# PROCEEDINGS

## JOINT MEETING

## TWENTY-SIXTH ANNUAL WESTERN FOREST INSECT WORK CONFERENCE

## TWENTY-SECOND ANNUAL WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

Monterey, California
February 23-28, 1975

<u>Not for Publication</u>

(For Information of Conference Members Only)

Prepared at

Intermountain Forest and Range Experiment Station
U.S.D.A. - Forest Service
Ogden, Utah 84401

and

Northern Forest Research Centre
Canadian Forestry Service
Edmonton, Alberta T6H 3S5

Back row (l. to r.): M. Page, B. Wickman, B. Copper, L. Browne, C. Ohmart, P. Felch, W. Larson, R. Gustafson, ____________, J. Moore.

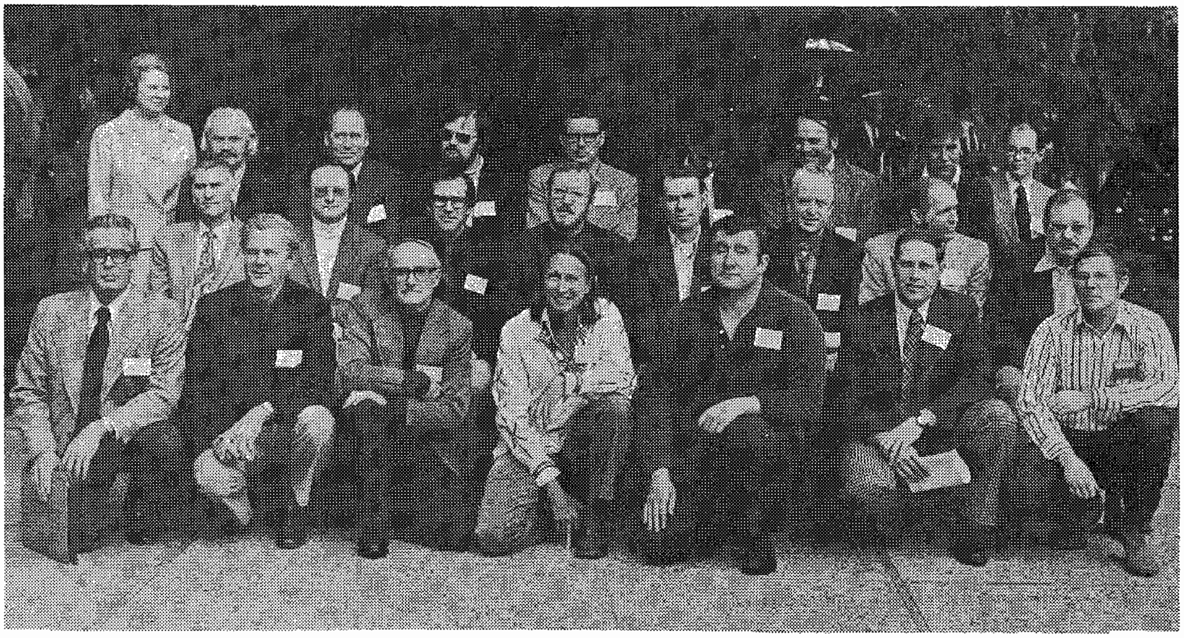
Middle row: R. Livingston, R. Washburn, B. Baker, D. Schmiege, J. Niesis, B. Fisher, G. Amman, G. Paul.

Front row: F. Stephens, R. Luck, A. Rivas, G. Trostle, F. Stovall, R. Lyon, B. Roettgering, L. Stipe.

Back row (l. to r.): K. Stoszek, E. Lessard, R. Stark, D. Leatherman, R. Johnsey, M. Meadows, K. Swain, R. Mitchell.

Middle row: R. Hunt, R. Stevens, W. Brewer, D. Parker, D. Dotta, J. Mitchell, S. Mata, P. Shea.

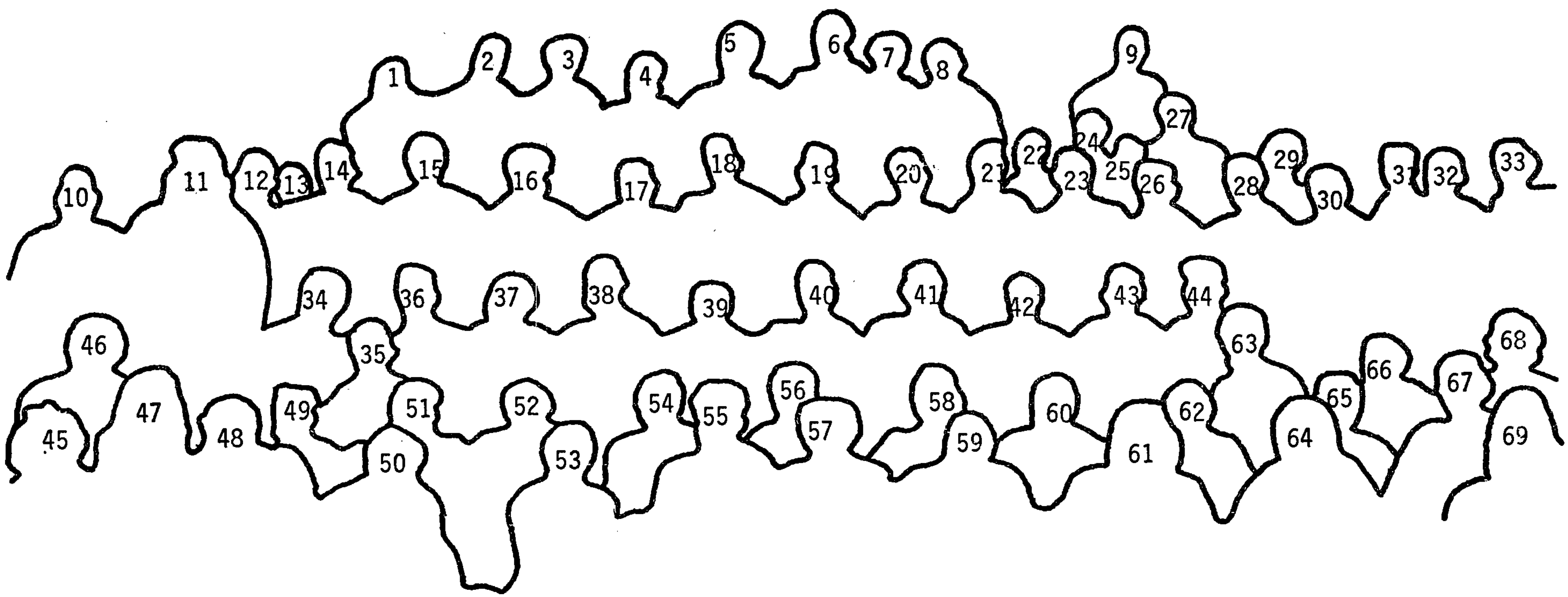
Front row: M. Ollieu, H. Yates, A. Hedlin, R. Shephard, R. Werner, R. Bega.



Back row (l. to r.): T. Finlayson, R. Campbell, W. Ives, E. Nebeker, L. Campbell, J. Harris, W. Ciesla, D. Greenbank, J. Bromenshenk.

Middle row: L. Pettinger, L. Kline, T. Payne, J. Coster, Richard Myhre, J. Wear, F. Honing, R. Dolph.

Front row: W. Waters, R. Heller, W. McCambridge, W. Bedard J. Caylor, S. Kohler, B. Averill.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1. John Wenz
2. Walt Thies
3. Clint Carlson
4. John Schenk
5. Ed Sharon
6. Paul Aho
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8. Charles Tiernan
9. Dick Krebill
10. Phil Weber
11. Neil MacGregor
12. Nick Colotelo
13. Tom Hinds
14. Peter Gaidula
15. Robert James
16. Bjarne Uhrenholdt
17. Dave Graham
18. Tom Laurant
19. Elmer Canfield
20. Jim Smith
21. Neil Martin
22. Tom Landis
23. Jim Byler
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28. Bro Kinloch
29. Johann Bruhn
30. John Kliejunas
31. Doug Pierto
32. Don Knutson
33. George Hudler
34. Rich Hunt
35. Stu Whitney
36. Geral McDonald
37. John Laut
38. Don Leaphart
39. Mike Atkins
40. Dick Smith
41. Max Meadows
42. Reed Miller
43. Ralph Hall
44. Rich Dresser
45. Wayne Williams
46. Dave Wood
47. Chris Conrad
48. Ed Wood
49. Al Tegethoff
50. Frank Hawksworth
51. Dick Parmeter
52. Ed Wicker
53. Janet Andersen
54. Bob Scharpf
55. Duncan Morrison
56. Oscar Dooling
57. Jim Hadfield
58. Dave Johnson
59. Mike Srago
60. Ken Russell
61. Mike Schomaker
62. Bob Edmonds
63. Dave Adams
64. Bob Mathiasen
65. Jim Walters
66. Walter Mark
67. Don Graham
68. Nagayoshi Oshima
69. Linnea Gillman

PROCEEDINGS

JOINT MEETING

TWENTY-SIXTH ANNUAL WESTERN FOREST INSECT WORK CONFERENCE

TWENTY-SECOND ANNUAL WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

Monterey, California

February 23-28, 1975

EXECUTIVE COMMITTEE (Twenty-Sixth WFIWC Conference)

| | |
|---|---|
| G. C. Trostle, Boise | Chairman |
| R. E. Stevens, Fort Collins | Immediate Past Chairman |
| G. D. Amman, Ogden | Secretary-Treasurer |
| W. G. H. Ives, Edmonton | Councilor (1972) |
| R. G. Cox, Lewiston | Councilor (1973) |
| L. Safranyik, Victoria | Councilor (1974) |

| | |
|---|---|
| K. M. Swain, San Francisco | Program Chairman |

EXECUTIVE COMMITTEE ELECT

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|---|---|
| G. C. Trostle, Boise | Chairman |
| R. E. Stevens, Fort Collins | Immediate Past Chairman |
| G. D. Amman, Ogden | Secretary-Treasurer |
| R. G. Cox, Lewiston | Councilor (1973) |
| L. Safranyik, Victoria | Councilor (1974) |
| D. L. Parker, Albuquerque | Councilor (1975) |

| | |
|---|---|
| B. E. Wickman, Corvallis | Program Chairman |

# PROCEEDINGS

## JOINT MEETING

## TWENTY-SIXTH ANNUAL WESTERN FOREST INSECT WORK CONFERENCE

## TWENTY-SECOND ANNUAL WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

### OFFICERS (Twenty-Second WIFDWC Conference)

| | |
|---|---|
| R. V. Bega, Berkeley | Chairman |
| E. F. Wicker, Moscow | Immediate Past Chairman |
| D. Hocking, Edmonton | Secretary-Treasurer |

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| J. R. Parmeter, Berkeley | Program Chairman |

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### OFFICERS ELECT

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| S. H. Whitney, Victoria | Chairman |
| R. V. Bega, Berkeley | Immediate Past Chairman |
| J. W. Byler, San Francisco | Secretary-Treasurer |

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| E. F. Wicker | Program Chairman |

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*Summary not submitted

# PROGRAM

## JOINT MEETING

Twenty-Sixth
Annual Western Forest Insect Work Conference

Twenty-Second
Annual Western International Forest Disease Work Conference

Del Monte Hyatt House
Monterey, California

February 23-28, 1975

### Sunday, February 23rd

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| 4:00 p.m. - 9:00 p.m. | Registration for early arrivals |
| 8:00 p.m. - 10:00 p.m. | Meeting of the Executive Committee |

### Monday, February 24th

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| 7:00 a.m. - 12:00 a.m. | Registration |
| 8:30 a.m. - 9:30 a.m. | Welcoming address<br>Initial business meeting |
| 9:30 a.m. - 10:10 a.m. | Keynote Address: The Future of Integrated Forest Pest Management Strategies, Dr. Wm. Waters, Dean of the School of Natural Resources, University of California, Berkeley, California |
| 10:10 a.m. - 10:30 a.m. | Coffee |
| 10:30 a.m. - 11:10 a.m. | Keynote Address: Do Integrated Forest Pest Control Strategies Meet the Forest Land Managers' Needs, Dr. Donald Leaphart, Intermountain Forest and Range Experiment Station, Moscow, Idaho |
| 11:10 a.m. - 1:00 p.m. | Lunch |

1:00 p.m. - 5:00 p.m. — Panel: Pest Management Strategies in Forestry.
Moderator: Bill Bedard, Pacific Southwest Forest and Range Experiment Station, Berkeley, California.
Panelists: Dave Blakeman, California Region, San Francisco, California; D. C. Schmiege, Pacific Northwest Forest and Range Experiment Station, Juneau, Alaska; D. E. Teaguarden, University of California, Berkeley, California; R. S. Hunt, Provincial Forest Research Center; A. M. Rivas, Forest Service, Intermountain Region, Ogden, Utah; K. H. Wright, USDA, Douglas-fir Tussock Moth Program, Portland, Oregon

<u>Tuesday, February 25th</u>

8:00 a.m. - 11:30 a.m. — Panel: Current Status of Pest Management Projects.
Moderator: H. S. Whitney, Canadian Forest Service, Victoria, B.C.;
Panelists: J. E. Coster, Stephen F. Austin University, Texas; J. D. Hodges, Southern Forest and Range Experiment Station, Pineville, Louisiana; A. L. Safranyik, Canadian Forest Service, Victoria, B.C.; J. W. Byler, Forest Service, California Region, San Francisco, California; W. H. Padgett, Forest Service, Northeastern Area, Upper Darby, Pennsylvania

11:30 a.m. - 1:00 p.m. — Lunch

1:00 p.m. - 5:00 p.m. — <u>Concurrent Workshops</u>

Remote Sensing.
Moderator: Robert Heller, University of Idaho, Moscow, Idaho

Results of the 1974 Douglas-fir Tussock Moth Field and Pilot Tests. Moderator: Carroll Williams, Pacific Southwest Forest and Range Experiment Station, Berkeley, California

Pesticide Registration Regulations. Moderator: Bob Harrison, Dow Chemical Co., Bellevue, Washington

Bark Beetles & Root Diseases-Pine. Moderator: Ron Stark, University of Idaho, Moscow, Idaho

Impact Evaluation of Pest Complexes. Moderator: William Waters, University of California, Berkeley, California

Modern Approaches to Information Retrieval and Storage. Moderator: Mary O'Hara, Forest Service, Washington Office

<u>Wednesday, February 26th</u>

8:00 a.m. - 12:00 p.m. — <u>Concurrent Workshops</u>

Biological Evaluation of Pest Complexes. Moderator: Jim Byler, Forest Service, California Region, San Francisco, California

Bark Beetle & Root Diseases-Fir. Moderator: Art Partridge, University of Idaho, Moscow, Idaho

Regulations Affecting Pesticide Use. Moderator: Fred Honing, Forest Service, Washington Office

Data File Management.
Moderator: Cliff Myers, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado

Wood Rot - Insect Interaction (Decomposition).
Moderator: Russ Mitchell, Pacific Northwest Forest and Range Experiment Station, Corvallis, Oregon

Insects and Rust Fungi.
Moderator: Dick Krebill, Forest Service, Washington Office

Conflicts Between Insect and Disease Recommendation.
Moderator: Larry Stipe, Forest Service, Intermountain Region, Ogden, Utah

Afternoon Open

7:00 p.m. - 7:30 p.m. Attitude Adjustment

8:00 p.m. Banquet

Thursday, February 27th

8:00 a.m. - 11:30 a.m. Concurrent Workshops

Pest Control Through Improved Forest Management.
Moderator: Donald Schmiege, Pacific Northwest Forest and Range Experiment Station, Juneau, Alaska

Dwarf Mistletoe - Insect Relationships.
Moderator: Robert Scharpf, Pacific Southwest Forest and Range Experiment Station, Berkeley, California

Concerns of Conference Members.
Moderator: Ed Wicker, Intermountain Forest and Range Experiment Station, Moscow, Idaho

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| | Data Analysis.<br>Moderator: Floyd Johnson, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon |
| | Insect & Disease Problems and Relationships in Urban and Recreation Areas.<br>Moderator: Rick Johnsey Washington Dept. of Natural Resources, Olympia, Washington |
| | Are Microorganisms Beneficial to Insects?<br>Moderator: Stan Barras, Southern Forest Experiment Station, Pineville, Louisiana |
| | Air Pollution and Insects.<br>Moderator: Clint Carlson, Forest Service, Northern Region, Missoula, Montana |
| 11:30 a.m. - 1:00 p.m. | Lunch |
| 1:30 p.m. - 5:00 p.m. | Workshop Summaries |

<u>Friday, February 28th</u>

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| 8:30 a.m. - 10:30 a.m. | Final Business Meeting |
| | Western Forest Insect Work Conference |
| | Western International Forest Disease Work Conference |
| 10:30 a.m. - 10:45 a.m. | Coffee |
| 10:45 a.m. - 12:00 a.m. | Joint Business Meeting |

WESTERN FOREST INSECT WORK CONFERENCE

MINUTES OF EXECUTIVE COMMITTEE MEETING
February 23, 1975

The Executive Committee was called to order by Chairman Galen Trostle at 8:10 p.m. in Room 758, Del Monte Hyatt House, Monterey, California.

Present were Trostle, Ives, Hocking, Kline, Shephard, Wickman, Swaine, Stevens and Amman.

Mailing list for meeting announcements was discussed. Pat Shea expressed his embarrassment when announcements were returned and had been marked "deceased." The importance of periodically polling the membership to determine those who want to receive announcements was emphasized. The membership list will be posted at the registration desk; and members requested to indicate needed changes.

Registration fees of this meeting were discussed. The $18 fee was needed to cover the cost of meeting, coffee and Proceedings.

Student's fee of $9 is to cover cost of coffee and Proceedings for three consecutive meetings.

Motion MSC that the Program Chairman, Executive Committee Chairman, and Secretary-Treasurer set registration fees for future meetings.

Motion MSC that registration fees be set at a level that will cover the cost of the meetings and Proceedings, reduce the present balance, and leave approximately $300 in the Treasury.

Hospitality rooms were discussed. They were approved for this meeting because the WIFDWC has given approval for hospitality rooms at their meetings. It was the consensus of the executive committee to continue our present policy of not having hospitality rooms at WFIWC meetings.

Location of the 1977 meeting was discussed. An invitation was received from Victoria, B. C. In addition, the Southern FIWC has expressed interest in a joint meeting.

Committee membership was discussed. It was noted that a councilor should be nominated to replace Bill Ives. A nominating committee for selection of a councilor was established subject to their acceptance to serve.

Letter by David Wood to the Chairmen of the WFIWC and WIFDWC proposed reorganization of these Conferences into a single organization. The executive committee decided to place this issue before the membership.

Motion MSC that suggestions made by John Schmid, past Secretary, for preparing future Proceedings be adopted. Drake Hocking, and Gene Amman will meet with workshop chairmen in Room 758 at 5:30 p.m. today to present these suggestions.

Motion MSC that John Schmid be commended for his exceptional effort in publishing the 1971-72 and 1974 Proceedings, and a note of thanks sent to the Secretaries who typed the Proceedings.

TWENTY-SIXTH ANNUAL WESTERN FOREST INSECT WORK CONFERENCE

TWENTY-SECOND ANNUAL WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

MINUTES OF JOINT BUSINESS MEETING
February 24, 1975

The joint meeting of the 26th WFIWC and 22nd WIFDWC was called to order by Galen Trostle and Robert Bega, Chairmen, at 8:55 a.m. in the Terrace Room, Del Monte Hyatt House, Monterey, California.

Robert Bega and Galen Trostle, Chairmen of the respective groups extended welcomes to the membership.

Robert Bega called Stu Whitney to present memorials:
There were 3 entomologists, George Hopping, Bill Wilford, John Chapman; and 2 pathologists, Art Parker, and Joe Baranyay; who died during the past year. A moment of silent tribute was paid to these departed colleagues.

Letter from Dave Wood to Chairmen of the WIFDWC and WFIWC was read. Dave proposed that the 2 organizations be dissolved and joined into a new Integrated Forest Pest Management Work Conference. The Conference would meet on a triadic basis as:

1. Society of American Foresters, Section on Forest Insects and Diseases (and/or a meeting with the Canadian Forestry Institute) when the national meeting is held in western North America.

2. Western Forestry and Conservation Association, Pest Committee, and

3. Integrated Forest Pest Management Work Conference (IFPMWC).

Program chairpersons would develop sessions at each annual meeting to include the following interests:

1. land manager, pathologist, entomologist, and silviculturist jointly

2. pathologist and entomologist jointly

3. entomologist specifically, and

4. pathologist specifically

No reorganization of the SAF or WFCA would be necessary other than to accommodate an expanded interest and participation by the IFPMWC. The specific and joint sessions of the entomologists and pathologists would be added to the SAF and WFCA program or, if feasible, a portion of these sessions could be concurrent with some of the SAF or WFCA sessions.

Discussion was deferred until final business meetings of the respective organizations.

The joint meeting was adjourned at 9:05 a.m.

# WESTERN FOREST INSECT WORK CONFERENCE

## MINUTES OF INITIAL BUSINESS MEETING
February 24, 1975

Meeting was called to order at 9:10 a.m. in the Terrace Room, Del Monte Hyatt House, Monterey, California, by Chairman, Galen Trostle.

New members were asked to introduce themselves. Minutes of the final business meeting and Treasurer's report were read and approved.

John Schmid, past Secretary-Treasurer received an ovation for prompt and efficient publication of the 1971-72 and 1974 Proceedings.

Chairman Trostle mentioned that a hospitality room would be made available by a chemical company at this meeting. The WIFDWC has not discouraged hospitality rooms; therefore, after polling the Executive Committee, Chairman Trostle gave approval for this meeting. It was questioned why WFIWC has this policy. Chairman Trostle explained that discussion of chemical insecticides can be conducted without a feeling of pressure from the chemical companies.

Chairman Trostle appointed a committee consisting of Bill Ives, Bill McCambridge and Russ Mitchell to nominate a councilor to replace Bill Ives on the Executive Committee.

Boyd Wickman, Program Chairman of the 1976 meeting to be held in the Portland area, reported that his Committee consists of LeRoy Kline, Don Curtis, and Roy Beckwith.

Trostle appointed Bob Dolph to be Chairman of the Ethical Practices Award. An award was not made in 1974 because a worthy candidate was not available.

Meeting was adjourned at 9:35 a.m.

# FOREST PEST MANAGEMENT: PRESENT PERSPECTIVES AND A LOOK AHEAD

by

William E. Waters
Dean, College of Natural Resources
University of California, Berkeley

## ABSTRACT

It is time that forest entomologists and pathologists get together at the ground level to discuss pest problems in the context of pest management. This is the reality of where it all comes together--biologically, economically, and sociopolitically. I hope--and urge--that this joint meeting be the start of a permanent relationship under a single organization. Future meetings should include research and practicing foresters from public and private organizations as regular participants, also, since forest pest management must be developed and applied as an integral part of the total resource planning and decision process.

The concept of pest management in forestry is not new. The idea of regulating pest numbers and damage so as to minimize the chances of intolerable loss or of disruptions in the management process were sagely propounded by the founding fathers of forest entomology and forest pathology many years ago--and, foresters generally liked this idea. Of the approaches suggested, biological control and silvicultural practices always had a special appeal since they utilized "nature's way" and held promise of long term effectiveness with minimal change in management operations.

In practice, the story has been quite different--especially with major pest insects. Direct control with chemicals and salvage have been relied upon generally. Forest managers have been badly afflicted with the "wait-till-it-happens" syndrome--and then have proceeded to make subjective, arbitrary, and sometimes capricious decisions on actions against specific pests. In many, perhaps most, instances the quick and easy approach has been supported by insect and disease control specialists. The syndrome persists, and its symptoms are expressed not only by the way in which actions are taken but by the seriously inadequate way in which insect and disease effects on forest productivity and values are accounted for in the inventory process--and in projections thereof. If the syndrome is to be cured--and after 25 years of effort, I am still an optimist--there needs to be better understanding of two basic facts: (1) insects and diseases are an integral part of forest ecosystems--they are not a "random event", and (2) any management objective involving maximization or optimization of forest resource productivity and/or values--or minimization of risk and uncertainty in the management process--requires minimization, or at least regulation, of the losses and disruptions due to destructive insects and diseases over the entire planning horizon.

FORESt PEST MANAGEMENT: William E. Waters

My perennial optimism has had severe setbacks in the last several years. These have been due to (1) the tussock moth fiasco of 1972-74, including both research and control efforts, (2) the spruce budworm dilemma, particularly in the Northeast, which has reached a critical point this year, and (3) the southern pine beetle delusion of the past decade, which is still affecting "control" decisions today. Problems and difficulties involved in the decision-making for "management" of mistletoes and root rots in western forests at present have some of the same earmarks.

There is emerging, however, a clearer realization by researchers and action people alike that to really handle pest problems--from survey and inventory to treatment strategies--a lot of things have to be put together in a scientifically rational and operationally practical way. Fortunately, this realization seems to have come through to the administrative hierarchy and Congress who hold the purse strings, too. A substantial increase in federal funding was provided in 1971 and 1972 for the comprehensive R&D program on the gypsy moth. This program, based on one overall plan, has required the coordination of personnel and activities of several agencies of the U.S. Department of Agriculture, states, and universities. The expanded Research/Development/Applications Programs of the USDA on the tussock moth, southern pine beetle, and gypsy moth have carried this comprehensive approach one step further to a wholly committed organizational structure and fiscal arrangement. And current planning for an expanded program on the mountain pine beetle-western pine beetle-disease complex in western forests is even more broadly ranging yet more sharply focused on the primary elements of the pest management system(s) involved.

This latter effort is an outgrowth of the Pine Bark Beetle subproject of the NSF-EPA funded program on the Principles, Strategies, and Tactics of Pest Population Regulation and Control in Major Crop Ecosystems 1/. The model system structure developed for this subproject is shown in Figure 1. Each of the basic components--the insect population dynamics, stand dynamics, impact, and treatment strategies--is a subsystem in itself. Each requires detailed analysis and understanding. The arrows between them indicate the linkages and, in terms of modeling, which components comprise parameters for another in the overall sequence of a planning-decision process. The focal point of the process is the benefit/cost integration, where a whole spectrum of outputs is possible, depending on the benefit and cost inputs from impact (value judgements, potential benefits) and treatment strategies (costs, relative efficacy).

1/ NSF Grant No. GB-34718 to the University of California, Berkeley--C.B. Huffaker, Director. For the Pine Bark Beetle subproject, the leaders are D.L. Wood (Western Pine Beetle), R.W. Stark (Mountain Pine Beetle), R.N. Coulson (Southern Pine Beetle), and W.E. Waters, (Subproject Coordinator).

