were doubled and given separate numerical codes. One group was sent to GERAL McDonald and the second was sent to Hal Burdsall.

McDonald created two Punnett squares, following the design shown in McDonald and Martin (1988), one for Hal's code and one for his. The resulting challenges were read as follows: The "y" class in McDonald and Martin (1988) signifies mycelial fusion and therefore members of the same clone. Their "n" class was divided into two classes -- nonpigmented antagonism and pigmented antagonism. Nonpigmented signifies clones belonging to the same NABS and pigmented antagonism clones belonging to different NABS.

Preliminary Results

To be honest, I am flabbergasted they did as well as they did!

Geral's Score: In all cases where he designated that a particular group of isolates belonged to a single clone, he was correct. In each of two designated but unidentified groupings of NABS's he could not distinguish between six isolates belonging to two different clones. In both of these cases, I am reconfirming from the sources that supplied the isolates that they are, in their opinion, different clones. Admittedly, I, with some additional knowledge as to the source of the isolates in question, do have some slight concern that groups of isolates may indeed be of a single clone rather than the two clones intended.

Geral designated that the isolates fell into 8 groupings of NABS,s; in fact they fell into 9--assuming all previous identifications were correct. The actual NABS groupings have not been designated by GERAL or Hal and thus "which is which" has not yet been determined. However, based on the current grouping of similar isolates, they are grouped so that NABS's II, III, V, VI, VII, and XI (Morrison's "F") could be properly identified. Problems exist in his present groupings such that he will not be able to properly separate NABS's I, IX, and X. Confusion between I and X is

understandable because of apparent close affinity, but confusion of these with IX is somewhat perplexing, particularly when one knows the geographical separation amongst the confusing isolates (over 3000 Km's).

Hal's score: In all cases except one where he designated that a particular group of isolates belonged to a single clone he was correct. The case in error is rather confusing in that there is either an error on the printout as to what the isolate number actually was, or he used an isolate he was not supposed to use. Giving him the credit of the doubt, we will throw it out and give him a perfect score here, too. (I sure am benevolent today!)

The rest of Hal's results parallel Geral's. The alignment of the Punnett square suggests that he may have done slightly better than Geral in sorting out differences amongst NABS's I, IX, and X. Of course, the "alien" isolate he used exacerbates interpretation of this situation!

Preliminary Conclusions

Geral was successful in transferring the "how to" technology associated with this test to another warm body (Hal in this case). The test seems reasonably reliable in properly grouping isolates into their respective clones. The test has the potential to correctly separate amongst six of the known NABS. Confusion still exists with three of the known NABS, if one accepts that the original identifications were correct.

To be honest, the results are much more encouraging than I anticipated. They may well lead to development of another tool to aid with identification of field-collected, diploid isolates of Armillaria.

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HAZARD TREE SURVEY OF THE FT. LEWIS HISTORICAL
DISTRICT, WASHINGTON.

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ABSTRACT. A hazard tree survey was conducted for the 300+ acre historical district of Ft. Lewis, Washington, approximately 50 miles south of Seattle. Our survey consisted of a complete inventory of all woody plants >6 inches DBH, mapping all tree locations, and systematically describing all trees for hazard potential. We found over 90 species of trees and described 3,302 individual stems >6". Although our analysis is not yet completed, we have made generalizations concerning important hazard species, which include Douglas-fir, grey poplar, Oregon oak, American elm, European elms, maples, other poplars, spruce, cypress, and other less abundant species. Influencing factors such as root disturbance during sidewalk replacement and pruning practices have had a major effect on hazard potential of many hardwood species, while butt rot and large size make Douglas-fir the most important hazard species.

INTRODUCTION

A hazard tree survey for the 300+ acre proposed historical district of Ft. Lewis, Washington was conducted as part of a Landscape Development Plan being prepared by the National Park Service for the Army Corps of Engineers to aid in management of the district. Our project serves the needs of the landscape development plan by providing a complete inventory of trees greater than 6 inches DBH, a map of all tree locations, a data base which contains all information collected on individual trees, a report summarizing our findings, recommendations regarding specific actions required to deal with hazard and tree health problems and a maintenance plan to manage the current species composition into the future.

The historical district at Ft. Lewis was built and landscaped in the early 1930s when it was converted from a Garrison to a Fort. A diverse collection of trees including native Douglas-fir and Oregon oak plus many deciduous hardwoods from eastern North America were used. Many buildings had foundation plantings of Lawsons cypress (5 cultivars), sawara cypress (4 forms), variegated western red cedar, English holly, Portugal laurel, and English laurel. Open landscapes have Douglas-fir, Oregon oak, Norway spruce, and less numerous species such as Sassafrass, river birch, Cedar of Lebanon, Atlas cedar, American basswood, Northern catalpa and white mulberry. Extensive plantings of American elm, grey poplar, hawthornes and European Mt. Ash were used

as street trees. Yards were commonly planted with Colorado spruce, fruit trees, sweetgum and others.

The objective of the hazard tree survey was to provide the baseline information necessary to manage trees in the historical district in a safe and responsible manner.

METHODS

We systematically described and mapped all trees greater than or equal to 6 inches in diameter at breast height (4.5 ft) within the historical district, approximately 300 acres. Multistemmed trees were treated as multiple trees if the crotch was below breast height and the fork was functioning as an individual tree. We mapped trees by "eyeballing" them on 1" = 50' maps provided by the Army Corps of Engineers, Seattle Office. Trees were systematically described using our data sheet (Figure 1) as a guide and hazard rated using the Washington State Department of Natural Resources seven point system (Mills and Russell 1981). The system uses a two part number rating, one based on the potential for the tree to fail (1 low to 4 high) and one based on the potential to damage a target (1 low to 3 high). Trees rated 6 or 7 are recommended for removal, 4 or 5 monitored, 2 or 3 not hazardous. The potential for tree failure was based on knowledge of external indicators which can infer structural soundness (Tattar 1989, Mills and Russell 1981). We were especially looking for root/butt rot, cut roots, internal decay of the trunk or large limbs, and weak forks (Tattar 1989).

In addition to systematic descriptions based on external indicators, we drilled trees suspected of having internal decay with a 12" long, 1/8 inch diameter bit. This included drilling the base of all Douglas-fir greater than 16 inches in diameter whether external indicators made us suspect decay or not. Thickness of sound wood was used to determine hazard. A table in Wagener (1963), provided by Mills and Russell (1981), gives minimum allowable thickness before recommending removal.

RESULTS

The results of our survey indicate that many of the species we inventoried will never become hazardous (hollies, laurels, hawthornes), and many trees are too young at this time. The primary hazardous species is Douglas-fir because of the large size this tree attains. Douglas-fir commonly had butt rot due to Phaeolus schwienitzii, and occasionally had conks of Phellinus pini present. These seemed especially important in cases of large forked trees. Some Norway spruce were large enough to pose a serious hazard and were structurally unsound due to forking of the lower bole as were some Douglas-fir that had no noticeable decay.

HAZARD TREE SURVEY FORM (05-17-90)

CREW _____

TREE # _____ ZONE _____ LOCATOR _____ SURVEY DATE: m _____ d _____ y _____

SPECIES _____ DBH _____ HEIGHT _____ WIDTH _____

TREE CONDITION

ROOTS _____

STUMP/BUTT _____

LOWER STEM _____

MID STEM _____

UPPER STEM _____

CROWN _____

TARGET DESCRIPTION

A) _____	DIST: _____	DIR: _____
B) _____	DIST: _____	DIR: _____
C) _____	DIST: _____	DIR: _____
D) _____	DIST: _____	DIR: _____

INFLUENCING FACTORS/REMARKS: _____

TREE FAIL RATE: 1 2 3 4 TARGET RATE: 1 2 3
low high low high

HAZARD RATING: 2 3 4 5 6 7

RECOMMENDED ACTION: _____

YEAR TO RE-EXAMINE _____

FIGURE 1. DATA SHEET

Sawara cypress was another conifer which posed a potential hazard due to weak forks. Lawsons cypress appeared structurally sound, but was often topped which infers decay was common in the upper bole.

American elm and grey poplar were the most important hazardous hardwood species, with other less numerous species such as maples, European elms, Lombardy and hybrid black poplars, and oaks being potentially hazardous. Weak forks accounted for some hazard, however, internal decay of the trunks from large cut limbs and roots cut during sidewalk replacement were the primary cause of trees becoming potentially hazardous.

DISCUSSION

The hazard tree survey of the Historical District at Ft. Lewis identified trees with the potential to fail and cause significant damage. Douglas-fir was hazardous primarily from weak forks and butt rot which could not necessarily be prevented. Most hazardous deciduous hardwoods resulted from cut roots during sidewalk replacement and internal trunk decay from large cut limbs. These conditions are a result of maintenance activities and could be prevented. The following recommendations provide a guide to future management of the trees in the Historical District.

RECOMMENDATIONS

A) Removals and Replacements

1. Remove hazard trees.
2. Review near hazard trees.
3. Plan for replacement of large forked conifers.
4. Plan for removal of large mature trees.

B) Pruning

1. Follow proper pruning practices.
2. Do not top trees.
3. Anticipate pruning needs, prune early.
4. Prune hardwoods with dead wood and hazardous limbs.
5. Thin crowns of hardwoods which have had root damage and are showing tip dieback. Remove small diameter branches from throughout the crown.

C) Influencing Factors

1. Do not cut roots when doing sidewalk replacement.
2. Minimize disturbance to trees, especially mower damage.
3. Remove sod from around shade trees, mulch around base.
4. Treat soil compaction areas.
5. Use more care with herbicides.
6. Deep water hardwoods during summer drought.

D) Maintenance of Tree Health

1. Implement long term maintenance plan.
2. Hire urban forester.
3. Provide training for grounds crews.
4. Begin Dutch Elm Disease program.

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ACKNOWLEDGEMENTS

Judith Greenleaf has been instrumental in organizing and cleaning our database, in addition she aided in field work. Prof. Jim Agee and Bob Edmonds are the Principle Investigators for this project. Tony Basabe and Marianne Wampler aided in the field work. Bob Harvey from Forest Service, FPM, Portland and Ken Russell and Jim Arthurs from WA DNR, Olympia gave critical review and technical assistance. This project was a subcontract to the National Park Service, Pacific Northwest Regional Office, Seattle, WA.

CREATING WILDLIFE TREES WITH INOCULATION WITH DECAY FUNGI

Catherine A. Parks, Gregory M. Filip, Robert L. Gilbertson
and Elizabeth Dorworth

Introduction

Several investigators have reported the relation between cavity nest sites of birds and internal decay of trees (Shigo and Kilham 1968, Conner et al. 1976, McClelland 1977, Miller et al. 1979). Managing for cavity-dependent wildlife is a major issue for State and National Forest resource managers who have difficulty maintaining snags (dead standing trees), which are often harvested for fiber and firewood or felled for safety. Several methods for killing trees to produce snags for cavity nesting birds have been tested (Conner et al. 1981, McComb and Rumsey 1983, Bull and Partridge 1986). Observations from these studies suggest that trees killed by herbicides and girdling fall sooner than trees killed by natural causes and are rarely used by cavity nesters. Bull and Partridge (1986) report that trees that are limbed and topped by an explosive charge are most frequently used by nesting woodpeckers and stand the longest. This technique is the method used most in the Pacific Northwest by forest managers actively recruiting snags by killing trees. Unfortunately, this technique is expensive, requires highly skilled personnel, and produces unpredictable results.

Although dead trees are the most common nest sites for cavity dwellers, live trees may also accommodate nesters if the boles contain decayed wood. Affeltranger (1971) and Conner and Locke (1983) suggest that live trees might be made suitable for cavity excavation by inoculating them with stem-decay fungi. Conner et al. (1983) report an 80% success rate when inoculating living oaks. Successful inoculation of conifers could produce a wildlife tree less likely to fall within a short time or to be harvested for firewood.

In 1988 we initiated a research project to identify decay fungi associated with woodpecker cavities in live western larch trees (Larix occidentalis Nutt.). Using the decay organisms isolated from the survey, we have initiated an artificial inoculation trial. The study goal is to determine the capacity to cause internal decay of living western larch by artificial inoculation, and to monitor inoculated trees for woodpecker excavation.

Study Summary

For our study, we surveyed 18 live western larch with woodpecker cavities located in Union and Umatilla counties in northeastern Oregon. To assess the incidence of decay and the associated fungi we climbed each tree to take wood samples at cavities. Samples were collected by drilling into the bole with an increment borer around the cavity area. Increment cores were cultured to determine the identity and incidence of hymenomycetes. Seven hymenomycetes were identified from the core samples (Table 1). Three trees had two decay fungi present.

Table 1. Incidence of Decay Fungi in 18 Live Western Larch at Woodpecker Cavities

<u>Fungus</u>	<u># of Trees</u>
<u>Lentinus lepideus</u> Fr.	1
<u>Phaeolus schweinitzii</u> (Fr.) Pat.	1
<u>Gleopyllum sepiarium</u> (Fr.) Karst.	3
<u>Coniophora puteana</u> Schum.:Fr.	5
<u>Sterium sanguinolentum</u> (Alb. & Schw.:Fr.)Fr.	2
<u>Wolfiporia cocos</u> (Wolf) Ryv. & Gilbn.	1
<u>Postia placenta</u> (Fr.) M. Lars. & Lomb.	3
no hymenomycetes identified	5

We inoculated 10 trees in each of six study areas in northeastern Oregon. Western larch with no obvious wounds and at least 40 cm dbh were inoculated with five of the seven fungal species identified from the survey (Table 1). Inoculum consisted of mountain alder (Alnus incana) stem sections (8 x 2.5 cm), thoroughly colonized by one of fungi. Inoculations were made at 7 m above ground. This height was chosen because it is within the nest height of most woodpeckers (Thomas et al. 1979) and could be reached with two sections of a 3-m Swedish climbing ladder. Inoculum was inserted into drilled holes followed by a partially inserted 10-cm-long hollow plastic tube, 2.5 cm in diameter (Fig. 1). Tubes were placed in holes to keep resin out and to prevent tree growth from sealing the opening (Conner and Locke 1983). Non inoculated holes served as controls. Inoculations were made in early September when resin flow was minimal (to reduce wound sealing) and moisture conditions had increased from the summer (to reduce inoculum drying).

Inoculated trees will be checked each year for evidence of woodpecker use (i.e., presence of nest cavities, chips, or foraging activity in the bark or wood). Inoculated trees will be harvested in 1999 to evaluate the inoculation success and decay progress.

Our survey results support evidence reported by others that cavity nesters depend on decayed wood for nesting habitat. Managers of public lands are now required to retain habitat for snag-dependent wildlife in timber sales or other intensive management activities. Current technology does not supply the tools needed if the laws are changed to mandate that land managers not only retain but establish this critical habitat. We believe that, if successful, inoculation could be used to create suitable habitat for snag-dependent wildlife in coniferous forest in greater abundance or at younger ages than would normally occur.

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"MANAGING FOREST DISEASES IN RECREATION AREAS"

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Vegetation on the San Bernardino National Forest (SBNF) is managed primarily for watershed protection, biodiversity, wildlife habitat and recreational values (USDA-Forest Service 1988). Vegetative treatments are prescribed and implemented to meet objectives which are consistent with the Environmental Agenda of the USDA-Forest Service, Region 5 (USDA-Forest Service 1990a).

These objectives include managing timber stands to improve their health and vigor. The SBNF is attempting to meet this objective through integrated pest management, which requires understanding the biology and ecology of forest pests.

Managing the impacts of ozone pollution

The impacts of ozone pollution, generated by smog from the Los Angeles basin, have been monitored in conifer forests in the San Bernardino Mountains of southern California for nearly two decades (Miller et al. 1989). The SBNF is cooperating with this study by maintaining a series of permanent plots across the entire length of the Forest.

