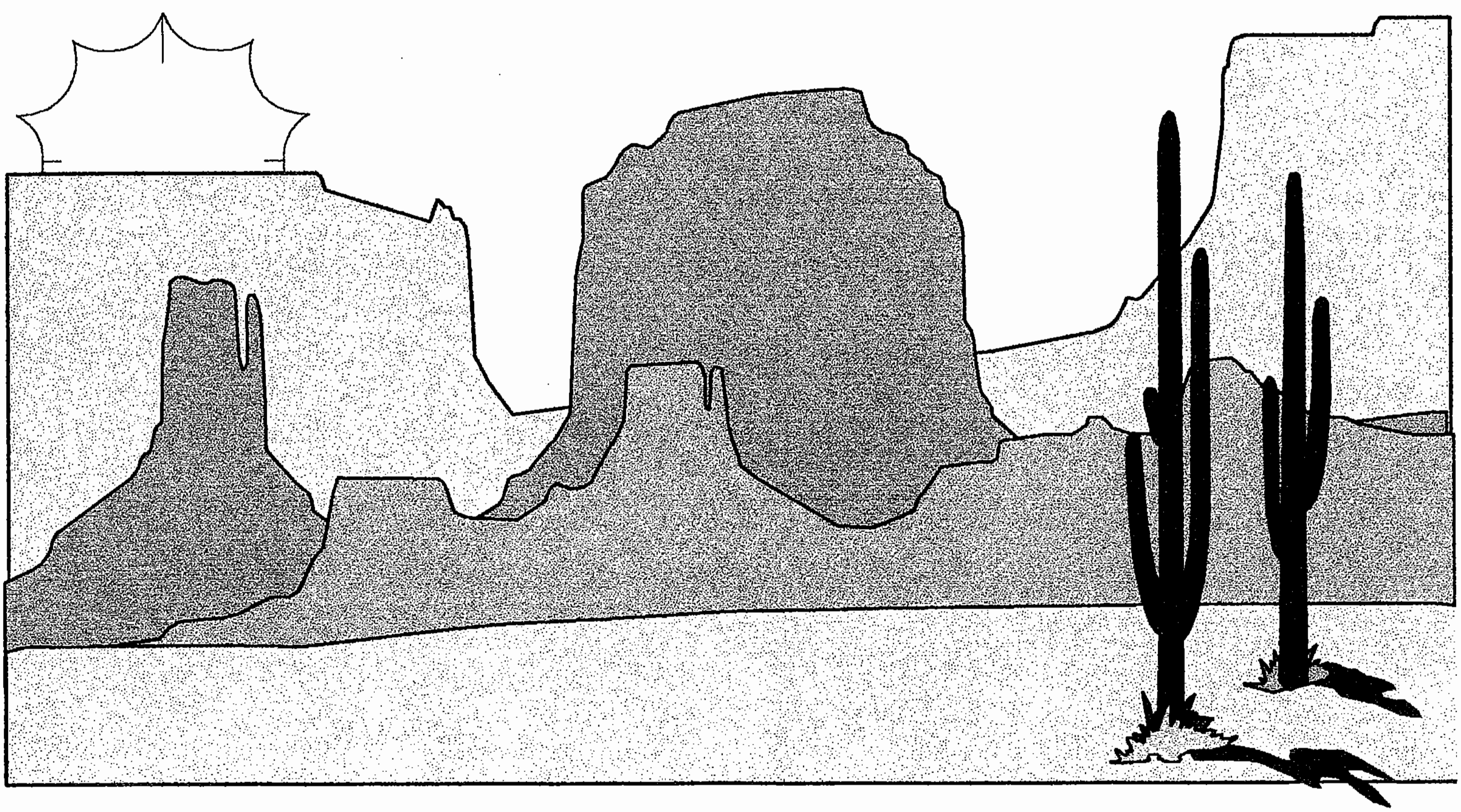
Proceedings of the 4th Joint Western International Forest Insect and Disease Work Conference

Albuquerque, New Mexico
March 7-10, 1994



PROCEEDINGS OF THE FOURTH COMBINED

WESTERN FOREST INSECT WORK CONFERENCE
AND
WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE

SHERATON, OLD TOWN
ALBUQUERQUE, NEW MEXICO

MARCH 7-10, 1994

Compiled by:

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APPENDICES

45th Annual Western Forest Insect Work Conference
42nd Annual Western International Forest Disease Work Conference

March 7 - 10, 1994
Albuquerque, NM
(Old Town Sheraton)

Monday, March 7

3:00 - 7:00PM	Registration	**LOBBY**
1:00 - 5:00PM	Western Disease Steering Committee	**TURQUOISE**
5:00 - 7:00PM	WFIWC Executive Meeting	**KACHINA**
7:00 - 9:00PM	No Host Mixer	**FIREPLACE**

Tuesday, March 8

7:30 - 9:30AM	Registration Root Dis. Cmte Breakfast	**LOBBY** **FIREPLACE**
8:00 - 9:00	WFIWC Business Meeting	**BALLROOM**
9:00 - 9:30	Break	**LOBBY**
9:30 - 10:00	Welcome and Announcements - Chair Addresses	**BALLROOM**
10:00 - 12:00PM	Panel - **Cultural Development of the Southwest: Implications for Forest Insects and Diseases.** *Moderator*: **Mark Schultz** (FPM R3) Speakers: Cultural History. **Jerry Williams** (UNM) Changes in NM Vegetation Patterns. **William (Sandy) Dick-Peddie** (NMSU) Insects and Diseases in the Southwdst, a Historical Perspective. **Borys Tkacz** (USFS FPM R3)	**BALLROOM**
12:00 - 1:30	Lunch Dwarf Mistletoe Committee Meeting	 **FIREPLACE**
1:30 - 3:00	Concurrent Workshops High tech toys Several rotating workshops. Survey Laser - **Steve Marsh** (R3) Data Visualization - **Ann Lynch** (RMS) B.C. RD Model - **Jeff Beall** (BC Forestry)	 **TURQUOISE** **WEAVERS** **POTTERS**