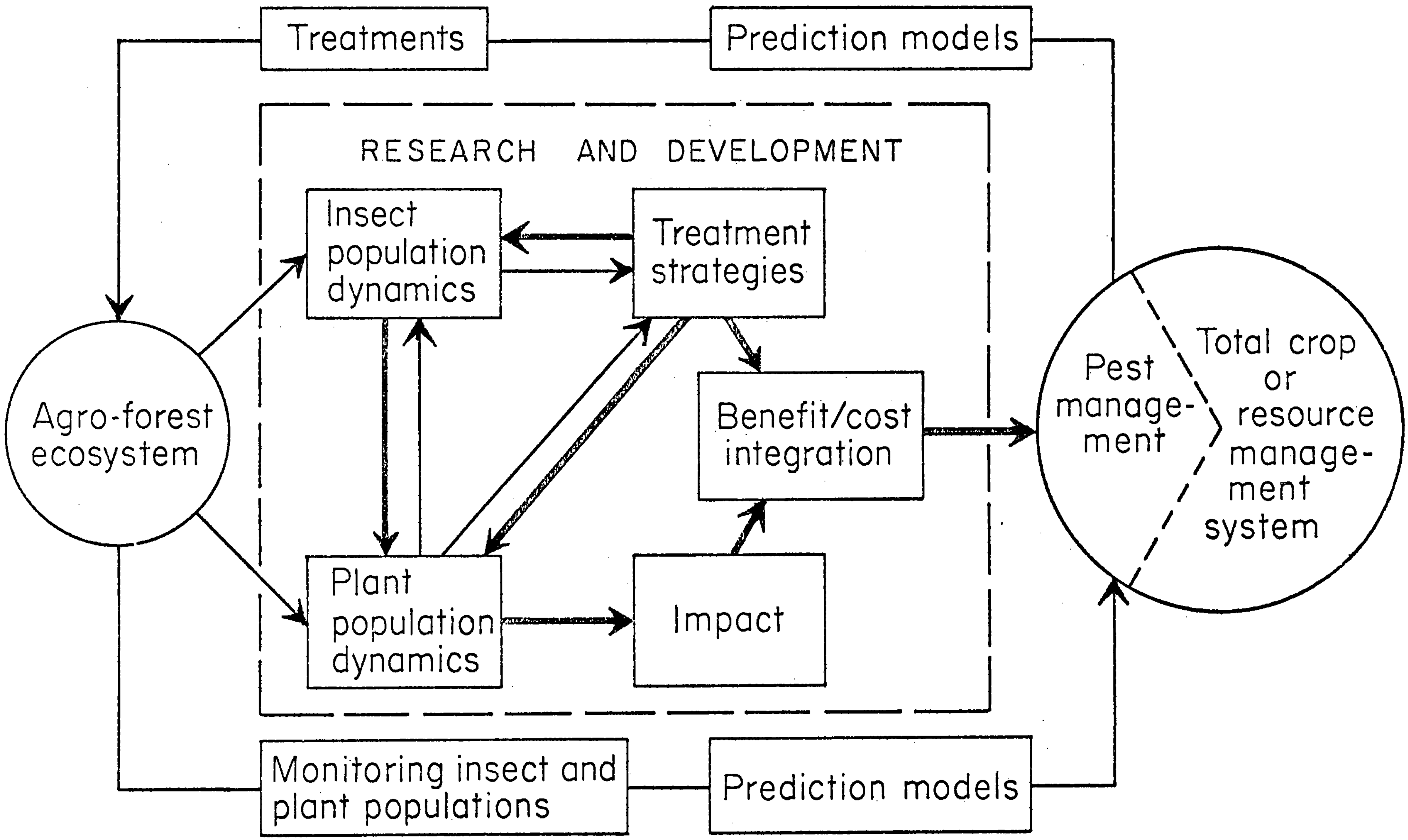



Figure 1. Model structure of an insect pest management system, with research and development components and the action sequence.

In operation (the external action sequence), the system requires the capability to predict (1) changes in numbers and distribution of the pest and/or its effects on host stands, (2) the effects of insect-and disease-caused damage on specific stand parameters (net growth, age-size distribution, etc.), (3) the effects of these changes in stand parameters on potential productivity and/or value increment as related to specific management objectives, and (4) the outcomes of alternative treatment strategies in terms of the pest population(s) and/or stand conditions, and ultimately in terms of values saved or values gained. The data requirements for an action program are critical. Large sampling errors preclude the rational use of predictive models--however sophisticated or precise they _might_ be, inadequate data make them nonsense guesstimators. Similarly, adequate computerized data management systems are needed to reduce, store, retrieve, and perform necessary calculations efficiently and reliably.

What of the future--what can we expect of the new, systems approach to forest pest management? I forsee some highly meaningful and important advances: (1) positive, operationally compatible inputs to the total forest resource management process--from inventory to operations, (2) improved capability to meet statutory requirements for all treatment strategies contemplated--more rational justification of actions taken, and more reliable prognoses of outcomes with respect to the benefits and costs concerned, (3) better training and education in the concepts and technology of forest pest management, and (4) a higher order of integrated pest management systems--_total_ protection systems for given tree species, forest types, or geographic areas.

Premature claims, organizational labels, and shotgun projects on "forest pest management" are counterproductive. These lead only to loss in credibility and, more importantly, to a loss in support for research and development at the levels required for positive results.

We need to concentrate now on the expanded programs in progress --to produce and demonstrate comprehensive operational management systems for the pests involved--and thus to prove conclusively to pest control specialists, forest resource managers, and the administrative hierarchy that this truly is the way to go.

INVITED PAPER

# Do Integrated Forest Pest Control Strategies Meet The Forest Land Managers' Needs?

Charles D. Leaphart

I have a fair capability for getting into trouble--as I demonstrated not too long ago, by telling an old mentor and friend, Charles Wellner, what the title of my talk would be today. Although I didn't change the title that Dick Parmeter concocted for me, I agree fully with Chuck. His words to me, as follows, help set the tone of my thoughts for the subject. "The terms, 'integrated pest control' and 'integrated pest management,' are symptomatic of a basic problem of forest protection people. We are concerned and interested not with pest management but with resource management. Pests and their mitigation (and I'll add enhancement) are but a part of the resource management job. Forest protection is an integral part of silviculture. We are always in trouble when we take it out of that context and treat the insect or the disease apart from the overall management of the ecosystem."

But how do we face up to the needs of the land manager? He could care less whether you're a pathologist, an entomologist, or the good Lord himself, as long as you were able to tell him what was causing his problem; and I'm sure he'd think you were the latter if you provided him a solution to it. My own background is probably as narrow as anyone's here, but I have been extremely suspect of joint pathology-entomology ventures which have been proposed here in the West to provide practical insect and disease control guidelines that can be integrated into on-the-ground resolution of the selected problem. Usually, these ventures have been set up to satisfy political or personal objectives that have little direct bearing on most land management needs.

I have another related concern about a current fad in certain government circles. Groups of scientists from various disciplines are being organized into programs with objectives directed toward solution of a resource problem within a 5-year span. Not to be outdone by the similar Asian programs, these also are undertaken without benefit of guiding comprehensive analyses of needs and related courses of action. Obviously, we do have some resource problems where multi-disciplinary programs are necessary, but how do we usually set them up? Actually, the present organizational zeal to generate research dollars tends to build complex research and development (R&D) programs involving all possible solutions rather than quite simple ones. The "critical mass" fad produces nothing unless, and I reiterate, adequate research planning zeroes scientists in on the solution of bottlenecks. One must ask, "How much scientific ability is being wasted at a time when we can ill afford to waste a single scientist or research dollar?" Dr. J. H. Nobles, Jr., in his September 13, 1974, article in Science, proposed buttressing and extension of peer review to provide quality control of policy-related research and to improve research adequacy. Think what effect such a control system would have in our multi-million dollar disease or insect R&D programs, either underway or proposed in the United States, if it simply did nothing more than unmask and curtail the use of scarce R&D funds for service subsidy and the seeking of influence.

I'd like to use some examples to illustrate why I question the need for integrated pest control strategies for most land management situations. Many of you are not acquainted with the pole blight disease of western white pine, and nearly all of you would not recognize it today if you were put in a stand affected by it in either the U.S. or Canada. It is called a disease probably because an entomologist was smart enough in the 1940's to disclaim any associations of the problem to entomology. Today, its cause is still unknown; but, even if an insect or a disease organism was found to be closely allied to cause, the management strategy would not involve management of pests but a risk rating of sites for growing white pine based on soil moisture characteristics.

Pole blight represents something different for your deliberations this week than simply consideration of management strategies. I'll call it "groupism" in which "teamwork" and "consensus" are the principal bywords. As excerpted from "Who Killed Individuality" in Management Notes, Issue No. 25, "The premise inherent in the teamwork concept is that 'two heads are better than one.' Whereas this idea has some validity where information collection is involved, it completely ignores quality of performance--which is the essence of the more vital, creative management tasks... No matter how many different minds contribute data to a particular discovery, the innovation itself is the product of individual achievement. All raw material for the creative process has to be understood, synthesized, evaluated, and transcended by a single mind! To herd creative people into committees for accomplishment is to compromise their vision, average out their drive, and whittle down their understanding to the lowest common denominator. Committees can regulate, but only individuals can create. Committees can negate, but only individuals can initiate. Committees can provide a majority opinion, but only individuals can determine truth." Pole blight illustrates, to some of us, anyway, how a multi-disciplinary program could be carried out and what "desirable groupism" might be all about. People from the Canadian and United States governmental forest research and administrative agencies and the University of Idaho got together, pooled knowledge, decided on a program of inventory and research, and fixed on responsibilities. With the exception of a few people working together, e.g., a soil scientist and a pathologist for a few seasons, each went about his assignments functionally. The whole group periodically met, discussed results and interpretations, and reset goals and studies. Managers and researchers were continuously involved in the program. While Bob McMinn, an ecologist from Canada, and I, a pathologist from the U.S., ended up as the last people working on the problem and in rather good agreement on our conclusions, any other specialist--a silviculturist, a physiologist, and yes, an entomologist--would have arrived at, basically, the same conclusions.

Another example exists with mountain pine beetle (MPB) in western white pine. By far, the vast majority of white pine stands affected by mountain pine beetle exceed 100 years of age. Although I have seen and know of only one stand of a younger age to suffer epidemic-type losses, losses have, in fact, occurred periodically in 80- to 100-year-old stands. Today, all of these stands, at least in the northern Rockies, are affected by blister rust to varying degrees--generally the younger the stand the higher the mortality rate from rust. Also today, annual losses from rust probably average less than 0.5% in 200- to 220-year-old stands; but I know of no reason why that loss should not approach, at some future time, perhaps soon, a yearly loss rate of about 3 to 6%, and sometimes higher, which we now get in young pole stands. What I'm saying is that for some 200,000 acres of non-cutover white pine stands over 120 years old, if the beetle doesn't get the western white pine trees, the rust will in 90% or more of the cases. The same applies to many acres of similarly old but cutover stands with a white pine residual. The land manager's question is, "How can I stretch the harvest out over this acreage in an orderly fashion yet with minimal loss?" I don't know any way of storing beetle bait on the stump with impunity, or certainly without considerable risk, and am not convinced that we should if chances are as good as they appear now to be that it will sooner or later be knocked off by another pest, like blister rust. Until we can demonstrate differently, we have two totally independent forces operating against continued life of mature white pine. If our ability to predict the future of either stands or trees from just one of these agents appears staggering, would development costs of a prediction system for the two combined exceed a fair return on the value of the current live volume? With a decision already having been made not to conduct research which would prolong the lives of mature and over-mature rust-infested pines from the rust itself, the lack of a similar decision for the MPB is quite outstanding. I believe that man, instead of trying to be the eternal conqueror of nature, should come to reason here, i.e., management should take all that is known about the three organisms, rust, beetle, and pine, and develop a risk rating system for inventorying mature and overmature stands as the basis for setting priority cutting. Then, they should set about their job of cutting, but they must expect some stands to suffer losses earlier than anticipated.

Now, comparing my recommended strategy with what is actually going on really reveals my complete ignorance of resource management strategy. In other words, nearly all land managers are cutting out the white pine whether it represents a short-or long-term risk from either beetles or rust as quickly as they can get to mature and older stands. If stands have already been cut, these will usually be cut again before the uncut ones, as will the more accessible young stands but under the guise of commercial thinnings. These thinnings are O.K. if the selection process leaves white pine with a good risk from blister rust. However, the procedure often is to cut all white pines because management believes that they have more than a fair chance of dying from rust before the next cutting. Management follows this course because we in protection have not done our job in communicating all our knowledge. Furthermore, there has been no concentrated effort to develop with research a priority risk rating for a stand inventory system. Finally, there has been one serious research effort, promoted by at least some managers, to develop a technique (in this case utilization of pheromones) whereby stands might be protected from serious losses for a period of time until they could be harvested.

You can see that my batting average for management strategies at this point is zero; but, if we look ahead concerning these same three organisms after current mature and older stands are cut, most future stands of white pine will be managed for timber production on rotations of 120 years or less. MPB may not be worth worrying about though I'm not sure we should assume that future managed stands of these younger ages will be as resistant to MPB as rather comparable ones seem to be now. Surely, we will be using seed or stock from sources resistant to the rust disease, and again I think we would be wrong to assume that resistance today will be resistance tomorrow. We'll have many acres growing a lower proportion of white pine than they have grown or are growing today due to current cutting procedures. We'll probably have other insect or disease problems, like pole blight, to affect planned strategies; but, as of the moment, I would predict a rosier picture for white pine management in the future than in the present.

On this subject of MPB, many of you may have seen the 1974 article by Safranyik, Shrimpton, and Whitney titled, "Management of lodgepole pine to reduce losses from the mountain pine beetle." To me, these people are telling us that the beetles have signaled 80 years, plus or minus, as some type of physiological maturation of trees or stands beyond which we'll have deterioration that will come in the form of beetles, diseases, some other debilitating factor, or some combination thereof. Similarly, we have known for many years that the seral species, Douglas-fir and lodgepole pine, in Tsuga heterophylla/Pachistima myrsinites habitats do not persist in most stands for many years past the time of culmination of mean annual increment for a variety of reasons, none of which would require specific guides for pest control management. Lodgepole pine is also seral in nearly all other habitats in the Rocky Mountains. For those of you looking for bark beetle-root disease associations, you might find all sorts of root disorders in MPB infested lodgepole pine stands; but, what will you really have accomplished for the resource manager? For those resource managers present, if you don't listen to the research story or you don't have the money to do the job, how much more data should "we" continue to crank out on the beetle?

I want to mention one other problem--root diseases, beetles, and either pine or fir hosts. This faddish subject is covered in at least two of the 21 workshops scheduled later in the conference. So far, I find little unanimity on what organism is really causing damage, let alone what the manager should do about it. Whatever our game is of placing credit where it's supposedly due, I suggest we get off the fence and level with the manager by telling what we know he can do about whom. It makes little sense to me that any bark beetle should be the problem to be attacked when the beetle-infested trees are within a Poria root disease center. Though some might argue me out of it, I'd go so far as to substitute Fomes annosus and Verticicladiella sp., and possibly Armillaria mellea and Polyporus schweinitzii for P. weirii in theorized root disease-bark beetle relationships. You might agree that trees, like people, have a certain life span. For those of you that do, you'll find that span will vary by geographic location, habitat, aspect, elevation, etc., and that, like some of us more senile characters, certain trees within each site become members of the over-the-hill gang earlier than others. Yet time after time after time, I find various people trying to determine the relationships between bark beetles and root diseases in 80- to 100-year-old and older pine and/or fir stands. For what purpose, and have they forgotten their silvics, ecology, the histories of the agents present, and, most importantly, what the resource management objectives are? How many of these people have actually witnessed an endemic population of bark beetles with the "root disease connection" serving as the focal point of a beetle epidemic? Therefore, I'll repeat: Where root diseases and bark beetles exist together, the land manager can rarely afford to treat the latter because (to use an analogy) he would be like a doctor treating a lip sore on a person whose core problem was syphillis--a new one will be popping out somewhere else before long.

Let me try to put what I've been beating around the brush about into a message I want to leave with you. The circumstances are rare in the West where two or more organisms of such divergent character as an insect and a fungus occur together and require integrated control strategies to meet resource management needs. Twenty years ago, most people in an audience such as this would have rejected that statement flat out. If some of you older entomologists will look back, how often did you find yourselves treating the bug and not the patient? Your concern, and that of the pathologists, too, was zeroed in on the organism associated with some damage and very little on why the host was responding as it was to produce the damage. If this seems to be an unfair indictment against the professions, maybe you'd better review our role today with respect to a saying by the famous Russian physiologist Ivan Pavlov, which goes, "Do not become a mere recorder of facts, but try to penetrate the mystery of their origin."

Today I see some people trying to penetrate the maze and, more importantly, not trying to kill a tree twice, once with a bug and again with a fungus. With such a philosophy, I believe we in our professions, either individually or collectively, can set down with both the involved resource managers and those people most knowledgeable about a problem tree species or species group, the silviculturists or ecologists. Together, we can describe and define the problem and its bottlenecks, i.e., do the prerequisite problem analysis and identify the disciplines needed to do the job before a team is put together. Maybe you'll only need an inventory specialist, who can pick the brains of entomologists or pathologists and come up with a classification system capable of handling the situation. I cannot emphasize enough the need for the heavy head-knocking early in the game with relentless use of available knowledge. Once the course is set, by all means continue to involve the land manager. I'm only too well reminded of our own blister rust research effort. We knew we had to break through one or two bottlenecks in our chemical control research before we could really branch out and effectively test chemicals as one means of rust control. Just as we had broken through one, i.e., got the rust organism and its hosts in separate and combined culture, our support dropped and 5 years of research essentially went down the tube. I'm sure we didn't keep the land managers with us, but I feel also that they, perhaps influenced by research administrators, opted for one control strategy for blister rust rather than an integrated one, which would involve not only resistance, the current bag, but silviculture, biological agents, and possibly chemicals as well.

I have outlined one plausible strategy. Although I feel that there will rarely be need for more than a one-discipline approach for solution of most problems, several functions obviously could be involved. If control strategies are eventually required, we will have followed a logical course to integrate them into resource management. That course will have involved the researcher and the land manager at all times, not acting completely independent from each other as has been the usual course of past events. Even so, I'd like to leave a word of caution as expressed by Keely Johnson, a gifted and recently retired airplane designer, in the January 20, 1975, issue of Time. He implied that we can expect more and more future decisions to be made by committees of experts with no experience beyond their specialties. The trouble is, he says, committees "never do anything completely wrong, but they never do anything brilliant either."

PANEL: PEST MANAGEMENT STRATEGIES IN FORESTRY

Moderator: Bill Bedard

Panelists: Dave Blakeman, Rich Hunt, Al Rivas, Don Schmiege, Dennis Teeguarden, Ken Wright

Introduction: William D. Bedard

The common focus of Forest Pathology and Entomology is the solution of the applied problem: How should a forested area be managed to meet the goals of the manager with a minimum risk of losses from pests and a minimum of expenditures for manipulation to ameliorate pest cause losses. Its solution depends on providing management alternatives with full information of their short and long-term benefits and costs. This information must be in a form compatible with the long-range planning methods employed in multiple-use management.

Figure 1 represents a conceptualization of this focus. It represents the types of information and how they are coupled in the pest management decision process. Detection, survey, and control personnel can determine what information is needed for a pest control decision and how it should be structured. They, too, can easily detect missing information and, using the conceptual model, work with others to obtain the needed information.

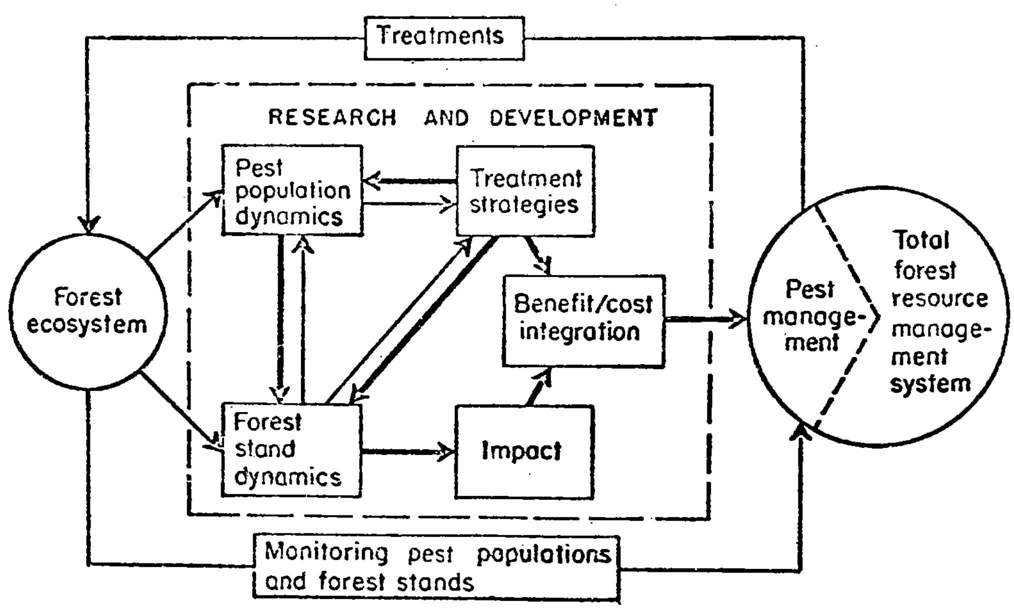



Figure 1.--Conceptualization of a forest pest management system, including both the research and development phase inside the dotted line, and the operational phase, outside the dotted line.

Those engaged in research can see where new information is lacking and how research resources should be directed to achieve maximum progress toward chosen goals.

Virtually all forest pathology and entomology activities fit into this scheme. Following is a brief description of the components of the model and how they interact.

The pest population dynamics "box" deals with factors and/or processes determining differences in pest abundance at given places and times. Here, the ability to predict pest abundance and distribution is developed so that effects on forest stands can be predicted and various manipulations of pests and stands (= treatments) can be evaluated and predicted.

The stand dynamics "box" deals with the direct and indirect effects of pest activity on stand growth and development and associated forest resources. Here the technology is developed to predict, for given pest levels, the effects pest activity will have on yield, quality, species composition, age distribution, wildlife, water yield, etc. This prediction capacity is used to: 1) determine the socioeconomic effects of pest activity (in conjunction with the impact box); and 2) evaluate the effects of treatments.

The treatments "box" deals with the efficacy, cost, and safety of various treatments that are directed toward reducing stand susceptibility or reducing pest abundance. Treatment information is supplied to the pest management decision process in parallel with values information from the impact box. Information on treatment effects is developed between and among the treatments box and the population and stand dynamics boxes.

The impact "box" deals with developing methods for assigning values (positive or negative) to both the direct and indirect effects of pest activity. Values of all resources effected (i.e., wood, fiber, forage, water, recreation, etc.) are considered. These methods will be used to predict the benefits that can be gained through treatment.

The benefit cost integration "box" deals with developing methodology to combine the "benefits" to be gained information (from the impact box) with the cost of treatments information (from the treatments box) in a manner compatible with multiple-use planning methods.

These 5 "boxes" and their interactions constitute the research and development (R&D) phase of a pest management system. They are set off in the figure with a dotted line. Once the technology is developed in this phase it is used operationally. This is represented in the figure by the outer square of relations.

Each panel member spoke on part of figure 1 stressing, 1) its usefulness from the points of view of their specialty; 2) the types of information needed; 3) how the information should flow; and 4) what techniques are currently available for various parts of the pest management job.

Stand Growth Modeling - Blakeman

Growth models are available to the researcher and resource manager which should be valuable tools, if data to develop coefficients for the equations in the models were available. The growth modelers and the pest population dynamics modelers need to work together to determine if, 1) a pest or pest complex is present in a stand, or not, and, if not, what is the probability of its appearing, and 2) what is the probability of the pest or pest complex successfully attacking any given tree at any given time at any given pest population level, i.e. is the probability of a successful attack of a tree a linear, geometric, exponential or whatever function of time or population level, or whatever.

Survey Needs for Monitoring Systems - Hunt

Information on the monitoring of pests is useful for: 1) establishing trends and predicting losses; 2) anticipating where and when controls or salvage may be applied; and 3) checking for possible new pests.

Checking for new and exotic pests requires general surveys. Broad trends on known endemic pests may be developed from general surveys, but usually more precise surveys have to be undertaken.

The population of pests depends on a wide range of environmental and biological parameters. Each pest population frequently reacts slightly different to these parameters. Hence, monitoring systems which are indirect and general, such as the use of common meteorological data, may at best give rough estimates. More precise measuring of environmental parameters related to a particular pest would be desirable, but monitoring several such pests would be costly. Impact studies, coupled with control feasibility need assessment, in order to put priorities on pest problems. With a sound dollar and cents background in losses and control, priorities for a more precise indirect monitoring system can be established.

Direct monitoring systems such as egg or spore counts are specific and usually costly, moreover their use on certain pests has not been justified by impact data comparisons to other pests. Such systems, coupled with previous knowledge, have been successful with several defoliating insects. With other pests the history of population fluctuations is inadequately known, or there are too many other interactions involved for reliability on population counts. As an example, in 1972, Keithia blight of western red cedar was barely noticeable in British Columbia. In 1973, despite apparently low inoculum density there was an explosion of this disease. So in 1973, the inoculum density was extremely high, but this did not result in a more intense epidemic in 1974; in fact, the disease was back to the low level of 1972.

Similar complications can exist for perennial pests. For example, with white pine blister rust, the inoculum density in area "A" may be very much higher than area "B"; this may be correlated to the amount of alternate hosts present. Thus an indirect monitoring system for blister rust could be devised by counting the alternate hosts - the currants and gooseberries. On the other hand, another indirect method could be the measurement of the precipitation during the infection period. In area "B", where the inoculum density is low, the precipitation could be higher than in area "A", so that the infection in both areas could be similar. Under British Columbia conditions it would more likely be higher. Hence, indirect monitor of ribes does not correlate to the amount of infection, only to the amount of spores, but our indirect monitor of precipitation may correlate to infection. Precipitation is certainly easier to monitor than measuring infection <u>per se</u>. Have we solved the problem of monitoring for blister rust? Area "B" has the most infection, and the most rain during the infection period, but a count of the tree mortality indicates that the trees survive rather well, and in fact, the impact, as measured by tree mortality, is greater in area "A".

This blister rust example indicates that good, clear-cut economic impact studies need to be made, rather than finding a correlation, which on the surface appears to be a good thing to monitor.

To develop a realiable monitoring system for specific pests, we need to know what factors relate to impact, then we need to measure these factors. Measurements should be quantitative to eliminate variation between observers. Ideally, the measurements should be simplified so that a simple system can be used by management over small geographic areas. The measurements should be reported and recorded to produce a history which may have predictive value.

In summary, one should ask oneself: What is the correlation between infestation or infection to impact? Does monitoring the population produce a correlation to infestation, or infection, and do these have anything to do with impact? To answer these questions (with a fair estimation of certainty) we need to know the epidemiology, or in some cases the history, of the pest.

Pest Management Decision Process Model - Rivas

As an administrator charged with forest pest responsibilities, it is my charter to discuss the model as an aid in making decisions, reducing criticisms, and improving specialist dialogue.

We need to know, for each part of the model, what criteria or parameters are and are not meaningful. We must know which biological and socioeconomic criteria will produce realistic and helpful assistance to the resource management decision-maker.

Although the model, or its components, may not have been quite so well articulated in the past, the process has been understood, yet, there have been shortcuts to this process. Some have been unintentional, some have been intentional but well meaning. Nevertheless, whether in retrospect or in the midst of an ongoing project, we have been vulnerable to criticism. To the extent an awareness and implementation of the considerations and processes of this model will take place, we can reduce those criticisms.

The consideration of all the integral parts of this model by those who have in the past been concerned with just one or two segments of it should produce better communications between researcher, academecian, and pest controller. Hopefully, these considerations and dialogue between these individuals will result in a better decision-making base for the resource manager.