The SBNF is attempting to manage the problem of ozone pollution by creating healthier growing conditions for trees through stocking control, and by selecting for trees (particularly pine species) displaying inherent tolerance to the disease.

Learning to live with *Heterobasidion annosum* (H.a.)

Giant Sequoia has been planted on the SBNF because of its ability to outperform native species in terms of growth rate, and because of its apparent resistance to the "P" strain of *H.a.* (Chase 1989). However, on one known site planted 15 years prior, giant Sequoia is beginning to yellow and mortality is occurring. Sugar pine on the site is suffering similar symptoms.

A biological evaluation was performed to determine if a biological agent, specifically a root disease, was contributing to this situation. Samples were collected and examined in the lab; fruiting bodies of *H.a.* were found on both sugar pine and giant Sequoia wood samples, implying that both the "P" and "S" strains are occurring on the same site (USDA-Forest Service 1990b). Further tests are being conducted.

*Forest Silviculturist. Paper presented at a meeting of the Western International Forest Disease Work Conference. Redding, CA. Sept. 17-21, 1990.

A stumping project has been initiated which involves a series of operational and experimental treatments to control the spread of H.a., and to hasten reforestation with native conifers (Bloomberg and Reynolds 1988). This work is being conducted within a campground now under construction; the site has approximately 40 known and highly active H.a. centers within an 80 acre area, so control of the disease is of great importance (Wood 1978).

The tree spade is being used on the SBNF to transplant black oak and other apparently resistant vegetative species within active H.a. centers in developed campgrounds. This procedure allows for restoration of vegetative cover for shade and screening between campsites; it may also serve to hasten cleansing of the site from the disease by forming a biological barrier to further spread.

Dwarf mistletoe suppression in developed recreation areas

All SBNF family campgrounds and day use areas have been surveyed for dwarf mistletoe infection and treatment recommendations have been made (USDA-Forest Service 1989). Treatments are scheduled to begin in 1991. The primary objectives of these treatments will be to prolong the lives of high value trees, and to reduce the amount of inoculum in the stand, thereby reducing the rate of spread (Scharpf 1988).

The SBNF is cooperating with the USDA-Forest Service Pacific Southwest Experiment Station (PSW) and Region 5-Forest Pest Management (R5-FPM) in field testing resistance in Jeffrey pine to dwarf mistletoe infection (Scharpf 1987). If resistance is concluded, it will provide a very valuable option for managing this disease.

Managing black stain (*Leptographium wagneri*) in pinyon pine

The pinyon pine timber type is important to the SBNF in terms of watershed, wildlife habitat and recreation. A major contributor to mortality of pinyon pine is black stain root disease.

The SBNF is very interested in elucidating management options and knowing how management treatments affect the rate of spread of the disease. We are interested in knowing persistence of the disease within a center and in understanding disease/insect interactions.

The SBNF has encouraged a cooperative study between PSW and R5-FPM which we hope will come to fruition and provide much needed information (USDA-Forest Service 1990c,d).

Controlling true mistletoe in developed recreation areas

Campground trees are very valuable for the shading and screening they provide. True mistletoe is contributing to decline and mortality of these trees. An array of hardwoods, as well as white fir and juniper, are affected.

The SBNF is engaged in a cooperative study with R5-FPM to control the spread of true mistletoe. Both manual and chemical methods are being examined (USDA-Forest Service 1990e).

In conclusion

We on the San Bernardino National Forest believe that our vegetation management efforts are greatly in line with the New Perspectives agenda of the USDA-Forest Service. We further believe that research aimed at providing answers to management questions is vital to our efforts. We intend to maintain a close working relationship with our colleagues at R5-FPM, PSW and interested universities.

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A Comparison of Sampling Methods for
Armillaria Root Disease

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Currently, disease detection methods rely primarily on the presence of external symptoms to alert the observer to the presence of a pathogen. However, due to the hidden nature of root disease such external indicators are often not present or difficult to discern until the disease is in an extremely advanced state. Researchers and forest managers have long sought a quick, accurate and reliable method of sampling for and quantifying disease intensity in a stand at levels below which external symptoms are apparent. This differs from simple field checks used to identify the presence of a pathogen and not much more.

Several different methods have been used to survey Armillaria in mature forests in North America. These include single and multiple root excavations to a predetermined distance from the base of the main stem, area excavations (either manual or hydraulic), mechanical extraction of stumps and stump removal using explosives. A useful sampling scheme should balance quality of information collected against the amount of effort required to obtain that information. It should also provide some margin of uncertainty so that the reliability of the estimate can be judged by the user. Such criteria implies a model that is mathematical in nature.

The 'real world' system we will attempt to model for is a high-elevation, dry site lodgepole pine stand located in northern Utah. This stand was found to be heavily infected with Armillaria ostoyae (Romagn.) Herink although the infected trees exhibited few, if any, external symptoms. Our baseline data was obtained by area excavation of six plots (a total of 20 trees) within the lodgepole pine stand. We feel area excavations are the best method for collection of accurate and precise information on the action of root disease on tree roots. Conversely, this method is also very costly in terms of time and labour. The method is also highly destructive and does not allow the design of 'before' and 'after' sampling into surveys or experiments.

We will examine three sampling methods, one destructive (single root excavation) and two essentially non-destructive (random and systematic area sampling), to test how well they estimate disease intensity on a site. Results for these methods will be compared against data from our lodgepole pine stand area excavations. Single root excavation will be judged on how closely the level of disease intensity can be estimated to the area excavated

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standard. For the other two methods, we will evaluate whether a sufficient level of quality data can be obtained while realizing a corresponding savings in effort. Finally, probability mathematics will be employed to create a model which can estimate, from survey data, the level of disease in a stand.

Single root excavation

Lateral roots from the 20 trees in our area excavated plots were assessed individually to determine the point closest to the tree base where attack by Armillaria occurred. Roots were divided into two categories: those infected within one metre of the tree base and, those where no infection was found. Results indicate that although all the trees were infected, only 55% of the main lateral roots showed any signs of infection within the one metre zone. Therefore, random selection of single roots may have provided misleading information for half the trees sampled. Using the percent length of lateral roots infected as an index of severity, we found that there was a gross overestimation (55% vs 20%) of total infection. Such an overestimate is likely due to the concentrated presence of the disease at or near the base of trees.

We feel that using single root excavations to obtain quantitative measures of disease intensity fail in two ways. First, the narrow focus of the sampling can underestimate the number of trees infected (incidence). Second, extrapolation of the number of infected lateral roots discovered over whole root systems overestimates the severity of infection within individual trees. Therefore, single root excavation should be limited in use to pathogen identification or to obtain suitable material from which to culture the fungi.

Systematic and random area sampling

For both of these sampling systems the same reference baseline is used. The sampling "universe" is a 3 x 3 m grid subdivided into 225 individual cells (the population N), each 20 x 20 cm. We use this grid to overlay the root systems of between 2 to 5 Armillaria-infected trees. Then each of the individual cells is differentiated into one of two groups: those cells containing infected roots (infected) and those cells which contain no or only uninfected roots (uninfected) (Figure 1).

In keeping with our stated requirement that any sampling system be relatively quick and easy to implement in the field, we chose to test our two methods at three levels of sampling intensity (n= 3, 5 and 8). For systematic sampling, we arranged cells to be sampled into certain fixed configurations which we could then overlay onto a grid (Figure 2). These cell configurations were then sampled at each and every location that they could possibly be arranged on the grid without repetition. This gives a finite number of locations, each of which we used as a replicate. For example, the cell configuration for n= 3 can be placed in one of 165 possible locations on the 3 x 3 m grid. Similarly, there are 121 and 77 ways, respectively, that the configurations can be placed on the grid at n= 5 and 8.

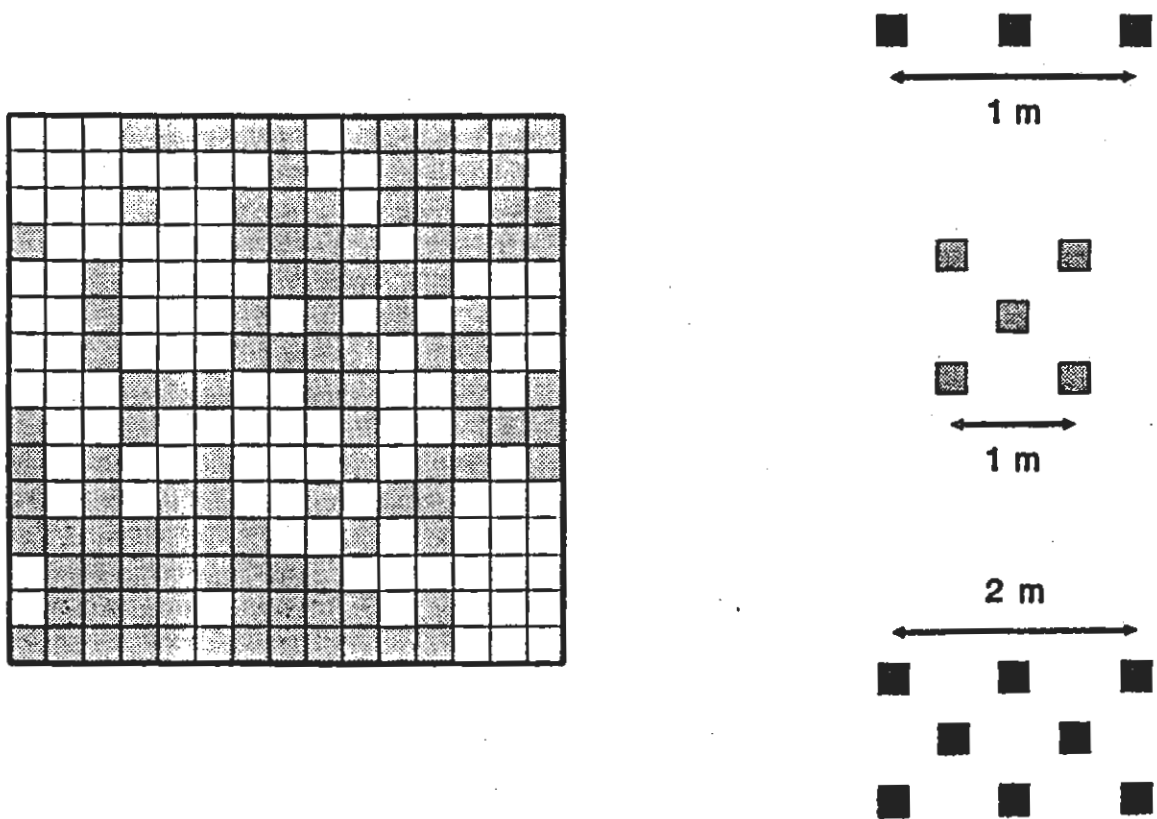


Figure 1. (above) Example of grid used to test systematic and random sampling methods. Grey shaded cells contain Armillaria-infected roots while blank cells contain no or uninfected roots; (right) Configurations used for systematic sampling at $n=3, 5$ and 8.

For each replicate, a tally of the cells sampled which contained infected roots was kept (successful contacts). A mean and variance was calculated based on the final tally after all the replicates had been polled. This mean could then be compared to the reference data from the area excavations of those same grids to determine how closely the sampling results matched.

For random sampling, the same grids, sampling sizes and number of replicates were maintained as for systematic sampling. A computer program randomly selected without replacement n cells from the grid. These were then checked to determine if they were infected or uninfected and the result tallied. After the appropriate number of replicates had been completed, a mean and variance were calculated and compared to the reference data.

The results indicate that systematic sampling more accurately reflects the reference data as indicated by percent bias (Figure 2). Random sampling tended to have a greater bias but this bias was consistently negative in all cases. In addition, random sampling results tended to display a lower variance indicating that the estimates were more precise. Thus, random sampling would be the superior approach if a correction factor could be found to take into account the negative bias. If this correction factor is unavailable, then systematic sampling provides the best reflection of disease occurrence.

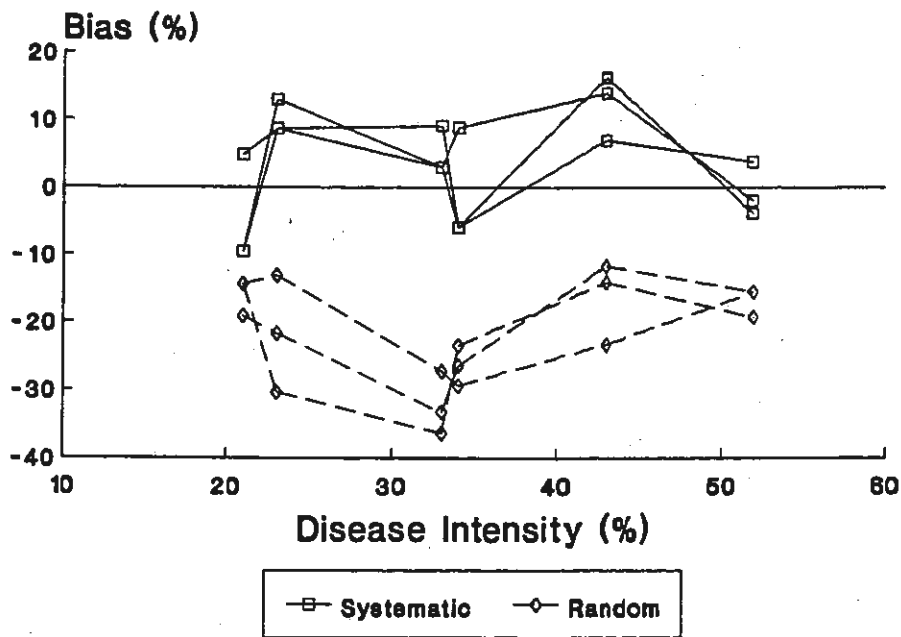


Figure 2. Plot of percent bias for systematic and random sampling methods. Lines represent results at $n = 3, 5$ and 8 for each method.