	Aerial Videography - **Bill Krausmann** (R3)	**BALLROOM**
	PC INDIDS - **Barbara Bentz** (INT)	**ISLETA**
	INFORMS-TX - **Delora Greenlee** (FPM WO MAG)	**JEMEZ**
	Software/Hardware for FH - **Ralph White**	**SANDIA**
3:00 - 3:30	Break	**LOBBY**
3:30 - 5:00	Concurrent Workshops (*Moderators* Listed)	
	1. What hs a Healthy Forest?? **Mike Wagner and Tom Kolb** (NAU)	**ISLETA**
	2. Use of exotic organisms to control native pathogens. **Catherine Parks** (PNW)	**POTTERS**
	3. Dinosaurs or DNA - Which way are we heading?? **Boyd Wickman** (Emeritus PNW)	**WEAVERS**
	4. Susceptibility/risk rating for Insects and Diseases. **Terry Shore** (Forestry Canada)	**TURQUOISE**

Wednesday, March 9

7:00 - 8:00AM	Breakfast (Rust Committee Meeting)	**FIREPLACE**
8:00 - 10:00	Concurrent Panels	
	1. **Approaches for Modeling the Effects of Disease and Insects to Meet the Needs of Forest Managers.**	
	Moderators: **Kathy Sheehan** and **Jerry Beatty** (FPM R6)	
	Speakers:	**PUEBLO**
	What Questions Should be Ask?	
	Dawn Hansen (FPM-R4)	
	Al Stage (INT)	
	Jesse Logan (INT)	
	Fred Baker (Utah State)	
	Biological Processes	
	Jeff Beale (B.C. Ministry of Forestry)	
	2. **International Cooperation to Manage Forest Pests.**	
	Moderator: **James (Denny) Ward** (FAOR)	
	Speakers:	**BALLROOM**
	Mechanisms for International Cooperation on Forest Pest Research and Management in North America.	
	Dr. Celedonio Aguirre-Bravo (RM)	
	Evaluation of a Disorder of Neem in Niger.	
	Jerry Beatty (FPM R6)	
	South American Cooperation?	
	Ron Billings (Texas FS)	
	Experiences with Russian Far East.	
	Greg Filip (OSU)	

	Cypress Aphid. **Dan Kucera** (NA,FHP) Cooperation with Russia on Asian Gypsy Moth. **Steve Munson** (SPF-R4) Aphid Problems in East Africa. **Dr. Joe Mwangi** (Kenya, FH Management Centre)	
10:00 - 10:30	Break	**LOBBY**
10:30 - 12:00PM	Panel - **Ecosystem Management** *Moderator*: **Iral Ragenovich** (FPM R6) *Speakers*: Ecosystem Management: Why and How. **Jack Ward Thomas**, Chief (USDA Forest Service) An Ecological Basis for Ecosystem Management. **Merrill Kaufmann** (USDA Forest Service, RMS) Ecosystem M`nagement in an Information Society. **Bob Coulson** (Texas A & M) Industrial Perspective of Ecosystem Management. **Will Littke** (Weyerhauser)	**BALLROOM**
12:00 - 1:30	Lunch Hazard Tree Committee Meeting	 **JEMEZ**
1:30 - 3:00	Concurrent Workshops (*Moderators* Listed) 1. Future needs for Seed, Cone and Regeneration Work under Ecosystem Management **Chris Niwa** (PNW) 2. Experimental approaches to Investigating the roles of Insects and Diseases in Forest Ecosystems. **Karen Clancy** (RMS) and **Detlev Vogler** (UCB) 3. Incorporating Forest Health into Ecosystem Mgt. **Joan McAndrew** (FPM WO) 4. Ecosystem management case studies. **Liz Blake** (Coconino NF)	 **TURQUOISE** **WEAVERS** **POTTERS** **ISLETA**
3:00 - 3:30	Break	**LOBBY**
3:30 - 5:00	1. Poster Session - *Organizer*: **Dave Conklin** (FPM) 2. Video Techniques - **Drex Rhoades** (WSU) 3. Budworm Pop. Model - **Kathy Sheehan** (R6)	**PUEBLO** **POTTERS** **WEAVERS**
5:30 - 9:00	Indian Pueblo Cultural Event	**IPC CENTER**

Thursday, March 10

7:00 - 8:00AM	Breakfast	

	Disease Control Committee Meeting	**FIREPLACE**
8:00 - 9:45	Concurrent Workshops (*Moderators* Listed)	
	1. Tree Hazards. **John Pronos** (FPM R5) and **Mike Schomaker** (CO)	**TURQUOISE**
	2. Updates on exotic insects and diseases. **Tom Hofacker** (FS WO)	**WEAVERS**
	3. What's new in semiochemicals of forest insect.s **Steve Seybold** (PSW)	**POTTERS**
	4. Insect and Disease Interactions. **Dave Wood** (UCB)	**ISLETA**
9:45 - 10:15	Break	**LOBBY**
10:15 - 12:00PM	Concurrent Workshops (*Moderators* Listed)	
	1. Translating predicted effects of insects and diseases into terms and models used by non-timber resources **Kathy Sheehan** and **Jerry Beatty** (FPM R6)	**TURQUOISE**
	2. Factors that trigger bark beetle outbreaks **Ken Hobson** (INT)	**WEAVERS**
	3. Insects and Diseases affecting Pinyon-Juniper Woodlands **Jose Negron** (RMS)	**POTTERS**
	4. Graduate Student Papers (Special Papers) **Joel McMillin** (NAU)	**ISLETA**
12:00 - 1:30	Luncheon Banquet Trivia Contest Social Achievement Award (WIFDWC)	**BALLROOM**
1:30 - 3:00	Business Meetings	
	WFIWC	**PUEBLO**
	WIFDWC	**POTTERS**
3:00 - 3:30	Break	**LOBBY**
3:30 - 5:00	Concurrent Workshops (*Moderators* Listed)	
	1. The future of mistletoe research:What are the needs? **Mary Lou Fairweather** (FPM R3) and **Terry Shaw** (RMS)	**TURQUOISE**
	2. University based education programs:What do we need for student and continuing professional education? **Logan Norris** (OSU), **Gary Daterman** (PNW), and **Jim Byler** (FPM R1)	**WEAVERS**