Evaluating Pesticide Treatments - Schmiege

Despite the worldwide concern over the use of pesticides and their effects on the environment, there are no accepted criteria in use to evaluate these chemicals. Consequently, there is an urgent need for a uniform guide for evaluating the effects of pesticides on target and non-target organisms. Data on the effects of pesticides on population numbers and quality over time and place are especially needed. The criteria needed to interpret and evaluate these data should be agreed upon by all agencies responsible for gathering this information.

An environmental appraisal of a pesticide must consider the whole ecosystem and must therefore involve several disciplines. Populations of both target and non-target animals must be studied for several years to discover whether pesticides have altered the numbers and quality of individuals in the populations.

Benefit-Cost Analysis in Forest Pest Management - Teeguarden

The purpose of benefit-cost analysis is to enable the decision-maker to decide which investment projects are justifiable, or alternatively, in what order projects should be undertaken if the budget is too small to fund all projects

Evaluation of pest control projects is based on estimates of incremental benefits and costs. Incremental benefits are defined as the difference in the dollar value of pest-caused damage "with and without" control efforts. Incremental costs are those real extra costs attributable solely to control activity. Undertaking or increasing the scale of a pest management program is justifiable if discounted incremental benefits exceed discounted incremental costs.

Benefits of forest pest control, even in the relatively simple case of timber which is priced in competitive markets, are more difficult to measure than incremental costs. Pests may kill merchantable timber and immature trees held for future harvest, reduce growth and quality, cause sharp reductions in the planned allowable cut of timber, and induce adverse secondary impacts in the economy at large.

Each situation requires a unique benefit-cost model since different sorts of impacts must be weighed. For analysis, it is convenient to classify pest control projects in one of three categories: (a) growth stimulating; (b) quality stimulating; and (c) inventory protection. To calculate incremental benefits in the case of growth or quality stimulating pest control projects, analysts have traditionally used yield or stand table models constructed so as to predict stand growth and development to rotation age without pest control versus growth and development with control. Incremental changes in yield or quality are then measured by computing differences in the present net worth of the stand with and without control effort. Recently, some economists have advocated that benefits be measured in terms of the "allowable cut effect" (ACE) of pest control practices. This measure of benefit will make growth stimulating practices appear more beneficial than the traditional approach. Moreover, the ACE criterion tends to shift control priorities away from inventory projection and quality improvement projects toward growth stimulating programs.

Douglas-fir Tussock Moth Research and Development Program - Wright

The conceptual model (fig. 1) of a forest pest management system has proven very helpful in structuring the Douglas-fir tussock moth (DFTM) research and development (R&D) program. Using the model as an overall guide we have structured the DFTM program under five R&D subject matter goals or "phases" as follows:

1. Determine the ecological factors affecting dynamics of DFTM populations.

2. Determine the relationships between ecosystem attributes, forest management practices, and susceptibility of stands to DFTM outbreaks.

3. Develop materials, methods and techniques for suppression of DFTM.

4. Evaluate socioeconomic impacts of DFTM.

5. Integrate knowledge of insect dynamics, tree and stand factors, suppression alternatives and socioeconomic impacts into forest and pest management systems.

About 40 numbered "activities" or areas of investigation have been identified under the five phases. Each activity has a programmed 3-year objective or goal, thus there is very little long-term, basic research scheduled.

We have further structured the program as shown in figure 2. The boxes of figure 2 can be traced to the boxes of figure 1. We feel we need all 10 boxes to provide the organization, coordination and control to keep the program on track.

The bottom "integrative" box is the key one--not only does it "pull it all together" at the end, it also identifies gaps in knowledge at the start of the program and as new information is generated.

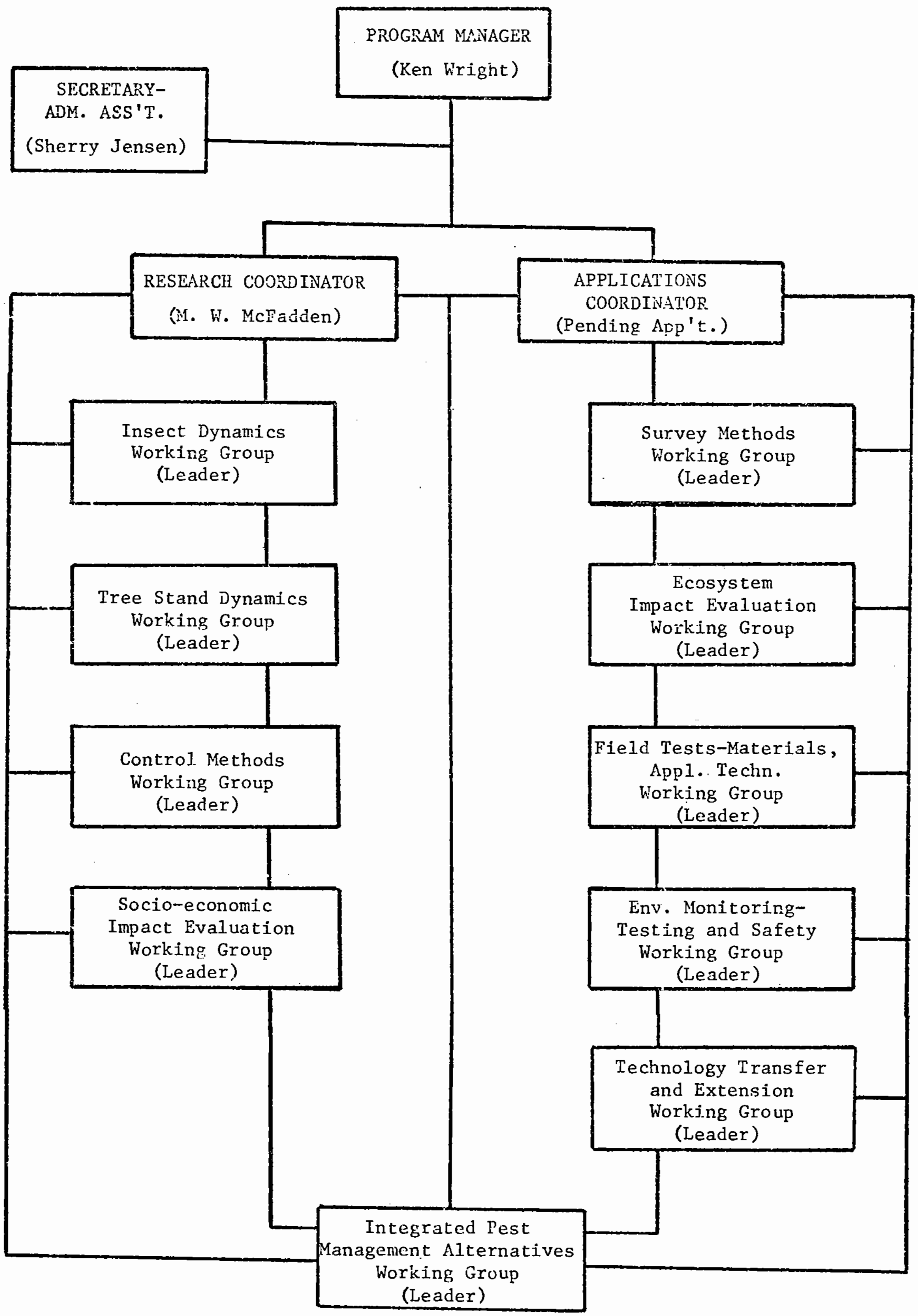



Figure 2.--Organization of the expanded Douglas-fir tussock moth program.

PANEL: CURRENT STATUS OF PEST MANAGEMENT PROJECTS

Moderator: Stu Whitney

Participants: Jim Byler, Jack Coster, John Hodges, Bill Padgett, Les Safranyik and Stu Whitney

Notes:

1. This panel provided examples of the action that various forest-pest Research and Management Establishments are currently taking towards solving problems, where the cause of the trouble involves both forest entomology, forest pathology and probably other disciplines too.

2. Apart from Byler's paper on Pest Damage Inventory and Padgett's annotated listing of Ent. and Path. problems in the Northeast, the panel addressed itself primarily to the non- or less-orthodox-entomological aspects of bark beetle problems.

3. We were sorry that neither Al Shigo nor Dave Fellin were able to be present to give us their perspectives respectively on, Beech Scale-Tree Disease Interactions and Evaluation of the Biological Environmental Effects of Harvesting Systems with Special Reference to Insect and Disease Problems.

Pest Damage Inventory: James W. Byler

Forest managers need reliable information on losses caused by insects and diseases. To meet this need in California, pathologists and entomologists -- with the help of many other specialists -- have been developing a system for measuring and evaluating pest-caused damage. The data for this Forest Pest Evaluation System come from several sources, one of which is the Pest Damage Inventory.

An important feature of the Pest Damage Inventory (PDI) is that it measures the tree mortality caused by all pests on all major tree species at the same time. The direct effect of the pest, not pest incidence, is measured.

A second feature of the PDI is that the cause of tree death is expressed as a pest complex. This is realistic since more than one agent commonly contributes to the death of a tree. Insect complexes, disease complexes, and insect/disease complexes are commonly encountered. The ultimate aim is to identify pathogen/insect/stand/site/climatic complexes responsible for the mortality and to describe the relationships between these factors.

A third feature of the PDI is that it emphasizes forest management rather than pest control. High-loss stands will be identified and scheduled for treatment as part of the management planning process.

The California Region of the Forest Service has been working on the PDI for three years. Each field season a successively larger area has been surveyed; the most recent was the entire timber-growing portion of the Stanislaus National Forest. Results of this survey are not yet available, so I will discuss the methods and results of the 1973 survey of a 100,000-acre portion of the Eldorado National Forest.

The 1973 survey had three main objectives: to measure tree mortality, or the number of dead trees for the survey area, by size class, tree species, and timber type; to identify the disease/insect complexes causing the damage; to describe the stand and site factors that predisposed the trees to attack by insects and diseases.

## Methods

A combination of remote sensing and ground survey techniques was used. The survey area was stratified into three timber types -- pine, mixed conifer, and red fir. A random area sample was selected within each type stratum and aerial photographs were taken of these areas.

The aerial photographs were then interpreted in stereo for dead trees. Each group of recently-killed trees (as determined by foliage color, primarily) was circled on the photos and the number, species, and size class of the trees were recorded.

A field crew, using the aerial photos, located randomly-selected dead tree groups on the ground, measured the trees, examined them for insects, diseases, and contributing conditions, and recorded the data on forms.

Computer programs were developed and used for data input, manipulation, retrieval and analysis.

## Results and Discussion

Tables 1 and 2 illustrate the type of damage estimates that were obtained.

Tree mortality is expressed in Table 1 as the number of trees killed during the survey year within each of the three timber type strata. Essentially the same number of trees was killed in each type per acre (there were more acres in mixed conifer than in pine or red fir). The damage was about 0.11 trees/acre/year, representing a low-level chronic loss.

Table 2 gives estimates of tree mortality for several stand condition classes within the photo plots. Stand condition classes are units used in forest management planning.

Mortality is expressed as number of dead trees per acre per year and dead tree volumes per acre per year. Based on this data, we would say that the overmature stands should be cut first from the standpoint of insect and disease mortality. Foresters knew that this was the case, but with quantitative estimates of the damage for these and other stand condition classes, management planners can consider the relative importance of pest damage among all the other biological and management considerations and schedule cutting in various stands accordingly.

TABLE 1. Pest-Caused Tree Mortality; by Timber Type

| TIMBER TYPE | NO. OF DEAD TREES |
|---|---|
| Pine | 1249 ± 176 |
| Mixed Conifer | 6940 ± 1900 |
| Red Fir | 1242 ± 184 |
| TOTAL | 9568 ± 1189 |

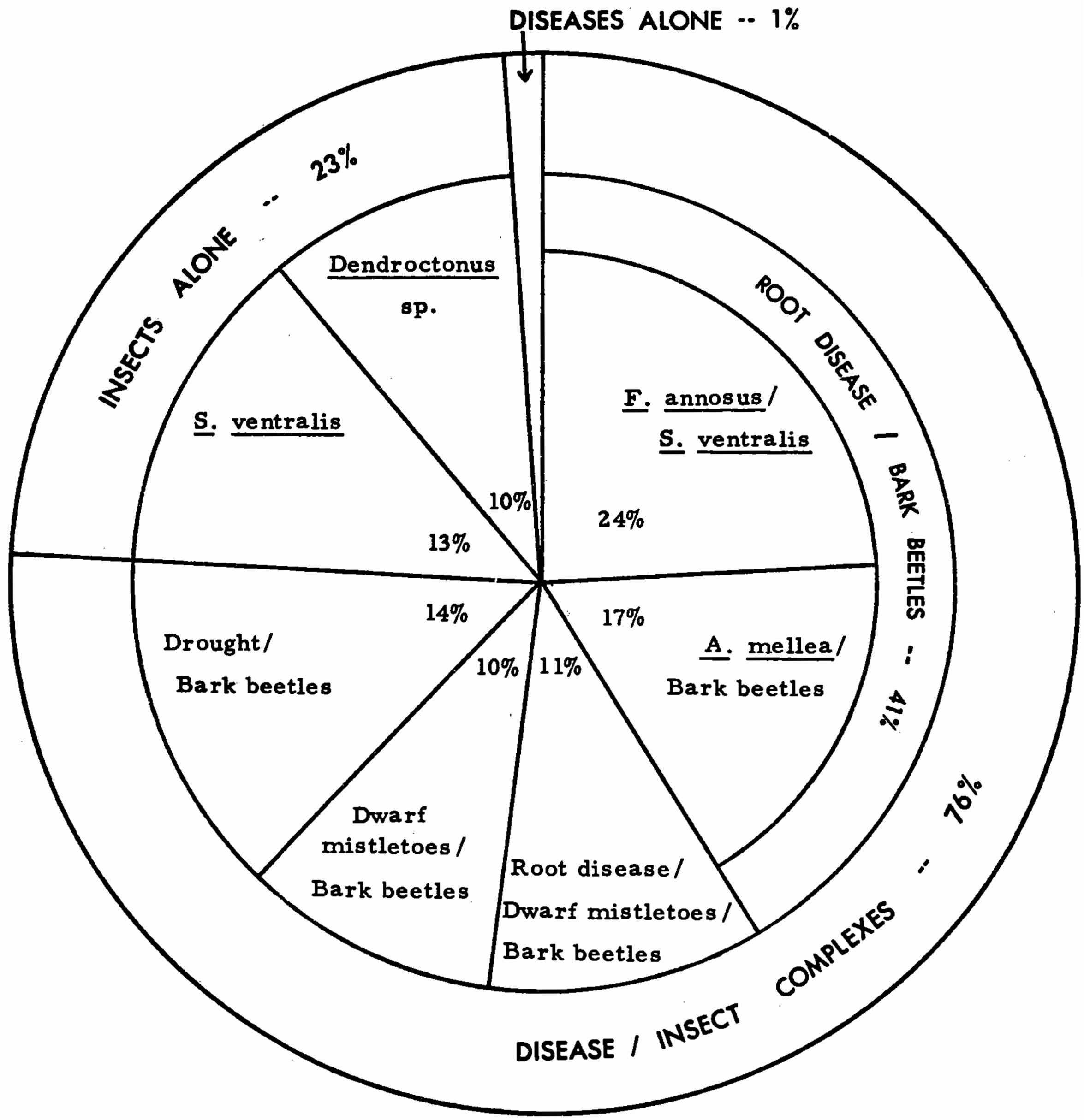
TABLE 2. Pest-Caused Tree Mortality; by Stand Condition Class

| STAND CONDITION CLASS | DEAD TREES (NO.) | DEAD TREES PER ACRE | VOLUME (cu.ft./acre) |
|---|---|---|---|
| Young Sawtimber | 1,201 | 0.09 | 0.5 |
| Mature Sawtimber | 1,457 | 0.05 | 3.2 |
| Two-Story Stands | 973 | 0.07 | 0.3 |
| Overmature Stands | 2,815 | 0.13 | 5.7 |

Most of the trees in the study area were killed by disease/insect complexes, not by a single insect or disease (Figure 1). A disease/insect complex refers to an insect species and disease-causing agent that both contribute to the death of the tree. Mortality is expressed in Figure 1 as the percentage of all trees killed. We also obtained reliable estimates of the number of trees killed by each of the most frequently occurring insect and disease/insect complexes.

Most of the information on the stand and site factors that predisposed the trees to attack by insects and diseases comes from a second stage of the Inventory. I won't describe the methods for

FIGURE 1. The Percentages of Sample Trees Killed by Individual Diseases, Insects, and Disease/Insect Complexes.



this stage, but I will describe briefly the type of information that we are getting using two pest complexes. One complex is composed of Fomes annosus root rot and the fir engraver beetle, Scolytus ventralis (FA/SV). The other comprises F. annosus, S. ventralis, and the dwarf mistletoes of white and red firs (FA/SV/DW).

The stands in which the FA/SV/DW complex killed trees tended to be pure fir or mixed conifer with predominant fir, and they tended to be the overmature sawtimber stands, typically with a young understory. Little mortality from this FA/SV/DW complex occurred in stands that were young, or those that were predominantly pine.

On the other hand, most of the killing by the FA/SV complex was in mixed conifer stands, many of which were predominantly pine; almost all of the FA/SV mortality was in young sawtimber stands.

This may be an important distinction. The FA/SV/DW complex should be less of a problem as the old-growth timber stands are cut, but the FA/SV problem will likely increase.

Conclusion

In closing I will suggest three applications of Pest Damage Inventory results:

1. Impact Evaluation. By making systematic, continuing surveys of the National Forests of the Region, we will for the first time have valid damage estimates for the pests and pest complexes for making impact evaluations.

2. Timber Management Planning. By providing quantitative damage estimates for the stand condition classes, we can influence timber management plans on the National Forests.

3. Pest Management Prescriptions. By identifying the high loss stand condition classes, the pest complexes that killed the trees, and the stand and site factors that predisposed the trees to damage, we can make management prescriptions for these pests in the form of silvicultural treatments.

Host Physiology and Susceptibility to the Southern Pine Beetle: John D. Hodges

Past research has been aimed at determining how supposedly susceptible trees differ physiologically from "normal" trees. We have examined differences in the physical and chemical properties of the oleoresin and chemical properties of the inner-bark tissue. So far the indication is that increased susceptibility is due to a decrease in total exudation of oleoresin.

In some of our current work, we are testing trees against the beetle. This required the development of a techniques for obtaining controlled attacks of the southern pine beetle. The research is designed to determine (1) how many beetles it takes for a successful attack (and, consequently, death of the tree) and how this is related to physiological condition of the tree, and (2) whether or not certain physiological parameters can be used to assess or predict susceptibility to attack. Preliminary results were discussed.

Some ideas concerning the possible role of host physiology in the development of a pest management program were presented.

Stand and Site Factors in Southern Pine Beetle Outbreaks: Jack E. Coster and Kenneth G. Watterston, presented by Coster

An intensive survey of southern pine beetle (SPB) infestations was begun in 1974 in cooperation with the Southern Forest Experiment Station with the aim of evaluating site factors and stand characteristics as they relate to the occurrence of beetle infestations. Occurrence of disturbance factors in the infestations is also being noted. In addition to the field information, soil samples are analyzed in the lab. The ultimate use of the results will be as input to the development of hazard-rating systems for southern pine stands.

Field information consists of: infestation characteristics (size, number of infested trees, age of infestation), stand characteristics (host species, tree size, tree age, basal areas of pines and hardwoods, radial growth), stand disturbance (logging damage, lightning, flooding, fire, wind-ice damage, previous insect infestations) and physiography and soil description (land form, soil texture, water regime, accessory characteristics). Laboratory analysis of the soil samples consists of: texture, organic matter content, phosphorus, cations, cation exchange capacity, percent base saturation, pH, moisture equivalent, and xylene equivalent.

Preliminary results show that basal areas of pine and hardwood as well as radial growth are the stand characteristics most often correlated with infested stands. Of the disturbance factors, lightning is found at the point of origin of 20% of the infestations. The studies will continue for two more years.

A Conceptual Model of Spruce Beetle Population Dynamics: Les Safranyik and Stu Whitney, presented by Whitney.

Background

In 1972, a multidiscipline, coordinated research project was developed at the Pacific Forest Research Centre, Victoria, B.C. with the main objective of reducing losses from woodboring and phloem feeding insects. The research team is comprised of six scientists: one tree physiologist, a pathologist, an insect physiologist, two insect biologists and an insect ecologist. At present, this team is studying spruce beetle problems in Western Canada and their main objective is to develop management guidelines to reduce losses in high hazard areas.

Purpose and Scope of the Model

It was decided to develop a model for evaluating the effects of a) various management practices; b) climate, tree and stand variables; and c) beetle population size and quality on stand depletion by the spruce beetle. The results of this analysis will be used for 1) evaluating current research efforts and 2) to set research priorities in order to develop the best management guidelines for reducing losses in spruce - from the action of spruce bark beetles.

It is a conceptual or theoretical model because the mathematical formulations of the interrelations among variables in each of the sub-models are derived from the collective intuition, experience or hypothesis of the research team. Only a limited amount of data was used in the construction of the various fragmental equations.

Model Development

Decisions on the scope and purpose of the model, the variables to be included, the interactions among variables and on time sequence and pattern of the occurrence of the relationships were made during a series of meetings. Subsequent mathematical formulations, development of sub-models, flow-charting, programming, testing and refinement were done by Les Safranyik in consultation with members of the research team.

The model is comprised of the following 15 sub-models:

1. Stand: Generates average tree height, Dbh, density of spruce by three site classes, as well as windthrow density separately on well drained and soggy soil. Also, generates slash surface area, windthrow surface area on cutting edges and inside stand.

2. Tree Susceptibility: Generates the probability of tree susceptibility separately for soggy and well drained soil and the density of susceptible trees.

3. Beetle: Generates size of attacking female beetle populations.

4. Attacks: Generates attack density in windfall, slash and live trees as well as flight loss.

5. Surface Area: Generates the proportion of the searching females that will attack slash, windfall and standing trees; the proportion of susceptible trees that will be attacked; the proportion of attacked trees that will die; and the density of trees dying on account of attack.

6. Eggs: Generates beetle quality; eggs laid per female; average gallery length; egg density.

7. Development: Generates the proportion of individuals that come through a one year life-cycle.

8-13. Sub-models of beetle development and survival: Generates, separately for each of the three kinds of host materials and first and second year of the life cycle, survival through summer; mortality from competition, insect parasites and predators; winter mortality and host related mortality.

14. Population: Generates total beetle population for area, the proportions coming through 1 or 2 year life cycle, proportions emerging from the three kinds of host materials.

15. Plotting sub-routine:

<u>The driving variables are as follows:</u>

A. Climatic: 1) wind 2) precipitation 3) temperature

B. Man's actions: 1) logged acreages 2) width/length ratio of logged area 3) stump height 4) slash and windthrow removal 5) proportion of population removed through direct control

C. Site factors: 1) proportion of land area comprised of poor, medium and good site 2) proportion of each site with well drained and soggy soil

D. Stand factors: 1) species composition (=proportion of spruce in stand) 2) proportion of spruce stems with visible decay.

<u>What Kind of Information Can We Generate?</u>

Numerous relationships between interacting variables can be evaluated using this model. For purposes of examples a few graphs were generated using real climate data from Prince George, B.C. (The Spruce Capital of North America!) from 1916 to 1973 inclusive. We assumed the stand was 150 years old in 1971, contained only pure spruce growing on the best site on soggy soil, and that there was no significant amount of rot in the stand. Two examples are now illustrated.

The total numbers of female adults emerging on 10,000 acres and available to attack trees in the years 1917-1973 inclusive are shown in Figure 1. The location of the horizontal lines at the top indicate the periods of known or suspected outbreaks in the Prince George area. We do not know much about the 1939-1944 outbreak but we do know that there was a major outbreak in Colorado during this period. It is seen that the model simulated the occurrence of outbreaks surprisingly well. Figure 2 shows there is a close but curvilinear relationship between the number of trees attacked and the number of trees killed.

Other interrelationships emerging from preliminary "what-if?" scenarios are:

a) The number of attacked trees is related quite closely to the size of the beetle population. But, the number of attacked trees is not equal to the number of killed trees.

b) Outbreaks do not necessarily follow or coincide with periods of windfall.

c) Attack density in windfall in the following year is somewhat related to female density

d) Population quality (measured from 0.1 to 1.9 with 1.0 designating the average or "normal" situation) in the current year tends to be inversely related to population density in the previous year.

e) There does not seem to be any relationship between the percentage of population emerging from windfall and the total number of females.

f) Nor is there much relationship between the percentage of one year life cycle beetles and the density of attacked trees the following year.

Further Work and Model Development.

A. As indicated earlier, the model will be subjected to a sensitivity analysis and the results will be used for evaluation of study goals and research priorities.

B. We are planning to refine the structure of the sub-models and refine the parameters of the fragmental equations when data become available.