Disease intensity prediction model

After determining that systematic sampling could provide a reasonable estimate of disease intensity, we constructed a theoretical model which could predict intensity from survey data input. This model uses

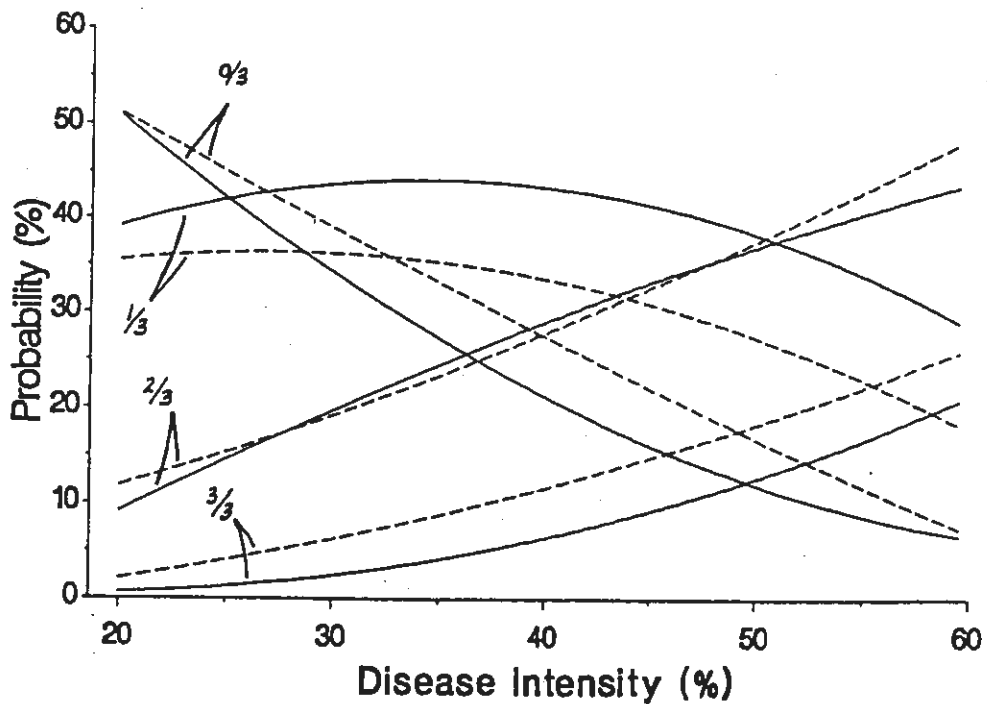
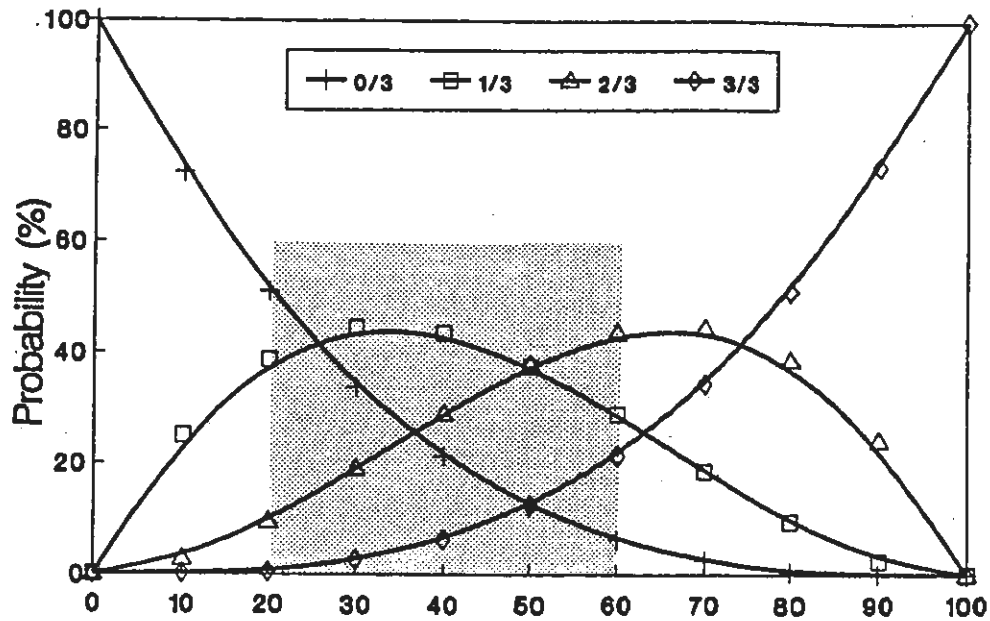


Figure 3. (above) Graph of probabilities for sample of $n=3$ as estimated by the model. Grey shaded area represents section of curves where direct comparison with systematic sampling data could be made; (below) Comparison of systematic sampling data (dashed lines) versus theoretical model estimates (solid lines).

Table 1. Example of model output for n= 5. Input values are: N= 225 and n= 5. Pairs of columns are indicated by confidence interval (ie. 80%). Left column of each pair is lower confidence limit while right column is upper confidence limit. Rows indicate successful contacts found at specific level of n (ie. 3 of 5 cells infected). Grey shaded figures are for example in main text.

r/5	50%		60%		70%		80%		90%		95%	
0	00.0	04.9	00.0	05.8	00.0	07.1	00.0	08.4	00.0	09.8	00.0	10.2
1	00.0	24.4	00.0	26.7	00.0	28.9	00.0	31.1	00.0	33.8	00.0	35.1
2	23.6	50.2	19.6	52.9	15.1	55.6	00.0	58.7	00.0	62.7	00.0	64.4
3	49.8	76.4	47.1	80.4	44.4	84.9	41.3	100.0	37.3	100.0	35.6	100.0
4	75.6	100.0	73.3	100.0	71.1	100.0	68.9	100.0	66.2	100.0	64.9	100.0
5	95.1	100.0	94.2	100.0	92.9	100.0	91.6	100.0	90.2	100.0	89.8	100.0

Although this is a preliminary test of the model's reliability and accuracy, we feel it indicates promise that the model can be used to develop sets of curves which reflect the level of disease on a variety of sites. Such estimates may assist foresters by providing better information with which to make management decisions.

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STATUS OF THE ANNOSUS/BARK BEETLE VARIANT OF THE WESTERN ROOT DISEASE MODEL

Bov Eav, John Kliejunas, Peter McNamee, and Charles G. Shaw, III

BACKGROUND

The Western Root Disease Model (Stage and others 1990) considers effects of root disease caused by either pathogenic Armillaria spp. or Phellinus weirii (Murr.) Gilbn. in coniferous forest of Western North America. This model was developed through the combined efforts of research plant pathologists, pest management specialists, and modelers throughout the western United States and Canada (Brookes 1985). At present, the model is linked to the Prognosis growth and yield system (Stage 1973, Wykoff and others 1982).

Annosus root disease (caused by Heterobasidion annosum (Fr.) Bref.), which significantly reduces stand yields and site productivity in California and parts of eastern Oregon, was not included in the original model for several reasons. These include:

- 1) Armillaria spp. and P. weirii are the major causes of root disease in the Intermountain Region of the Pacific Northwest for which the model was originally developed; and
- 2) The field disease cycle of H. annosum differs from that of P. weirii or Armillaria spp. in that airborne inocula are an important component of disease dynamics. For example, primary infections can occur through spore colonization of freshly-cut stump surfaces--a scenario not currently addressed by the Western Root Disease Model.

In 1988, the Forest Pest Management Washington Office staff of the USDA Forest Service conducted a root disease activity review in Regions 1, 5, and 6. The objectives were to evaluate the management implications of root disease in forests and recreation areas and to determine the nature and degree of management concerns, their direction, and their appropriateness. A major recommendation of the review, based on the observed impact and concerns caused by root diseases, was that the existing root disease model needed to be validated and expanded to include Annosus root disease.

Following the Review, Region 5 and the Pacific Southwest Forest and Range Experiment Station requested through the Chief of the Forest Service that the Research Project on Pest Impact Assessment at the Rocky Mountain Forest and Range Experiment Station aid with extending the existing root disease model to include effects of Annosus root disease. The request was timely in that a strong user need had been clearly identified, the User's manual for the Western Root Disease Model was nearing completion (Stage and others 1990), and the SORNEC and WESSIN variants of Prognosis were available to host pest models.

Concurrently, Shaw and others (1989) presented a paper at the Annosus Root Disease Symposium (Otrocina and Scharpf 1989) that indicated the feasibility of adapting the Western Root Disease Model to include effects of Annosus root disease. Following this presentation, representatives of FPM's Methods Application Group, Regions 5 and 6, the RM and PSW Stations, and staff from the Washington office of Forest Insect and Disease Research met and agreed that:

- 1) There was a need for an Annosus root disease model;
- 2) The new model needed to include the actions and impacts of other pests, particularly bark beetles;
- 3) Research would be needed to support FPM's efforts to develop the model;
- 4) Funding would be a joint Region 5 and Region 6 effort;
- 5) Initial efforts would concentrate on modeling Annosus root disease in the east-side pine forests common to both Regions and;
- 6) The effort would start by using the Southeastern Oregon and Northeastern California (SORNEC) variant of Prognosis (Johnson and others 1986).

Following these guiding principles, a proposal was advanced with these objectives:

- 1) Develop a model for use in silvicultural planning and management that captures the dynamics, spread, and impacts of Annosus root disease and important associated pests, such as bark beetles, in the forests of R-5 and R-6;
- 2) Associate this Annosus model with the existing marriage between the Western Root Disease Model and the Prognosis growth and yield system;
- 3) Identify for potential research activity important information needs and data gaps that limit the ability to predict damage, impact, and spread of Annosus root disease and associated pests;
- 4) Provide the necessary user support to allow Regional staff to learn and apply the Annosus root disease model.

STATUS

The modeling process is well underway. A workshop was held in April, 1990 to develop the model's structure, specify its functional relationships, and define model parameters and input data. Approximately 25 representatives of the the root disease research and management community for Regions 5 and 6 attended.

Their existing data and professional judgements, augmented with other necessary information, guided model development. The prototype model that evolved from this workshop presently is being linked to the SORNEC (Johnson and others 1986) variant of Prognosis.

COMPARISONS WITH THE WESTERN ROOT DISEASE MODEL

There are some fundamental differences between this prototype and the existing Western Root Disease Model. First, the Annosus root disease model can simultaneously simulate two types of root disease. Users can examine concurrently spread and impact of both the "S" and "P" types of H. annosum within the same stand. This modification has strong implications for root disease inventory. For example, in stands harboring both types of H. annosum, users must specify host inventories for each fungal type. In making this step, we have had to assume that any one host species can support only one type of H. annosum. We believe that this assumption has more field validity for H. annosum than for either pathogenic Armillaria spp. or P. weirii; as such, the model architecture that accommodates the two types of Annosus root disease is not directly transferable to root disease caused by Armillaria spp. and P. weirii.

Second, this model for H. annosum includes as inoculum newly created stumps infected by spores. Concomitant with this enhancement is the ability to apply borax to these stumps for disease control. This action augments the only other direct control option in the the Western Root Disease Model--stump removal. The spore infection subroutine is relatively simple because detailed spore dispersal is not explicitly simulated. Rather, the user specifies the proportion of newly created stumps that will become infected by spores without a borax application. Progression of the fungus in stumps colonized after spore infection is simulated as being slower than that in live root systems. In addition, even after stumps become infected by spores, they develop into new root disease centers with reduce probabilities of disease transmission via root-to-root infection in the overlapping root systems of live trees.

Third, this model represents interactions between root disease and bark beetles in considerably more detail than any of the options currently available in the Western Root Disease Model. A new bark beetle type has been added where infestations are linked to the level of root disease present in the stand and the number of dead, standing trees. The risk of tree mortality from this bark beetle type varies with a tree's infection status. Infected trees inside root disease centers have the highest risk, uninfected trees outside root disease centers have the lowest risk, and trees on the edges of infection centers have an intermediate risk of death. In addition, this bark beetle subroutine will likely remain active for an entire simulation period and thus cause mortality whenever particular stand criteria are met, rather than having an infestation develop only once during a simulation.

Finally, this model maintains a list of standing dead trees which allows for their input into the bark beetle subroutines. However, this feature also provides a link to models that simulate forest resources values other than timber. For example, information on the attributes of standing dead trees may be useful to those modeling a stand's potential for providing suitable wildlife habitat or an enjoyable recreational experience. The rationale for including this capability comes in part from needs inherent to the New Perspectives movement in the USDA Forest Service.

FUTURE ACTIVITIES

A model presentation workshop, planned for January, 1991, will concentrate on reviewing model structure and behavior, and identifying important uncertainties and data gaps relating particularly to the spread and impact of Annosus root disease. Annosus root disease in two stands, one moderately infected with the "P" type of H. annosum and the other heavily infected with the "S" type, will be simulated under a variety of management scenarios designed to portray two major silvicultural regimes--timber production and maintaining the appearance of old growth diversity. Additional scenarios will consider borax treatment of stumps after stand entries to reduce the probability of establishing new infection centers through spore infections. Results of these treatment scenarios will be particularly interesting because when Shaw and others (1989) used the Western Root disease Model to predict impacts of Annosus root disease the benefits that accrued from this common practice were marginal in stands already infected with Annosus root disease.

Work to date on this model suggests that three areas are important to model dynamics or the utility of projections, have limited available information, and are thus in need of additional research. These are: interactions between

Annosus root disease and bark beetles; the spread and impact dynamics of stumps that become infected by spores; and the potential role and impact of Annosus root disease in management scenarios designed to meet the guiding principals of New Forestry.

A final activity of building the model consists of transferring it to the USDA Forest Service Computers. Following this action, a User's manual, complete with descriptions of model actions and Keywords designed to implement them, needs to be released. As this task nears completion, FPM's Methods Application Group plans to host training sessions to familiarize users with model operation, behavior, and capabilities. This training will hopefully serve as a precursor to utilization of the model in silvicultural planning and management. As with the Western Root Disease Model, we expect that detailed analyses will be required to more fully understand model behavior under a various stand conditions, management regimes, and assumptions about H. annosum and its interactions with other forest pests, particularly bark beetles.

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MANAGEMENT OF PORT-ORFORD-CEDAR (CHAMAECYPARIS LAWSONIA)
IN THE FACE OF IT'S RELATED ROOT DISEASE, PHYTOPHTHORA LATERALIS

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USDA Forest Service
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Port-Orford-Cedar is one of the most valuable tree species in southwestern Oregon and northern California forests, but its biologic, economic, and social viability is being threatened by Phytophthora lateralis which infects the roots resulting in death of the tree. The disease is spread by water-borne spores and by resting spores in muddy soil. It is believed that Phytophthora lateralis was introduced into the Seattle, Washington area in the early 1920's and gradually moved south through the sale and planting of Port-Orford-Cedar seedlings for landscaping purposes. It gradually spread to forest sites on wheels and undercarriages of vehicles and on the hooves of grazing cattle.

This presentation will describe current management strategies, research, investigation of genetic resistance and field trials that show promise for controlling the disease. A photographic display will also be presented that will demonstrate how the disease is spreading. The process described is likely to become the primary means of monitoring effectiveness of control strategies.

RUST COMMITTEE REPORT

The committee meeting was attended by 19 persons. Each person took a turn to state his keenness on rust or some interesting observations. In conjunction with the Vernon WIFDWC there is likely to be a Nelson Forest Region "club" meeting on blister rust aimed at the forester and all are welcome to attend. Also there is likely to be a meeting restricted to white pine blister rust workers in conjunction with the Vernon WIFDWC meeting.

R.S. Hunt, Chairman

WIFDWC MISTLETOE COMMITTEE REPORT FOR 1989-1990.

F. G. Hawksworth and John Muir, Compilers

I. TAXONOMY, HOSTS, AND DISTRIBUTION.

- a. Dwarf mistletoe was found to be common on Brewer spruce in an area on the Klamath N. F. near Baldy Mountain, west of Happy Camp, California. The species has been tentatively identified as Arceuthobium abietinum. This mistletoe has been previously found on Brewer spruce in the Siskiyou N. F. in Oregon and in the Rogue River N. F. in northern California. (G. DeNitto, USFS FPM R-5, and F. G. Hawksworth, USFS RM Station).
- b. Several new locations for limber pine dwarf mistletoe, A. cyanocarpum, were discovered in Nevada, and the mistletoe is also reported for the first time in the Warner Mountains in northeastern California (on whitebark pine). (Great Basin Naturalist 50: 90-91, 1990) (R. L. Mathiasen, USFS FPM R-4, and F. G. Hawksworth, USFS RM Station).
- c. The fir dwarf mistletoe, A. abietinum was found on Abies durangensis on Cerro Mohinora in extreme southern Chihuahua. This represents a range extension of more than 200 miles from the previously known southern limits of the mistletoe in Central Chihuahua. (J. A. Olivo, Sanidad Forestal, Chihuahua).
- d. A manuscript is in preparation describing the segregates of the hemlock dwarf mistletoe, A. tsugense. It has been decided that, on the basis of isozymal evidence, morphology, phenology, and host relationships, that this complex consists of two subspecies, one of which has two races. The populations on mountain hemlock are designated as a new subspecies, (mertensianae) which is common from central California to central Oregon. It is also in northern Washington (See I-d below) and possibly in southern BC near Vancouver. The common form of the mistletoe thus becomes subsp. tsugense, and it has two host races, one primarily on western hemlock from SE Alaska to NW California, and one on shore pine in BC and Orcas Island, Washington. (F. G. Hawksworth, USFS RM Station, and D. Nickrent, South. Illinois Univ.).
- e. The mountain hemlock subspecies hemlock dwarf mistletoe (A. tsugense subsp. mertensianae) was recently discovered near the Mt. Baker Ski Area in Whatcom County, Washington. The population occurred at elevations above 3700 feet. Although several western hemlocks were observed among heavily infected mountain hemlocks, none of the western hemlocks were infected. However, a population of the western hemlock race of mistletoe was observed at lower elevations. Both subspecies were observed parasitizing Pacific silver fir in this area. (R. L. Mathiasen, USFS FPM R-4)
- f. Evolution continues its rapid pace in the dwarf mistletoes and 3 new West Coast species have been found are being described. A. siskiyouense occurs only in the Siskiyou and Klamath Mountains of SW Oregon and NW California and is essentially restricted to knobcone pine. A. monticulum is found in the same area but attacks western white pine and rarely sugar pine. It does not overlap the range of the typical sugar pine dwarf mistletoe, A. californicum. The third new species, A. littorum ("coastal"), attacks Monterey and bishop pines along the California Coast from Cambria to Fort Bragg. (F. G. Hawksworth, USFS RM Station; D. Wiens, Univ. of Utah; and D. Nickrent, South. Illinois Univ.).