Adjourn

WESTERN FOREST INSECT WORK CONFERENCE
45TH ANNUAL MEETING
ALBUQUERQUE, NEW MEXICO

MINUTES OF THE EXECUTIVE COMMITTEE MEETING
MARCH 7, 1994

Chair Iral Ragenovich called the meeting to order at 5:02PM.

Present:

Iral Ragenovich, Chair
Terry Shore, Past Chair
R. Ladd Livingston, Treasurer
Carroll Williams, Secretary
Jill Wilson, Program Chair
Terry Rogers, Local Arrangements
Judy Pasek, Common Names Committee
Boyd Wickman, History Committee
Staffen Lindren, Chair, Founders Award Committee and Counselor (1992-94)
Nancy Rappaport, Counselor (1993-95)
Dan Miller, stand in for Jorge Macias-Samano
Ken Lister, Program Chair--1995

Copies of the minutes of the Executive Committee Meeting (March 1, 1993), Initial Business Meeting (March 2, 1993), and Final Business Meeting (March 4, 1993) of the 44th Annual Meeting were distributed to members of the 1994 Executive Committee by mail prior to the meeting. Ladd Livingston had a number of questions and provided information on various items in the minutes of the Final Business Meeting for 1993.

1. **The status of the PNW/PSW/INT Insect Collection.** Chair Iral Ragenovich and Boyd Wickman described the movement of the collection at Oregon State University (OSU) and reported that it will be integrated into the OSU collection with enough funding to curate and maintain the collection.

2. **Internal Revenue (IRS) Non-profit Status.** Ladd Livingston summarized the difficulties in obtaining the proper materials needed to apply to the IRS for non-profit status. He now has all the papers and will submit an application to the IRS.

3. **Surplus Funds.** Ladd Livingston raised the question of what to do about surplus funds. Discussion followed and covered many items, ranging from cost estimates needed to plan annual meetings to the printing of proceedings from the Sacramento meeting.

4. **Other Items.** Several additional items covered in the minutes of the 1993 Final Business Meeting were revisited:

a. Ladd Livingston commented that the secretary should indicate s/he prepared the minutes.
b. Staffen Lindgren summarized the situation regarding the Founders Award Plaque for Ron Stark.

c. The resolution concerning the threat of introducing exotic pests into the country was discussed.

Chair Ragenovich reported she will send the resolution to Secretaries of Agriculture in Canada, United States, and Mexico; Prime Minister of British Columbia, Governors of Washington, Oregon, and California. Suggestions were made to also include APHIS, California State Board of Forestry, and various state departments of agriculture.

5. **TREASURER'S REPORT.**

Ladd Livingston submitted the Treasurer's Report. It consisted of:

Balance	
a. Checking Account (1 Mar 93--28 Feb 94)	8210.47
b. Checking Account (1 Mar 94--28 Feb 95)	9633.62
c. Mark McGregor Memorial Account	2684.24

The Treasurer is still awaiting the bill for printing the Proceedings of the Penticton Meeting.

The Mark McGregor account was discussed. Funds from the account are to support students in forest entomology. However, the principal must reach $7500.00 US dollars before the interest could be used for scholarship purposes. Various suggestions were made on how to increase contributions to the account and where the account might be placed to obtain an higher rate of interest.

Ladd Livingston moved:" A chair with a volunteer be placed at the registration desk of each annual meeting to solicit contributions to the account".

Staffen Lindgren seconded. All approved.

COMMITTEE REPORTS

1.**History Committee.** Boyd Wickman gave written and verbal reports of his personal history projects. The written report covered various events--including a publication with Tom Swetnam on the long-term history of defoliation outbreaks in the Blue Mountains of Oregon. Boyd also is providing historical information and photographs of the great western pine beetle outbreak of the early 1920's to 1932 to the High Desert Museum at Bend, Oregon. Frances Furniss, the widow of Robert L. Furniss, donated a number of personal materials to Malcolm Furniss of the History Committee, including 24 diaries for years: 1945-79, 5000 35mm color slides taken between 1949-1969, and a book of 80 letters on the occasion of Bob's retirement. Many of these personal statements came from pioneers in forest entomology and research forestry.

Wickman also made a plea for personal and financial help for cataloging the contributions including oral histories of WFIWC members. Wickman announced the passing of WFIWC member Galen Trostle on September 15, 1993.

2. **Common Names Committee.** Judith Pasek gave the report of the Common Names Committee. Application for a name change of "Boreal spruce beetle" for *Dendroctonus punctatus* by Malcolm Furniss was submitted to Entomological Society of America Names Committee on October 7, 1993. A decision by that committee is pending.

3. **Founders Award Committee.** Staffen Lindgren reported that Gene Amman was selected by the committee for the 1994 Founders Award. The pros and cons on the variability in art/design work on the Founders Award Plaque were discussed.

Lindgren moved:" That one design be selected and that only the name of the selectee and the dates be changed".
Jill Wilson seconded. All approved.
Lindgren announced that he and Leroy Klein will be leaving the committee.