C. We are planning to use this model as an aid in developing management guidelines to reduce losses from spruce beetle.

Fig. 1

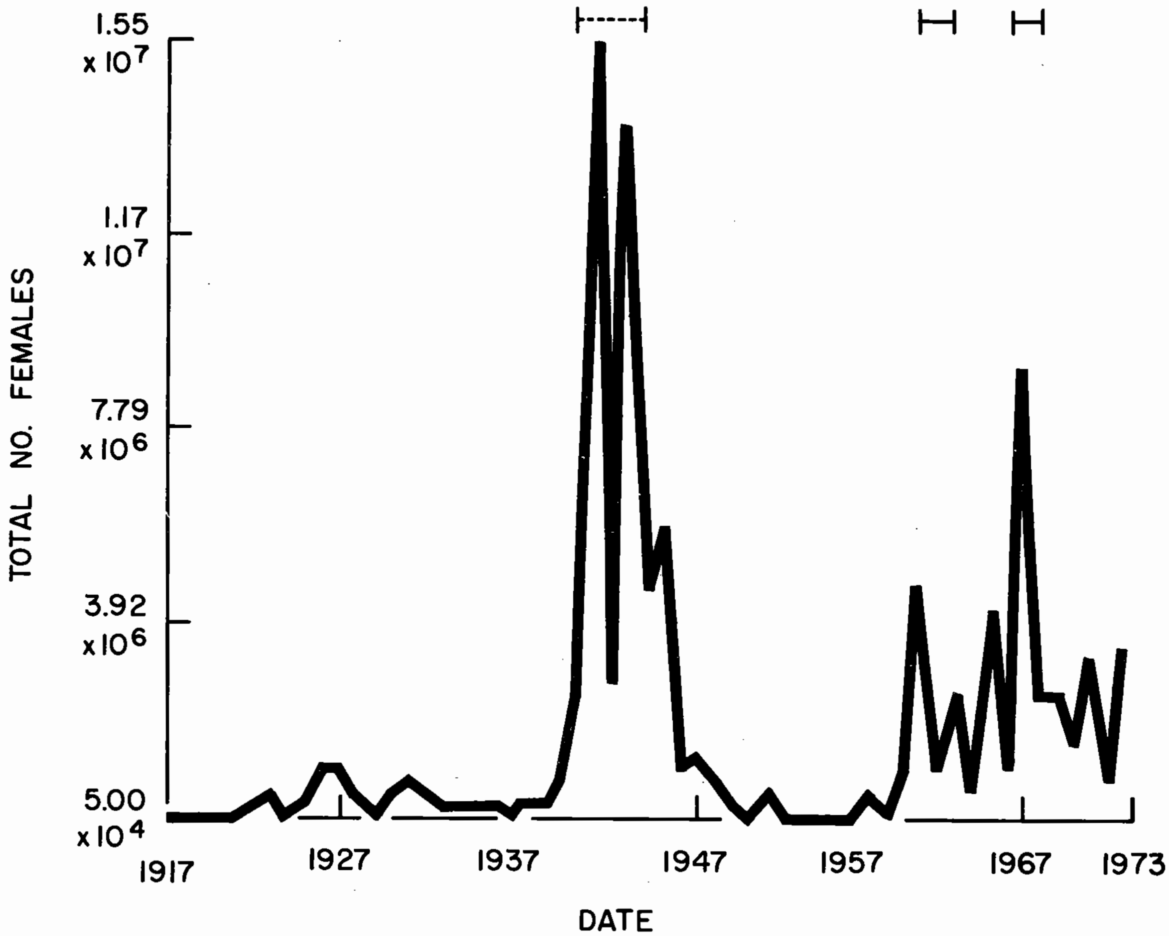
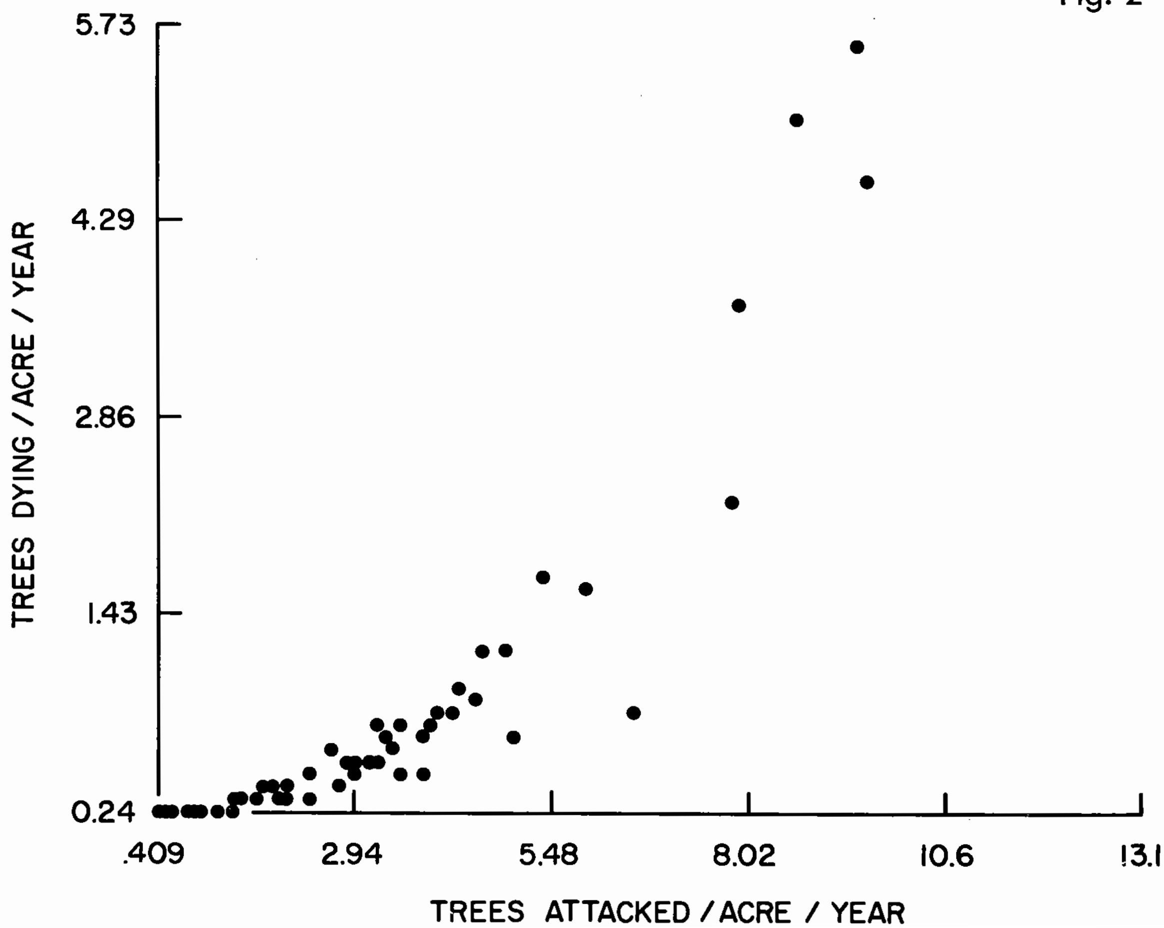

1.55
x 10^7
1.17
x 10^7
7.79
x 10^6
3.92
x 10^6
5.00
x 10^4
TOTAL NO. FEMALES
1917
1927
1937
1947
1957
1967
1973
DATE

Fig. 2


5.73
4.29
2.86
1.43
0.24
TREES DYING / ACRE / YEAR
.409
2.94
5.48
8.02
10.6
13.1
TREES ATTACKED / ACRE / YEAR

PANEL: REMOTE SENSING WORKSHOP

Moderator: Robert C. Heller

Participants: R. C. Heller, William Ciesla, Robert Averill, Phil Weber, John Wear, Jule Caylor, John Harris, Dave Greenbank

Notes: We had about 35 people who showed up and stayed until our last panelist, Dave Greenbank finished his contribution about 6:00 p.m.

The status of remote sensing to detect forest insects and diseases: R. C. Heller, University of Idaho.

Symptoms of damage by forest insects and diseases which cause changes in foliage color lend themselves to detection by some form of remote sensing. Examples (Table 1) are given of damages which have been detected successfully by normal color and color infrared films at various scales. High altitude color infrared film is one of the most efficient means of detecting severe damage over large areas; however, light to moderate damage or discoloration symptoms in single trees will not be detected with a high degree of accuracy at this scale. Other methods of remote sensing such as multispectral photography, radar, multispectral scanners and satellite imagery are discussed for application to detection of forest insect or disease detection. These other methods are not as effective as aerial photography at this time. Multispectral scanning and radar are very expensive, require an extremely high level of technical competence, and use of expensive equipment. ERTS satellite imagery has too coarse resolution and wavelengths too broad to detect the subtle discolorations associated with forest insect or disease damage symptoms.

Table 1. Rating 1/ of color and color infrared films for damage detection and evaluation.

| Damaging Agent 3/ | Color | | | Color Infrared | | |
|---|---|---|---|---|---|---|
| | Scale 2/ | | | | | |
| | Large | Medium | Small | Large | Medium | Small |
| Insects | | | | | | |
| Bark beetles | | | | | | |
| Southern pine | 2 | 1 | - | 2 | 2 | - |
| Western pine | 2 | 2 | 1 | - | 2 | 2 |
| Mountain pine | 2 | 2 | 2 | 2 | 2 | 2 |
| Douglas-fir | 2 | 2 | 1 | 2 | 1 | 1 |
| Defoliators | | | | | | |
| Spruce budworm | 2 | 1 | - | 2 | 2 | - |
| Tussock moth | 2 | 2 | - | 2 | 2 | - |
| Terminal feeders | | | | | | |
| White pine weevil | 2 | 0 | 0 | - | - | - |
| Sucking insects | | | | | | |
| Balsam woolly aphid | 2 | 2 | 0 | 2 | 1 | 0 |
| Diseases | | | | | | |
| Blister rust | 2 | 0 | 0 | - | 0 | 0 |
| Dutch elm | - | - | - | - | 2 | 1 |
| Dwarf mistletoe | 2 | 1 | - | - | 2 | 1 |
| Oak wilt | - | 2 | 0 | - | 1 | 0 |
| Ash dieback | 2 | 0 | 0 | 0 | 0 | 0 |
| Oxidant air pollution | 2 | 1 | 0 | 1 | 0 | 0 |
| $SO_2$ injury | 2 | 0 | 0 | 1 | 0 | 0 |

1/ Rating code: - = not tested; 0 = not useful or practical
1 = fair; 2 = good.

2/ Scale: Large 1:600 to 1:4,000; Medium 1:8,000 to 1:20,000; Small 1:30,000 to 1:80,000. Ultra small scales 1:125,000 to 1:1,000,000 are not classified in this table.

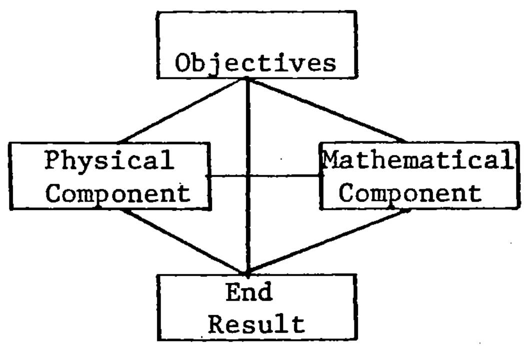
3/ Scientific names of insects and diseases are listed in Table 2.

4/ Used for sampling only at large photo scales.

Region 1 Involvement with Remote Sensing in FIDM: W. M. Ciesla, USFS, R-1

Forests of northern Idaho and Montana are plagued by a variety of extremely destructive insect and disease agents. In recent years, massive epidemics have provided opportunities to evaluate remote sensing as a survey tool for a wide variety of applications.

We view remote sensing as a component of an overall survey system. A model of a survey system may be expressed as follows:




The physical component includes such criteria as flying height, photoscale, film type, format, etc. The mathematical component includes statistical design, sampling intensity, design and aquisition of ground truth. These components are dictated by survey objectives to your desired data. Physical and mathematical components of a survey system are interrelated and both aspects must be fully integrated to achieve survey objectives.

Color and color IR aerial photography has been used successfully in biological evaluation, impact evaluation, and evaluation designed to assess effectiveness of suppression programs. Examples of successful use of aerial photo surveys include a 3-year evaluation of Douglas-fir beetle outbreaks in the North Fork Clearwater River of Idaho and multistage surveys of mountain pine beetle outbreaks in western Montana. A survey system using two levels of photography and ground sampling has been designed for assessment of impacts of western spruce budworm on forest resources. We hope to implement this survey in 1975. In forest disease evaluation, color and color IR photos are being used to assess impact of root rot in mixed conifer stands in northern Idaho and to monitor disease in the Coeur d'Alene nursery. Fall coloring of understory herbaceous vegetation is an aid in detecting root rot centers. Damage caused by various atmospheric pollutants is detectable in color aerial photos.

Availability of U-2 underflight photography of western Montana taken in conjunction with the ERTS program provided an opportunity to evaluate high level, ultrasmall-scale color IR photos for detection of insect damage. Defoliation by pine butterfly was readily visible in stands of pure or nearly pure host type with little or no herbaceous understory vegetation.

A problem which tends to prohibit full operational use of aerial photography in Forest Insect and Disease Management (FIDM) is lack of availability of specialized aircraft and camera equipment. Contractors seem reluctant to bid on FIDM applications because of rigid timing specifications. The merits of color versus color IR film for FIDM applications were discussed relative to specific requirements for haze penetration, used for differentiation of forest types or identifying subtle color differences between damage by various causal agents.

Recent publications dealing exclusively or in part with the use of color and color IR aerial photography for FIDM applications issued by R-1 Forest Environmental Protection staff group are as follows:

Bousfield, W. E., 1973. Estimating losses caused by the Douglas-fir beetle in the Northern Region. Proceedings symposium. Management and utilization of remote sensing data, Sioux Falls, South Dakota. Am. Soc, Photogrammetry:557-563.

Bousfield, W. E., M. D. McGregor, and S. Kohler, 1973. Mountain pine beetle impact survey on the Ninemile District, Lolo NF and surrounding state and private lands. USDA Forest Service, Northern Region, I&D Rpt. 73-7.

Carlson, C. E. and J. E. Dewey, 1972. Environmental pollution by fluorides in Flathead National Forest and Glacier National Park. USDA Forest Service, Div. S&PF, Missoula, Montana. 57 pp.

Carlson, C. E., M. D. McGregor, and N. M. Davis, 1974. Sulfur damage to Douglas-fir near a pulp and paper mill in western Montana. USDA Forest Service, Northern Region, I&D Rpt. 74-13.

Ciesla, W. M., M. M. Furniss, M. D. McGregor, and W. E. Bousfield, 1971. Evaluation of Douglas-fir beetle infestations in the North Fork Clearwater River drainage, Idaho--1971. USDA Forest Service, Northern Region, Div. S&PF, I&D Rpt. 71-46.

Ciesla, W. M., 1974. Forest insect damage from high-altidude color IR photos. Photogrammetric Eng. 41:683-689.

McGregor, M. D., W. E. Bousfield, and Dewey Almas, 1972. Evaluation of the Douglas-fir beetle infestation in the North Fork Clearwater River drainage, Idaho--1972. USDA Forest Service, Northern Region, I&D Rpt. I-72-10.

McGregor, M. D., M. M. Furniss, W. E. Bousfield, D. P. Almas, P. J. Gravelle, and R. D. Oakes, 1974. Evaluation of the Douglas-fir beetle infestation, North Fork Clearwater River drainage, Northern Idaho--1970-73. USDA Forest Service, Northern Region, I&D Rpt. 74-7.

McGregor, M. D., W. E. Bousfield, R. D. Lood, and H. E. Meyer, 1974. Mountain pine beetle impact survey Ninemile drainage, Lolo NF and state and private lands, Montana, 1973. USDA Forest Service, Northern Region, I&D Rpt. 74-22.

Williams, R. E., 1973. Color infrared photography for root disease detection in the Northern Region. USDA Forest Service, Northern Region, I&D Rpt. 73-22

Copies of these publications are available on request.

Evaluation of Mountain Pine Beetle with 70mm Color Photography and Ground Techniques: Robert Averill, USFS, R-2.

On the Black Hills National Forest Aerial evaluation of Mountain Pine Beetle was conducted from 1971 to 1973, a variety of Hasselblad camera systems and films were tested. The camera systems and films used were satisfactory. Photo reading errors were: lightning-struck trees, late faders and overtopped infested trees. Lack of stratification of the sample area hampered the statistical reliability. Ground truthing of selected areas in effect resulted in double sampling. In 1974 ground surveys and aerial mapping of infested patches resulted in reliable estimates of infested trees at a lower cost.

How Good is Satellite Imagery for Detecting Mountain Pine Beetle Infestations? F. P. Weber. Forest Economics and Marketing Research, WO.

We did not receive Phil's contribution at the time these summaries had to be forwarded. Phil reported primarily that neither the computer processing of ERTS data tapes nor the optical combining of the ERTS images was successful in detecting and mapping large bark beetle infestations in the Black Hills. Color infrared aerial photography (scale 1:32,000) was the most useful sensor for mapping the large infestations.

Pros and Cons of Remote Sensing for Douglas-fir Impact Surveys in the Pacific Northwest: John F. Wear, USFS, R-6.

Despite a broad array of sophisticated remote sensing techniques and equipment on the market today, only a few can be considered helpful in providing answers for insect and disease problems today. Optical mechanical scanners, thermal scanners, and radar imagery have unacceptable resolution, complicated systems, and are generally not applicable to most forestry problems. Multispectral scanners, operating from satellite altitudes, have some possibilities of use for detecting mortality and very heavy concentrations of Douglas-fir tussock moth epidemics. Work by Dr. J. Herzog, O.S.U., has shown moderate success in identifying moderate, heavy, and dead categories in solid canopy, old growth Douglas-fir stands that are five acres or more in size. Additional R & D is expected in this area. ERTS imagery using channels 4, 5, 6, and 7 in photographic composites have not shown promise. The biggest hangup on MSS imagery or digital tapes is the 6 month turnaround from Sioux Falls, S.D. and the 1 to 3 month lag in processing tapes.

The most productive and practical remote sensing technique today is still aerial photography for evaluating the impact of forest insect outbreaks. Color and particularly color infrared films at relatively large scales (1:4000) have proved highly effective in differentiating 5 damage categories of defoliation caused by the tussock moth. Multiband image enhancement techniques using 4 or 6 lens photography has not proved superior to color infrared (CIR), 2443, taken with G (15) filter, 10 CC blue, and 20 CC magenta filters. NASA 1:30,000 scale CIR taken from the U-2 jet is being studied by the Washington State Dept. of Natural Resources in conjunction with ground truth from the 1:4000 CIR U.S. Forest Service imagery. Microdensitometer analysis of the U-2 photos shows good correlations with heavy and moderate categories of damage, and about 35% with light damage. Additional study is being conducted to improve photo interpretation techniques.

At this time, our primary viable tool for obtaining impace survey data on defoliator problems such as the Douglas-fir tussock moth or the western spruce budworm is to specify large scale color or color infrared photography on a sampling basis for areas larger than a township in size and total photo coverage for smaller size areas. It is my estimate that practical forest survey technology using the other more sophisticated remote sensing techniques will not be operational for another 5 to 10 years.

New Techniques and Equipment for Interpreting 9x9 Color Aerial Transparencies in the Office and in the Field: Jule A. Caylor, USFS, R-5.

Sequential photographic techniques were utilized in a study to evaluate usefulness of synthetic aggregating pheromones in suppressing and sampling in-flight western pine beetle populations in California. The author described practical office procedures for precisely interpreting changes over time in incidence of tree mortality on a 48-square mile area by visually comparing, tree-by-tree, corresponding images on seven sequential photo sets taken over a 3-½ year period. He also described a practical field technique for efficiently using large format transparencies stereoscopically in the field to locate individual trees for ground checking. The study required very high precision of the photo interpretation estimates and enormous numbers of sequential image comparisons. The requirements of the photo interpretation resulted in building unique equipment for illumination and juxtaposition of sequential stereo models, for optical examination of the photos, and for utilization fo stereoscopy with the transparencies in the field. A sunlight illuminated stereo light board, allowing easy use of transparencies stereoscopically in the field, made large format transparencies entirely practical for field use. The techniques and equipment were available for examination.

Remote Sensing Techniques, Including Small Scale Photography and ERTS (LANDSAT) Imagery, Applied to Forest Pest Surveys In British Columbia: John W. E. Harris, Pacific Forest Research Centre, Victoria, B. C.

Aerial forest pest surveys in British Columbia currently are done by sketch-mapping from small aircraft, but there is a inaccessible areas that are involved. This need could be met by using suitable remote sensing techniques. Studies showed that conventional large-scale vertical and oblique color aerial photography was a useful supplement to aerial observations. Small scale (1:120,000 approximately) color photography also was tested and found to be of assistance in defining damage caused by both defoliators and bark beetles. A significant advantage of this scale of photography was the ease of handling the limited numbers of photographs needed to cover infestations. Disadvantages were the difficulty in obtaining this type of photography when required, and the necessity af showing that the better information obtained justified additional costs.

ERTS-1 imagery was also assessed, and in one infestation of spruce budworm in the interior of the province large areas of damage contrasting well with the surrounding uninfested areas could be detected. Color composites prepared by the Canada Centre for Remote Sensing and printed by the National Air Photo Library, Ottawa, using bands 4, 5, and 6; 5, 6, and 7; and 4, 5, and 7 were equally useful. However, while specific areas of damage were detectable, other areas were not; the resolution was not adequate to permit complete surveys to be made. Nevertheless, resource satellites provide routinely available data that is cost-shared by miltiple users, so with probable improvements in the future, satellites may become of considerable value in pest survey programs.

New Techniques in Studying Spruce Budworm Moth Dispersal: D. O. Greenbank, Canadian Forestry Service, Fredericton, N.B.

The Maritimes Forest Research Centre of the Canadian Forestry Service began an intensive program of research in 1973 on the dispersal process of spruce budworm moths. The aim of the program was to investigate the density and height distribution of moths in the airspace, the duration of flight and the nightly displacement of moths, the proportion of a local population emigrating and its reproductive potential, the number of flights made by an individual, and the role of uniform vs. convergent winds in transporting, concentrating, and depositing budworm moths. To fulfill these aims new techniques were employed and these included the successful use of ground based radar operating on a wavelength of 3.2 cm for monitoring the aerial densities of budworm moths with respect to altitude and time.

## WORKSHOP

### RESULTS OF THE 1974 DOUGLAS-FIR TUSSOCK MOTH INSECTICIDE PROGRAM

Moderator: Carroll B. Williams, Jr.

Participants[1/]: Bob Dolph, Dave Graham, Charles Henny, Steve Kohler, George Markin, Tom Palmer, Patrick Shea

The Douglas-fir Tussock Moth (DFTM) Workshop first examined the series of insecticide applications against declining DFTM populations in the Pacific Northwest, Montana and Idaho. These consisted of:

1. The major DDT Control Operation on 427,000 acres.

2. The DDT variable dosage experiments.

3. Pilot tests and field experiments of Dylox, Sevin-4-oil and other "alternative" insecticides, applied at different scales from single trees to hundreds of acres of apparently DFTM infested forests.

Generally the results of these tests consistently showed an apparent high field effectiveness of DDT when applied at different dosages in one gallon of fuel oil against DFTM populations. In contrast the performances of the alternative insecticides were highly variable from place to place in the various tests, and they did not consistently achieve the high mortality that was obtained in the DDT treatments. However, there were some exceptions to this.

Although applications of Sevin-4-oil at 1 lb./qt./acre gave highly variable results in the pilot and field tests conducted near Halfway, Oregon, applications of this insecticide at 2 lbs./1/2 gal./acre reduced DFTM populations by 95 to 99 percent in pilot tests in Idaho and Montana. Orthene, a systemic organophosphate, applied at 1 lb./2 gal./acre produced over 95 percent DFTM mortality seven days following treatment. Ground tests of 15 new insecticides applied at

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1/The workshop contained over 50 participants. The ones listed here are those who formally presented data from the various studies of interest.

three different dosage levels to DFTM on single trees were discussed. Seven materials produced over 95 percent control. Two of them, Phosvel and 3/4 lb. DDT, gave 100 percent control.

It appeared to many attending this workshop that the variable results in the performance of the alternative insecticides were caused mainly by poor coverage of the target areas by materials applied in volumes less than a gallon per acre. Much of this information came from data presented by Pat Shea for the field tests of DDT, Dylox, and Seven-4-oil conducted by Forest Service Research personnel at Halfway, Oregon. This data indicated that the test designs in which spray volumes and droplet sizes differed among the three insecticides, did not provide a valid comparison of field efficacy between these materials. DDT, for example, may have shown superior results partly because of better foliage coverage. The DDT treatment provided the best coverage of the study plots, averaging .121 gallons per acre (GPA) and 11.6 droplets per square centimeter on the spray plates and cards. The Dylox treatment provided the next best coverage, averaging .115 GPA and 4.2 droplets/cm$^2$. Sevin-4-oil had the poorest coverage with an average of .032 GPA and 1.6 droplets/cm$^2$.

Although the same nozzle size (8002) and spray pressure (40 to 50 psi) were used when applying all materials, the differences in their viscosity produced different droplet sizes. Droplet size was smallest for DDT and largest for Sevin-4-oil. The VMD's averaged 132, 287, and 314 for DDT, Dylox and Sevin-4-oil respectively.

This also suggests that the apparent improved performance of 2 lbs of Sevin-4-oil applied in 1/2 gal./acre over 1 lb./1 qt./acre may be partly due to increased volume application resulting in better coverage. It is also possible that improved performance is due to increased dosage. We should compare the coverage data for the two dosage treatments of Sevin-4-oil and of Orthene with that of DDT to determine if indeed the differences in their performance is due to coverage.

The high virus levels in the low and variable DFTM populations present on many of the treated areas also helped to obscure and prevent good comparisons of treatment efficacies. It was impossible to distinguish virus induced mortality from insecticide induced mortality in the DFTM larval populations, nor was it possible to measure synergistic impacts of the virus-insecticide combinations on the DFTM larval populations.

The DFTM populations in the Pacific Northwest had completely crashed by the end of the summer and no new egg masses were found in any of the insecticide treated and untreated areas. Although a combination of natural factors contributed to this population crash, substantial data from the research tests indicated virus as the primary agent responsible for the DFTM population crash. The widespread presence of high virus levels in the DFTM populations was determined from egg mass surveys and rearing studies in the fall of 1973 and spring of 1974. It was difficult to find suitable areas, those with high tussock moth populations and low virus levels, to conduct the field tests of insecticides. Many areas scheduled for DDT treatment had to be dropped from the spray program due to lack of population.

The Workshop discussed the criteria used to decide when to spray and what results constitued adequate and excellent control. We examined the meaning of the population threshold of 20 DFTM/1000 $in^2$ foliage in terms of rising and declining populations and tree condition. We concluded that it did not have an adequate biological base and that no single threshold value is appropriate to determine the necessity of direct control for the variety of population levels and stand damage conditions, usually found at different points in the DFTM outbreak.

Questions arose about the effectiveness of the DDT program in protecting the forest resources. These couldn't be adequately answered since there was very little data on tree and stand condition before or after the DDT application. With few exceptions there were little differences between the damage appearance of treated and untreated stands.

A very important part of the DDT program was the substantial monitoring effort to determine residue levels and the short range effects of DDT on non-target organisms. This monitoring effort involved 26 agencies and over 460,000 dollars. Water, air, forest vegetation, fish, birds, deer, elk, small mammals, milk and livestock, and human blood samples were examined. No adverse affect was reported to have occurred on people directly associated with the handling, mixing or application of DDT during this project.

The amount of DDT in the fat of livestock grazing on treated areas varied considerably. It ranged from 1 to

73 ppm for cattle and up to 54 ppm for sheep. These residue levels are slowly declining; however, a number of cattle on the Colville Indian Reservation still exceeded the legal marketable residue level of 5 ppm in the spring of 1975, and have been restricted from market. Samples from the fatty tissues of several big game animals (deer and elk), collected during the hunting season, indicated residue levels up to 31 ppm for deer and 48 ppm for elk. The Forest Service advised hunters to consume only the red meat of these animals which showed DDT residue levels less than .50 ppm.

Studies of the acute and long-term effects of the 0.75 lb. DDT application on birds gave mixed and contradicting results. Short-term observations of mountain and western blue bird and house wren nests, by representatives of various 26 governmental agencies, indicated no significant differences in eggs layed or hatched or nestling survival between birds residing in treated and untreated areas. In contrast, the EPA supported studies by Evergreen State College students of forest passerine birds indicated substantial treatment effects. A 24 percent decline was measured in the density of the 14 most common species on the DDT treated plot; whereas, no detectable change occurred on the untreated plot. The three most common species on both plots (Townsend's warbler, yellow-rumped warbler, and chipping sparrow) occupied about 60 percent of the territories covered by the census system. Considering just these three species a decline of 8.2 percent occurred on the non-spray plot simultaneously with a 54.8 percent decline on the plot that received DDT.

Passerine birds may have suffered substantial mortality from the 0.75 lb. DDT application. Between July 7 and August 6 Evergreen State College students found 14 dead or dying birds on 16 searched acres that were treated at the end of June. Only three of these birds were fresh enough and large enough to allow an examination of a brain sample for DDT analyses. The examination revealed that the death of the three birds resulted from the toxic effects of DDT. Considering what is known about the difficulties in finding dead birds when they are present in field situations, the Evergreen State College people conservatively estimate that thousands, and perhaps hundreds of thousands of passerines, died as a result of the DDT application on the 427,000 acres.