II. PHYSIOLOGY AND ANATOMY.

- a. Histological studies are underway to determine the mechanism of resistance of Jeffrey pines to dwarf mistletoe. (R. F. Scharpf, USFS PSW Station)
- b. Alkaloids are rare in the Pinaceae but they have been recently found in for the first time in Picea. Analyses of dwarf mistletoe (A. microcarpum) on blue spruce from Arizona show that alkaloids are also present in the parasite. (F. Stermitz, Colorado State Univ.)
- c. A manuscript is nearly complete on the pre-dispersal reproductive success in Arceuthobium. (D. Wiens, Univ. of Utah, and C. Calvin, Portland State Univ.)

III. LIFE CYCLE STUDIES.

- a. Studies of pollen dispersal of A. americanum in Colorado show that most grains were deposited within 8 m. of the source plant but a few grains were found up to 500 m. away. (Southwestern Naturalist 34: 291-293, 1989)(J. Coppola, ex USFS RM Station).
- b. The first study of spiders associated with dwarf mistletoes was made. Spiders associated with A. americanum, A. cyanocarpum, and A. vaginatum were studied in northern Colorado. Twenty two species, representing 18 genera in 10 families were found. Spider-species composition varied among the dwarf mistletoe species. All the spiders found were associated with conifers and none were restricted to dwarf mistletoe. The spider-dwarf mistletoe relationships are unknown but could involve predation on insects that feed on or pollinate the mistletoes, vectors of mistletoe pollen (pollen was found on spiders), or their webs could be deterrents to pollen dispersal. (Southwestern Naturalist 34: 349-355, 1989) (D. T. Jennings, F. B. Penfield, R. E. Stevens, and F. G. Hawksworth, USFS NE and RM Stations).
- c. Studies on the possible animal vectors of lodgepole pine dwarf mistletoe (A. americanum) were conducted from 1982 through 1988 on the Fraser Experimental Forest, Colorado. Mistletoe seeds were found on 10 species of birds, but the gray jay was by far the most frequent carrier. Seeds were also found on 4 mammals, but least chipmunk and red squirrel are most likely involved in seed dispersal. (Colorado Field Ornithologists Journal 23: 3-12, 1989) (T. H. Nicholls and L. M. Egeland, USFS NC Station, and F. G. Hawksworth, USFS RM Station)

IV. HOST-PARASITE RELATIONSHIPS.

- a. A study of A. laricis in a thinned, 35-year old western larch stand in the Coram Experimental Forest, Flathead National Forest in northern Montana, showed that during the period 1978-1988 height growth of thinned larch trees averaged 37 cm per year. This was more than 4 times the rate of upward advance of the dwarf mistletoe, which was only 9 cm. per year. Infection is too low (dwarf mistletoe ratings of only 1 or 2) to have measurable effects on height or diameter growth to date. Spread from inoculated trees to previously uninfected trees occurred at all three spacing levels tested: 2.4 X 2.4, 4.3 X 4.3, and 6.0 X 6.0 m. These results are to be published as a RM Station Research Note. (E. F. Wicker and F. G. Hawksworth, USFS RM Station)
- b. From a sample of 445 Douglas-fir trees infected with dwarf mistletoe (A. douglasii) in the Southwest, three models for predicting mistletoe intensification were developed. Two models relate the mean rate of intensification since the tree became infected to initial and current tree conditions; the third one describes the proportion of trees that increased

by 0, 1, 2, or more classes of dwarf mistletoe infection (DMR) in the past 10 years. The models suggest that the rate of intensification is most rapid (2 DMR classes per decade) for severely infected trees of small diameter and slowest (0.5 DMR classes per decade) for lightly infected trees of large diameter. Intensification within a tree increases with the abundance of mistletoe in nearby, larger trees and with stand basal area. No other significant relations were found between rates of intensification and site or stand factors such as habitat type, site productivity, or stand composition. A comparison of mistletoe ratings for standing trees and ratings for carefully examined felled trees indicates that trees can be correctly rated by standard procedures about 75% of the time. (Forest Science, in press) (B. W. Geils, USFS RM Station, and R. L. Mathiasen, USFS FPM R-4).

- c. Studies were made to quantify infection in young Douglas-firs by A. douglasii in 77 stands in Arizona and New Mexico. In young stands growing under infected overstories, less than 5% of the young trees under 26 years old were infected, and 6 % of those under 4.5 feet tall. Both percentage of trees infected and dwarf mistletoe ratings of young Douglas-firs increased as tree age, tree height, and stand dwarf mistletoe rating of the overstory increased. (Great Basin Naturalist 50: 67-71, 1990) (R. L. Mathiasen, USFS FPM R-4, and C. B. Edminster and F. G. Hawksworth, USFS RM Station).
- d. Studies are being conducted on the phenology of bud break and branchlet growth of dwarf mistletoe (A. douglasii) infected vs. uninfected Douglas-fir branches and trees so the western spruce budworm model can be adapted to mistletoe infected trees. Preliminary results from the Lincoln National Forest in southern New Mexico show that branchlet elongation of infected branches was about twice that of uninfected twigs on the same trees. Phenology of bud break was earlier on infected twigs vs. uninfected twigs in some areas but later in others. (Plant Physiology 93(1): 54, 1990)(J-W. Briede and J. G. Mexal, New Mexico State Univ.; A. M. Lynch and F. G. Hawksworth, USFS RM Station).

V. EFFECTS ON HOSTS.

- a. Plans are underway to develop a comprehensive, integrated dwarf mistletoe/stand development model that will respond to all types of silvicultural management and represent a variety of stand conditions found in the western United States. The model will interface with the Prognosis or GENGYM growth and yield models that are in use or under development in the western Forest Service Regions. The project will be under the overall direction of Bov Eav of the Forest Pest Management Methods Application Group in Fort Collins, but it will be an intensive cooperative effort involving all the 4 western Forest Experiment stations, the FPM units of all 7 western regions, the Washington Office Timber Management Group in Fort Collins, and some university and private cooperators.
- b. A field manual for establishing permanent plots in dwarf mistletoe-infested stands has been prepared as part of the Forest Pest Management Westwide Permanent Plot Project. The field procedures were field tested in 1990. Test plots were established on the Dixie N. F., Utah (1 plot); Kaibab N. F., Arizona (2 plots); Lolo N. F., Montana (1 plot); Payette N. F., Idaho (2 plots); Targhee N. F., Idaho (1 plot); and Tongass N. F., Alaska (1 plot). Results of the field tests will be evaluated during early 1991 and an improved version of the field manual will be ready by March. (D. Conklin, P. Hennon, J. Hoffman, R. L. Mathiasen, J. Taylor, and B. Tkacz - USFS FPM, Western Regions)

- c. The effects of dwarf mistletoe (*A. douglasii*) on growth and mortality of Douglas-fir was studied on 387 plots in mixed conifer stands in three National Forests in New Mexico and two in Arizona. Growth analyses of 8,570 trees showed that low infection ratings (dwarf mistletoe class 1 or 2) had no effect on tree growth, but that losses increased markedly in trees of more severe infection classes. Average 10-year volume growth losses for trees over 10 inches in diameter were: class 3 - 10%, class 4 - 25%, class 5 - 45%, and class 6 - 65%. Mortality of Douglas-fir severely infested with dwarf mistletoe was 3 to 4 times that in healthy stands. (Great Basin Naturalist 50: 173-179, 1990) (R. L. Mathiasen, USFS FPM R-4; and F. G. Hawksworth and C. B. Edminster, USFS RM Station).
- d. Tagged ponderosa pines were examined at Grand Canyon National Park, Arizona to determine 32-year survival rates in trees with various intensities of dwarf mistletoe (*A. vaginatum*). Survival was influenced mainly by dwarf mistletoe severity, but also by tree diameter. More than 90 % of the uninfected and lightly infected (Dwarf Mistletoe Rating Class 1) trees survived the 32-year study period. However, only 5 % of the heavily infected (DMR Class 6) trees over 9 in. dbh, but none of those in the 4-9 in. class, survived the period. The mean longevity or half life (period during which half the trees are expected to die) for Class 6 trees was 10 years for trees over 9 in. and 7 years for smaller ones; comparable data for Class 4-5 trees were 25 and 17 years, respectively. (Western Journal of Applied Forestry 5: 47-48, 1990) (F. G. Hawksworth and B. W. Geils, USFS RM Station.)
- e. 33-year longevity of ponderosa pine mistletoe was analysed for some 3,500 trees (about half originally infected by *A. vaginatum*) on 25 plots (50 acres) in Arizona and New Mexico. The average initial diameter of the trees was 9 inches. Survivorship curves were constructed for the number of trees remaining alive over time. Initial diameter was evaluated as a covariate, and curves for various DMR classes were compared. In this preliminary analysis, the interaction of diameter and DMR, diameter growth, and mistletoe intensification were not modeled, although they may have an important effect on tree survival beyond 10 years. The 7 initial DMR classes (0 to 6) were pooled to generate 4 significantly different survivorship curves (0, 1-3, 4-5, and 6). Initial diameter was a significant covariate for all the curves except the curve for trees initially in DMR Class 6. Mortality rates decreased with initial diameter and increased by DMR class. The additional effect initial DMR on a mortality rate could be computed as the increased loss of infected trees compared to uninfected trees. Regardless of initial diameter, 40% fewer of DMR class 6 trees survive 10 years and 60% fewer class 6 trees survive 30 years than the initially uninfected trees. (B. W. Geils and F. G. Hawksworth, USFS RM Station)
- f. A Ph.D dissertation "Southwestern dwarf mistletoe damage to multi-aged ponderosa pine stands of the Colorado Front Range" has been completed. Two manuscripts for Forest Science from it are in review: "Incidence-severity relationships for dwarf mistletoe in ponderosa pine stands of different structural types" and "The effect of dwarf mistletoe on the growth and mortality in multi-aged ponderosa pine stands". (H. M. Maffei, Deschutes N. F.; W. R. Jacobi, Colorado State Univ.; and F. G. Hawksworth, USFS RM Station).
- g. A summary publication lists 40 permanent plot installations in the West that have been established to monitor the effects of dwarf mistletoes on growth and mortality or to quantify mistletoe spread and intensification. The distribution of the plots is: Interior ponderosa pine (11), Coastal ponderosa pine and Jeffrey pine (10), lodgepole pine (5), Douglas-fir (6),

true firs (4), western larch (2), western hemlock (1), and spruce (1). (USFS Research Note RM-498, 6 p, 1990) (F. G. Hawksworth and M. A. Marsden, USFS RM Station).

- h. The dwarf mistletoe plots in young lodgepole pine on the Gallatin N. F., Montana, were remeasured in the summer of 1989 with the help of a crew from the Rocky Mountain Station. These plots were established in 1971 in even-aged lodgepole with 3 pruning treatments and 4 thinning levels. The level of mistletoe infection in these plots is still very low. Spread and intensification have been minimal, and no significant growth effects have occurred. (J. Taylor, USFS FPM R-1).
- i. In 1990, Region 1 permanent plot systems were examined to determine if existing plots could be used in the west-wide permanent plot project/pest modeling effort. Existing dwarf mistletoe plots have been properly catalogued, and their existence is recognized by those involved in the modeling efforts. Timber-based permanent plot systems were also examined using a computer search of existing data bases. This investigation found that most of these plots were purposely established in areas of little or no pest activity and, thusly, will provide very little information on pest impacts. One permanent plot was installed for the purpose of testing the installation methods described in the permanent plot work plan (Mathiasen 1990), and for estimating the time and costs required for this effort. The plot was established in a 40 year old lodgepole pine stand on the Ninemile District, Lolo N. F., Montana. This is a 0.25 acre square plot with a 33 foot buffer. (J. Taylor, USFS FPM R-1, and R. Mathiasen, USFS FPM R-4).
- j. We hope to initiate 3 permanent plot studies in the summer of 1991 in the following Montana areas: Beaverhead N. F. (lodgepole pine dwarf mistletoe), Lolo or Bitterroot N. F. (Douglas-fir dwarf mistletoe) and Flathead Indian Reservation (western larch dwarf mistletoe). Through discussions with forest silviculturists and other "front-line" managers, we have decided to concentrate our effort on stands that have regenerated under an infected overstory for different durations from 20-40 years with and without sanitation and stocking control. These permanent plots will provide valuable information on intensification and spread (changes in DMR's and changes in % infected), long-term growth effects, and mortality, and also provide data on treatment effects. (J. Taylor, USFS FPM R-1).
- k. Surveys have been completed to determine the response of 10 stands (6,345 acres) of ponderosa pine 14 years after thinning and control of Southwestern dwarf mistletoe. Resurvey of an additional three stands (3,821 acres) on the Navajo Indian Reservation will be completed this summer. These stands, located throughout the Southwest Region were originally inventoried to provide inputs for the SWYLD program to generate empirical yield tables for ponderosa pine stands infested with dwarf mistletoe. An examination of these yield tables was used to determine desired post-thinning density and mistletoe level. Results of the surveys conducted by the Southwest Region will be summarized by the Rocky Mountain Station to examine the long-term effectiveness of operational scale control projects, and the correspondence of projected and actual growth and mistletoe intensification at a stand level. (B. Geils, USFS RM Station; B. Tkacz, D. Bennett, and M. Fairweather, USFS FPM R-3)
- l. Studies to evaluate the effects of dwarf mistletoe on growth of thinned Douglas-fir were begun on the Okanogan N. F., Washington, and the Malheur N. F., Oregon, in 1973-1974. About 370 trees with various intensities of infection from uninfected to Class 6 were tagged in 15 plots. The trees averaged about 8 inches dbh and 45 feet tall. The 10-year results of the study were published in the Can. J. For. Res. 16:30-35, 1986. Data for an

additional 5 years were obtained on the plots in 1988 and 1989, and the results are being analyzed for publication. (R. O. Tinnin, Portland State Univ., and D. Knutson, Minneapolis).