4. **Nominating Committee.** A nominating committee was formed to recommend names to replace people leaving various offices and committees of WFIWC. This nominating committee consists of Terry Shore, Staffen Lindgren, Nancy Rapport and Jill Wilson. The positions to be filled:

a. Chair of WFIWC--1995
b. Counselor
c. One position on the Founders Award Committee

OTHER BUSINESS

1. **Local Arrangements.** Terry Rogers and Jill Wilson described the various features of programs and local arrangements for the Albuquerque meeting. Nina Carlson, from the convention center, will speak on the history of Albuquerque and vicinity. A listing of nearby restaurants and other facilities will be provided to all attenders. The disposition of free rooms at the Sheraton Hotel was discussed. It was suggested that recipients of the Founders Award be supported in their trip to the WFIWC meeting the year following receipt of the award to give the speech. The support may be free room accommodations, or help with airfare.

Staffen Lindgren moved:"WFIWC funds be used to offset or cover part of the expenses of recipients of the Founders Award in the year they are obliged to give the speech".
Ladd Livingston seconded. All approved.

2. **Announcements From The Chair.** Chair Iral Ragenovich announced:

a. The University of Idaho Archives now has a complete set of WFIWC Proceedings.
b. Status of members:Deceased-- Robert Denton, Galen Trostle; Retired-- Roy Beckwith, LeRoy Klein.
c. A copy of the seating arrangements and visual aid requirements is available for each workshop room.
d. The location of the 1995 WFIWC will be at Rapid City, South Dakota. Proposed dates--April or May. Program Chair is not yet named.
e. The North American Forest Insect Work Conference will be held in San Antonio, Texas in April of 1996.
f. Canada is the proposed site for the 1997 WFIWC.

Chair Iral Ragenovich adjourned the Executive Committee Meeting at 7:02PM.

Minutes prepared by Carroll Williams, Secretary.

WESTERN FOREST INSECT WORK CONFERENCE
45TH ANNUAL MEETING
ALBUQUERQUE, NEW MEXICO

MINUTES OF THE INITIAL BUSINESS MEETING
MARCH 8, 1994

1. Chair Iral Ragenovich called the meeting to order at 8:05AM, and announced the status of members:
   Deceased--Robert Denton, Galen Trostle.
   Retired--Boyd Wickman

2. Minutes of the 1993 Final Business Meeting and of the 1994 meeting of the Executive Committee were read by the secretary, Carroll Williams.
   Nancy Rappaport moved: "Approval of minutes as read".
   Terry Shore seconded the motion. All approved.

3. **Treasurers Report.** Ladd Livingston reported a balance of $9633.32 in the checking account, and a balance of $2684.24 in the Mark McGregor Memorial Account as of March 3, 1994.
   Boyd Wickman moved: "Approval of Treasurers Report".
   Ken Lister seconded the motion. All approved.

4. **History Committee Report.** Boyd Wickman, Co-Chair, submitted a written report. He verbally requested past records and other information on the history of WFIWC members for incorporation into an annual report. He went on to state that our ranks are thinning fast. The first generation of forest entomologists is gone. Ralph Hall is the sole survivor of the second generation, and losses are occurring in the third generation. Need to catalog the contributions of members before they pass. Need money and people to obtain oral histories of third generation forest entomologists.

5. **Common Names Committee.** Judith Pasek gave the names of the committee membership as of March 3, 1994. They are: Lee Humbel, Robert Lavigne, Judith Pasek, Iral Ragenovich, John Stein, Larry Stipe, and chair--Torolf Torgersen.

Judith reported that the application for a name change of "boreal spruce beetle" for *Dendroctonus punctatus* by Malcolm Furniss was resubmitted via WFIWC Names Committee to the Entomological Society of America (ESA) Names Committee on October 7, 1993. The original submittal of April 1992 had been lost by the ESA Names Committee which changed it's chairperson. A decision by the ESA Names Committee is pending.

6. **Founders Award Committee.** Members include John Neises, LeRoy Klein, Les Safranyik, John Borden, and Staffen Lindgren, Chair. The committee selected Gene Amman as the 1994 recipient of the Founders Award.

7. **Future Meetings**. Ken Lister announced the 1995 WFIWC will be held at Rapid City South Dakota. Bill Shop will chair Local Arrangements, Ann Lynch will chair Program Development. Proposed dates --April or May.

Ron Billing described some of the planning process for the North American Work Conference to be held April 15-18, 1996 in San Antonio, Texas. It will be hosted by the Southern Conference. Alan Berryman questioned the changing of dates from March to April. He indicated the change makes attending the conference difficult for university people.

Terry Shore announced the 1997 WFIWC will be held in British Columbia.

8. **Old Business.** Chair Iral Ragenovich summarized a letter she received from George Moeller dated September 8, 1993, concerning the Western Forest Insect Collection: "In FY 1991, the Washington Office Forest Insect and Disease Research (FIDR) Staff arranged for the Pacific Northwest Experiment Station (PNW) to maintain all western stations insect collections under a joint funding agreement. The Pacific Southwest Experiment Station (PSW) was shipped in September of 1991 ; however, funding for combining collections was not available until late FY 1992. A cooperative agreement was then made with Oregon State University (OSU) Department of Entomology to combine, curate, and maintain the western collections".

"OSU contracted to remodel three adjoining rooms in Cordley Hall to house the combined insect collections and ancillary materials. Renovation was completed sufficiently by late spring of 1993 to start transferring the collection from storage at the Forest Service Corvallis Laboratory to OSU. Jack Lattin is in charge of this effort. The combined collection, "The Western Forest Insect Biodiversity Center", will focus upon the species diversity of forest insects and their varied roles in ecosystem processes".

Boyd Wickman indicated the formation of The Biological Survey under the aegis of the Department of Interior makes the combined insect collection very important and WFIWC should maintain a proprietary interest in the collection.