Dr. Charles Henny of the U.S. Fish and Wildlife Service - Denver lab describes the beginnings of a long-term study on the effects of the DDT application on Kestrals (sparrow hawks) in eastern Oregon. Blood samples from 50-60 Kestrals showed that a pre-spray background of 110 ppb of DDT metabolites in blood sera had changed in four days post spray to much higher levels for birds in and near the spray boundaries. Those Kestrals sampled 0 - 1.0 mile from the DDT spray boundaries contained 312 ppb of DDT metabolites in their sera. Birds sampled 1.1 to 3.0 miles from the spray area averaged 174 ppb. Only those Kestrals found 6 - 12 miles from the spray area contained the pre-spray levels of 110 ppb of DDT metabolites in their blood sera. The Kestrals will be examined in a long-term study to determine the rate of decline of the DDT metabolites in blood sera and the impact of the DDT operation on nesting success. Other hawks--particularly the Coopers hawk and the Sharp skinned hawk--will also be studied for effects from the DDT application.

These conflicting reports of the effects of the DDT application on bird populations produced a discussion on what are the proper groups of birds to study to ascertain the effects of DDT. Which groups of birds are the most sensitive and vulverable to DDT at the acute toxicity levels and the chronic toxicity levels. Apparently the bird-eating and fish-eating hawks are the most vulnerable in the long run to DDT since they are at the top of several terrestrial and aquatic food chains.

Although the monitoring effort detected no fish kill in streams within the spray boundaries, the Evergreen State College students reported that 643 sculpin fry were found in seven drift nets in Wallupa Creek in the 72-hour period after DDT drift reached the stream. None had been found pre-spray.

Aquatic insects were almost totally eliminated from streams receiving DDT drift that were studied by Forest Service Research personnel and Evergreen State College students. No significant recovery was detectable 4 - 6 weeks following the DDT treatment.

Tom Palmer, meteorologist for the research field tests, described the meteorological conditions that prevailed at several of the study plots under daylight and nighttime conditions, and particularly during the Dylox and Sevin-4-oil applications. Strong upslope currents occurred during the day, switching to strong down-slope winds at night.

Dense inversion layers normally settled in the canyons at night. The small droplets from early morning applications could not penetrate this cold air layer until the inversion broke up under the influence of the sun's rays. However, the strong upslope winds that developed by 8 a.m. blew the fine droplets from midmorning applications out of the area. Insecticide applications made under these conditions have little chance of achieving good coverage of the target area. Yet these fine droplets (those below 50 microns in size) are the most effective for penetrating foliage and impingement on the target insect.

These studies emphasized that a study of the spray physics in aerial application of insecticides under mountainous conditions should receive much greater attention. A proper understanding of spray physics and a capability to effectively use the information is needed before we can consistently obtain good spray coverage on our target areas. Only after we can consistently achieve good coverage of our target area in our insecticide applications will we be able to examine and compare the various properties that affect the field effectiveness of insecticides.

# PESTICIDE REGISTRATION REGULATIONS AND REGULATIONS AFFECTING PESTICIDE USE

ROBERT P. HARRISON AND FRED HONING

In the first workshop Lynn Fransen of E.P.A. Regional office in Seattle gave an historical overview of Federal legislation concerning pesticides followed by a summary of the Federal Insecticide Fungicide and Rodenticide Act (F.I.F.R.A.) as amended 1972.

In the second workshop Fred Honing extracted sections of the act which were particularly pertinent to the use of pesticides in forestry and discussed these in detail.

In both workshops there was extensive discussion of the implication to forest pest control. Of particular concern were the procedures that must be followed by individuals, by State and Private organizations, and what kinds of data must be obtained in order to get the necessary chemical tools with which to work.

The amended F.I.F.R.A. recognizes the necessity of pesticides. However the purpose of the act is to prevent serious misuse of pesticides that may constitute a threat to man and his environment. The thrust of earlier legislation was aimed at regulating the pesticide industry. There were no provisions for controlling the use of pesticides on the consumer level except for residue levels in food or feed crops in interstate commerce. The new law provides for severe penalties for use of any pesticide not in strict conformity with the label. A recent modification of this section allows a State Agency to recommend applications at lower than labeled rates provided that historical or research data are adequate to support such recommendations.

F.I.F.R.A. Amended requires that the Pesticide Industry provide a great deal more data on the environmental chemistry of both old and new products and provisions are made for more comprehensive toxicological data including, if warrented, teratogenicity, tumorgenicity and mutagenicity.

Labeling is much more restrictive and must be more comprehensive and supported by more extensive data. In addition the law restricts the size of area and locations of test areas on which experimental compounds can be applied.

Each compound and formulation is assigned an EPA registration number which must appear prominently on the label. In addition every establishment that makes any modification to a chemical composition must be registered and is assigned a number. These establishment numbers must appear on the label.

All pesticidal compounds are being classified as either for "General Use" or "Restricted Use". This classification must appear on the label.

"General Use" pesticides are those which any one can purchase and use. "Restricted Use" pesticides are those that can only be applied by "Certified Applicators". The law requires that the individual states certify "private and commercial" applicators.

Those involved in forest application of pesticides will be required to hold a "Commercial Applicator" Certificate or greater. These will be obtained through the individual states.

There were a number of questions regarding "Experimental Use Permits" in both workshops. The act states that any person may apply for an Experimental Use Permit in order to obtain data necessary to register a pesticide.

If necessary a temporary tolerance for residues that may result from these applications may be obtained.

These permits are generally not difficult to obtain. However they usually require at least 90 days and the area that may be treated is restricted to a maximum of 10 acres. An effort is being made to enlarge this for temporary permits in forests. There will be no requirement for these during 1975 however.

There are a vast number of unanswered questions, poorly defined procedures and regulations within E.P.A. as well as among those who must operate within the confines of the act. Never-the-less the act is scheduled for complete implementation by October 1976.

Section 18 of the act provides an emergency clause which empowers the Administration to exempt any Federal agency from any parts of the act. However these are difficult to obtain and time consuming. Because of the long delays and difficulty experienced to date the entire act is currently under review by a congressional group.

Al Larson discussed some of the difficulties experienced in Oregon between State, Private and Federal programs and some of the efforts that are underway to resolve some of the questions that have arisen.

Les Morton discussed the affects of the State of Washington's new Forest Practices Act on forest insect control on private lands.

Tighter restrictions and regulations are with us to stay, it appears.

WORKSHOP: BARK BEETLES AND ROOT DISEASES - PINES

MODERATOR: R. W. STARK

From the discussion it is apparent that our knowledge of bark-beetle root disease relationships is still scanty. A modicum of "hard" data and a plethora of circumstantial evidence has convinced most, if not all, of the fifty plus participants that root diseases are a factor predisposing pines to bark beetle attack.

The preponderance of evidence comes from California from studies on the western pine beetle. The probable relationships to date are:

*Fomes annosus* - Major significance
*Verticladiella wagenerii* - Major significance
*Polyporus schweinitzii* - Minor significance
*Armellaria mellea* - Relationship dubious

There appears to be a definite relationship between southern pine beetle attacks and infection by *Fomes annosus* and *Phytophthora cinnamomii*. Very scanty evidence links the mountain pine beetle and *V. wagenerii* and *Poria subacida*.

There was general agreement that bark beetle success, if not attack, in disease-infected trees was in response to a "stress" factor or condition as yet undefined and non-determinable. Stress can be short term or long term and exploited by bark beetles if their attack period juxtaposes with the stress period. Stress can be caused by other factors and agencies than root diseases such as pathogens other than root, defoliation, stand competition, drought, etc. Studies in California have shown that root diseases do cause changes in tree respiration, transpiration and photosynthesis. Attempts to simulate stress using techniques such as artificial defoliation, girdling, etc., have been unproductive. The stress invoked by natural factors is obviously extremely complex.

From the discussions it was concluded:

1. That the tree disease-insect interaction is extremely complex involving as it does the alteration of a living system, complex and plastic. Therefore, we should consciously avoid seeking the simplistic "one-parameter" solution.

2. From the above, it is apparent that if meaningful interpretations leading to protection measures usable by those to whom we are responsible, i.e., resource managers, are to be achieved an interdisciplinary approach is essential. It may well be that the least important members of interdisciplinary "teams" will be entomologists or pathologists.

3. While it is certain that much basic research is necessary we should never forget that the practitioners of forest protection enjoy their state for the value they contribute to resource management.

# SUMMARY

## WORKSHOP ON IMPACT EVALUATION OF PEST COMPLEXES

Moderator: William E. Waters
University of California, Berkeley

This Workshop considered in turn: (1) the concept and definition of forest insect and disease impact(s) in the context of the overall pest management planning and decision process, (2) the development of criteria and methodology for impact evaluation and prediction, (3) specific approaches to the analysis of impact--determination of the really critical agents affecting productivity and values of a given tree species and/or management unit, and (4) data needs for operational impact evaluation. The format of the Workshop was open discussion of the foregoing points; no formal presentations were made. Following are the highlights.

Impact was defined as the net cumulative effects of a given pest, or pest complex, on the productivity, usefulness, and values of a tree species or forest type with respect to specific resource values (timber, watershed protection, recreation, etc.) and management objectives. It is not damage per se, because a given kind and amount of damage will have different effects on management planning and operations according to the resource values and particular management objectives involved in each case. Examples of the effects of different kinds of insects and diseases, and combinations thereof, were discussed in this context.

Reliable quantitative data on the changes in stand parameters (i.e. net growth, age-size distribution of trees, amount of defect, appearance, etc.) due to insect and disease activity are essential for impact evaluation. Estimates of value in terms of dollars or some other meaningful parameter also are needed. The particular combinations of values and management specifications (silvicultural treatments, cutting cycles, rotations, etc.) will be more or less unique in each circumstance. At present, there is no agreed-upon procedure for economically defining and assigning such values, nor is there a method developed for calculating present and future impacts that is generally applicable. Different views on this were expressed by the Workshop participants.

There are at least three approaches to the analysis of forest insect and disease impacts--i.e. analysis in the sense of finding out or comparing the relative importance of different pests over the life span of a tree crop, or over the planning horizon of any management unit, in terms of the real or potential values lost from the different kinds and degrees of damage incurred:

1. Life tables of forest stands.--a ledger of direct and indirect loss in numbers and quality of trees in a given area--or in a representative set of sample plots--from seed (or seedling) to harvest, with the causes of successive losses recorded when they occur,

will provide the basic data for impact analysis. Value increment(s) must also be recorded. Since such data gathering encompasses a long time span, a life table for a given tree species may also be constructed from a large series of sample areas with stand data taken at just 2 or 3 points in time. Losses due to specific agents are recorded by cause and the age-size of tree(s) affected. Details of this approach have been published by Waters 1/, and partial life tables have been developed by a number of researchers in the U.S. and Canada.

2. Stand prognosis models.--Mathematical or algorithmic models that move stands through time and permit the accounting of insect and disease effects in successive intervals, and include tree and stand variables that relate to the probability of occurrence and rates of observed damage and loss, also provide the basis for quantitative analysis of insect and disease impacts--as, for example, the stand prognosis procedure of Stage 2/. A variety of values can be applied to the stands involved, and changes in value increment or decrement can be assessed accordingly. Real or simulated data can be used with this approach.

3. Complete computer simulation.--To gain some insight into the interactions of the biological factors (pest and stand dynamics), the economic factors (resource values), and management specifications (set by particular objectives), a comprehensive computer simulation can be developed to run a large number of possible combinations over time. The data inputs must be realistic so that the outputs are credible. Various examples of particular pest / tree species complexes were discussed in regard to this approach. It was agreed that mixed hardwood complexes present greater difficulties--i.e. a wider range of biological, economic, and sociopolitical factors--than coniferous species complexes generally.

Impact evaluations and projections provide estimates of the benefits to be derived from pest management activities. They can be expressed in terms of either values saved or values gained. They are the economic and/or social benefits component of benefit/cost assessment, which is the primary mechanism for decision-making in any pest management system.

The primary conclusion of the Workshop was that impact evaluation is largely a void--or guesswork--in current forest pest control programs, and that research and practical experience must be brought together now to provide sound criteria and methodology in this critical problem area.

1/ Waters, W.E. 1969. The life table approach to analysis of insect impact. J. Forestry 67: 300-304.
2/ Stage, A.R. 1973. Prognosis model for stand development. USDA, Forest Serv., Intermountain Forest & Range Expt. Sta., Res. Paper INT-137. 32 pp.

BIOLOGICAL EVALUATION OF PEST COMPLEXES -- James Byler, Moderator

Discussion began with an attempt to define "pest complexes." As we used the term it referred to two or more insects and/or diseases acting together to kill the tree. Pest complexes include insect complexes, disease complexes, and disease/insect complexes.

The point was made that pests are agents that cause damage, but there are many other factors besides pests in the tree and stand damage equations. The real complex is an ecosystem complex: a combination of pathogen/insect/stand/site/tree/climatic factors is responsible for the damage. Forest pest management should be based upon the manipulation of key factors that cause the damage, not merely upon suppression of the most prominent insects and pathogens.

Geral McDonald discussed the importance of host resistance in the damage equation, a point that is sometimes overlooked by entomologists and pathologists studying natural systems. He proposed that all co-evolved host/pest systems are characterized by the presence of a level of resistance that is determined by the interactions of selection pressures. The level of resistance is modified by the influence of the environment. Examples of several such systems were discussed with the aid of a conceptual model that illustrated the interaction of selection pressures and the environment.

## DATA COLLECTION, VERIFICATION, AND FILE MANAGEMENT

Moderators: Clifford A. Myers and Peter Rouch

Moderators: The flow of data should be based on the activities and mission of the research project. Data files should be planned during the preparation of study plans, not during the period data are already accumulating. Numerous systems for storage, retrieval, and updating of data files are already operational and available. It is usually unnecessary to start building a new system from scratch, unless the research job requires a complex system. Degree of system complexity will vary with amount of data to be stored, frequency of retrieval or updating of each file, and the amount of preliminary analysis to be done during retrieval. A data file system selected for project use must conform to the search requirements for retrieval. These requirements depend on the amount of data to be handled and the analysis planned. Some systems provide for random search to select specific data sets. Other systems, oriented to magnetic tape, require sequential search or examination of every data set to select those that are to be retrieved for any one analysis.

Jim Barbieri: A study of the effects of smog on ponderosa pine (San Bernardino) requires the handling of large amounts of data. Subject areas include meteorology, vegetation, soils, arthropods, pathogens, and wildlife. As an example of how the items build up, the arthropod data includes sticking, eggs, x-ray treatments, rearing, insects observed in the field, and observations of trees. The research group is involved in: (1) data capture, (2) data banking, and (3) data processing (analyses and modeling). In research, data capture techniques must be dynamic. This affects data banking. There is great need for continuous communication between data collectors and data handlers. They must be sure that they really understand each other's meanings of words and terms. For most situations, analyses of the data should be included in data files.

C. J. DeMars: An evaluation of pheromone treatments requires a ground check of photo interpretation and the mapping of areas of interest. The procedures are being computerized. True coordinates of photo points are computed from known control points. Photo measurements to locate the photo points are obtained with a Numonics digitizer. A teletype provides contact with the computer. The goal is to store all photo data so there will be no need to re-examine the photos. One problem being solved is the identification of infected trees that have already been classed as infected in the past.

Richard H. Smith: Individual tree data on resin composition characteristics of ponderosa pines is being accumulated. A computer program retrieves the data and prints frequency distributions of the terpenes. Much information can be obtained just by looking at and comparing the printouts. Comparisons are made by parts of the tree's range, etc. Another computer program assigns a 5-digit number to each tree on the basis of selected characteristics. The computer can then group similar trees quickly and print the results for further study by the investigator.

# WOOD ROT - INSECT INTERACTION (DECOMPOSITION)

Moderator - Russ Mitchell

Participants - Fluctuated between 15 and 20; names not recorded.

It is estimated that in much of our forests some 90% of a sites nutrient capital is tied up in vegetative material. With some diversion, we discussed the role of diseases and insects in the process of cycling woody material back to the soil--specifically featuring what we already know and what we need to know.

We concluded that there is probably a series of microorganisms and arthropods that work on woody material to bring about mineral cycling. We also concluded that microorganisms and arthropods work closely together in this process, that one probably cannot operate without the help of the other.

In some cases, particularly in the early stages of decomposition, there is good information on the relationships between bark beetles and fungus. Beyond that, though, little is known. We can guess at some of the organisms involved, but we know nothing of the interrelationships, whether arthropods are important vectors or fragmentors or if significant nitrogen fixation occurs. Our information is nil on the rate of decomposition and the environmental conditions that affect rate.

The IBP has made a start in this kind of research, but it is only a start. We concluded that research institutions have been derelict in this area of investigation and deserve criticism. Analysis of the decomposition subsystem is needed now. We are concerned about the trend toward complete utilization in forest management, where whole trees are removed from the woods--roots, bark, limbs, everything. We are concerned that the nonentities in the forest (the unknown microorganisms and arthropods) are so casually dismissed. It may turn out that these are the best friends we have, for it is apparent that we cannot live in the forests without decomposition.

Two areas of field research were also summarized in this workshop. One was by Doug Piirto of the University of California who is studying failure of the giant sequoia as it relates to carpenter ants and heart rot. The other was by Tom McGrath of Stephen H. Austin University who is studying the association of nematodes with a heart rot (*Polyporus hispidus*) of oak.

# INSECTS AND RUST FUNGI WORKSHOP

R. G. Krebill, Moderator

Adapting to the casual Monterey atmosphere, our workshop, composed of a small, select group of entomologists and pathologists, informally discussed the interrelationships of insects and rusts. We all had accumulated ideas and shared them freely.

We reviewed the life cycles of rust fungi and conjectured that insects such as Drosophylla spp. are attracted to pycnial fluids and might facilitate spermatization of rust fungi. In this association, insects might be essential for gene exchange and survival of some rust fungi.

We reviewed the works of John Powell on the associations of insects with various phases of Cronartium comandrae, the work of Mal Furniss and colleagues on insects associated with C. ribicola, and the study in progress by Dave Nelson on a Nitidulid common in aecia of Peridermium filamentosum. The diversity of insect-rust associates revealed by these studies is surprisingly great and fascinating. Some such as Mycodiplosis spp. and Epurea obliquis are highly dependent upon rust sori for their food supply and appear rather frequently to reduce the inoculum potential of the affected rust fungus. The consequence of such a reduction is unclear and might bear further study. It was doubted by our group to be very significant for aeciospores of fungi such as Cronartium comandrae and C. ribicola which have a large capacity to increase by alternate spore stages. Other rust fungi such as lodgepole pine's Peridermium harknessii and P. stafactiforme might be more sensitive. P. harknessii doesn't have an alternate repeating stage and the lodgepole pine P. stalactiforme usually produces few uredinia on its alternate hosts. Our work group expressed that insects should not be overlooked as possible vectors of rust fungi, as a supplement to the well-recognized mode of wind dissemination. Many kinds of insects are associated with infected bark of rust cankers, and some probably help kill the infected host tissues. Perhaps the most conspicuous and frequently reported insects of this type are Diorcyctria spp. Mal Furniss provided the interesting observation that Drosophylla help produce the small post-pycnial pits that are one of the common symptoms used to identify young white pine blister rust cankers. Our work group also expressed the view that a wide variety of insects might be involved as possible vectors of microbial pathogens or antagonists of rusts. Such insects might already be involved in natural inactivation of rusts and this type of association possibly could be manipulated to the rust's disadvantage.

Another association of insects and rusts of obvious interest to forestry involved pine stem rusts and bark beetles. Mountain pine beetle had been observed by some of our group as occurring at elevated levels in heavily rusted western white pine stands, Ips spp. are commonly involved in killing comandra rust cankered lodgepole pine, and Roger Peterson's work correlated endemic populations of Dendroctonus beetles with limb rust of ponderosa pine. Entomologists of our work group considered these associations as physiologically comprehensible but doubted that removal of rusted trees would have a significant effect in reducing the probability of future bark beetle outbreaks.

Our work group agreed that we have much to learn about rust fungi-insect relationships but that such knowledge is not likely to provide a panacea to solution of forest rust problems.

## CONFLICTS BETWEEN INSECT & DISEASE RECOMMENDATIONS

Moderator: Lawrence Stipe (R-4)

The moderator opened the workshop by presenting the results of an investigation designed to provide data on the relationship between dwarf mistletoe and the mountain pine beetle. The objective of the study was to determine whether trees infested with dwarf mistletoe are selected and killed by the mountain pine beetle. Data were collected in three separate mistletoe-infected lodgepole pine stands on the Targhee National Forest in 1973 (Parker & Stipe, 1974). Variable and fixed-area plots were used to record live and mountain pine beetle-killed trees 5 inches d.b.h. and above. All trees were rated by degree of mistletoe infection using the six class rating system developed by Hawksworth and Lusher, 1956. Part of the survey data is summarized below:

| | AREA | | |
|---|---|---|---|
| | Split Creek | Black Mtn. | Hatchery Butte |
| Lpp/acre | 334.2 | 312.9 | 204.5 |
| Mistletoe-infected Lpp (percent) | 85 | 80 | 54 |
| Lpp with mistletoe rating 4,5 and 6 (percent) | 42 | 46 | 19 |
| Ave. mistletoe rating for all trees | 2.95 | 3.07 | 1.45 |
| Total mpb-killed Lpp/acre | 5.4 | 14.5 | 4.3 |
| Dead mistletoe-infected Lpp (percent) | 97 | 98 | 92 |
| Ave. mistletoe rating for all dead trees | 3.31 | 3.68 | 3.16 |

A preference for diseased and weakened trees by the mountain pine beetle is shown by the consistent increase in the average mistletoe rating of trees killed by the mountain pine beetle over that of all trees (row 4 vs row 7). Although these data were not analyzed statistically, they indicate a preference by the mountain pine beetle for non-vigorous trees. However, a more intensive survey is needed to confirm this theory. Due to the high level of mistletoe infection, the attacking beetle population had little else to attack but mistletoe infected trees. The high percent of mistletoe infection may have overshadowed the relationship. The largest difference in average rating between all trees and dead trees was in the stand with the lowest rate of mistletoe infection. Therefore the relationship would probably be more evident in a stand with light mistletoe infection and heavy mountain pine beetle losses.

The stands sampled in this study were located within a massive bark beetle control project. No adjustments were made based on the level of mistletoe infection during the evaluation phase or included in the recommendations or justifications for control. The major conflict associated with this control project was the disregard for the disease conditions in the treated stands. Priorities were based entirely on entomological data.

A similar relationship between mistletoe and the mountain pine beetle was described by another workshop participant from data collected in Colorado. In a 2 x 2-chain area of ponderosa pine, all mistletoe brooms were pruned from all trees. In the treated area no new bark beetle attacks were found on any of the manicured trees, but several trees around the test plot were attacked and killed.

Douglas Parker (R-3) described the bark beetle and mistletoe problems found in the southwest. To understand the problems associated with timber harvesting one must understand the naturally high level of bark beetle activity found in stands of the southwest. Good weather and the availability of suitable host material provide the environment for a constant high level of *Ips* activity. With this constant source of bark beetle pressure from adjacent areas slash from logging or thinning operations is quickly infested. These conditions present forest managers special problems in dealing with logging slash. To minimize *Ips* buildups, preventive management techniques are foremost in all cutting plans.

Of greatest importance are the following:

1. Proper timing of cutting. Trees cut in late summer and fall dry out enough during the winter to be unattractive to *Ips* by the next spring.

2. Slash disposal. The high background population of *Ips* makes slash disposal an important part of all timber sales. Without proper slash disposal *Ips* buildups are a constant problem. When fire hazard conditions do not permit slash disposal by conventional techniques, piling and covering slash with clear plastic can be used. High temperatures created by the green house effect are lethal to the *Ips* broods. Material treated in this manner is utilized by the public for fire wood.

3. Better utilization. This technique similarly reduces the amount of material requiring slash treatment while providing increased yield.

Direct control is used only in logging areas where the above preventive techniques have failed to provide the necessary control. Unfortunately, direct control is only effective in the immediate area of the treatment and has little influence on the natural background conditions in adjoining areas. Direct control is not used to manipulate the background population. These control projects lack any attempt to change the disease conditions in the treated stands. To resolve this conflict, control recommendations should include optimum benefit provisions for insect and disease problems in the stand. If techniques are not available that can benefit both, an effort should be made to minimize the creation of other problems. Many times, however, political considerations take priority over the biology of the insect, and disease conditions. Restrictions caused by fiscal year spending requirements needs improvement.

Jim Walters (R-3) felt the biggest conflict between insect and disease recommendations was the failure to evaluate problems from both an entomological and pathological standpoint at the same time. A better approach may be to make joint recommendations based on a concurrent evaluation from both areas. This approach would guard against one treatment causing the need for another and provide better coordination between the entomologists and pathologists.

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## PEST CONTROL THROUGH IMPROVED FOREST MANAGEMENT

Don Schmiege-Moderator
Bruce Baker -Panelist
Gene Amman -Panelist

A summary of recent spruce beetle (*Dendroctonus rufipennis* Kby.) outbreaks in Alaska's white spruce (*Picea glauca* [Moench] Voss) and Lutz spruce (*P. X lutzii* Little) was presented by Bruce Baker.

Between the late 1960's and 1975, 500,000 acres of outbreak have occurred in a transition climatic zone in Cook Inlet. High beetle populations have been associated, to varying degrees, with at least three factors: 1) extensive forests of large spruce, 2) warm dry summer weather in 1968 and 1969, and 3) downed trees, which become host material for the insect, resulting from land clearing for man's activities. Blowdown, while a common source of beetle buildup material, has not been widespread.

One severely depleted forest area of 20 square miles was sampled. It was found that 65 percent of the white spruce 5 inches d.b.h. and larger were killed in recent years. As expected, tree mortality was skewed toward larger trees. A large salvage sale has been awarded in the area, providing for harvest on 223,000 acres with a total of 425 million board feet of spruce and associated hardwoods.

Public information efforts have attempted to:

1. Place spruce beetle losses in a proper long-term ecological perspective.
2. Identify the negative effects of an outbreak on forest inventories and the positive effects that might exist, such as wildlife habitat improvement.
3. Assist in identifying salvage harvest opportunities.
4. Identify stands where risk of beetle buildup is present.
5. Stress land clearing and timber harvest practices that can minimize man's contribution to outbreak buildup.

A discussion followed. Topics included the increased stumpage values of Alaska's white spruce, increased demand for timber and improved access to white spruce forests, salvage harvest efforts to date, potential impacts of logging, and opportunities for and limitations of natural forest regeneration. Size of cutting units was discussed. A question was raised as to the likelihood of genetic selection of spruce by the beetle.

The Alaska spruce beetle situation seems to blend two distinct land management policies. First is a trend of land resource development with relatively little concern for environmental impacts. At the opposite end of the spectrum is a trend toward no land resource development or a minimum of development until many of the existing uncertainties are resolved.

Gene Amman spoke on management practices for areas inhabited by the mountain pine beetle. He presented evidence that trees with a d.b.h. greater than 13 inches had a thicker phloem than smaller sized trees and therefore maintained a higher population of beetles. Damage by mountain pine beetles differ on different habitat types. Losses also differed with changes in elevation with the greatest losses at lower elevations. This bark beetle differs from other species in that it primarily attacks vigorous trees rather than stressed, over-mature timber.