- m. In 1987 a study similar to that above was established in younger stands with an average diameter of 3.5 inches. A total of 210 trees have been tagged. The objective of the study is to measure diameter growth, height growth, broom development, tree mortality in relation to thinning in young Douglas-fir stands. (R. O. Tinnin, Portland State Univ.)
- n. I am studying the effects of A. americanum on the volume growth and form class of lodgepole pine in Oregon. This work is based on stem discs taken at 12 ft. intervals along the boles in trees with low, moderate, and high dwarf mistletoe ratings. The study began in 1989 and will continue through 1991. (R. O. Tinnin, Portland State Univ.).

VI. ECOLOGY.

- a. As part of the RM Station's new research initiative on old growth, an ecological study of old growth lodgepole pine was initiated on the Fraser Experimental Forest, Colorado. Data are being obtained on about 6,000 tagged trees on three 5-acre plots in 300-year old stands. The plots were established in 1939 when all trees were tagged, but dwarf mistletoe information was first recorded in 1990. Infected areas on each plot are being mapped and 50-year mortality recorded. We are also studying stand-breakup and succession in infected vs. uninfected parts of the plots. Analyses have not yet been made but the general impression from the plots is that the effects of dwarf mistletoe on growth rates and mortality are less than for younger stands. Also rates of local and long-distance spread seem to be lower in the old growth stands. For example, we found no isolated infection centers in the old growth stands compared to 0.6 per acre in nearby 90-year old stands. Another major difference is that, because of the large branches and tendency to "broominess" even in uninfected trees, it is much more difficult to rate dwarf mistletoe in old lodgepole pines. (F. G. Hawksworth and W. Moir, USFS RM Station).
- b. A study to determine the utility of the 6-class dwarf mistletoe rating system for quantifying wildlife habitat in ponderosa pine stands infested by A. vaginatum is underway in Colorado. The specific objectives of the study are to determine the types of use (i. e., nesting, roosting, foraging, loafing, etc.) of birds, squirrels, porcupine, deer, and elk in mistletoe infested vs. uninfested stands and how management activities might affect these uses. Preliminary results show that there are considerably more bird numbers and bird species in heavily infested stands than in comparable uninfested stands. Data for other animals are less clear, but porcupine activity seems to be more prevalent in infested stands. (R. Bennetts and G. White, Colorado State Univ., and F. G. Hawksworth, USFS RM Station).
- c. Recent investigations of northern spotted owl nests on the east slope of the Cascades in Washington have shown that more than half of them are in Douglas-fir witches brooms caused by A. douglasii. Northern flying squirrels, a major prey item of spotted owls, may also utilize the witches brooms as dens. Thus a study is underway to investigate the distribution, intensity, and impact of dwarf mistletoes and other pests, including root diseases, bark beetles, and defoliators, on spotted owl nest trees and nest stands. Also, the characteristics of nest trees and nest stands that may make them useful to spotted owls, and the impacts of forest pests on trees and stands which generate important attributes of spotted owl nesting

habitat are being investigated. (S. Martin and W. Theis, USFS PNW Station; J. Beatty, USFS FPM R-6; and F. G. Hawksworth, USFS RM Station).

- d. A Ph.D. dissertation "Ecological interrelationships of dwarf mistletoe and fire in lodgepole pine forests of Colorado" has been completed. Several aspects of the study have been published and a summary manuscript for Ecological Monographs is in preparation. (G. T. Zimmerman and R. Laven, Colorado State Univ.)
- e. A dwarf mistletoe-infested ponderosa pine stand at Grand Canyon National Park, Arizona, was prescribed burned in 1985. The degree of crown scorch was positively correlated with the tree dwarf mistletoe rating, and crown scorch was the dominant factor in mortality one year after the fire. Tree mortality was about 70% in Class 6 trees, 40% in Class 5 trees, and 0-20% for Class 0-4 trees. (USFS Gen. Tech. Report RM-191: 234-240, 1990) (M. G. Harrington, USFS INT Station, and F. G. Hawksworth, USFS RM Station).
- f. I am surveying a stand of lodgepole pine in southern Oregon to evaluate the effects of dwarf mistletoe on community structure. This research is a continuation of our work reported in the Can. J. For. Res. 19: 736-742, 1989. In that article we reported clear differences between heavily infected and lightly infected lodgepole pine stands. This study seeks to determine whether the observed differences are generally descriptive or are unique to the original study site. The study began in 1990 and will continue through 1992. (R. O. Timmin, Portland State Univ.)

VII. CONTROL-CHEMICAL.

- a. Evaluations of the effects of the growth regulator ethephon on lodgepole pine dwarf mistletoe continued on the Arapaho National Forest in Colorado. Visual inspections on control plots on the Fraser Experimental Forest and at the Cutthroat Bay Campground were conducted in the summer of 1989. In separate tests, ethephon, at a rate of 2500 ppm in water with a surfactant, was applied during August with a bottle sprayer in 1983, a back pack mist blower in 1984, and a hydraulic sprayer in 1985. While more shoots were observed in 1989 than in 1988, many sprayed infections failed to resprout. Some treated bole infections and older branch infections have not produced fruit-bearing shoots for as much as 7 years. It thus appears that additional spray applications may have the potential to reduce the overall number of active infections, and thereby reduce the number of subsequent new infections. Additional tests will be required to prove the above hypothesis. (D. Johnson, USFS FPM R-2)
- b. Evaluation of field tests of the plant growth regulator, ethephon, has shown that significant abscission of dwarf mistletoe shoots occurs within a few weeks after application. Tests conducted in the Black Forest north of Colorado Springs, Colorado in 1988 on ponderosa pine dwarf mistletoe showed abscission rates of 73 to 98 percent with mid-June, mid-July and mid-August applications of the chemical at rates of 2200 and 2700 ppm ethephon in water with a spreader-sticker. Examination of trees two years following treatment showed some development of immature shoots on all treatments, but insignificant numbers of mature shoots with fruits on all infections including controls (non-chemically treated trees). The reduction in numbers of infections with shoots observed in the controls is attributed to a combination of natural control agents including, drought, branch mortality, and insects. Observations are planned for several more years to determine when mature shoots will develop on ethephon-treated trees (D. Johnson, USFS FPM R-2).
- c. A cooperative test of the effectiveness of the plant growth regulator

Ethephon against western dwarf mistletoe on Jeffrey and Ponderosa pine was conducted. On ponderosa pine, 15 entire trees were sprayed with 2700 ppm. ethephon. 65% of examined branch infections showed complete abscission but 59% of treated infections had resprouted after 5 weeks. On Jeffrey pine, dwarf mistletoe branch infections were sprayed individually with 2500 ppm ethephon. On Jeffrey Pine, 82% of ethephon treated mistletoe branch infections were completely defoliated after 5 weeks but new mistletoe shoots were sprouting on 92% of treated infections. More details are available in R-5 FPM Report R90-09 "Removal of Western Dwarf Mistletoe Shoots on Jeffrey and Ponderosa Pine using Ethephon (Florel) on Two California State Forests". (S. Frankel, USFS FPM R-5, and D. Adams, Calif. Dept. For.).

- d. Observations on the ethephon tests on ponderosa pine dwarf mistletoe at Los Alamos, New Mexico were made in June, 1990, 3 years after treatment. (Apparently no observations on the tests were made in 1989). We observed no significant differences between the 3 treatments (1200PPM, 2500PPM, and water) in terms of changes in shoot area, numbers of visible infections, or dwarf msistletoe rating. Our only conclusions are in terms of the limitations of Ethephon beyond the initial shoot abscission. We did not check on fruiting. (D. Conklin, USFS FPM R-3).

VIII. CONTROL-BIOLOGICAL.

- a. Isozyme analyses were used to determine multi-locus phenotypes of several hard pine stem rusts endemic to the western United States. Rusts assayed include comandra blister rust (Cronartium comandrae), and the lodgepole pine mistletoe rust (Peridermium bethelii). Electrophoresis was carried out on 287 rust isolates, of which 207 yielded interpretable banding patterns at each of 11 isozyme loci. Each species exhibited distinctive phenotypes that distinguished isolates from those of other species. Based on number of shared phenotypes, P. bethelii and C. comandrae appear closely related biochemically and perhaps evolutionarily. (D. R. Volger, F. W. Cobb, B. W. Geils, and T. L. Popenuck, Univ. of Calif. and USFS RM Station).

IX. CONTROL-GENETIC.

- a. Field tests are continuing on the resistance of Jeffrey pines to dwarf mistletoe. In the spring of 1990, five 1400 tree plots were established on the San Bernardino National Forest in Southern California, and five 1400 tree plots established on California Department of Parks and Recreation, state parks in the Lake Tahoe area of Northern California. Half the trees planted were of local seed sources and half resistant selections from Foresthill in Northern California. The seedlings were grown for one year at the Institute of Forest Genetics, Placerville and planted as bare root stock in a random design on each plot. Plot maintenance, including irrigation is being conducted by the forest and state parks. Annual evaluations will be made for tree survival and mistletoe resistance. (R. F. Scharpf, USFS PSW Station; M. Marosy, USFS FPM R-5; E. Del Rio, San Bernardino N. F.; and C. MacDonald, Calif. Dept. Parks & Recreation).
- b. A cooperative effort was undertaken in Fall 1989 and Summer 1990 to evaluate the resistance of ponderosa pines to dwarf mistletoe on experimental plots established in 1967-69 in central Oregon. Pine seedlings grafted from "susceptible" and "resistant" parent selections and susceptible seedling stock were planted among infected overstory in a replicated, random plot design for the test. In 1989-90 the plots were examined for tree survival, level of infection and tree growth. The data will be analyzed to determine the relationship between tree survival and

infection level; relationship between infection level and tree height, branch length, and differences in levels of infection and proportion of trees infected among the resistant and susceptible selections. In addition, certain parent trees selected for resistance are being maintained for seed collection and cross pollination with other selections. Guidelines are also being developed for the selection of other resistant parent trees in central Oregon. (L. Roth, Oregon State Univ.; R. F. Scharpf, USFS PSW Station; H. M. Maffei, Deschutes N. F.; and R. Steinhoff, Ochoco N. F.).

- c. The data from studies in which 13,500 inoculations were made on Jeffrey pines to test for resistance to dwarf mistletoe are being analyzed for publication. A review draft of the manuscript should be available by December, 1990. (R. F. Scharpf, B. Kinloch, and J. Jenkinson, USFS PSW Station).
- d. Inoculation tests on putatively resistant lodgepole pines on the Fraser Experimental Forest, Colorado were continued. Seedlings from presumably resistant and susceptible trees were inoculated in 1988. By 1990 some infection was taking place but it is too soon to analyze the results. The trees were re-inoculated in 1990. Observations will continue. (G. Fechner, Colorado State Univ., and F. G. Hawksworth, USFS RM Station).

X. CONTROL-SILVICULTURAL.

- a. (1989). Plans are to treat 2,087 acres of dwarf mistletoe infested stands on the Arapaho and Roosevelt; Grand Mesa, Uncompahgre and Gunnison; Medicine Bow; Pike and San Isabel; Routt; Shoshone; and White River National Forests in Colorado and Wyoming. (D. Johnson, USFS FPM R-2).
- b. (1990). Plans are to treat 2,674 acres of dwarf mistletoe infested stands on the Arapaho and Roosevelt; Grand Mesa, Uncompahgre and Gunnison; Medicine Bow; Pike and San Isabel; Routt; Shoshone; and White River National Forests in Colorado and Wyoming. (D. Johnson, USFS FPM R-2).
- c. The 40-year examination was made in April 1990 of the treated and untreated plots for the ponderosa pine dwarf mistletoe control project at Grand Canyon National Park, Arizona. The results will be summarized this winter. Also, if Gramm or Rudman will let us, we plan to make the 40-year readings this fall on the plots for the dwarf mistletoe control project on the Mescalero Apache Reservation, New Mexico. (F. G. Hawksworth, USFS RM Station).
- d. Seventy-three acres on the Angeles National Forest and an area on the Lake Tahoe Basin Management Unit were treated for dwarf mistletoe suppression in FY 1989. 705 acres on the Angeles and Mendocino National Forests were treated for dwarf mistletoe suppression in FY 1990. Five acres on the Angeles National Forest were treated for true mistletoe control in 1990. Over 6000 acres on the Angeles, Cleveland, Los Padres, Plumas, and San Bernardino National Forests will be treated for dwarf mistletoe suppression in FY 1991. (M. Marosy, USFS FPM R-5).
- e. Dwarf mistletoe suppression projects were funded and scheduled over nearly 16,500 acres on National Forest and lands managed under the agencies of the Bureau of Indian Affairs in Arizona and New Mexico, during 1989 and 1990. (B. Tkacz, M. L. Fairweather and D. Conklin, USFS FPM R-3)
- f. Five thousand and sixty-eight acres were treated for dwarf mistletoe suppression on 13 national forests in the Intermountain Region (Region 4) in FY 1990. (J. Hoffman and L. LaMadeleine, USFS FPM R-4).

XI. SURVEYS.

- a. (1989). Presuppression surveys for dwarf mistletoe are planned for 8,424 acres on the Arapaho and Roosevelt; Pike and San Isabel; Routt; and White River National Forests in Colorado. (D. Johnson, USFS FPM R-2).
- b. (1990). Presuppression surveys for dwarf mistletoe are planned for 18,184 acres on the Arapaho and Roosevelt; Medicine Bow; Pike and San Isabel; Routt; and White River National Forests in Colorado and Wyoming. (D. Johnson, USFS FPM R-2).
- c. Pre-suppression surveys were conducted on 800 acres on the San Bernardino National Forest in FY 1989. Surveys were conducted on 5926 acres on the Angeles, Cleveland, Los Padres, Plumas, and Inyo National Forests in FY 1990. An additional 5000+ acres on the Los Padres and Plumas National Forests will be surveyed in FY 1991. (M. Marosy, USFS FPM R-5).
- d. Pre-suppression surveys were completed on over 57,000 acres in Arizona and New Mexico in 1989, and are planned for over 100,000 acres in 1990. The areas surveyed include National Forests and Indian Reservation lands. Post-suppression surveys are planned on 5300 acres in 1990 on Reservations in New Mexico. (M. Fairweather and D. Conklin, USFS FPM R-3).
- e. Pre-suppression surveys were conducted on 14,110 acres in FY 1990 on the Bridger-Teton, Caribou, Dixie, Fishlake, Manti-LaSal in the Intermountain Region (Region 4). (J. Hoffman and L. LaMadeleine, USFS FPM R-4).

XII. MISCELLANEOUS.

- a. Some dwarf mistletoe mottos for the 1990's are:
 - "If its got the 'toe, its got to go". (Helen Maffei, Deschutes N. F.).
 - "Just say NO to 'toe". (Jim Hoffman, USFS FPM R-4).
- b. Is it more than coincidence that the 1990 WIFDWC in Redding was held near the corner of Hilltop Avenue and Mistletoe Lane?

1989 - 1990

Investigator: R. L. James, R. K. Dumroese and D. L. Wenny
 Location/Organization: USDA Forest Service, Coeur d'Alene ID + University of Idaho
 Research Nursery
 Disease Name: Fusarium/Cylindrocarpus Root Disease
 Hosts: Douglas-fir seedlings
 Causal Organism(s): Fusarium spp.; Cylindrocarpus spp.
 Type of Control (chemical, silvicultural, biological, etc.):
 Biological
 Development Stage of Control Project:
 Experimental
 Short Narrative of Project:

A lignite prill of the biocontrol agent Gliocladium virens was tested to control Fusarium/Cylindrocarpus root disease of container-grown Douglas-fir seedlings. The prill was either incorporated into peat-vermiculite growing media prior to sowing or was added as a top dressing at the time of sowing. Disease was monitored (without artificial inoculation) throughout the growth cycle and treatment effects on seedling infection, size, and biomass production was evaluated. Data are currently being analyzed.