Chair Ragenovich brought up the issue of the Mark McGregor Memorial Fund. She said that once the balance reaches $7500.00, interest can be used to support a scholarship for a student in forest entomology.

9. **New Business.** Evan Nebeker announced the Pest Management Group of the Society of American Foresters (SAF) wanted more articles on forest insects and diseases published in the Journal of Forestry. Hope to have at least one issue each year devoted to these subjects to get them before the SAF and the public. There are three such issues in the mill: (1) Ecosystems, (2) Forest Health, and (3) Forest Insects, Diseases, and Fire.

Ken Hobson announced the availability of three large electronic bibliographic files on topics of forest entomology and forest pathology. Each file has 5000-6000 citations with abstracts, and covers the years 1939-1992. Ken can provide instructions for accessing these files. You can contact him through e-mail: hobson@cc.usu.edu or DG:k.hobson:S22L06a.

Chair Ragenovich reported a Nominating Committee has been formed. The members are: Terry Shore, Nancy Rappaport, Jill Wilson, and Staffen Lindgren. Candidates are being sought for a position on the Founders Award Committee, a Counselor, and a new chair of WFIWC.

Chair Iral Ragenovich reported that Jorge Macias-Samano was unable to attend this WFIWC Conference, and that Dan Miller is attending in his place.

Chair Iral Ragenovich adjourned the Initial Business Meeting at 8:58AM.

Minutes prepared by Carroll Williams, Secretary.

WESTERN FOREST INSECT WORK CONFERENCE
45TH ANNUAL MEETING
ALBUQUERQUE, NEW MEXICO

MINUTES OF THE FINAL BUSINESS MEETING

MARCH 10, 1994

1. Chair Iral Ragenovich called the meeting to order at 1:43PM.

2. Secretary Carroll Williams read the minutes of the Initial Business Meeting of the 1994 WFIWC.
   Jill Wilson moved: "Approval of the minutes as read".
   Jan Volney seconded the motion. All approved.

3. **Mark McGregor Memorial Award.** An extensive discussion took place on broadening the McGregor Award to honor more forest entomologists, and the present generally small rate of funding. Some members expressed their concern over linking specific names to awards, but believed it improper to change the name of the McGregor Award. Boyd Wickman expressed his willingness to sponsor a drive to memorialize Galen Trostle. Some members suggested the Founders Award Committee be an umbrella for receiving funds for a variety of purposes. Staffen Lindgren indicated the Founders Award Committee was not the appropriate committee to handle memorial awards. Ann Lynch expressed her concerns about a checking account with too much funds, and a memorial award account with too few funds.

Ken Hobson moved: "The Executive Committee make a decision on this matter and act; and that Boyd Wickman and Staffen Lindgren be included in the deliberations".
   Nancy Rappaport seconded the motion. Motion failed.

Barbara Bentz moved: "The WFIWC establish a new account to allow persons to make donations in the name of specific people; and the Executive Committee recommend a name for this new account and a procedure to administer the funds and awards".
   Dave Wood seconded the motion. Motion passed.

Ann Lynch moved: "This new fund be named the WFIWC Memorial Scholarship Fund".
   Boyd Wickman seconded the motion.

Dave Wood moved an amendment: "That this be the name of the award".
   Nancy Rappaport seconded the motion on amendment. Motion on the amendment passed.
   Main motion passed.

4. **New Programmatic Arrangements Between For Forest Entomologists and Pathologists.** Boyd Wickman spoke his belief that individually the professions of Forest Entomology and Forest Pathology have become too insular and, thereby, are being left behind in the rush towards "environmentalism". Nevertheless, both must continue to examine forest insect and disease interactions in regards to the subject of forest health. Wickman suggested the two work conferences be combined. Bob Coulson recommended caution on changing formats. He suggested the two work conferences have combined meetings every other year, rather than every five years.

Jan Volney moved: "The Executive Committee address these questions i.e.: (1) Should the existing arrangements between the two groups continue, or (2) Should there be a new format"?

Dave Wood seconded the motion. All approved.

Dave Wood suggested that this be done well in advance of the next meeting. Alan Berryman suggested a debate format to handle this matter.

5. **General Announcements.** Chair Iral Ragenovich thanked Jill Wilson, Mark Schultz, Terry Rogers, and Marylou Fairweather for a successful meeting. She then announced that approximately 230 people attended the conference meetings. She reported that Mark Schultz asked for guidelines for compiling and publishing Proceedings of the Work Conference by April 14, 1994. Chair Ragenovich reminded the conference that the program and local arrangements chairs are responsible for the proceedings. The proceedings of the Sacramento meeting have been mailed; whereas, those of the Penticton meeting have yet to be mailed.

Ken Hobson repeated his announcement about the electronic bulletin board (See New Business section in the "Minutes of The Initial Business Meeting", March 8, 1994).

6. **Future WFIWC Meetings.** The 1995 WFIWC will be held in Rapid City, South Dakota in April or May. Ann Lynch is Program Chair, and Bill Schaup is Chair of Local Arrangements. Volunteers and those with ideas and suggestions should contact Ann Lynch.

The 1996 North American Forest Insect Work Conference will be hosted by the Southern Forest Insect Work Conference in San Antonio, Texas; April 15-18.

The 1997 WFIWC will be held in Prince George, British Columbia.

The 1998 WFIWC will be held in the Intermountain Region.

7. **Other Meetings**:

a. Joint SAF/Canadian Institute of Forestry National Convention in Anchorage, Alaska; September 18-23, 1994.

b. Jack Pine Budworm Research and Management Techniques. Winnipeg, Manitoba, Canada. January, 1995. Need papers. See Jan Volney.

8. **Report of the Nominating Committee.** Staffen Lindgren, Chair of the Nominating Committee, moved the nominations of:

a. Don Dahlsten for Chair of WFIWC.
b. Jan Volney for Counselor.
c. Boyd Wickman for Founders Award Committee.