Thinning practices in second growth ponderosa pine stands in California appeared to reduce infestations of mountain pine beetle. Similar observations were noted in South Dakota in lodgepole pine stands where stands were thinned to trees with a d.b.h. less than 11 inches. Thinning in Douglas fir stands during periods of low water stress reduced attacks by "secondary" beetles.

Questions were raised whether thinning would be logical as a management practice in stands prescribed for long-term rotation when evidence shows that larger, older trees are more susceptable to beetle attack. Thinning would appear to be an acceptable management practice in stands of short-term rotation.

Pathologists found that thinning of ponderosa pine stands in June reduced the incidence of *Fomes annosus* in small diameter trees (2-5-inch d.b.h.) and that this thinning practice might also be used to manage stands to prevent or limit bark beetle activity.

The question arose whether the manipulation of tree genetics to increase growth and vigor would have any affect on insect and disease problems.

Other speakers also presented information on their work but notes on what they said are not complete.

## DWARF MISTLETOE - INSECT RELATIONSHIPS

Moderator: Robert F. Scharpf

Discussion Leaders: Frank Hawksworth
Robert Stevens
Lloyd Andres

The workshop was attended by about 20 interested individuals and conducted at a very informal level. Much discussion and interchange of ideas took place. Insect and disease interests were more or less equally represented.

For convenience and continuity of discussion, the overall topic was subdivided into the following sub topics:

A. The unfavorable aspects (to forests) of dwarf mistletoe-insect relationships:

   1. Dwarf mistletoes as agents predisposing trees to attack by insects.

   2. Insects as pollinating agents of dwarf mistletoe.

B. Favorable aspects (to forests) of the dwarf mistletoe-insect relationships---or "biological control" of dwarf mistletoes by insects.

The first topic of discussion began with an area of utmost interest to most participants---What is the relationship between mistletoe infested stands and attack of these stands by bark beetles, borers, and other potentially damaging forest insects.

The general topic discussed among the group was the commonly expressed idea that insects, principally bark beetles and borers often buildup in and cause damage to forests infested by dwarf mistletoes. But the general consensus among most scientists present was that not enough is known about the factors triggering these outbreaks. Several problems and hypotheses were presented for consideration and discussion:

1. The insect-dwarf mistletoe problems appear to be more severe on poor sites or when forests are not growing under optimum conditions. The need to investigate such factors as host vigor, and growing condition on the interaction of dwarf mistletoes and insects, particularly in young and second growth forests under intensive management, was stressed.

2. The problems of dwarf mistletoe-insect relationships (as well as other insect-disease problems) are nearly always investigated during epidemic outbreaks of the insect or as a "crash program" shortly afterwards. The real need, as expressed by several individuals, is to study these relationships at endemic levels of insects or certainly also at times other than the "epidemic" period. Knowledge of the factors that hold insects at non-epidemic levels was expressed as possibly being the key to understanding why insects build up to epidemic levels in some years both in dwarf mistletoe infested and non-infested stands.

   One topic that was pursued further dealt with the idea of whether or not dwarf mistletoe infested trees make favorable "brood" trees for regeneration of bark beetles. Do dwarf mistletoe infested trees provide an important reservoir of insects for subsequent buildup in healthy trees when other conditions permit? Or do dwarf mistletoe weakened trees act as "trap" trees in which insects lay eggs that never develop into adults? This problem area is somewhat controversial and appears to require further study.

3. Impact on forests from insects and dwarf mistletoes needs further investigation.

   The type of impact occurring needs to be identified and quantified. The obvious questions are: How much mortality, growth loss and quality reduction in timber are we incurring? With what tree species and insect-mistletoe combinations are we realizing the losses? What size or age classes are involved? Some more subtle long-term questions of concern to managers that were mentioned for example are: Will impact from insects and dwarf mistletoes reduce or regulate the rotation age of a timber species under management? What are the impacts on recreational or non-timber values?

In general, the topic of dwarf mistletoes predisposing forests to attack by insect was actively discussed. Although some information is available on the topic and research is underway in this area, much yet needs to be learned about this insect-disease relationship, particularly with regard to projected forest management objectives for the future.

Following a much appreciated coffee break, the next topic, "Insects as pollinating agents of dwarf mistletoes" was introduced and discussed by Dr. Frank G. Hawksworth. Only recently has work begun in this area. Studies in Colorado with three different species of dwarf mistletoe show that many insects act as pollinating agents. A hundred or more different insects have been found associated with these mistletoes, but only a few are thus far considered major pollinating agents. Some insect species are found only on flowers of one sex and one mistletoe species, whereas others are found on both sex flowers of all species observed. Because of the abundance of many different insects on dwarf mistletoe flowers, any practical approach to prevent pollination by controlling insects appears a remote possibility. In addition, dwarf mistletoes in Colorado may be wind pollinated up to 300-500 feet. Studies underway in Utah suggest that some dwarf mistletoe species there may be primarily wind pollinated.

In spite of the remote possibilities of controlling mistletoes in the near future by controlling pollinators, the general impression of several participants was that this nearly unexplored area of research needs continuing effort.

The last topic on the panel to be discussed was "biological control of dwarf mistletoes with insects." Bob Stevens introduced the topic by summing up what is known about the various insects known to feed on dwarf mistletoes. Following Bob's introduction, Floyd Andres presented some principles and concepts involving biological control of "weeds" with insects. One of the major principles emphasized was that insects as biocontrol agents usually do not kill the target plant outright in most instances, but merely weaken it and put it under "environmental stress." By so doing the target plant is often unable to compete successfully with other plants. Unfortunately, this principle does not apply to parasitic plants. Therefore, insects functioning as biological control agents of parasitic plants must be able to keep the parasite in check in the absence of competition from other plants. No native insects are known to be able to fulfill this task with respect to the mistletoes.

Defoliation of mistletoes does not kill them, but it does prevent their spread. If an insect agent could be found that would consistently defoliate (or just prevent flowering, fruit development, or seed dispersal), it would be a valuable tool in preventing spread of the parasite. The few insects known that do occasionally defoliate mistletoes are considered too sporatic in occurrence to effect any measure of control. The best chance of achieving any success along these lines of control would probably be with an introduced exotic insect collected from mistletoes or related parasitic plants occurring elsewhere in the world. Scientists and others should remain aware of this possibility and actively be on the lookout for exotic insect predators that might be potential biological control agents of dwarf mistletoes. Use of insects as vectors of plant diseases is an area considered worth looking into with regard to mistletoes. Practically nothing is known with regard to this intriguing area.

Lunch time approached to the delight of several and the group broke up with many questions asked and nearly as many unanswered. But most participants left, I feel, with fruitful ideas to ponder and perhaps pursue some day when time and research dollars allow.

## CONCERNS OF CONFERENCE MEMBERS

Moderator: Ed F. Wicker

This workshop was conducted on a completely informal basis with no prearranged presentations. It was a rather small workshop in comparison to some others with about 10 persons in attendance. However, federal, state, and private interests were rather equally represented. A variety of concerns surfaced during the workshop and they were not necessarily restricted to entomology and pathology. The concerns discussed are itemized below with no order or ranking intended.

1. The framework of a computer-based system for pooling and retrieving technical information needed for forestry has been developed by the U.S. Forest Service (USFS), the Energy Research and Development Administration (ERDA), and the Foreign Agricultural Organization (FAO). It is called the Forestry Technical Information Service (FTIS). It is available both nationally and internationally and a common format for bibliographic information in machine-readable form is used.

WFIWC and WIFDWC members and their administrators are invited to express their interest in the FTIS to the Forest Service Technical Information Office, Forest Service, USDA, Room 808 RP-E, Washington, D.C. 20250.

2. Nonfederal forestry workers and the general public are concerned over the current policies of the Federal Forest and Range Experiment Stations regarding the availability and distribution of reprints of Station publications. Recently, several requests for reprints of both in-service and professional journal publications have been denied without logical explanation for such denial. Perhaps Experiment Stations should issue a policy statement on this topic.

3. The chaotic state of forest protection education in the United States was a concern of a majority of those persons attending the workshop. It was noted that several forestry schools do not require forest protection courses in their curricula. It was suggested that input and feedback from the profession and professional societies are needed to correct this situation. Apparently, this method was successful in solving a similar situation in Canada.

4. Should the conferences take a position on relevant controversial issues concerning our area of expertise? Since this was a joint conference, the general consensus was

that this topic should be discussed with the membership of WFIWC and IWFDWC, separately, at their respective business meetings.

5. A general dissatisfaction was expressed concerning the location, cost, program arrangement, and scheduling of workshops for the conference. As with item 4, it was agreed that this topic could best be resolved through discussion with the separate conference memberships.

6. Several persons voiced their concern of the trend in research in the U.S. Forest Service of financial bleeding and overall degradation of continuing research programs to support numerous multi-million dollar Research and Development (R&D) or Research, Development, and Application (RD&A) programs. Our two keynote speakers did not portray a very optimistic future for these cumbersome multi-functional programs. Many people are suspicious that such programs are merely politically or personally motivated bureaucratic fads that are forced into action programs devoid of adequate analyses of land management needs and alternative actions.

7. A question was raised concerning the ethics of permitting commercial agents to sponsor social functions at the conference. This concern was discussed briefly and the consensus was to refer this topic to the individual conference memberships for further discussion.

# DATA ANALYSIS WORKSHOP

Moderator: Johnson, Floyd A.

Participants: Mitchell, Russ; DeMars, C. J.; Williams, Carroll; Smith, Dick; Wear, John; Johnson, Dave; Dolph, Bob; Campbell, Bob; Shepherd, Roy; Harris, John; Stipe, Larry; Neisess, John

It was agreed at the outset that this session was to be issue oriented, that there were to be no speeches, and that subject matter covered should include statistical design since statistical design and data analysis are inseparable.

Twenty-one issues were identified prior to the meeting through consultations with prospective participants. There was time for discussion on only four of these issues.

Issue No. 1: Are disease and insect input analyses meaningful?

Participants agreed unanimously that entomologists and pathologists have been too loose with their impact estimates and, as a result, are losing credibility. Objectives for impact surveys are frequently insufficiently specific and are impossible to attain without resorting to a maze of untenable assumptions. Most impact statements in survey reports are probably greatly overinflated.

Issue No. 2: What is modeling and what has it achieved?

A distinction was made between modeling as hypothesis formulation and modeling as an exercise in determinism. In the first case, modeling is the initial step in the scientific method and is followed by tests and by inductive inferences. In the second case, modeling is an end in itself and tests are neither envisioned nor possible. Modeling in this second sense was the focus of considerable discussion. There was no consensus on this issue. One faction felt that the recent excessive preoccupation with deterministic models was leading nowhere. Reference was made to comparable efforts in the fields of economics and ecology, to an apparent lack of meaningful results from these efforts, and to the excessive costs involved. The other faction was unwilling to see such efforts as being without meaning.

Issue No. 3: Should the U.S. have a nationwide detection system for insect infestations?

The Canadians described their system and supported it with enthusiasm. They made no claim for infallibility but did claim side benefits for research. Costs were considered and it was suggested that it might be better to bear the losses than to incur the costs. However, there was general agreement that the U.S. should have a detection system somewhat like the Canadian system.

Issue No. 4: Are entomologists and pathologists being inadequately served by statistical consultants?

The statement was made that in-house, hybrid statistician-entomologists and statistician-pathologists would be more effective as statistical consultants than part-time, pure mathematical statisticians. However, career ladders were said to be lacking for hybrids in this kind of service capacity. Examples were cited of the waste which has resulted from improperly designed experiments and surveys. There seemed to be general recognition of a need for statisticians in entomology and in pathology, but the general reaction was one of apathy.

## WORKSHOP: INSECT AND DISEASE PROBLEMS AND RELATIONSHIPS IN URBAN AND RECREATION AREAS

Moderator: Rick Johnsey

Moderating this workshop was a very self-satisfying experience because all too frequently forest entomologists and pathologists are confronted with insect and disease control projects of such magnitude and questionable benefit/cost ratios that practical solutions are rendered impossible. In the case of insect and disease problems in urban and recreation areas we have a very favorable benefit/cost ratio and the number of trees requiring attention is small enough to allow practical treatments.

In order to get the workshop off to a good start, I had made previous arrangements with four people with varied backgrounds and from different geographic regions to come prepared to discuss problems relating to their respective areas.

A Report on Tree Hazard Problems and a Brief Review of Research: Mr. Peter Gaidula, California Department of Parks and Recreation. (Discussion and slides).

Peter addressed himself to problems of tree hazards in outdoor recreation sites caused by tree failures due to defects in wood structure brought about by damage from fungi and insects. He also informed us about the activities of the Committee on Forest Disease Recreation Hazards, which is a standing Committee within the Western International Forest Disease Work Conference.

The California State Park system (about 200 parks) spends approximately $60,000 annually in tree hazard control. Personal injury and property damage totaled about $25,000 based on figures for the 1972-1973 fiscal year. Considering the size of the system (approximately 10,000 camp units) and an annual visitor day count of over 42 million, these costs and losses are not especially high. One of the reasons is due to their well-defined policy and program on tree hazard control. They feel a moral obligation in addition to the legal obligation to keep the recreation sites reasonable safe from hazards.

The Committee on Forest Disease Recreation Hazards has several projects underway at this time; one consists of assembling a bibliography on the subject of tree hazard; a second involves preparation of a training outline to aid in training personnel assigned to tree hazard detection and evaluation.

Research activities on tree hazard problems have been underway since 1966 by Forest Pathologist Dr. Lee Paine at the Pacific Southwest Forest and Range Experiment Station. He is extending his studies into tree failures on urban park, regional park, and street tree plantings.

Another example of research in tree hazards is the cooperative work of the Forest Service Regions and the University of California on the Fomes annosus problem within a visitor cabin area in Yosemite Valley, and the work of Dr. Parmeter on the big tree, Sequoiadendron giganteum, at Sequoia National Park.

In his first report regarding the Yosemite problem, Mr. MacGregor made the observation that pines infected by Fomes annosus tended to be killed by bark beetles before root decay is far advanced.

Mr. Gaidula also showed a series of slides illustrating the tree hazard problem in California parks.

Weather Damage in the Puget Sound Area: Mr. Ken Russell, Washington State Department of Natural Resources, Olympia, Washington.

Ken Russell gave a slide presentation and discussed weather related problems in the Puget Sound Area of Western Washington.

Windthrow is a problem in some residential areas in Olympia. Soil type is closely related to windthrow problems especially in areas where clay is overlaying a glacial till creating a hardpan situation. Very little uprooting occurs in sandy or gravelly soils which enable trees to establish deeper root systems.

Super-cold winds also cause needle and leaf damage occasionally resulting in mortality.

Cold air inversions sometimes cause top-kill due to spot freezing of cambium.

In 1974, excessive temperatures caused heat injury to needles on grand fir.

Two of the most common problems Ken has encountered is mechanical injury caused by bulldozing during clearing operations and covering up of trees by soil during construction.

Sequoia Pitch Moth Damage to Pines: Dr. Lee Campbell, Western Washington Experiment Station, Puyallup, Washington.

Lee Campbell gave a presentation with slides concerning his work with the sequoia pitch moth, Vespamima sequoiae.

This moth has been around western forests for a long time without causing much concern. Attacks can be found in a wide variety of conifers but not much damage occurs. In the past few years, for unknown reasons, attacks on trees planted as ornamentals have been increasing. Some of the conifers used in landscaping seem to be much more susceptible than forest trees. One report shows that, on a relative scale of number of attacks, if ponderosa pine is 1, then lodgepole is attacked 3X, Austrian 6X, and Scotch pine 21X. In Washington, we have had the most trouble with Scotch pine, but only when grown as an ornamental, not in Christmas tree plantations. The probable reason is that Christmas trees are sheared while landscape plantings are not, and adult flight is probably hampered by a tightly sheared tree. Attack is also favored by wounds to the trunk and larger limbs. The most severe damage occurs where Scotch pine is used to separate fairways on golf courses.

Lee has tried some insecticidal control and Dursban, Zectran, Imidan, and Zalone look promising.

Dutch Elm Disease Program and Mountain Pine Beetle Control Program in Colorado: John Laut, Larry Helburg, and Dave Leatherman, Colorado State Forestry Service, Fort Collins, Colorado.

Larry Helburg gave a presentation on the Dutch Elm Disease Program in Colorado.

The Dutch Elm Disease was first discovered in Colorado in 1948 in the City of Denver. The trees were burned and nothing was heard of the disease until 1968 when it was discovered again at Fort Morgan in northern Colorado. It is now widely spread throughout the state. Since 1970, the Colorado State Forest Service has been charged with monitoring its progression.

Records indicate that there are 2,104,900 elm trees in the State, of which 182,500 are of the large-leaf varieties found mainly in the major municipalities. (Elms are not native to Colorado and are, therefore, found in highest number in the larger municipalities and in localized windbreaks). Since 1968, 7,600 elms have been diagnosed as positive and an additional 8-9,000 have been removed without benefit of culture.

The state-wide loss of American elm is estimated at three percent but some local areas are suffering as high as thirty-two percent losses. This range indicates the variation in effectiveness of various local programs. Their goal is to establish effective programs in all areas in which American elm is a significant element in the community environment. There are about 101 of these so-called critical areas in Colorado.

Thirty local governments (municipal or county) have now initiated active programs for Dutch elm disease through cooperative efforts of the Colorado State Forest Service.

Discussion:

Q. Is the Dutch Elm Disease Program doing any good?

A. The Dutch Elm Disease Program as a single entity will be merged with their overall urban program, and urban forest management plans will be written. Right now, they are buying time and keeping shade in the communities until they can take over the over-all management of urban tree problems. Yes, in this sense it is doing good. (They are trying to buy time.)

Q. What sort of measure do you have on the amount of time you are buying?

A. None; by removing trees we are removing beetle breeding trees and slowing progress of the disease.

Q. Who is doing anything in counties?

A. They have four counties with inspectors having authority to remove trees.

Dave Leatherman gave the presentation on the Mountain Pine Beetle Control Program in Colorado.

The mountain pine beetle problem is confined to the east slope in ponderosa pine and is considered a residential problem as the trees are in mountain sub-divisions and homebuilding has increased stress on the trees.

They work in local areas where they can limit the spread and clean-up a high percentage of trees in the area to a point where homeowners can handle the situation.

Homeowners are responsible for dropping the trees and then state crews take over. The trees are cut into firewood lengths and stacked in cord piles. The piles are then sprayed with Ethylenedibromide (4% active) distributed throughout the pile. The pile is then trenched around, covered with clear plastic (6 mil) and left covered about six weeks.

One of their major problems is a market for the wood as the primary use is for firewood.

Several workshop participants were skeptical of this program and Dave Leatherman pointed out that it was something of a political football.

A general discussion period followed the slide presentations.

## ARE MICROORGANISMS BENEFICIAL TO INSECTS

Stan Barras, Moderator

Participants: N. Colotelo, J. L. Foltz, P. Hughes, R. L. Livingston, B. McKnight, C. J. DeMars, D. Morgan, D. Norris, G. Pitman, G. Poinar, G. M. Thomas, H. S. Whitney

The title of the workshop led us quickly into a discussion of the word symbiosis. In general, there are two schools of thought on the use of the word--on the one hand many regard symbiosis and mutualism to be synonymous, but others feel the symbiosis has a much broader connotation, covering all forms of cohabitation or even interspecific influence without physical contact. Barras stated he looks upon the word as it literally means--"living together." The word was first formed in 1879 by Anton DeBary, a botanist. He made it clear that he was using the term in relation to dissimilar organisms living together irregardless of the outcome and included parasitism, commensalism, and mutualism. At the time however, the newest scientific news was the discovery of the mutually beneficial association of algae and fungi to form lichen. The mutualism of these two disimilar genetic entities was so striking that it was natural for this association to overshadow others cited by DeBary. From then on the predominant use of symbiosis denoted mutualism. All to often, I think this narrower view has led to a compartmentalization of associations into specific subject areas, without due consideration that these all represent various degrees of intergration on the biochemical level encompassed by symbiosis.

Interspecific intergration has been well documented in the last 100 years and many thousands of associations could be cited. In relation to insects, microbial symbionts are considered either endo- or ectosymbionts. The insect is designated the macrosymbiont and the smaller microbe is known as the microsymbiont. In practice however, the associates are usually referred to as the insect and its symbiont with no designation or macro or micro. As the name implies, endosymbionts are found within the body cavity and are either intra- or extracellular. These symbionts contribute nutrients or other required chemicals. Symbionts associated with the digestive tract often provide enzymes for digestive activity.

Ectosymbionts on the other hand, usually act upon host substrates before they are ingested by the insect. The symbionts obtain ready access to the substrate following transport by the insect. Transport is insured by the presence of specialized pits, tubes, or other modifications of the exoskeleton to form mycangia within which the symbionts are protected and nourished by insect secretions. Less specific modes of transport involve spores on the exposed exoskeleton.

Following a short discussion Ladd Livingston reviewed his thesis work on the fir engraver beetle and associated brown staining fungus *Tricosporium*. The fungus is transported in mycangial pits on the head. After inoculation in the host tree, the mycangial fungus and others grow ahead of larvae as they develop through the phloem. Fungi appear to be of benefit to the insect. Whitney reviewed his work with the mountain pine beetle. Laboratory studies in bolts showed that eggs in axenic conditions showed 66% hatch while those recontaminated with *Ceratocystis* and two yeasts showed 9% hatch. This opened a discussion on role of *Ceratocystis* associated with bark beetles. Exact role is still not understood but Whitney's work and that of Barras indicates that *Ceratocystis* is antagonistic to bark beetles. Barras found that the southern pine beetle exhibits poor or no development when the insect is exposed to pholem colonized by *C. minor*. The discussion also touched on the fact that a single associate of the insect may have an adverse effect in a one-to-one relationship, but may be benign when present in the total ecosystem. Norris and Barras spoke of the relationship between microbes, bark beetle, and tree host constituting a supraorganism. This is demonstrated when absence of one or two components upsets the whole system.

George Poinar presented a very interesting slide presentation on nematodes associated with bark beetles and wood wasps. In the case of *Sirex* wood wasps a nematode *Delandenus* can change forms depending on whether it infects larvae or is developing on fungi associated with the insect. The relationship becomes very complicated because on the one hand the fungus is apparently beneficial to the insect but the fungus also provides food for the nematodes which infect the larvae. The nematodes eventually invade the gonads of the insect. Dave Morgan added general comments about the *Sirex*-fungus associations and the biological control program with the nematode in Australia. Dale Norris reviewed his work on *Xyleborus*-microbial symbiosis and Scolytid feeding stimulants/deterrents. He brought out that changes in chemical structure in closely related compounds can have profound effects on insect response. Two examples are *p*-hydroquinone and *p*-benzoquinone. The first chemical is a potent feeding stimulus but blocks fertility while the second is a potent feeding inhibitor but enhances reproduction.

AIR POLLUTION AND INSECTS

Moderator: Clinton E. Carlson

Mr. Bill Ciesla, USDA Forest Service, Region 1, discussed the role of atmospheric pollutants in predisposing trees to insect attack. In recent years foresters, plant pathologists, and to some extent forest entomologists have become interested in studying effects of certain airborne effluents on forest vegetation. Epidemic populations of certain insects have been associated with air pollution damage and considerable disagreement has been expressed as to whether or not the damage observed was the result of the pollutant, insects, or a combination of the two. A logical question which follows is: Are trees damaged by atmospheric pollutants predisposed to insect attack?

Numerous case histories describing insect-air pollutant associations in forested areas are documented in the literature. Evenden (1923) studied infestations of Dendroctonus brevicomis and other scolytids associated with trees weakened by sulphur emissions from a smelter at Kellogg, Idaho and concluded "that these weakened trees are selected as a host tree by D. brevicomis is assured, but the outcome of the epidemic is unknown." Several years later Keen and Evenden (1929) evaluated role of insects in an area near Northport, Washington affected by fumes from a smelter near Trail, B.C. Here they discounted insects as having a primary role in tree mortality in this area. Johnson (1950) studied an outbreak of the black pine leaf scale, Nuculaspis californica (Coleman) in the city limits of Spokane, Washington and discusses the role of dust and fluoride as possible agents predisposing trees to attack by this insect. He concluded that the pattern of fluoride concentrate did not coincide closely with the distribution pattern of the scale insect population but did not reject the premise that there may be an affinity between the two.

More recently detailed studies have confirmed atmospheric pollutants as agents which predispose trees to insect attack. Stark et al. (1968) established that trees exhibiting advanced symptoms ot photochemical air pollutant injury in the San Bernadino Mountains of California were more frequently attacked by western pine beetle, Dendroctonus brevicomis and mountain pine beetle, Dendroctonus ponderosae and concluded that air pollution injury predisposed ponderosa pine to bark beetle infestation.

Wong and Melvin (1973) collected 33 species of insects representing 4 orders and 19 families associated with trees injured by accidental release of liquid hydrocarbon condensate near Strachan, Alberta. Most of these insects were recovered from dead crowns. Carlson et al. (1974) working with a fluoride-insect complex associated with an aluminum plant near Columbia Falls, Montana established that damage caused by the pine needle sheath miner, Zelleria haimbachi (Busck.) and a pine needle miner, Ocnerostoma strobivorum Zeller was directly correlated with foliar concentrations of fluoride in lodgepole pine, Pinus contorta.

Importance of establishing sound-valid relationships in scientific investigations is obvious. It need only be referred to here because the investigator identifying a polluting agent, its source, and resultant impact on an ecosystem will very likely be asked to give expert testimony on his findings in a court of law. He will be interrogated by an attorney for the defense who may do everything possible to cast some shadow of doubt on the results of the investigator's studies. Association of an insect complex with the pollution source adds still another variable to an already complex problem and evidence of a relationship must be carefully established. Several approaches--some empirical and other detailed analytical procedures--are outlined which might aid in establishing an insect-air pollution relationship.

Pattern of Insect Damage Relative to Source--Patterns of an insect outbreak relative to a pollution source may be the first tip-off that the two are interrelated and may be the first evidence which makes the investigator consider this hypothesis. Carlson and Dewey (1971) describe a complex of 4 species of insects associated with fluoride injury from an aluminum reduction plant near Columbia Falls, Montana. This outbreak was confined to areas where foliar fluoride levels were at least 30 p.p.m. (Carlson et al., 1974). Johnson (1950) in his study of a "blight" of ponderosa pine in Spokane, Washington concluded that the pattern of fluoride injury in foliage and N. californica populations did not coincide very closely. However, his map of fluoride injury and insect infestation shows two more or less concentric circles, a smaller circle of visible fluoride injury and a larger area of heavy scale infestations. This may seem to suggest that the insect is responding to a sub-damaging level of particulate or gaseous emissions from single point pollution source.

It must be emphasized that a distribution pattern is something which might make the investigator consider the pollutant-insect hypothesis, not conclude that it in fact exists. The literature also refers to coincidental insect-pollutant relationship. For example, Compton et al. (1961) report the occurrence of N. californica infestations on ponderosa pine in an area damaged by fluoride emissions from an aluminum reduction plant near The Dalles, Oregon. This infestation existed at least 3 years prior to the time this plant went into operation, however, and was probably due to dust and heavy use of chemical sprays in adjoining fruit orchards (Edmonds, 1973). Similarly, injury to approximately 5,000 acres of Douglas-fir forests by sulphur emissions from a pulp and paper mill near Missoula, Montana (Carlson et al., 1974) was accompanied by two localized infestations of the Douglas-fir tussock moth, Orgyia pseudotsugata McD. in 1973. It was concluded that the two were probably not related in this instance because at the same time additional infestations occurred near Lolo, Montana and in residential areas within the city limits of Missoula (Tunnock et al., 1973). Thus, the overall outbreak pattern did not coincide with the damage from the pollutant source. This conclusion was confirmed when additional epidemic populations of Orgyia pseudotsugata appeared in western Montana in 1974 at locations far removed from the pollution source (Tunnock et al., 1974).