Please return completed form to John Schwandt during the meeting or to Bob James (USDA Forest Service, 1201 Ironwood Drive, Coeur d'Alene, ID. 83814).

WIFDWC DISEASE CONTROL COMMITTEE INVESTIGATIONS

1989 - 1990

Investigator: R. L. James, R. K. Dumroese and D. L. Wenny
 Location/Organization: USDA Forest Service, Coeur d'Alene, ID - University of
 Idaho
 Disease Name: Jack Pine Nurseries
 Conifer seedling Root Disease
 Hosts: Douglas-fir seedlings
 Causal Organism(s): Fusarium spp., Cylindrocarpum spp., Pythium spp., etc.
 Type of Control (chemical, silvicultural, biological, etc.):
 Chemical
 Development Stage of Control Project:
 Experimental
 Short Narrative of Project:

Sodium metabisulfite and hot water immersion treatments were evaluated as to their efficacy in controlling conifer seedling root diseases by effectively cleaning styroblock and pine cell containers prior to reuse. Containers were treated and used to grow crops of Douglas-fir seedlings. Effects of treatments on disease (two artificial inoculations), seedling root infection, seedling size and biomass were determined. Data are currently being analyzed.

Please return completed form to John Schwandt during the meeting or to Bob James (USDA Forest Service, 1201 Ironwood Drive, Coeur d'Alene, ID. 83814).

WIFDWC DISEASE CONTROL COMMITTEE INVESTIGATIONS

1989 - 1990

Investigator: Will Little & John Browning

Location/Organization: Weyerhaeuser Research

Disease Name: Black Stain Root Disease

Hosts: Douglas-fir

Causal Organism(s): *Verticicladiella wagneri*

Type of Control (chemical, silvicultural, biological, etc.):
chemical

Development Stage of Control Project: Experimental

Short Narrative of Project:

"Barrier" trees were selected at least 2-trees past the nearest "B.S." symptomatic tree. These trees were cut with a chainsaw and the cut surface was treated with borax (powder), diesel oil, or roundup herbicide, or not-treated. Treatments were conducted in May, just prior to the vector flight season (June). Stumps and at least 1-meter of lateral roots were removed the following March. Larvae of *Hylastes*, *Pissodes* and *Stemmatus* were counted for each stump treatment.

Roundup treated stumps reduced the survival and brood production *Pissodes*, but not *Hylastes* or *Stemmatus*. Diesel reduced *Hylastes*, but not the other two species. Borax had no apparent effect.

Combinations of these treatments may be necessary to reduce attraction and reproduction of the various vectors. This may imply different host queuing mechanisms by the various vectors?

Please return completed form to John Schwandt during the meeting or to Bob James (USDA Forest Service, 1201 Ironwood Drive, Coeur d'Alene, ID. 83814).

1989 - 1990

Investigator: Will Little & John Browning

Location/Organization: Weyerhaeuser Research

Disease Name: Fusarium Blight

Hosts: Douglas-Fir

Causal Organism(s): Fusarium oxysporum

Type of Control (chemical, silvicultural, biological, etc.):

Cultural

Development Stage of Control Project: Testing / Research

Short Narrative of Project:

Brassica cover crop was not as effective as Bare-fallow treatment in reducing soil-borne levels of *F. oxysporum*. We consistently show greater reduction in soil-borne *Fusarium* using bare-fallow than any other cover-crop i.e. Peas, Oats, Sudan grass, brassica. This technique will be incorporated with Compost treatments to further enhance biological control.

Please return completed form to John Schwandt during the meeting or to Bob James (USDA Forest Service, 1201 Ironwood Drive, Coeur d'Alene, ID. 83814).

WIFDWC DISEASE CONTROL COMMITTEE INVESTIGATIONS

1989 - 1990

Investigator: Will Little & John Browning

Location/Organization: Weyerhaeuser Research Centralia, WA. ~~98502~~
98531

Disease Name: Botrytis Blight

Hosts: Douglas-fir & Western Hemlock

Causal Organism(s): Botrytis

Type of Control (chemical, silvicultural, biological, etc.):

Chemical Agribrome pellet

Development Stage of Control Project: Operational Testing

Short Narrative of Project:

Injection of 6-12 ppm Agribrome into overhead watering system (misting system) prevented Botrytis blight. Tests show that 30 ppm Agribrome prevents Botrytis & Fusarium spore germination on contact. Our tests show no apparent phytotoxicity at this level.

Please return completed form to John Schwandt during the meeting or to Bob James (USDA Forest Service, 1201 Ironwood Drive, Coeur d'Alene, ID. 83814).

WIFDWC DISEASE CONTROL COMMITTEE INVESTIGATIONS

1989 - 1990

Investigator: Walt ThiesLocation/Organization: At Vernonia, OR; Cooperative PNW Station, ^{Longview} Fiber CoDisease Name: Laminated Root RotHosts: ~~All conifers~~ All commercial conifers in the northwestern USCausal Organism(s): Phellinus weiriiType of Control (chemical, silvicultural, biological, etc.):
Silvicultural

Development Stage of Control Project:

Study ~~initiated~~ installed during FY 90 and 91.

Short Narrative of Project:

Primary objectives: determine the relative susceptibility of six commercial conifers to laminated root rot.

Approach: A 25 acre study area was surveyed for presence of inoculum. Based on the survey 60 1/2 acre circular plots were established. Six species will be planted and replicated 10 times. Additionally, ^{infected} root pieces were collected from infected stumps. The root pieces were each evaluated, measured, and reburied in a grid pattern. ~~Specific~~ seedlings of the six species are to be planted directly over the root pieces. In both cases the results will be recorded as appearance of mortality due to laminated root rot.secondary objectives: ~~what~~ determine the effect of time on viability of inoculum; ~~and~~ determine the characteristic of ~~inoculum that best~~ infected root pieces that best serve as inoculum. Results ~~from this~~ will be used to improve the west-wide root disease model. A total of 500 root pieces were buried.

Please return completed form to John Schwandt during the meeting or to Bob James (USDA Forest Service, 1201 Ironwood Drive, Coeur d'Alene, ID. 83814).

PRE-WIFDWC FIELD TRIP

Saturday, September 15

0800 Leave Days Hotel Redding
Bring a lunch from Redding or we will stop in Willow Creek at a deli before going to the first stop
Highway 299 West
Visit Phellinus weirii in Douglas-fir and white fir, Lower Trinity RD
Dwarf mistletoe on western hemlock near Redwood Creek
Highway 101 North
Humboldt Nursery
Prairie Creek Redwoods State Park and Redwood National Park
Lady Bird Johnson Grove, "Big Tree", Pacific Ocean
Crescent City
Harbor
Jedediah Smith Redwood State Park
Stout Grove

Evening lodging and dinner are available at Patrick Creek Lodge near Gasquet, CA. Arrangements have been made with Patrick Creek Resort for lodging. They don't have direct phone access, so people will have to leave a message on their message machine to make reservations. Indicate that you want a room for 9/15 and are part of the WIFDWC field trip. The rate is \$39.50 + tax for 1 person. A second person costs \$10.00 extra (\$49.50 + tax). Their telephone number is 707-457-3323. Their address is Patrick Creek Resort, 13950 Highway 199, Gasquet, CA 95543. Reservations should be made by September 5. Also contact John Kliejunas, Bob Mathiasen, or Gregg DeNitto so we can confirm reservations. Those who want to camp will be able to do so across the highway at the Patrick Creek FS campground. They also should contact John, Bob, or Gregg so that enough sites are reserved.

Sunday, September 16

0830 Leave Patrick Creek Lodge
Gasquet Ranger District
Black Stain Root Disease on French Hill
POC Root Disease/Stigmina on French Hill
POC Root Disease Survival - Cedar Rustic Campground
Highway 199 North to Grants Pass/Medford/Ashland
Lunch in Cave Junction
New species of Dwarf Mistletoes along Oregon Mountain Road
Oregon Caves National Monument
Oregon wineries are located close to Highway 199 for those interested.
Evening: Ashland, Oregon
Attend plays at Oregon Shakespearean Festival in Ashland.
Information on plays and housing in Ashland will be sent to individuals that sign up for the trip at a later date.

Monday, September 17

8:00 a.m. Leave Ashland
Drive to Mt. Shasta area on Interstate 5.
Observe various dwarf mistletoes along Stewart Hot Springs road.
Drive to Redding in late morning/early afternoon.

FOR MORE DETAILS AND TO SIGN-UP, CONTACT ONE OF THE FOLLOWING INDIVIDUALS

Bob Mathiasen	(801) 625-5292	FTS 586-5292	DG S22L02A
John Kliejunas	(415) 705-2571	FTS 465-2571	DG R05A
Gregg DeNitto	(916) 246-5101	FTS 450-5101	DG R05F14A

Specific diseases and stops subject to change without notice.

EFFECTS OF PRECOMMERCIAL THINNING AND RELEASE
IN DOUGLAS-FIR PLANTATIONS ON INCIDENCE OF BLACK STAIN
ROOT DISEASE AND STAND GROWTH

SITUATION

Douglas-fir plantations on French Hill, Gasquet Ranger District, Six Rivers NF, are experiencing high levels of black stain root disease (caused by Leptographium wageneri) resulting in mortality of crop trees and lost stand productivity. It appears that incidence of this disease is related to precommercial thinning activity. Although it is known that thinning increases growth in Douglas-fir plantations (Reukema, 1975; Tappeiner et al, 1982), the effect of spacing on disease development and stand productivity is not known. Neither is it known what influence release will have on disease development and stand growth.

OBJECTIVES

- 1) To determine the influence of precommercial thinning Douglas-fir on the incidence of black stain root disease and disease development.
- 2) To evaluate the effects of precommercial thinning or release on productivity of Douglas-fir plantations in areas with black stain root disease.

METHODS

A series of thinning and release blocks will be established in a Douglas-fir plantation. French Hill E-5, on Gasquet RD (T. 17 N., R. 2 E., section 28). This area was planted in 1964 and part of the plantation thinned in 1981. Black stain root disease has been observed in the thinned part of the stand and along the skid trails in the unthinned section.

Treatment blocks will be established in the unthinned part of the plantation in August 1989, avoiding existing black stain root disease centers where possible (see figure). Blocks will be 1/2-acre. Treatments will include a control, mechanical brush control, 12 x 12 foot spacing, and 18 x 18 foot spacing. Two replicates of each treatment will be implemented. Treatments will be performed under a Forest Service contract. Following treatment, block corner trees will be banded with 3 orange stripes.

Following treatment, 1/4-acre plots will be established in the center of each block, with a buffer around each side of the plot. Plot boundary trees will be banded with one orange paint stripe. Trees within the plot will be spot painted on the north side at 5 feet with orange paint. Plot trees will be counted.

Within each plot, 3 measurement subplots will be established (see figure). These will be 0.05 acre square plots (46.7 feet on a side). Trees within each subplot will be counted and banded at breast height with white paint. DBH to the nearest 0.1 inch will be recorded for all subplot trees.

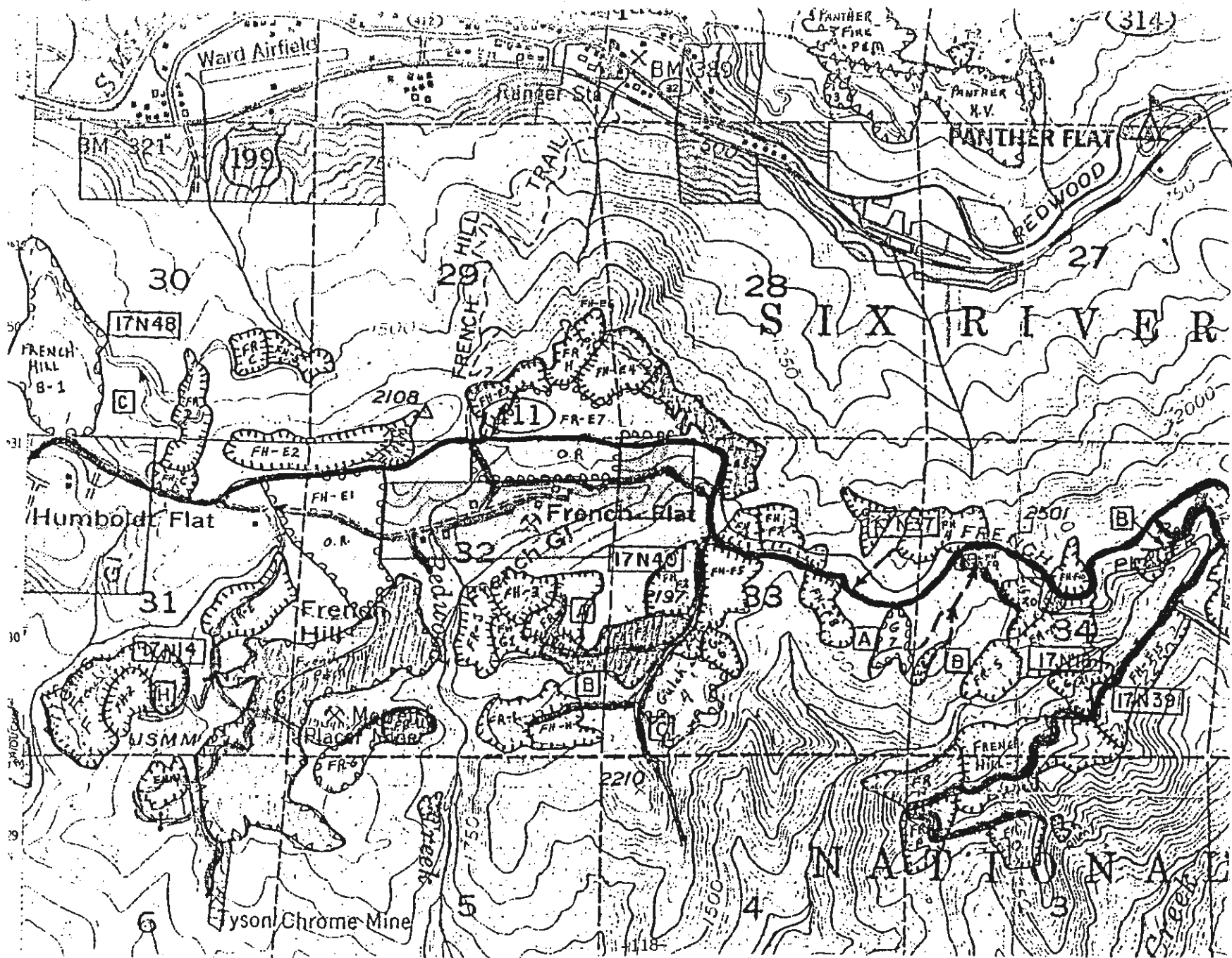
Treatment blocks will be examined annually for the occurrence of black stain root disease. Needed maintenance will be performed at this time. Disease

development will be monitored by counting trees infected and killed by black stain root disease. Additional disease monitoring plots may be established around infection centers to determine rates of disease spread in the various treatments.

After 5 years, subplot trees will be counted and dbh measured to the nearest 0.1 inch. This information will be used in currently available growth and yield models to make volume projections for the various treatments. The need for continued monitoring of these plots will be made at the time of these measurements.

Reukema, D.L. 1975. Guidelines for precommercial thinning of Douglas-fir. USDA Forest Service Gen. Tech. Rep. PNW-30. 10p.

Tappeiner, J.C., J.F. Bell, and J.D. Brodie. 1982. Response of young Douglas-fir to 16 years of intensive thinning. Forest Research Laboratory, Oregon State University, Corvallis. Research Bulletin 38. 17p.