Staffen Lindgren will continue as Chair of the Founders Award Committee through 1994. Boyd Wickman will assume the chair in 1995.

Jill Wilson seconded the motion. All approved.

Chair Iral Ragenovich adjourned the 1994 WFIWC Final Business Meeting at 3:00PM.

Minutes prepared by Carroll Williams, Secretary.

WESTERN INTERNATIONAL FOREST DISEASE WORK CONFERENCE
42TH ANNUAL MEETING
ALBUQUERQUE, NEW MEXICO

MINUTES OF THE FINAL BUSINESS MEETING

MARCH 10, 1994

Prepared by Gregory M. Filip, Co-Secretary

Chairman Terry Shaw convened the WIFDWC business meeting on March 10, 1994 at 1:30PM in Albuquerque, NM.

Last year's business meeting minutes were tabled until next year.

Committee Reports were presented. There was no report from the **Disease Control Committee**. The **Dwarf Mistletoe Committee** report was presented by Chairman Bob Mathiasen. The committee met earlier in the week. Reports were presented by Mathiesen, Johnson, and Shaw at their meeting. The **Root Disease Committee** report was presented by Chairman Greg Filip. The committee met earlier in the week, and written reports were encouraged as in the past. The **Hazard Tree Committee** report was given by Chairman John Pronos. At their earlier meeting, a questionaire was handed out, tree failure reports were discussed, and literature on hazard tree management will be compiled by Mathiasen and Sharon. The **Rust Committee** report was presented by Chairman John Schwandt who requested single-page reports for the proceedings.

Sue Frankel commented that Jim Allison is working on the proceedings from the Boise WIFDWC meeting.

A report was presented by Blakey Lockman concerning the 1995 WIFDWC. It will be held somewhere in the Flathead Valley, MT to take advantage of visiting Glacier NP. Dates are undecided but will be either August or September.

Ken Russell reported on the 1996 WIFDWC to be held in either Hood River, OR or Stevenson, WA. A possible site will be the new Skamania Lodge with field trips to the infamous Glenwood Armillaria Research Site, mountaineering with Bob Mathiasen, and/or windsurfing with Ken's daughter.

It was suggested that a new mailing list of WIFDWC members be compiled that included telephone, FAX, E-mail, and DG numbers. This info and any changes should be sent to Co-Secretary Greg Filip, who will compile the list.

Paul Hennon, Interim Program Chairman for the 1995 WIFDWC meeting, presented a list of suggested meeting topics:
1. Hazard tree panel - John Pronos
2. *P. weirii* in older stands - Jeff Beale
3. Partial cutting/thinning, wounding, and decay fungi
4. Interior cedar/fir systems and uneven-age management problems
5. Disturbance ecology in high-elevation spruce/fir forests
6. Update on *P. weirii* taxonomy - Pete Angwin
7. Dwarf mistletoe workshop - Bob Mathiasen
8. Wildlife-disease interactions
9. Dwarf mistletoe suppression: logic with ecosystem mat. - Bob Scharpf

10. Doug fir dwarf mistletoe and plant associations in SW Oregon - Greg Filip/Katy Marshall
11. Insect/Disease interaction panel - whitebark pine?
12. Biodiversity/edible fungi panel - Will Littke
13. Riparian communities and pathology - Bob Edmonds
14. New developments in disease/plant relations - Det Vogler

Paul received comments that we need to hold a spouse meeting and that we need a hospitality suite/room in the future. Terry Shaw suggested that we need to consider future meetings with at least one panel that includes entomologists and/or other disciplines as well.

Ken Russell presented the treasurer's report. John Schwandt will be the future WIFDWC treasurer. We have a current balance of $2490.20 plus interest at the Washington State Credit Union. Some funds were received from the selling of old proceedings. Some money was given to the Hawksworth Scholorship at CSU and some to Mark Schultz for this year's meeting. A full report will be included in the 1994 proceedings.

Norm Alexander was unanimously voted as a new Life Member of WIFDWC. There were no deceased members this year.

A report was presented by the **"Railroad Committee"** consisting of Ken Russell, Dave Johnson, and Jim Byler. For the 1995 WIFDWC in Montana, Sue Frankel was selected as Chair and Bob Mathiasen as Secretary. Sue Frankel subsequently chose Paul Hennon and Jim Byler as Program Co-Chairs.

Jeff Beale offered to host the 1997 WIFDWC in Prince George, BC. Because there were no other offers, the motion was unanimously passed.

It was suggested that we should advertise future WIFDWC meetings through APS, SAF, and Pac. Div. APS newsletters. Fred Baker offered to help with this.

Bill Jacobi, Chair of the Forest Pathology Committee of APS, presented a report about the 1994 APS meeting in Albuquerque this August. There will be a one-day field trip on Saturday, 8/6, to the Jemez Mts., and early sign-ups were encouraged. He also suggested that comments concerning the APHIS Federal Register concerning log imports be sent to Bill by April 20.

Evan Nebeker announced a North American Insect Work Conference to be held in mid-April 1995. As a member of the editorial board for the Journal of Forestry, he commented on the themes for upcoming issues of the journal. Of particular note were the topics for July (What is a Healthy Forest) and November (Pest and Fire Management: Policy and Practice). He suggested that we consider submitting papers.

Ken Hobson announced that he has electronic reference files for pathogens, defoliators, and bark beetles for 1939 to 1992 with abstracts. Also, the Hawksworth dwarf mistletoe file is still available through the Rocky Mountain Station.

Ken Russell read thank-you letters from CSU and Peggy Hawksworth concerning the WIFDWC donations to the Hawksworth Scholarship. The letters were submitted for the proceedings.

Carla Thomas commented on a 1989-91 APS survey submitted to SAF concerning the status of education and jobs for entomologists and pathologists.