Deviations from "Normal" Outbreak Patterns.--Many destructive insects undergo more or less predictable cyclic patterns. These are well documented as in the case of O. pseudotsugata in the Northwest which reaches epidemic levels at intervals of 7-10 years and maintains epidemic populations for 2-4 years (Wickman et al., 1973; Tunnock, 1973). The scales, Phenacaspis pinifoliae (Fitch) and N. californica, are commonly associated with dust and epidemics and are frequently confined to trees along dusty roads (Keen, 1952; Edmonds, 1973). Deviation from established patterns such as prolonged epidemic periods of insects with an established history of "short cycled" outbreaks or epidemics of an insect which tends to be localized over extensive areas may be indicators that the insect is responding to stresses from a pollution source.

Appearance of Insects in Outbreak Levels Which Rarely Reach Epidemic Levels.--A pollution source could conceivably form a buildup of an insect species which rarely, if ever, reaches epidemic levels. The pine needle miner, Ocnerostoma strobivorum Zeller, is one of 4 species of insects associated with a fluoride source in western Montana (Carlson et al., 1974). To our knowledge this insect has not been previously recorded in outbreak numbers.

Statistical Analysis.--First approach to systematically establishing a relationship between levels of an atmospheric pollutant and damaging insect populations is to demonstrate a correlation between the two agents. Carlson and Dewey (1971) attempted to relate population levels of the scale Phenacaspis pinifoliae to foliar-fluoride content. They showed that scale counts on lodgepole pine foliage decreased with an increase in distance from the source but a simple linear regression analysis failed to demonstrate a signicant correlation. Several years later Carlson et al. (1974) using a stepwise multiple regression analysis demonstrated that foliar-fluoride content was significantly related to damage caused by Z. haimbachi and O. strobivorum and concluded that fluoride is a contributing factor in predisposing trees to damage by these insects.

Establishment of Ecological or Physiological Basis for the Relationship.--If a statistical significance between an insect and a pollutant is established, it is important to understand the basis of this relationship. Is there, in fact, a basis for the relationship or is one dealing with the proverbial "nonsense correlation?" Working with a photochemical oxidant-bark beetle complex in the San Bernardino Mountains of California, Stark et al. (1968) demonstrated a relationship between the two. Cobb *et al*. (1968a) demonstrated that severely affected trees had reduced oleoresin exudation pressure, yield and rate of flow. Sapwood and phloem moisture content of diseased trees was less than 60 percent of the healthy trees. In addition, Miller *et al*. (1968) demonstrated that soluble sugar and reserve polysaccharides were less in diseased trees. These workers concluded that these changes enhanced successful establishment of *D. brevicomis* and *D. ponderosae* in ponderosa pines affected by this pollutant (Cobb *et al*., 1968b).

Edmonds (1973) discusses the role of the parasite *Prospaltella* sp. in regulating populations of *N. californica* and the lethal effects of dust and insecticide drifts on populations of *Prospaltella* and other parasites. Reduction of parasite populations by dust may account for preponderance of scale insect populations around particulate sources in Spokane, Washington (Johnson, 1950) and Columbia Falls, Montana (Carlson and Dewey, 1971).

Documentation of Change Through Time Relative to a Presource Baseline.--Perhaps one of the most conclusive approaches to the establishment of an insect-pollutant relationship is a careful recording of events both prior to and after a potential source begins operation. Preparation of environmental impact statements and public review of all major actions with potential environmental impacts provides the opportunity for acquisition of baseline data both on diseases which might mimic or mask air pollution injury and insect population levels prior to the proposed actions. Continued measurement of levels of injury after the potential source has begun operation may pinpoint problem areas at an early date. This approach is being taken by a multidiscipline team representing the Forest Service, Washington State University of Washington and Northwest Alloys at a magnesium reduction plant site near Addy, Washington. This plant is source of potentially damaging sulfur dioxide emissions. Systematic foliage samples are being taken annually from ponderosa pine and Douglas-fir in the Addy airshed and estimates of needle retention, foliage disease, basal necrosis, scale insects and foliage-feeding insects are being made. Two years of preplant operation baseline data will be available with which to compare annual postoperation monitoring data. In addition, aerial and ground detection surveys, a network of sulfation monitoring plates, an annual set of color infrared aerial photos and a long range study designed to monitor changes in plant communities are part of the monitoring program. This effort is designed to detect upsurges of insect populations in the Addy air-shed as well as symptoms of acute or chronic fumigation due to $SO_2$.

These are some approaches which may be taken to establish the fact that an epidemic insect population near a pollutant source is, in fact, the result of increased levels of a toxic pollutant or a random or coincidental occurrence.

Bruce Baker and Tom Laurent from USDA Forest Service at Juneau, Alaska discussed the association between high defoliating insect populations and high foliar chemical levels near two pulpmills in southeast Alaska.

Combinations of high western black-headed budworm (Acleris gloverana (Walshm.)), hemlock sawfly (Neodiprion tsugae Midd.), or saddle-backed looper (Ectropis crepuscularia (Schiff.)) populations in western hemlock (Tsuga heterophylla (Raf.) Sarg.) and high foliar sulfur levels in western hemlock, Sitka spruce (Picea sitchensis (Bong.) Carr.), and other conifers have been found.

Symptoms of tree decline include needle cell damage, needle discoloration, defoliation, top kill, and entire tree mortality in young- and old-growth trees. Damage varied between and within tree species in the two mill areas.

Dr. Jerry Bromenshenk, Environmental Studies Laboratory, University of Montana, presented his work near a coal-fired power plant complex currently under construction at Colstrip in eastern Montana. Two 350-megawatt generators will begin operation during 1975, and the applicants have filed for construction permits for two additional 700-megawatt generators. The Environmental Studies Laboratory, University of Montana, received a grant from the Environmental Protection Agency to study the impact of this development on the ecosystems of eastern Montana.

The primary objective is to obtain baseline data and to monitor subsequent changes in the ecosystems that occur because of pollution stress. Dr. C. C. Gordon is examining the responses of fungal host plant systems, while Jerry's work concentrates on insect-host plant systems. Two insect complexes are being intensively investigated: (1) ponderosa pine and pest insect relations and (2) pollination systems. It has been well documented by researchers that increases of certain insect infestations do occur in some polluted areas, and field experiments have been established to ascertain increases or decreases of selected destructive and beneficial insect species at potentially high impact and/or high stress areas. At present, insect damage to ponderosa pines in the Fort Union Basin of eastern

Montana is at a low level. The most prevalent insect harm is by cone mining larvae of Conophthorus beetles and by Laspeyresia and Diorcytria moths. Influxes or increases may occur in populations of other insect pests such as cambial feeders in areas subjected to elevated air contaminant stress as a result of deterioration of the physiological condition of the trees and/or of an imbalance of predators, parasites, and pathogens on the insect populations. Certain air pollutants have been shown to directly affect tree vigor or condition and there is indirect evidence that airborne substances may initiate chain reactions among dependent organisms such as associated predator, parasite, pathogen complexes. Toward this objective they are collecting data from field sites located along compass radii from Colstrip at distances from 5 to 80 airmiles. They are quantifying insect species and damage to ponderosa pine, tree condition, foliage concentrations of fluorides and sulfurs, and precipitation chemistry.

A major portion of this study concerns honeybees--a beneficial insect whose presence in both agricultural areas and indigenous ecosystems is essential to normal plant reproduction and growth. Bees are extremely sensitive to air contaminants, rapidly accumulate substances such as arsenic and fluoride, and demonstrate lethal and sublethal effects. Samples of bee tissue, pollen, and bee products obtained from commercial apiaries in the study area are being analyzed. Concurrently, pesticide residue analyses are being performed by the Biological Investigations Laboratory, Environmental Protection Agency, Beltsville, Maryland because insecticides are a major confounding factor. There is evidence that air contaminants and pesticides may alter foraging behavior, cause breakdowns of communication systems, and effect memory and orientation in bees as well as cause damage to the physiological condition of the bees. Observation hives will be used to monitor behavior responses which may be valuable indicators of pollution stress and colony condition. We intend to use a simple, efficient capture-recapture system to monitor insect flight activities. The method developed by Dr. N. E. Gary, University of California at Davis utilizes metal tags which are glued to the thorax of bees and magnetic retrieval traps at monitoring locations. The behavioral work will be conducted primarily on a field fumigation plot near Fort Howes, Montana. The Environmental Protection Agency is constructing a sulfur dioxide delivery system for field experiments on the effects of $SO_2$ on grassland ecosystems.

The monitoring of changes induced by air pollutants in host plant condition, in insect population trends, and in the behavioral, biochemical, and physiological responses of the insects should provide information necessary for a working knowledge and understanding of these complex relationships.

Dr. Drake Hocking presented work that he and Dr. S. Malhotra are doing on sulfur dioxide at the Northern Forest Research Centre in Edmonton, Alberta. The primary visual symptom of acute $SO_2$ injury to foliage is bleaching of the affected area, followed by necrosis. They have examined the processes of pigment destruction in lodgepole pine (Pinus contorta Dougl. var. latifolia Engelm.) following treatment of excised needles with aqueous solutions of $SO_2$.

Losses of total chlorophyll began during treatment with the lowest concentration tested (10 p.p.m. $SO_2$), becoming significant at treatment with 250 p.p.m. and increasing to almost 50 percent during 22 hours treatment with 500 p.p.m. $SO_2$ (pH 3.95). Treatment with HCl at pH 3.95 resulted in only 4 percent loss of total chlorophyll.

Separating the pigments showed that chlorophyll a was selectively destroyed by removal of the $Mg^{++}$ because a parallel increase in phaeophytin a occurred. Chlorophyll b resisted destruction by this route; no phaeophytin b was found.

The reason for selective destruction was found when they examined the activity of chlorophyllase, the enzyme that removes the phytol side chain from chlorophylls to make chlorophyllides. This enzyme was stimulated by almost 40 percent at low $SO_2$ concentrations (peak at 50 p.p.m.) and in this situation was acting selectively on chlorophyll b. Chlorophyllide b was formed by treatment at all concentrations of $SO_2$ with a peak at 50 p.p.m., the same level at which chlorophyllase activity peaked. Chlorophyllide a was absent throughout.

The two routes of chlorophyll breakdown come together with formation of phaeophorbides through removal of the phytol chain from phaeophytins and through removal of $Mg^{++}$ from chlorophyllides. In our studies phaeophorbides were present but they have not completed quantitative determinations.

Parts of this work are being prepared for publication and some other injury mechanisms are being examined.

Mr. Wayne Williams, USDA Forest Service, San Francisco, California discussed oxidant air pollution damage in California forests. There has been a general worsening of photochemical oxidant air pollution disease on forest trees in California since 1971. Air pollution generated in California's major population centers is now weakening and killing millions of valuable pines on the four southern National Forests. Damage is heaviest on portions of the San Bernardino National Forest. Oxidant injury is evident in every major stand of yellow pine type on the Angeles National Forest. On the Los Padres National Forest pines are being damaged by air pollution from the

Bakersfield-Central Valley and the Los Angeles-San Fernando Valley urban complexes. Doses of oxidant probably generated in San Diego and Tijuana have been detected on the Cleveland National Forest where smog injury on Jeffrey pine is common.

Oxidant-induced smog injury is most severe on ponderosa and Jeffrey pines but air pollution disease symptoms were detected on other tree species in 1974 including big cone Douglas-fir (*Pseudotsuga macrocarpa*), sugar pine (*Pinus lambertiana*), limber pine (*Pinus flexilis*), knobcone pine (*Pinus attenuata*), incense cedar (*Calocedrus decurrens*), white fir (*Abies concolor*), and black oak (*Quercus kellogii*). Oxidant injury is also suspected on pinyon pine (*Pinus monophylla*), digger pine (*Pinus sabiniana*), and giant Sequoia (*Sequoiadendron giganteum*). Although oxidant injury has been reported on coulter pine (*Pinus coulteri*), this species appears to be one of the more resistant native pines in California.

Atmospheric monitoring on the southern National Forests has recorded concentrations and durations of ozone that are considered sufficient to account for the observed intensities of injury to pines. This decline caused by oxidant air pollutants is contributing to increased fire hazards, insect and disease problems, and resulting in potential successional patterns of forest ecosystems that are unfavorable for optimum and necessary resource yields and utilization. The extent and intensity of smog disease are such that air pollution is a serious threat to the continued maintenance of healthy and productive coniferous forests in southern California.

In 1974 the Forest Pest Control Staff, Forest Service, Region 5 began a survey to determine the incidence of smog-damaged trees in the Sierra Nevada. The survey began on the Sequoia National Forest where smog-damaged trees were reported in 1971 (Miller and Millecan Plant Disease Reporter 55:555-559). By the end of the 1974 season roadside stands from the Kings River to Mineral King had been systematically examined for trees showing symptoms that have been associated with smog damage in southern California for many years, i.e., chlorotic mottle of living needles, premature needle cast, increased mortality in lower crowns, needle shortening, and general decline. Ponderosa and Jeffrey pines, which are among the most sensitive of native California plants, were found with symptoms of oxidant disease throughout the ponderosa and mixed conifer forests adjacent to the San Joaquin Valley in a crescent-like horizontal band following the many ridges that rise abruptly from the San Joaquin Valley floor to the 6,000 to 8,000 feet elevations. Preliminary observations near Shaver and Huntington Lakes in the southern Sierra National Forest and in the Greenhorn Mountains at the southern end of the Sequoia National Forest suggest that this condition may be common throughout the southern Sierra Nevada.

In northern California specimens of ponderosa pine from Nevada City, Grass Valley, Auburn, and Placerville have been examined and all had symptoms reminiscent of typical oxidant injury. Evidence from several sources including preliminary monitoring in 1974 by the Forest Pest Control Staff, earlier monitoring by the Pacific Southwest Range and Forest Experiment Station, and reported episodes of air pollution in the Sacramento-San Joaquin Valley by the California Air Resources Board indicates that ozone of sufficient concentration and duration necessary to produce the above described symptoms occur from Fall River Mills in the northern Sierra Nevada to Bakersfield in the southern Sierra. The Sierra Nevada survey will continue in 1975 and a comprehensive evaluation of air pollution damage to forest trees in southern California is proposed.

If the trend of increased smog injury to sensitive coniferous species continues, forest management practices will have to be altered. Logging frequencies and volumes can be expected to temporarily increase as the forests decline, but indications are that future timber yields will be reduced. Replanting over large acreages will be necessary, but smog resistant genotypes for ponderosa and Jeffrey pine are not presently available. Since the episodes of air pollution are exceptionally high in parts of the San Bernardino National Forest, it may be impracticable to select for pollution tolerance in those areas where air pollution mortality factors for sensitive species are already exceeded. Storing southern California genotypes of sensitive species until air pollution is abated would preserve those lines best adapted to marginal growing conditions in southern California. Outplantings of more smog tolerant genera and species such as giant Sequoia may help maintain the aesthetic properties of high valued lands.

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# WESTERN FOREST INSECT WORK CONFERENCE

## MINUTES OF THE FINAL BUSINESS MEETING
February 28, 1975

Chairman Trostle called the meeting to order at 8:35 a.m. in the Terrace Room, Del Monte Hyatt House, Monterey, California.

Secretary and Treasurer's reports were read and approved.

David Wood's letter was placed before the membership for discussion. Dave summarized the letter and discussion followed. Some comments were that a group such as proposed should include disciplines in addition to entomology and pathology, for example silviculturists and forest managers. If all disciplines were represented, the group would become large and unwieldy. However, it was felt that the WFIWC might want to meet occasionally with other groups such as the Western Forestry and Conservation Association and SAF. It was felt that a final decision was not in order at this time concerning merger of the WFIWC with other groups. No motion or vote was taken.

The 1976 meeting was discussed. Continued informality of workshops was emphasized. Expense of the meeting should be kept low so that younger members and particularly students could afford to attend.

Victoria, B. C. was selected as the 1977 meeting site.

Proposed that at future meetings, the Chairman may wish to have a business meeting luncheon rather than meet on the last day after some members already have gone home.

The membership was made aware that Julius and Mrs. Rudinsky had been involved in a serious auto accident. Individuals were encouraged to send a card.

Motion MSC that a note of appreciation be sent to Joan Bega and Maude Wagner for their efforts in making the Women's Program a success.

Motion MSC that a letter of appreciation be written to L. T. Peterson, Deputy State Forester, California Division of Forestry, for supplying buses for the educational tours.

The Program Committee consisting of Ken Swaine, Pat Shea, and Mike Srago was recognized for the excellent job of putting together the 1975 meeting.

Preparation and inclusion of a short biographical note in the Proceedings for deceased members was discussed. There was no motion.

Statement to the Chairman that when approached by a chemical company proposing a hospitality room at our meeting, the Chairman might suggest that the company use the money for a scholarship fund.

Chairman Trostle called for committee reports:

Common Names Committee

No action.

Nominating Committee

Motion MSC Douglas Parker become councilor, replacing Bill Ives whose term expired this year.

Ethical Practices Committee

Rick Johnsey appointed by Bob Dolph as Chairman because of Bob's early departure. Several candidates and their performance were reviewed by Rick. Fred Honing, while visiting the hords of fornicating butterflies was overcome by the pheromone and had to leave in order to keep from violating civil rights of a female colleague.

A female attendee at the Conference had several visitors to her room; however, presumably they were only playing with her computer.

Bill McCambridge was nominated as this year's winner of the Award--seems there was a little hankie pankie between Bill and a (possibly more than one??) waitress at a downtown restaurant. Bill graciously accepted the Award; he plans to use it for a spinnaker on his new sailboat. Congratulations, Bill! Good to see that young spirit! It was the opinion of the Ethical Practices Committee that Watergate had dampened the enthusiasm of the young members of our group to report the deeds of their colleagues. However, they now should be fully aware that cover-ups do not occur in the WFIWC.

Meeting was adjourned by Trostle at 9:40 a.m.

## WESTERN FOREST INSECT WORK CONFERENCE

## TREASURER'S REPORT

| | | |
|---|---|---|
| Balance on hand March 11, 1974 | | $1,097.73 |
| Received from Registration, 1974 | $448.00 | 1,545.73 |
| Expenses for 1974 meeting | 237.88 | 1,307.85 |
| Received membership fees | 30.00 | 1,337.85 |
| Received interest | 60.94 | 1,398.79 |
| Preparation of Proceedings | | |
| 1971-72 379.50 | | |
| 1974 250.50 | 630.00 | 768.79 |
| Transfer of account to new Treasurer | 1.70 | 767.09 |
| Balance on hand February 22, 1975 | | 767.09 |

# WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

## BUSINESS MEETING

FEB. 27, 1975

DEL MONTE HYATT HOUSE: MONTEREY, CALIF.

Called to Order 3:30 by Chairman Bob Bega.

Thanks to: Co-chairman Mike Srago
Program Dick Parmeter
Women's Program Joan Bega and Maude Wagener
(letters to go: Joan Bega, Maude Wagener)
(applause)

It was moved by Bob Scharf, seconded by Paul Ahoe, that the minutes as reported in the proceedings of the last meeting be adopted without reading. Carried.

The question of whether or not to hold the fall 1975 meeting of WIFDWC was raised. The fall 1974 meeting was postponed owing to the present joint meeting. This question was tabled pending discussion of the proposal (by Dave Wood), to merge with the WFIWC and form a larger grouping for integrated forest pest mananagment.

Clint Carlson moved, Tom Laurent seconded, that WIFDWC not merge with WFIWC. Reed Miller endorsed joint meetings, but felt that every 5 years would be often enough. The consensus of discussion supported that view. Ed Wicker stated that WIFDWC members present had no right to commit future.

Drake Hocking moved, Walt Thiese seconded, an amendment that the motion be preceded by a qualifying clause that WIFDWC endorses the principle of periodic joint meetings with WFIWC. The amendment was carried unanimously.

Discussion proceeded on the motion as amended. The issue of participation by land managers in our meetings was determined to be irrelevant to the issue of a merger. The motion as amended was carried by vote.

Walt Thiese moved, Reed Miller seconded that WIFDWC should meet in the fall of 1975. Some members thought that funds would be hard to come by to attend another meeting so early after this one, but the alternative of postponing the next meeting another year was not favoured. Motion carried by a vote.

Further discussion on a favourable date led to the conclusion that a consensus on a suitable date may be derived by the local arrangements committee.

Jim Hatfield, on behalf of Forest Pathologists of the State of Oregon, invited WIFDWC to hold its fall of 1975 meeting in Oregon. Oscar Dooling made a similar invitation to host the meeting in Missoula. A vote determined that the fall 1975 meeting will be held in Missoula.

Discussion was held on what to do with a manuscript, held by Dick Krebill, on the history of western forest pathology by Tom Buchanan. Don Leaphart volunteered to assist in plans. Frank Hawksworth suggested contacting the Forest History Society.

Duncan Morrison raised the question of procedure for obituary notices. He moved, Ed Wicker seconded, that WIFDWC duly record written obituaries of members deceased in the preceding year. Bob Bega said that we have always done this. Motion carried unanimously.

Consensus instructed the Secretary to write to Union Carbide a letter of thanks for providing hospitality at this meeting.

Standing Committee reports would be accepted in writing by the Secretary for inclusion in the Proceedings (Dwarf Mistletoe, Disease Control, and Hazard).

Frank Hawksworth made the suggestion that consideration should be given to planning meetings two years in advance. Jim Hatfield moved, Walt Thiese seconded, that the fall 1976 meeting of WIFDWC be held in Oregon. Motion carried. The Chairman then appointed Frank Hawksworth to strike a Future Meetings Standing Committee.

Ed Wicker promised to mail out copies of points raised in the "What's your bitch?" workshop, if the Proceedings did not come out before the next meeting.

Ed Wicker nominated, Bob Scharf seconded, Stu Whitney for Chairman and Jim Byler for Secretary-Treasurer. Bob Scharf moved, Tom Laurent seconded, that nominations cease. Carried. The Officers were declared elected by acclamation.

A unanimous vote of thanks was carried, with applause, for the local arrangements of the present meeting.

The meeting adjourned at 4.45.

# WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

## SOCIAL ACHIEVEMENT AWARD

The WIFDWC Social Achievement Award has a long and distinguished history. This award has been honestly won by some truly dedicated contendees like Reed Miller, Toby Childs, Alex Molnar, and Vivian Muir. In recent years the quality of competitors has definitely been of low rank and furnished little incentive to gifted contenders such as myself.

The presentation of the award to Bob Bega is an example of the low level to which we have sunk. Instead of being awarded for a brilliant exemplary performance, the trophy was awarded for a plodding-meeting-after-meeting performance.

We hope, after the shame of this year's award is behind us, that we can look forward to performances in the tradition of Stuie Andrews, Larry Wier, and other winners of their caliber.

TOM LAURENT
(Last Year's Winner)

# REPORT OF COMMITTEE ON FOREST DISEASE RECREATION HAZARDS

Peter Gaidula - Chairman

The Committee on Forest Disease Recreation Hazards held a meeting on February 25, 1975 at Monterey, California during the 22nd Western International Forest Disease Work Conference held jointly with the 26th Western Forest Insect Work Conference. The Chairman reviewed briefly the program sponsored by the Committee at the 21st WIFDWC held at Estes Park, Colorado in October 1973.

A status report was given on the two projects underway by the Committee members. These projects are:

1. Compilation of a literature list specific to tree hazard problems in forested recreation sites;

2. Preparation of a training outline to prepare personnel to detect and evaluate tree hazards in recreation sites. A deadline of April 1, 1975 was set for sending comments to the chairman on the drafts of both projects, copies of which had been previously distributed. Also, the Committee agreed to expand the literature list to include publications on arboriculture, legal aspects, and on the prevention of tree hazards. In this regard, Dr. Lee A. Paine, Forest Pathologist, Pacific Southwest Forest and Range Experiment Station, has kindly made his reference list available to the Committee.

   The Chairman reported on Dr. Paine's research on tree hazard problems and the present attention being given to gathering tree failure data from urban recreation sites. This led to a discussion by the group as to the applicability in the field of Dr. Paine's research findings, and in particular, his hazard rating system to tree hazard problems. The opinion of the group was divided as to the desirability of using Dr. Paine's system, or of using a simpler system, or even no system at all. The group expressed the desirability of having Dr. Paine explain his work in person at one of our meetings.

   There was a discussion of current research pertinent to tree hazard problems in recreation areas. Mike Srago, Region 5, United States Forest Service, has been engaged in a study at Yosemite National Park aimed at detecting hazard in incense cedar infected with Fomes annosus. Tom Hinds of the Rocky Mountain Forest and Range Experiment Station, mentioned the current work on tree diseases being done for the National Park Service by Dr. Dave French of the University of Minnesota. Dr. John R. Parmeter of the University of California mentioned the work the University is doing at Sequoia - Kings Canyon National Park on the effect of carpenter ants on failures of the Big Tree (Sequoiadendron giganteum) and it's ecology.

# DWARF MISTLETOE COMMITTEE REPORT

Ed F. Wicker, Chairman

## Mistletoe Research and Development Activities

## I. Taxonomy, Hosts and Distribution

New distribution records for U.S. species of *Arceuthobium* include (1) *A. douglasii* in the Guadalupe National Park, Texas (first state record), (2) *A. cyanocarpum* in the Deep Creek Mountains of Utah, (3) *A. divaricatum* near Rangely, Colorado (northern extension of known range), (4) *A. cyanocarpum* near LaVeta Pass, Colorado (southern extension of known range). (F. Hawksworth, USFS, Fort Collins)

New host records include: *A. cyanocarpum* on *Pinus aristata* near LaVeta Pass, Colorado. This mistletoe is common with Intermountain bristlecone pine (*Pinus longaeva*) but has not been previously collected in Rocky Mountain bristlecone pine (*Pinus aristata* and associated *P. flexilis*). (F. Hawksworth, USFS and J. G. Laut, Colo. State FS, Ft. Collins)

Studies of the juniper dwarf mistletoe in the Old World reveal that there are three species: (1) *A. oxycedri* which occurs from the Mediterranean to the Himalayas on several species of junipers, (2) *A. juniperi-procerae* Chiov. which parasitize *Juniperus procera* in Kenya and Ethiopa, and (3) a new species which occurs on *J. brevifolia* in the Azores. A manuscript on these studies has been submitted for publication in the Kew Bulletin. (F. G. Hawksworth, USFS, Ft. Collins, and D. Wiens, Univ. of Utah)

## II. Physiology and Anatomy

Studies to obtain scanning electron photomicrographs of the pollen grains of all *Arceuthobium* taxa were continued and about half have been photographed to date. Preliminary results suggest that morphology of the pollen of some taxa is distinctive enough to warrant specific identification. (F. G. Hawksworth, USFS, Ft. Collins)

The effect of water stress on dwarf mistletoe parasitism has been investigated for several years using ponderosa pine and lodgepole pine and their respective parasites, *Arceuthobium vaginatum* and *A. americanum*. The pressure chamber technique, calibrated against thermocouple psychrometry, has shown that dwarf mistletoes normally have lower water potentials than their hosts. Additionally, the water potential gradient from host to parasite usually becomes greater with increased host stress. Transpiration experiments involving intact plants have shown that parasite transpiration usually exceeds host water loss on a surface area basis. Moreover, the transpirational gradient between host and parasite especially widens when host stomatal closure occurs. Studies have also shown that dwarf mistletoe shoots act as respiratory sinks throughout drying cycles. Water potential, transpirational and respiratory gradients, being interrelated are thus maintained with increased host water stress and afford the flow of water and nutrients to the parasite under adverse conditions. (J. T. Fisher and C. P. P. Reid, Colo. State Univ., Ft. Collins, Colo.)