SOIL MONITORING FOR PHYTOPHTHORA LATERALIS
AT CEDAR RUSTIC CAMPGROUND

Background

Areas infested with Port-Orford-cedar root disease are a source of inoculum for spread of the disease, either in drainage water or by movement of infested soil. Once a site is infested, the only means of eliminating the pathogen is to eliminate the host from the site for a period of years. A minimum of three to five years has been suggested. The Gasquet Ranger District, as part of a program to reduce cedar root disease impact, requested FPM assistance in monitoring Cedar Rustic Campground for present of Phytophthora lateralis after host removal.

Objective

To determine if removal of Port-Orford-cedar from Cedar Rustic Campground can eliminate Phytophthora lateralis from the soil, thus eliminating the site as a source of inoculum for transport of Port-Orford-cedar root disease to uninfested sites.

Procedure

Remove all Port-Orford-cedars (120 trees via timber sale; saplings/seedlings via K-V) from the 6 acre site -- Fall, 1986

Select six locations, each consisting of a POC currently dying from root disease and an eight foot radius circle around the tree -- July 1986

Monitor each site 3 times/year (Oct., March, July), for up to 5 years

At each location, collect soil (about 2 scoops, hand trowel) from the upper 8 inches of soil at each of three points (about 90 degrees apart) about 8 feet from the base of each tree; consolidate 3 sub-samples

Wet sieve soil in lab; bait with POC branchlet sections, using double cup technique (10 replicates/location)

Baits on selective medium

Results

Date	Location					
	1	2	3	4	5	6
Jan 87	+	+	+	+	+	+
March 87	0	0	+	0	0	+
July 87	0	+	+	0	0	0
July 88	0	0	0	0	0	0
Dec 88	0	0	0	0	0	0
April 89	0	0	+	0	0	+
Aug 89	0	0	+	0	0	+
March 90	0	0	0	0	0	0
April 90	0	0	0	0	0	0

+ = lateralis recovered; 0 = lateralis not recovered

Potted Seedlings

April, 1990:

- 1) located 33 POC stumps (6 marked for soil baiting study, plus 27 additional)
- 2) at each stump, collected soil at 3 points
- 3) potted POC seedling (1-0, Humboldt Nursery) in each of 99 pots (3X33)
- 4) at Gasquet RD for symptom development

Results (as of 9/90):









- 1) 10 of 99 seedlings have died (9A, 9C, 10A, 11A, 13A, 17C, 19C, 22B, 24A, 24B)
- 2) P. lateralis was recovered from one seedling (11A)

Cedar Rustic Campground

T177N

SALE AREA MAP
 SALE NAME: Rustic Cedar Salvage (SSTS)
 TANGIER DISTRICT: Gasquet

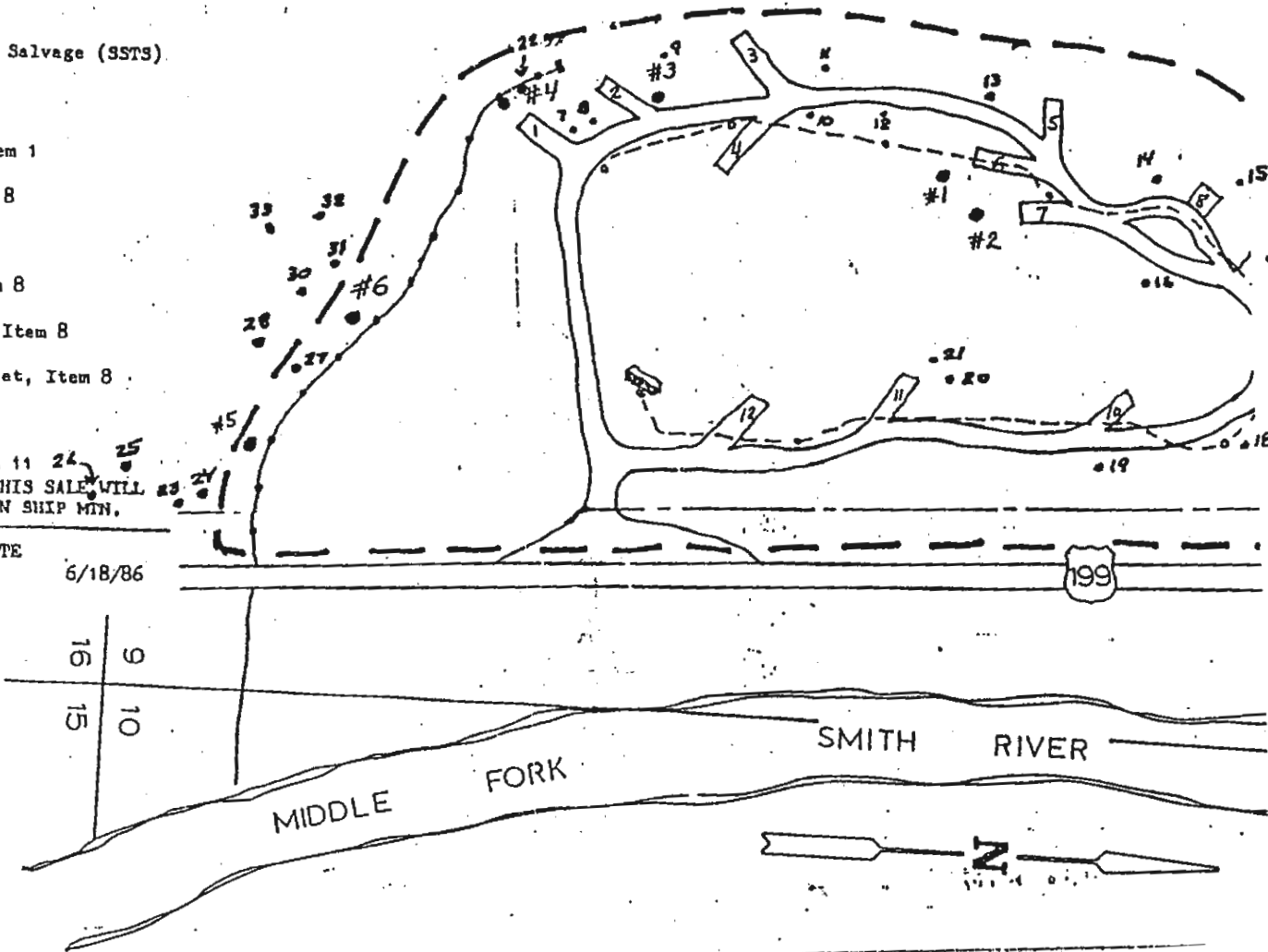
SCALE

-  Sale Area Boundry, Item 1
-  Campground Road, Item 8
-  U.S. Highway 199
-  Campground Fence, Item 8
-  Underground Pipeline, Item 8
-  Water Standpipe & Faucet, Item 8
-  Outhouse, Item 8
-  Protected Stream, Item 11

ACTIVITY LEVEL APPLICABLE TO THIS SALE WILL
 MODEL OF AN WEATHER STATION SHIP MIN.

LAND LINES ARE APPROXIMATE

6/18/86



16	9
15	10

199

MIDDLE FORK

SMITH RIVER

N

Port-Orford-cedar Root Disease

Scientific Name: Phytophthora lateralis

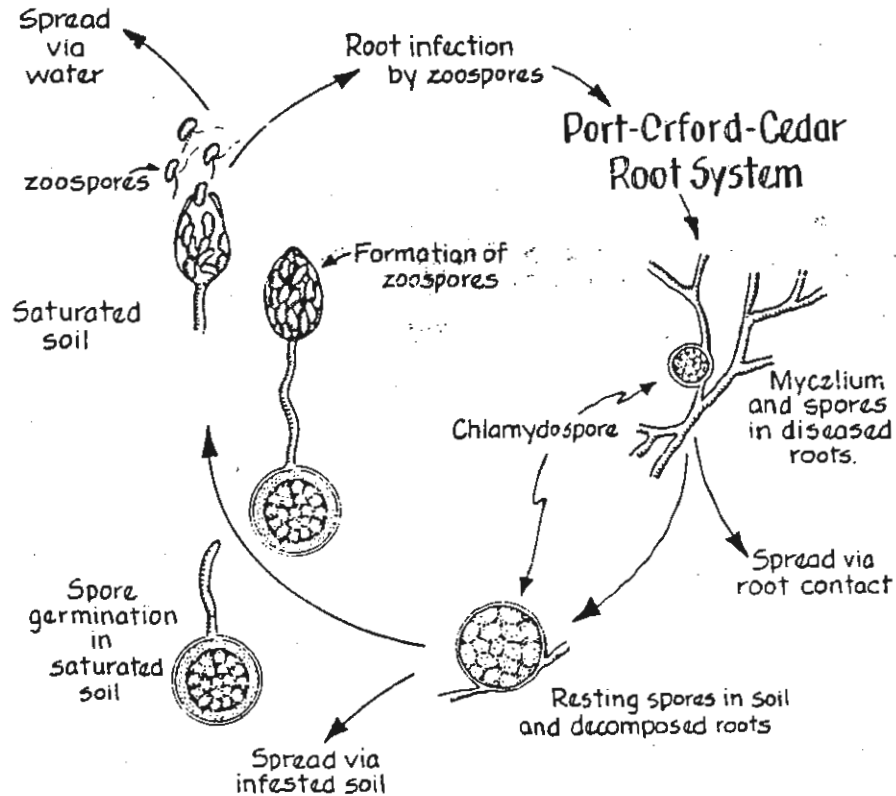
Hosts: Chamaecyparis lawsoniana

Distribution in California: Extreme northwestern CA, principally Smith River

Introduction

This disease causes a fatal root rot of Port-Orford-cedar. It is caused by a soil-borne fungus. At present, it is limited in Region 5 to parts of the Smith River drainage, mainly on the Gasquet Ranger District, Six Rivers National Forest. Transmission of the disease is mainly by people travelling from infested to uninfested areas. Special management practices may be necessary in some areas to prevent introduction of the disease or to manage healthy Port-Orford-cedar in infested areas.

Disease Cycle



Zoospores of *P. lateralis* infect fine root tips, causing rootlet decay. The fungus advances in the inner bark and cambium of the roots to the root collar and slightly up the stem. Resting spores, chlamydospores, develop in the rootlets and are released in the soil as the rootlets deteriorate. Movement of chlamydospore-infested soil by humans or animals helps to spread the disease.

The chlamydospores remain dormant until the soil is saturated, when they germinate and release zoospores. These zoospores swim and spread in the water and infect new root tips.

Symptoms and Signs

The initial symptom is simultaneous discoloration of the foliage throughout the crown. Discoloration progresses from a slight lightening in color, to bronzing, to browning and drying. Prior to tree death, cinnamon brown discoloration of the inner bark and cambium at the root collar is evident.

Damage and Importance

Port-Orford-cedar root disease is the most destructive agent of Port-Orford-cedar. When introduced into a drainage, it can rapidly kill many of the cedars along watercourses and in wet areas. Genetic resistance has not been identified in the host. Merchantable trees can be salvaged with some reduction in value. Smaller trees that are attacked, however, are lost. Once an area is infested, the ability to grow merchantable Port-Orford-cedar becomes limited.

Port-Orford-cedar is of relatively little importance economically on a national scale. Where it occurs, however, it can have considerable impact and can affect implementation of planned activities. Implementation of management activities in infested areas may require special planning and practices to reduce disease impact and spread.

Control Strategy

In California many areas exist where the disease is not present. It is of prime importance to prevent its introduction into these areas. Any vehicles and equipment that have been in infested areas should be required to be cleaned by steam or high pressure washing before entering clean areas. If this is not possible and there is reason for concern about transmission, then access should be restricted, especially when soils are wet.

In general areas where the disease is present, there may still be units where Port-Orford-cedar can be grown and the disease avoided. These units must be carefully selected and special management activities implemented. Basically, such sites are those unlikely to receive surface drainage from roads, from a diseased site, or from a site with a reasonable possibility of becoming diseased in the future. These units should be protected from nonessential human activity.

The following lists possible management activities that may be required to exclude Port-Orford-cedar root disease from identified protection units.

- Assess risks from proposed activities and determine mitigating measures before starting activity.
- Establish lateral and upper boundaries of units so that surface water does not flow onto the unit from outside. Locate lower boundaries, and those along lateral drainages, above flood stage.

- Engineer roads and landings to drain away from the unit. Do not build roads at the top of a unit.
- Work during dry weather with clean equipment.
- Separate operations in disease-free locations in both space and time from work in diseased stands.
- Strive for ideal spacing of the best trees during precommercial thinning. Eliminate Port-Orford-cedar in potholes, along streams, or adjacent to infected areas.
- Retain a mix of cedar in the stand.
- Minimize use of ground-based logging systems. Use cable systems and helicopters where feasible.
- Provide for natural regeneration of Port-Orford-cedar in protection units when possible.
- Do not plant Port-Orford-cedar in low spots, where water stands, within 50 feet of streams, or where it is subject to overland water flow.

References

Roth, L.F., R.D. Harvey, Jr., and J.T. Kliejunas. 1979. Port-Orford-cedar root disease. Report R6-FPM-PR-294-87. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. 11 p.

Trione, E.J. 1959. The pathology of Phytophthora lateralis on native Chamaecyparis lawsoniana. Phytopathology 49:306-310.

Zobel, D.B., L.F. Roth, and G.M. Hawk. 1985. Ecology, pathology, and management of Port-Orford-cedar (Chamaecyparis lawsoniana). Gen. Tech. Rep. PNW-184. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 161 p.

HISTORY OF PORT-ORFORD-CEDAR ROOT DISEASE IN THE US

1923 Disease first identified on ornamental POC in Seattle
1942 Disease found in POC nurseries in Willamette Valley
1952 Disease found in native range of POC in southwestern Oregon
1980 Disease found in northwestern California

October 1985

Letter to Regional Foresters of Regions 5 and 6 from the North Coast Environmental Center, Oregon Natural Resources Council, and the Oregon Native Plant Society. Letter stated that the Regional Foresters were "not fulfilling their legal obligation to protect Port-Orford-cedar from root disease". They requested the establishment of an interregional committee of Forest Service and private citizens with binding authority to formulate POC root disease policy. Regional Foresters cannot delegate this authority to private citizens.

February 1986

The first meeting of a consensus group was held. This group was comprised of Forest Service, BLM, Hoopa Indian Reservation, industry, university, and other interested organizations.

May 1987

The Regional Foresters established an interregional POC coordinating group
Tasks

- 1) Develop a coordinated interregional POC management program that would assure the continued viability of POC
- 2) Monitor the program
- 3) Recommend an education program
- 4) Recommend and coordinate research and administrative studies
- 5) Determine inventory needs
- 6) Coordinate information transfer
- 7) Recommend POC management policy

July 1988

The coordinating group developed a POC action plan with the following 4 areas

- 1) Inventory and Monitoring
- 2) Research and Administrative Studies
- 3) Public involvement and education
- 4) Management policy

August 18, 1988

The Chief of the Forest Service received a Notice of Appeal from NCEC stating that the Action Plan did not follow the procedures specified in NEPA. Also, spread of the disease violated the Clean Water Act, the Wild and Scenic Rivers Act, the Endangered Species Act, and other statutes.

September 9, 1988

The Regional Foresters requested dismissal of the appeal on the basis that the Action Plan was not a decision subject to appeal.

February 10, 1989

The Chief found the request for dismissal inappropriate.