The meeting was adjourned at 2:35PM by Chairman Shaw.

WFIWC/WIFDWC Chairs Address:

Iral Ragenovich - Chair, Western Forest Insect Work Conference
Terry Shaw - Chair, Western International Forest Disease Work Conference

Welcome to the combined meeting of the Western Forest Insect Work Conference and the Western International Forest Disease Work Conference. This conference represents the third time that forest entomologists and pathologists have met together.

There have been many changes in forest management and policy since we met together in Bend, Oregon five years ago. These changes have centered first around the concept of Forest Health, and more recently around the concept of Ecosystem Management. Agencies such as the USDA Forest Service have adopted an ecosystem management approach as policy. This means management on a watershed and landscape basis and looks at interrelationships among organisms in the system, as well as resource values and uses. This approach has raised several issues for forest entomologists and pathologists.

The shift to ecosystem management is requiring us to re-evaluate our roles. How do forest entomologists and pathologists fit into ecosystem management; how might our traditional roles change? One aspect is that our emphasis will change from looking at insects and diseases strictly as pests. We now need to look at them, at least in part, in terms of their benefits to resources. And our role is expanding to include those forest insects and fungi that we have not traditionally included: the butterflies, mushrooms and soil arthropods that we have always known existed, but generally ignored. We will need to determine their roles in the ecology of the system, and develop techniques to monitor their status.

As we begin to look at forest management on a landscape level, it becomes apparent that disturbance phenomena, including fire, insects, diseases and their spatial and temporal interactions, markedly influence system health and sustainability. Landscape level modeling and optimization modeling are emerging technologies that are becoming important to forest management. We need to ensure that operational versions of these tools include, in a realistic manner, the actions of insects and diseases across time and terrain. Over the past several years, a number of insect and disease models have been, or are being, developed that link with vegetation resource simulator models to project the effects of these organisms at both the stand and landscape level.

As emphasis shifts towards ecosystem management there is likely to be a continued de-emphasis on "specialists" and thus a decreased visibility of entomologists and pathologists. Agencies are reducing the number of insect and disease specialists that they employ; and forest pest management programs are being merged with other units, which further reduces the visibility of forest entomologists and pathologists. In addition agency "pest specialists" are still only consulted if the issue has overtones of plague or pestilence -- they are not considered "specialists" for the non-pest aspects of insects and diseases in the ecosystem. This approach by others to our professions must change if ecosystem management is to be successful.

Of continuing concern is the trend for Research organizations to reduce the number of research entomologists and pathologists and shrink the budgets of those that do remain. This action seems counterproductive in light of the new types of insect and disease information that will be needed to properly implement ecosystem management. The trend in Universities to combine the forest entomology and pathology curriculum into a single "protection" course, that often includes fire as well, is equally disturbing. Where is the necessary training that will become so critical to future decision-making in an era of ecosystem management?

Ecosystem management extends beyond individual watersheds or landscapes as it has global implications as well. This reality has been brought to the forefront though recognition of the increased trade among nations and the subsequent increased threat of introducing organisms foreign to our ecosystems. The global nature of business today is also apparent through the increased emphasis on International Forestry, the opportunities for technology exchange, and the International Research Agreements the USDA Forest Service has established with Mexico and China.

Technology also is re-shaping how we function as entomologists and pathologists. In the past, we spent much of our time on measuring impacts and developing ways to minimize these impacts through pest suppression and prevention strategies. Technology development, for entomologists for instance, often meant developing and testing new spray equipment and insecticides; and remote sensing (primarily sketch mapping and aerial photography) were used primarily for insect detection. Now the emphasis is on technologies that are designed to integrate insect and disease information into analysis and monitoring. For instance, computer models and hazard rating systems are designed to include insect and disease information into planning and decision making; and remote sensing is being used in combination to monitor forest health.

As you may have noticed, there are many parallels between the issues that we have mentioned and the workshops and panels for the Conference. We hope that you participate in active discussions in all of these aspects, and once again welcome to your Work Conference.

CULTURAL DEVELOPMENT OF THE SOUTHWEST: IMPLICATIONS FOR FOREST INSECTS AND DISEASES

Panel Moderator: Mark E. Schultz
USDA Forest Service, Albuquerque, New Mexico

Vegetation Changes

William Dick-Peddie, Professor Emeritus, Department of Botany, New Mexico State University, Las Cruces, New Mexico.

Past vegetation patterns must be determined if we are to assess vegetation changes. If changes are found to have occurred it is then desirable to ascertain if the changes were initiated by natural (climatic shifts) or man related causes.

A number of techniques have been used to reconstruct vegetation patterns of the past. Fossil pollen deposits and packrat "middens" have been used for the determination of prehistoric vegetation patterns. Territorial and boundary survey records, diaries and journals of explorers and military expeditions; and repeat photography have all been used to disclose vegetation patterns of more recent times.

It is now evident that extensive changes in vegetation have taken place in New Mexico. Grasslands have given way to desert scrublands on many mesas at lower elevations. Grasslands of higher mesas and upper bajadas have frequently been replaced by juniper or sagebrush savannas' while many mountain meadows have been replaced by montane scrub or juniper woodland. Instead of gallery forests of deciduous trees we now find most riparian habitats occupied by thickets of Russian olive or saltcedar or in many cases bare ground.

Most of these changes in vegetation patterns have come about in the last 140 years. Studies of fossil pollen and packrat middens indicate there has been virtually no climatic shift, even seasonal, over the 2,000 years. Consequently, the changes have been initiated by man's activities. Major among these activities have been overgrazing by domestic livestock, disruption of surface and ground water flow along water courses; and clearing vegetation without allowing regeneration. Secondary activities in a few areas have been the suppression of natural fires and in others an increase in fire frequency.