Our studies show viscin from the seeds of A. campylopodum and A. tsugense to be primarily composed of polygalacturonic acid interlaced by a large number of cellulose fibers. To date, only trace amounts of other substances have been detected in the viscin. (P. Pacquet and R. Tocher, Portland State Univ.)

Currently, the chemical nature of viscin from A. douglasii, A. laricis, A. abietinum, and A. americanum is being studied. Histochemical studies are also being conducted to determine the nature of the viscin producing cells. (P. Pacquet and R. Tocher, Portland State Univ.)

Studies were conducted on the lipid content of the aerial shoots of four species of dwarf mistletoe (A. douglasii, A. laricis, A. pusillum and A. tsugense). The lipids were extracted using a modified Bligh and Dyer technique and then the methyl esters of the fatty acids were identified by gas chromatography. The results will be published soon. (P. Pacquet and R. Tocher, Portland State Univ.)

## III. Life Cycle

To determine the direction of seed flight relative to the axis of the host tree, field infections of western hemlock dwarf mistletoe (A. tsugense) were excised together with a short length of branch after noting the branch orientation. Infections were supported in their field positions in the center of cheesecloth cages 1x1x1 m and placed in a warm room to induce seed dispersal. The experiment was replicated twice, each replicate using three plants dispersing 86 and 181 seeds respectively. Seeds trapped on the cloth were counted with respect to their portions relative to the center point of the infection. Both replicates agreed closely in the percentage of total seeds despersed in different directions, namely, up - 85%, down - 15%; towards tree - 32%, away from tree - 68%. These totals break down to in-up - 27%, in-down - 5%, out-up - 57%, out-down - 11%. (W. J. Bloomberg and R. B. Smith, PFRC, Victoria)

To get an approximate idea of the effect of distance from plant to crown perimeter of escape of A. tsugense seeds, excised field infections as above were attached to the inner, middle, and outer points of branches within a section of hemlock crown. The section was about 3 m high x 5 m crown diam. It was cut from the middle of a 35-yr-old tree and was supported upright and surrounded by a 3-m high curtain of cheesecloth. Two branches on opposite sides of the crown were used, each about 2.1 m long and approximately 60 cm up the stem. Seed dispersal was induced by a flow of warm air, 600-1200 seeds being released from each of the three positions along the branch. The percentage of seeds intercepted by the curtain was 25, 29, and 38 for the inner, middle, and outer positions, respectively. Undoubtedly a few seeds escaped over the top of the curtain but in view of its height and the density of the crown, the percentage was probably relatively small. The number intercepted therefore probably reflects the proportion, if not the absolute numbers of seeds escaping from different points within the crown. (W. J. Bloomberg and R. B. Smith, PFRC, Victoria)

The effect of plant height on the horizontal dispersal of A. tsugense seeds was studied by inducing seed discharge as above from heights of 1.7, 5.25, 9.25 and 16.5 m (windows in a four story building). Seeds were intercepted on a 6.6 m wide plastic sheet and counted at 1 m distances measured on a horizontal plane from the plant. Although the maximum distance recorded (16 m) was about the same for all heights, even the lowest, the distribution of seeds showed increasing percentages at greater distances as the plant height increased. For example, from 16.5 m height, 5 and 30% of the seeds landed at 3 and 7 m respectively, whereas from 9 m the percentages were 17 and 6. (W. J. Bloomberg and R. B. Smith, PFRC, Victoria)

A study was begun in 1974 to determine the effective distance of dispersal of Arceuthobium americanum pollen. Several small lodgepole pine seedlings bearing only pistillate infections were transplanted into a 90-acre clearcut. Seedlings were placed at various distances from the edge of the clearcut (where the residual stand is heavily infected) out to the center of the clearcut (about 18 chains). Counts will be made in 1975 and subsequently to determine the percentage of fruit set in relation to pollen flight distance. (F. G. Hawksworth, USFS, Ft. Collins, and Tom Landis, USFS, R-2, Denver)

Dwarf mistletoe seed dispersal by birds was studied at the Manitou Experimental Forest in 1974. Between July 24 and August 23, 131 birds were randomly caught and examined for dwarf mistletoe seeds. Many (99) were held in captivity to permit collection of feces. Dwarf mistletoe seeds were found on the feathers of mountain chickadees (27%), pygmy nuthatches (19%), gray-headed juncos (14%), and a chipping sparrow (5%). No seeds were found in fecal material during this time. Between August 24 and September 27, only nuthatches and chickadees were held in captivity when trapped. These birds were fed dwarf mistletoe seed and at least some were passed whole. Viability was not determined but, microscopically, the seeds appeared to be viable. (George Hudler, Colorado State Univ., Ft. Collins)

Studies are being conducted on the pollination and pollen dispersal of the dwarf mistletoes. Most work is being done on Arceuthobium douglasii in the Wasatch Mountains near Salt Lake City. There was very little insect activity associated with pollination of A. douglasii in the areas studied and this species appears to be primarily wind pollinated. Pollen dispersal was measured by use of plastic sampling rods. Pollen load decreased rapidly as distance from the pollen source increased. The maximum distance of pollen dispersal was about 60 feet. (Cooperative study with PNW Station, Glade Player and D. Wiens, Univ. of Utah)

## IV. Host-Parasite Relations

No report

## V. Effects on Host

Forest Survey data from the Okanogan N.F., Washington (1/5 acre plots, read 10 years apart) were evaluated to determine if tree mortality is related to presence of A. douglasii. (Knutson - PNW)

An evaluation is underway on the Fremont National Forest to measure the effects of dwarf mistletoe infestations on growth rates of lodgepole pine stands in the lodgepole pine-needle grass basin plant community. We expect to complete this evaluation prior to July 1975. (J. S. Hadfield, R-6)

We made the third-year reading on the Douglas-fir impact plots primarily to pick up latent infections, but we also measured tree growth for the period. Defoliation and top kill by the western spruce budworm has complicated the situation somewhat; most of the study trees showed negative height growth. Diameter growth was related to stocking density but not to infection levels. We also made the third-year reading on the lodgepole pine impact plots, and both height and diameter growth were again related to stocking density but not to infection levels. (O. J. Dooling, R-1)

Studies on construction of yield simulations in mistletoe-infested stands are continuing and we are now able to predict yields in two-storied as well as even-aged ponderosa pine stands. A manuscript on the new and improved version, which will replace the SWYLD program, is in preparation. Field work is still in progress in developing yield predictions in irregular (uneven-aged) stands. (F. G. Hawksworth and C. A. Myers, USFS, Ft. Collins)

VI. Ecology

The study, "Possible effect of ozone on the mistletoe infection process, shoot growth, and seed production," was terminated before data accumulated to a point of usefulness because ozone generating facilities were withdrawn from our use. There are no plans to repeat the study. (Stewart and Wilhour, PNW, Corvallis)

First production of mature fruit from field inoculations (see 1971-73 reports) resulted from 1970 inoculations of shore pine (*Pinus contorta* var. *contorta*) near Victoria with *A. tsugense* collected from shore pine. This corroborates our published report that a 4-year cycle is possible for *A. tsugense* in nature. Plants with fruit were bagged to collect seed and observe germination. No mature fruit were produced in 1974 from any of the other inoculations (see 1971 report). Many infections resulting from 1970 inoculations of *A. tsugense* on both lodgepole pine and western hemlock and one from a 1971 inoculation produced immature fruit in 1974 in the Interior of B.C. where *A. tsugense* does not occur naturally. (R. B. Smith, PFRC, Victoria)

A survey has been carried out to determine the distribution of _A. tsugense_ on shore pine and to define the characteristics of the infected stands and habitats. Twenty-four infected areas were located on hilltops and knolls in the southeastern tip of Vancouver Island. Stands consisted mainly of short pine, scattered over-mature Douglas-fir and arbutus (_Arbutus menziesii_). Western hemlock was not a component. These areas were generally exposed ridges consisting of dry salal - lichen plant associations and usually dominated by hairy manzanita (_Arctostaphylos columbiana_) in the shrub layer. The incidence of infection ranged from 47 to 100% and the average stand infection index from light to severe. Infected areas varied from a few residual shore pine to stands several hundred acres in size. (E. F. Wass, PFRC, Victoria)

The study of the effect of various levels of insolation on the production of seeds by _A. douglasii_ is continuing. Additionally, the study of _A. campylopodum_ at the early stages of infection is continuing inasmuch as technical difficulties will allow. We have also begun to look at _A. tsugense_ with respect to its response to insolation in open and closed stands. A number of parameters have been and will continue to be investigated. (P. Pacquet and R. Tinnin, Portland State Univ.)

## VII. Control - Chemical

No report.

## VIII. Control - Biological

Comparative biology of _Septogloeum_ on _A. campylopodum_, _A. tsugense_, and _A. abietinum_ is being investigated. (Knutson - PNW)

## IX. Control - Silvicultural

Thirteen dwarf mistletoe control projects were evaluated for effectiveness. Evaluations were made 1-2 years after project completion. The same survey technique was used for pre- and post- control evaluations. Data shows reduction in number of infected trees per acre ranged from 69 percent to 90 percent. Almost all remaining infected trees were Class I. (Al Rivas, R-4)

All field work has been completed and analyses are underway on an economic analysis of dwarf mistletoe control in the

Southwest. We expect to have our report on the results finished this year. (F. G. Hawksworth, and C. A. Myers, RM Station, D. Schweitzer, INT Station, and D. Graham, R-3, Albuquerque)

The plots for the silvicultural control study of the lodgepole pine dwarf mistletoe in the Routt National Forest, Colorado, will be reexamined in 1975. This study involves thinning and sanitation in stands of various ages (20 to 40 years of age) and intensities of mistletoe. A 10-year progress report on the results will be prepared next winter. (F. G. Hawksworth and T. E. Hinds, RM Station, and T. Landis, USFS, R-2, Denver)

We concluded a biological and economic appraisal of the control program in Region 1 in 1974. The economic appraisal showed a benefit/ cost ratio of 3.25/1 in Douglas-fir and western larch and 2.42/1 in lodgepole pine, based on stumpage values at the end of the fourth quarter, FY 1973. Growth predictions in Douglas-fir and western larch were based on some of our previous studies; growth predictions in lodgepole pine were made with the Myers, Hawksworth, and Stewart computer program LPMIST (RM-72). The appraisal was published as: Dooling, O. J., 1974. Dwarf mistletoe control--why and what? An appraisal of the Northern Region control program, USDA Forest Service, Northern Region. For. Environ. Protec. Rep. 74-16. (O. J. Dooling, R-1)

## X. Surveys

During the summer of 1974 a "How Are We Doing Type" survey was done in five-year-old dwarfmistletoe control units in eastern Washington. We measured 822 trees on 34 1/10th-acre plots scattered throughout the units. The survey objective was to evaluate DNR's dwarf mistletoe control precommercial thinning program currently running at about 1500 acres per year. Fourteen plots were established around Glenwood, 11 near Spokane and 9 northwest of Omak.

The survey revealed a low incidence of dwarf mistletoe on crop trees approximately 5 years following initial control. Growth response from the thinning could be measured. We found an approximate doubling of diameter growth rate except at Glenwood where it was less. We found that we should have removed more trees per acre including a few infected but merchantable overstory trees left for future harvest. The importance of removing these trees is difficult to get across to conservative foresters. They cannot bear to sacrifice a merchantable log. Removing more stems may increase growth response.

Only 9% of all trees measured had a 6 class mistletoe rating higher than 3. We allow no trees with ratings greater than 3. Four percent of the trees rated "3" and 5% rated "4". No trees rated 5 or 6, the significant growth reducing classes. We concluded that our mistletoe program in Washington when incorporated with precommercial thinning is a worthwhile forest stand treatment in ponderosa and Douglas-fir stands of eastern Washington. (Ken Russell, DNR, Olympia)

An administrative study was conducted to evaluate efficiency of the third nearest tree sampling system in even-aged, dwarf mistletoe-infected ponderosa pine stands of the Southwest. The third nearest tree survey provides data necessary for input in the ponderosa pine simulated yield program (SWYLD). Results indicated the third nearest tree survey, with plots at a 2-chain interval, will provide precise information relative to the intensity and distribution of dwarf mistletoe, stand density, and average stand diameter. Precision of the data provided by the survey is dependent upon the number of plots used. We plan to maximize use of the survey in evaluation of even-aged ponderosa pine stands that are scheduled for precommercial or commercial thinning. Survey data will be analyzed by the SWYLD program, resulting in simulated yields of various management alternatives. These simulated yields will assist the land manager in making management decisions in even-aged ponderosa pine stands of the Southwest. (J. Walter, USFS, Albuquerque)

## XI. Miscellaneous

A program has been developed for obtaining gross dwarf mistletoe impact data from forest inventory for use in Control Data Corporation's model 6400 computer. A manuscript has been prepared for publication as a PNW Station research note detailing the computer program and its application on one national forest in Oregon, "Estimating the magnitude of the dwarf mistletoe problem of the Deschutes National Forest." (DeMars and Stewart, PNW, Corvallis)

A study to develop a simulated yield table for dwarf mistletoe-infected ponderosa pine in the PNW was initiated in the summer of 1973. Data collected over the past two summers will result in an equation to be tested and refined during the summer of 1975. (DeMars and Stewart, PNW, Corvallis)

How long can mistletoe-infested residual hemlocks be left in cutover stands? A recent office report shows that young hemlock within 30 ft. of residual infected trees become infected relatively early, and the percent of trees infected increases rapidly beyond about 10 years of age. Early removal of residual trees is suggested, possibly combined with thinning operations (Stewart, PNW, Corvallis)

# DISEASE CONTROL COMMITTEE
# HIGHLIGHTS OF 1974 CONTROL INVESTIGATIONS

## I. NONINFECTIOUS PROBLEMS

a. Chlorotic decline of Jack pine and black spruce.
Causal agent: air pollution from nickel smelter.
Damage: natural stands.
Control: political
Development Stage: Operational
A unique form of control. . . . Public hearings are underway on conditions to be imposed on the smelting company prior to renewal of their operating license. Pathological input has established nature, extent and cause of decline. Containment of emissions is under consideration. (Hocking, D., Northern Forest Research Centre.)

## II. SEEDLING DISEASES

a. Damping-off of nursery and container seedlings of several species.
Causal agent: soil borne fungi
Control: chemical
Development stage: field trial
Field trials have been going on for four years. To date, none of the fungicides tested have given spectacular control results. They have been applied as drenches, seed pelleting, seed soaks, etc. (Sutherland, J., Pacific Forest Research Centre.)

b. Damping-off of nursery seedlings of several species.
Causal agent: Pythium and Fusarium species.
Control: chemical (fumigation)

Development stage: field trial
During 1971-73 field trials using methyl bromide-chloropicrin (67-33%) fumigant gave best reduction in soil fungus populations and increased seedling survival. Trials with fumigant plus sulfur gave no additional control. (Johnson, D., USFS R-6, Portland)

b. Damping-off of nursery seedlings of ponderosa pine.
Causal agent: *Pythium* and *Fusarium* species.
Control chemical (fumigation)
Development stage: field trial.
During 1972-74 field trials using methyl bromide-chloropicrin (67-33#) plus sawdust. The combined fumigant plus sawdust treatment gave best reduction in populations of pathogenic fungi and increased seedling survival. (Johnson, D., USFS R-6, Portland)

c. Damping-off of nursery seedlings of Douglas-fir.
Causal agent: *Pythium* and *Fusarium* species.
Control: chemical (fertilization)
Development stage: field trial
Applied Dolomite at 1500-2000 lbs/a; Potassium sulfate at 60 lbs/a; ripping to 30 inches deep; and combined treatments. No significant differences occurred between treatments on *Pythium* species. Dolomite treatments favored *Fusarium* species over controls. No significant differences in seedling survival. (Johnson, D. USFS R-6, Portland)

d. Early and late damping-off of nursery seedlings of Douglas-fir and ponderosa pine.
Causal agent: *Pythium* and *Fusarium* species.
Control: chemical (fungicides)

Development stage: Pot trial.
Seed protectant applications of Arasan 75, Dexon 35 and Preseed (chemagro CHE 1843) provided some protection for Douglas-fir and ponderosa pine against early damping-off, but little protection against late root rot caused by Fusarium species. (Johnson, D., USFS, R-6, Portland)

e. Damping-off of nursery seedlings of Douglas-fir.
Causal agent: Pythium species
Control: chemical (fungicide)
Development stage: field trial.
Dexon was applied twice in May as a drench at label rate of 1.5 lbs/100 gallons of water over 400 sq. feet of bed after visual symptoms seen. No difference between treated or untreated probably because of late application. (Thies, W., USFS, R-6, Portland)

f. Damping-off of nursery seedlings of Douglas-fir.
Causal agent: Pythium species
Control: chemical (fungicide seed treatment)
Development: field trial
Captan soak (0.2% solution Cap. 50 WP), Captan dust (2 oz. Cap. 75 per. 100 lbs. seed) and Thiram (2 qts. Arasan 42-S per. 100 lbs. seeds) were tested. No significant differences in survival of emerged seedlings occurred probably due to low numbers of pathogens in the soil. (Thies, W., USFS R-6, Portland)

g. Damping-off of nursery seedlings of Douglas-fir.
Causal agent: Pythium and Fusarium species.
Control: chemical (fungicide seed treatment)
Development stage: field trial

Evaluated Arasan 75 (12.09 g./lb. seed) and Benlate 50 W (1.5 g./lb. seed). No significant difference occurred between treatments on the control probably due to low pathogen populations in the soil. (Hadfield, J., USFS R-6, Portland)

h. Root rot of nursery seedlings caused by Fusarium oxysporum.
Control: chemical and silvicultural
Development stage: field trial.
Evaluating field trials of post sowing drenches of Captan. Results will not be fully proved until heavy fungus populations are encountered. Removal of diseased seedlings as the primary source of inoculum is indicated. (Bloomberg, W. Pacific Forest Research Centre, Victoria)

III. FOLIAGE DISEASES

a. Needle cast of Scotch pine Christmas trees.
Causal agent: At least 2 species of Lophodermium
Control: chemical (fungicide)
Development stage: operational and field trials both nursery and plantations.
The best chemical treatment was Fundalin (Daconil 2787 + 0.025% Cycloheximide) applied 6 times at 4 week intervals from June - October. The best cost effectiveness was Maneb at 2 lbs/A applied 6 times with mist blower. Fewer applications gave less control. Average disease rating over 1972-73 trials was 10% infected. The next best costwise was Benlate. Nursery tests are still under evaluation. (Staley, J., USFS Rocky Mountain Exp. Sta., Colorado Springs.)

b. Needle cast of lodgepole pine.
Occurrance: Homowner ornamentals.
Causal agent: Lophodermium species
Control: chemical (fungicide)
Development stage: field trial.

Monthly applications began in January. Present evaluation is to reduce to minimum the number of sprays needed for best control. (Russell, K., Washington State Dept. of Natural Res., Olympia)

IV. WILT DISEASES

a. Dutch elm disease on American elm.
Causal agent: *Ceratocystis ulmi* & vector *Scolytus multistriatus*.
Occurrence: Mature ornamentals.
Control: chemical
Development stage: field trial
Benomyl field trials completed showed some promise but no operational control at present except sanitation. Planning for field trial of *Scolytis* pheromone effects on disease incidence. (Laut, J. Colorado State Forest Service)

V. ROOT ROTS

a. Lucidus root rot of mimosa and others.
Occurrence: Mature ornamentals & natural stands.
Causal agent: *Polyporus lucidus*
Control: chemical
Development stage: in vitro
*P. lucidus* in vitro shows great sensitivity to Benomyl but apparently rapid parasexual changes can tolerate it. Research progressing to pots and greenhouse trials. (Dickinson, A. and T. McGrath, Stephen F. Austin, State College, Nacodoches, Texas)

b. Laminated root rot on western conifers.
Occurrence: Natural stands, immature, mature.
Causal agent: *Phellinus (Poria) weirii*
Control: Biological - silvicultural
Development stage: field trial

Plots just established - no control data available for 20 years. (Lu, K. C., PNW Station, Corvallis, Ore.)

c. Brown root disease
Host: pinon pine
Causal agent: *Verticicladiella wagenerii*
Control: --
Development stage: field trial only beginning
Defining extent of problem and establishing trial control areas. (Helburg, L., Laut J, Leatherman, D. & Schomaker, M., Colorado State Forest Service)

d. Laminated root rot of western conifers
Causal agent: *Phellinus* (*Poria*) *weirii*
Occurrence: Regeneration of cut-over stands
Control: Biological and silvicultural.
Development stage: field trial
Three separate areas have been established in Washington to test the response of many western conifers and hardwoods on sites infested with root rot. Data available in 20 years. (Russell, K., Washington State Dept. of Natural Res., Olympia)

e. Root disease complex on Inland Empire conifers.
Occurrence: all age natural stands.
Causal agent: *P. weirii*, *Fomes* nigrolimitatus, Armillaria mellea and others.
Control: Silvicultural
Development stage: field trial, study just established.
(Williams, R., Leaphart, D., USFS Region 1, Missoula)

f. Laminated root rot of western conifers.
Occurrence: all conifer stands
Causal agent: *P. weirii*
Control: Biological
Development stage: In vitro. Chemical compounds

Chemical compounds with red alder have been studied as possible biological control agents. Field trial are being initiated in a cooperative study between USFS and International Paper Company in Washington. (Li, C. Y., PNW Station, Corvallis, Ore)

g. Laminated root rot of Douglas-fir.
Occurrence: all aged natural stands
Causal agent: *P. weirii*
Control: silvicultural
Development stage: field trial
Land clearing of a site, following removal of a 70-year-old, heavily infected Douglas-fir stand on the coast, effectively removed the stumps and a large proportion of the root systems but left considerable numbers of infected root pieces scattered through the soil. Two years after treatment, *P. weirii* had been replaced in small diameter (2 cm) pieces but was still viable in large chunks. In a similar trial in the Interior, *P. weirii* had been effectively replaced in all sampled pieces 5 years after treatment. (Wallis, G., Pacific Forest Res. Centre, Victoria)

h. Laminated root rot of western conifers.
Occurrence: all age stands.
Causal agent: *P. weirii*
Control: Biological - silvicultural
Development stage: field trial.
Results will not be available for about 10 years. (Nelson, E., PNW Station, Corvallis, Ore.)

i. Annosus root rot
Host: ponderosa and Jeffrey pines
Occurrence: natural stands - immature
Causal agent: *Fomes annosus*

Control: chemical
Development stage: field trial
Evaluation of borax as a stump protectant against
_F_. _annosus_ on the Fremont National Forest, Oregon
in precommercially thinned stands. No results yet.
(Thies, W., Hadfield, J., USFS R-6, Portland)

j. Annosus root rot on 24 species of pine.
Occurrence: Mature stands
Causal agent: _Fomes_ _annosus_
Control: chemical - silvicultural
Development stage: field trial
Study concerns removal of diseased trees, soil fumigation with methyl bromide and trenching of pockets in arboretum. Study began 10 years ago. Not analyzed but appears feasible in high value sites. (Bega, R., PSW Station, Berkeley, Cal.)

k. Annosus root rot on Douglas-fir and hemlock.
Occurrence: Natural stands immature.
Causal agent: _Fomes_ _annosus_.
Control: chemical
Development stage: field trial
Two years of testing applications to stumps with borax ammonium sulphamate and zinc chloride nearly complete. Zinc chloride best especially during wet months. (Morrison, D., Pacific Forest Research Centre, Victoria)

l. Annosus root rot on western hemlock.
Occurrence: Nursery - container and natural stands
Causal agent: _Fomes_ _annosus_
Control: Biological
Development stage: field trial, greenhouse, in vitro.

Final results to be present at IUFRO Congress 1976, Oslo. Title is "The feasibility of biological control with Ascocoryne sarcoides against F. annosus using pre-inoculation techniques. (Etheridge, D., Pacific Forest Research Centre, Victoria)

m. Rhizina root rot of Douglas-fir and hemlock.
Occurrence: seedlings in plantations.
Causal agent: Rhizina undulate
Control: silvicultural
Development stage: field trial, pot trial, greenhouse trial
Test sites located. Cultures being studied for use in pathogenicity tests. Tissue and single spore cultures will be used in greenhouse pot tests. (Morgan, P., and Diver, C., University of Washington, Seattle)

VI. RUST DISEASES

a. Western gall rust on Monterey pine.
Occurrence: Christmas trees
Causal agent: Peridermium harknessii
Control: chemical
Development stage: field trial.
Neither osycarboxin (Plantvax) nor triforine (Funginex, Cela 524) reduced the number of infections of gall rust (Peridermium harknessii) on Monterey pine (Pinus radiata). The fungicides were applied at 30-day intervals starting just as sporulation was beginning. Only two sprays were applied on 2/14/74 and 3/8/74. Possibly more frequent application would have been more effective. No plans for additional trials at this time. (McCain, A., and Andersen, J., University of California, Berkely)

b. White pine blister rust on western white pine.
Occurrence: immature stands
Causal agent: Cronartium ribicola

Control: chemical
Development stage: field trial
No data yet. Just established. (Hunt, R., Pacific Forest Research Centre, Victoria)

VII. DECAYS

a. Hymenomycetous Fungi of western conifers.
Occurrence: Natural stands - all ages
Control: chemical, biological, silvicultural
Development stage: field trial, in vitro.
Limited results available fall 1975. (Aho P., PNW Station, Corvallis, Oregon)

TWENTY-SIXTH ANNUAL WESTERN FOREST INSECT WORK CONFERENCE

TWENTY-SECOND ANNUAL WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

JOINT MEETING - MONTEREY, CALIFORNIA

TREASURER'S REPORT

| | | | |
|---|---|---|---|
| Receipts: | | | |
| Registration | | | |
| Regular Members | 166 @ $18 | | $2,988.00 |
| Student Members | 20 @ $ 9 | | 180.00 |
| Dinner Tickets | 36 @ $ 9 | | 324.00 |
| | | Total | $3,492.00 |
| Expenses: | | | |
| Del Monte Hyatt House | | | $2,214.80 |
| Miscellaneous | | | 67.95 |
| | | Total | $2,282.75 |
| Balance: | | | $1,210.25* |

*Based on cost for publishing 1974 WFIWC Proceedings, a surplus of funds is anticipated. Any surplus will be divided between WFIWC and WIFDWC Treasuries on the basis of attendance at the Monterey Meeting.

# WESTERN FOREST INSECT WORK CONFERENCE

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Note: Members registering at the Monterey Conference, February 23-28, 1975 are indicated by an *.

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