March 29, 1989

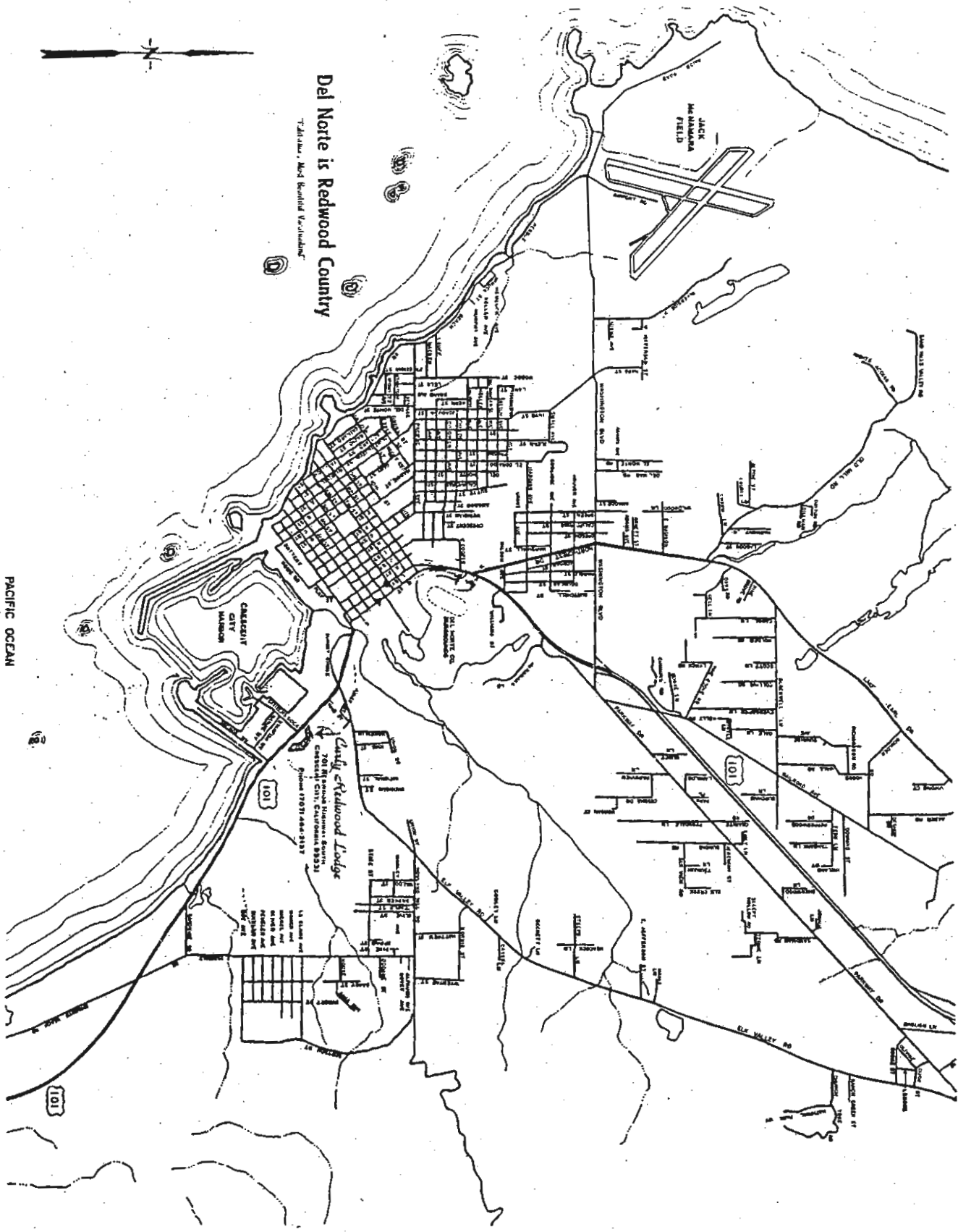
The Regional Foresters submitted Responsive statements to the appeal

April 18, 1989

NCEC submitted a response to the responsive statements.

October 20, 1989

The Chief denied the appeal based on the premise that the Action Plan does not invoke the procedural requirements of NEPA.



Del Norte is Redwood Country

"Del Norte is Most Beautiful Vacationland"



PACIFIC OCEAN

38TH WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

FIELD TRIP

MC CLOUD RANGER DISTRICT, SHASTA-TRINITY NF
SEPTEMBER 19, 1990

- 8:00 am Depart Days Hotel, Redding
- 10:00 am Arrive Lower Falls Picnic Area, McCloud RD
- Welcome - Steve Clauson
- 11:00 am Esperanza Spring, Pilgrim Creek Road
- Black Stain Root Disease
- Recent Disease Research - Fields Cobb
- Current Pine Vector Research - George Ferrell
- 12:00 noon Lunch
- 1:00 pm Pilgrim Creek Road
- Western Gall Rust - Detlev Vogler
- 1:45 pm Harris Springs Road
- Mechanical Harvesting - Bill Branham
- 2:45 pm Coonrod Flat Road
- Black Stain Root Disease and Stand Management
- History of BSRD Management, Gregg DeNitto
- Current Management Efforts, Bill Branham
- 3:15 pm Edson Creek Road
- Black stain root disease management
- Annosus root disease in pine
- 3:45 pm Depart for Redding
- 5 - 5:30 pm Arrive Days Hotel, Redding

PARTICIPANTS

Steve Clauson, USFS, District Ranger, McCloud RD
Gregg DeNitto, USFS, Plant Pathologist, FPM, Redding
Fields Cobb, Professor, University of California, Berkeley
George Ferrell, USFS, Research Entomologist, PSW, Redding
Detlev Vogler, Graduate Student, University of California, Berkeley
Bill Branham, Timber Planner and Silviculture Officer, McCloud RD
David Schultz, USFS, Entomologist, FPM, Redding

FOREST PATHOLOGY TRIVIA II - ANSWERS

1. Walt Thies, 1985 Meeting, 2 months
Harvey Toko, 1970 Meeting, 3 years
2. Dow Baxter
3. A peak in the Colorado Rockies is named for Elsworth Bethel.
4. Ken Russell began with the Washington State DNR in 1965.
5. Yasu Hiratsuka
6. Keith Shea and Earl Nelson at the 1967 WIFDWC
7. Henry Schmitz of the University of Washington
8. Lowell Farmer of the Intermountain Region
9. Ed Wood
10. Dow Baxter
11. Paul Lightle and Stuie Andrews--title was later changed to red ROT
12. Fields Cobb
13. Dick Parmeter
14. Jim "Three-fingers" Hoffman
15. Gardner Shaw/Terry Shaw; J. S. Boyce/ Jack Boyce, Jr.
16. Ellen and Don Goheen; Vivian and John Muir; John and Mary Shouting
17. Stu Whitney (Victoria) and Roy Whitney (Sault Ste. Marie); a third brother, Norm Whitney, is in forestry research in Fredericton, NB
18. Haven Metcalf, 1907-1949; Lee Hutchins, 1941-1953; Ray Hansbrough, 1953- (when the Division was transferred to the Forest Service)
19. E. P. Meinecke
20. Roger Peterson of St. John's College in Santa Fe
21. We nominate H. von Schrenk's 1903 USDA Bulletin, "The BLUING and RED rot of YELLOW pine in the BLACK Hills."

22. Caroline Rumbold began work with the USDA Mississippi Valley Laboratory in St. Louis in about 1905; Irene Mounce began with the Canadian Bureau of Botany in the mid 1920's.
23. In the late 1930's Lake Gill and Stueie Andrews found some decayed wood in a fossilized log on the Petrified Forest in Arizona, and decided that they would submit it to the Mycology lab in Washington for identification of the decay fungus. Ross Davidson looked over the specimen but said that he needed a culture for determining the fungus. Lake and Stueie promptly prepared a suitable culture of plaster of Paris and cement in a Petri dish and sent it to Ross, who was then able to determine the fungus as Prefomes (now Prephellinus) prepini. Several years later, Jim Mielke came across all this official-looking correspondence and chided Lake Gill for not reporting such an important discovery in the scientific literature.
24. T. S. "Buck" Buchanan, in southern Oregon in 1936
25. Chestnut blight in California, Oregon, and British Columbia
26. Chuck Wellner, in the mid 1940's
27. R. C. Thobium
28. Said to be that the USDA forest entomologist F. C. Craighead established this while studying the southern pine beetle in the mid 1920's.
29. Don Knutson at the University of Minnesota
30. F. G. Hawksworth
31. Hydnum (now Hericium) abietis, a decay fungus of living firs and hemlock in the Pacific Northwest, was first described in E. E. Hubert's 1931 "Outline of Forest Pathology."
32. A rare phenomenon in mistletoes wherein mistletoe species "A" parasitizes mistletoe species "B", and in which "B" parasitizes mistletoe species "C", which, in turn, parasitizes mistletoe species "A" (Ref.: R. Moran, Cactus and Succulents Journal 61: 133, 1989).
33. The other one
34. John Muir
35. Fields Cobb
36. Phytophthora?, Armillaria?, Dothistrom?, Fusarium?
37. John Lundquist, Rich Dorsett, Brian Geils, Dave Johnson and John Guyon found the rust for the first time in the state in July, 1990. Terry Shaw missed out on this great discovery because he was winning at blackjack in nearby Deadwood.

38. California has 22 (14 Arceuthobium, 7 Phoradendron, and 1 Viscum); Oregon and Arizona are tied for second with 15 each; British Columbia has 6.
39. Walter H. Snell in 1913, Ref: Mycologia 75:941-8, 1983.
40. The other "Robert L. Gilbertson" works on diseases of field crops at the Department of Plant Pathology, University of California, Davis.
41. Ah, an easy one, Skipper Ken Russell
42. John Ehrlich
43. W. H. Long
44. Arizona, Alaska, Hawaii, Nevada(?), Alberta, B.C.
45. James R. Weir, the collections were retrieved by John Stevenson
46. E. E. Hubert
47. W. H. Long, Ref: Plant World 4:49-51, 1901.
48. John Lundquist, whilst forest pathologist in South Africa
49. grand fir
50. Lew was A. J. Riker's first Ph.D. student and Geoff his last.
51. Terry Shaw
52. Rich Hunt has published on fungi, bacteria, insects, mites, nematodes, mistletoes, slugs, and abiotic agents; as well as on fir taxonomy and dog poisoning.

Treasurer's Report, 38th WIFDWC

Balance on hand at close of thirty-seventh meeting.	\$2628.58
Adjustment for 1989 (37th) proceedings cost. (Original estimate was \$1500.00; actual cost was \$1298.55)	201.45
Interest paid July 1, 1989 through June 30, 1990	153.23
Miscellaneous proceedings sales (24) from 1/1/90 to 12/31/90	226.00
Special contribution from Harold Offord	25.00
Sub-total	3234.26

Thirty-eighth WIFDWC statement from Redding meeting

Receipts:

Regular participants	62
Students	13
Spouses	11

Net Receipts	\$5153.00
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Expenses:

Master Hotel Bill	4105.96
Miscellaneous other expenses. (Includes \$250 advance)	498.04
Proceedings printing estimate for 130 copies. (Not subtracted from balance)	(1300.00)

Balance at close of thirty-eighth meeting	3783.26
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Funds held in account 936258-3, Washington State Employee's Credit Union. PO Box WSECU, Olympia, WA 98507. Phone (206) 943-7911. Official signatures for withdrawing funds are Walt Thies, Ken Russell and Fields Cobb.

Ken Russell, Treasurer, June 27, 1991.

WIFDWC - 1990
PROJECTS STATUS

(For a complete list of projects see 1988 WIFDWC Proceedings).

TERMINATED PROJECTS:

- 83-C-2 Assessment of new chemicals to control Botrytis blight in nurseries (R. James).
- 86-K-2 Development of a Tree Health Management Series (THMS) for recreational and urban and community forestry - multivolume slide video tape (M. Sharon).
- 87-C-5 Evaluation of Basamid granular to control root diseases in Northern Rocky Mountain nurseries (R. James, Myers).
- 88-C-3 Efficacy of granular Banrot to control root diseases of containerized conifer seedlings (R. James, K. Dumroese, D. Wenny, C. Gilligan).
- 88-C-6 Evaluation of the effectiveness of Dazomet (Basamid) to control root diseases at the USDA Forest Service Nursery, Coeur d'Alene, ID (R. James, J. Myers, C. Gilligan).
- 88-C-7 Conifer seed treatment: effect on germination and pathogen populations (K. Dumroese, R. James, D. Wenny).

CONTINUING PROJECTS:

- 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).
- 83-C-3 Fungi associated with pine seedling tip blight in Northern Rocky Mountain nurseries (R. James).
- 84-C-3 Studies of Fusarium-associated diseases of conifer seedlings at Northern Rocky Mountain nurseries (R. James, C. Gilligan, K. Dumroese).
- 85-F-5 Silvicultural control of dwarf mistletoe in young lodgepole pine stands (F. Hawksworth, D. Johnson).
- 86-D-17 Monitoring Armillaria root disease in precommercially thinned ponderosa pine plantations in Northern Idaho (perm-plots; continuing).
- 86-E-4 Monitoring needle diseases in ponderosa pine in Southern Idaho (J. Schwandt, J. Hoffman, B. Mathiason).

86-F-1 Evaluation of ethephon as a control of dwarf mistletoes in high use recreation forests (C. Johnson, F. Hawksworth).

87-C-3 Effects of seedling root colonization by Fusarium on Douglas-fir outplanting survival (R. James, K. Dumroese).

87-C-4 Pathogenicity of Fusarium spp. on conifer seedlings (R. James, K. Dumroese).

88-A-1 Evaluation of site factors involved with aspen sprout mortality (D. Hildebrand, W. Jacobi).

88-C-2 Epidemiology of Fusarium-associated diseases on containerized conifer seedlings (R. James, K. Dumroese, D. Wenny, C. Gilligan).

88-C-4 Efficacy of sodium metabisulphite in reducing root disease inoculum on seedling containers (R. James, K. Dumroese, D. Wenny, C. Gilligan).

88-C-5 Cylindrocarpus: pathogenicity to conifer seedlings and control tests (R. James, K. Dumroese, D. Wenny, C. Gilligan).

89-A-? Evaluation of pest conditions and potential hazard trees in selected campgrounds in Arizona and New Mexico (M. Fairweather, T. Rogers).

89-C-? Field trials on larger scale comparing MC-33, Basamid, and solar heating for effects on soil-borne Fusarium spp., weeds, and seedling growth and survival of fall-sown eastern red cedar at Bessey Nursery, Nebraska (D. Hildebrand, G. Dinkel).

NEW PROJECTS:

90-A-1 Evaluation of aspen sprout mortality in fenced-regeneration cuts in Arizona (M. Fairweather).

90-D-1 Monitoring nitrogen and potassium fertilizer effects on Douglas-fir in northern Idaho stands with Armillaria root disease. (This is our new root rot- fertilization study established last year in the Clearwater area).

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

90-H-1 Damage model for white pine blister rust (G. McDonald, B. Eav, et.al.). (This is the work we are starting on updating the damage model for blister rust and linking it to PROGNOSIS).

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

90-C-1 Evaluation of Gliocladium virens to control Fusarium root disease of container-grown conifer seedlings (R. James, K. Dumroese, D. Wenny).

90-C-2 Evaluation of treatments to reduce root disease inoculum on seedling containers (R. James, K. Dumroese, D. Wenny).

90-F-1 Intensification of Douglas-fir dwarf mistletoe, and associated tree mortality, in mixed conifer stands in the Southwest (B. Geils, T. Shaw).

90-F-2 Validation of Southwestern ponderosa pine-dwarf mistletoe relationships in growth and yield programs (B. Geils, B. Tkacz, D. Bennett).

90-H-1 Effects of commandra blister rust on lodgepole pine in the Rocky Mountain Regions (B. Geils).

90-K-1 Optimum stocking in young lodgepole pine stands with topkill (B. Geils).

90-H-2 Site-specific mapping of white pine blister rust on the Priest River Experimental Forest (G. McDonald, B. Geils, S. Scriptor).

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