Forest Insects and Diseases in the Southwest: A Historical Perspective

Borys M. Tkacz and **Jill L. Wilson**, U.S.D.A Forest Service, Southwestern Region, State and Private Forestry and Forest Pest Management, Flagstaff, Arizona, USA.

INTRODUCTION

Forest insects and pathogens have affected forest ecosystems in the Southwest for eons. As naturally occurring components of these ecosystems they play important roles in the dynamic processes by providing food and habitat for animals, affecting vegetative structure, and contributing to the biological diversity of the ecosystems. Along with fire, these organisms are among the major disturbance agents affecting forests in the Southwest. The incidence of bark beetles, western spruce budworm, dwarf mistletoes, root diseases has changed in recent years as a likely result of changes to the underlying structure and function of forest ecosystems in the Southwest.

The introduction of exotic agents, such as white pine blister rust, will also have significant impacts on southwestern forest ecosystems. The long term success of Ecosystem Management in the Southwest will depend, at least in part, upon how well we understand, and incorporate into our management, the effects of insects and diseases on the landscape now and into the future.

HISTORY OF OUTBREAKS

Bark Beetles

Numerous species of bark beetles affect forests in the Southwest, attacking all species of coniferous trees. Most are fairly host specific, and are confined to primarily one tree species. Some of the more important ones include: Dendroctonus rufipennis Kirby, the spruce beetle, in Engelmann spruce; *D. pseudotsugae* Hopkins, the Douglas-fir beetle, in Douglas-fir; *Dryocoetes confusus* Swaine, the western balsam bark beetle, in subalpine fir; *Scolytus ventralis* LeConte, the fir engraver, in white fir; and the mountain pine beetle, *Dendroctonus ponderosae* Hopkins, western pine beetle, *D. brevicomis* LeConte, roundheaded pine beetle, *D. adjunctus* Blandford, pine engraver, *Ips pini* (Say), and the Arizona five spined ips, *I. lecontei* Swaine, in ponderosa pine (Wood, 1982).

Historically, large bark beetle outbreaks have probably always been a significant type of natural disturbance in certain forest types. Spruce beetle outbreaks have been a significant type of natural disturbance in spruce-fir forests, perhaps comparable to fire. Baker and Veblen (1990) analyzed historic photos and dendrochronology data from central New Mexico to north central Colorado and found that spruce beetle has been a major disturbance agent in spruce-fir forests since at least the 19th century. Sizeable outbreaks probably have occurred periodically whenever favorable stand conditions developed. Schmid and Hinds (1974) describe a hypothetical process of succession in the spruce-fir type involving the spruce beetle. Spruce beetle outbreaks resulted in shifts in species composition, favoring sub-alpine fir over spruce. Over time, fir, a shorter lived species dies out, often from root disease, and spruce again predominates, matures, and is subsequently ripe for another spruce beetle outbreak.

Two major spruce beetle outbreaks occurred during the 1980's in the Southwest. An outbreak occurred in the White Mountains in Arizona, primarily on the Fort Apache Indian Reservation. This outbreak covered approximately 20,000 acres between 1981 and 1984, killing approximately 400,000 spruce (Linnane 1985). A second major outbreak of spruce beetle occurred in the Pecos Wilderness of northern New Mexico between 1982 and 1985, killing an estimated 30,000 spruce over approximately 7,000 acres according to aerial detection survey records. These outbreaks probably do not represent a change in status of spruce beetle. This insect has caused large outbreaks in the recent past and will probably continue to do so. A large portion of the spruce-fir type in the Southwest is densely stocked with large diameter spruce which are in excess of 150 years old and in a state of declining vigor due to competition. These stands are very susceptible to spruce beetle once an outbreak is initiated.

Similarly within the ponderosa pine type on the Kaibab plateau in northern Arizona, there is evidence of numerous mountain pine beetle outbreaks dating back to 1837. Blackman (1931) reports on a large outbreak that occurred between 1917 and 1926, and was caused primarily by the mountain pine beetle, referred to then as the Black Hills beetle, (Blackman 1931). In this outbreak, he reports that 12 percent of the ponderosa pines were killed on the plateau both on the Kaibab National Forest and Grand Canyon National Park. Using increment cores and evidence of pitch pockets (from unsuccessful attacks), he also found evidence of older outbreaks: 1837-1846, 1853-1864, 1878-1882, 1886-1892, and 1906-1910. He reports that the largest of these outbreaks was the one occurring during 1886-1892. Since 1926, only three localized and low level outbreaks have occurred on the plateau, 1935-1938, 1950, and 1973-1977 (Parker and Stevens 1979). Though no outbreak has occurred in recent years, stand conditions in many areas on the Kaibab Plateau are very favorable for development of mountain pine beetle outbreaks, consisting of dense stands of ponderosa pine larger than 10 inches in diameter. It is probably only a matter of time before another large outbreak occurs.

Elsewhere in the Southwest, reports of historic beetle activity, particularly outbreaks, are scarce. This may be due, at least in part, to the extensive early logging activity that occurred across much of the pine type in the Southwest. Hopkins (1909) reports that in general the amount of tree mortality caused by what he called the Black Hills beetle, now the mountain pine beetle, was less in New Mexico and Arizona and southern Colorado than in the Black Hills. He also reports that the western pine beetle, which was then considered to occur along the Pacific coast from California to Washington and Idaho, caused more mortality than what he called the southwestern pine beetle, now synonomized, occurring in the Southwest. Pearson (1950) reports bark beetles to be among the four main causes of mortality and notes that they are a major cause of death in reserve stands, causing about one third of the mortality reported by all causes. In virgin stands monitored between 1925 and 1940, he notes that they accounted for 1.6 percent of the mortality to trees overall, with somewhat higher rates for trees in the larger diameter classes. Meanwhile in cutover stands they accounted for 0.3 percent of the mortality to trees.

In recent times, however, some large bark beetle outbreaks have occurred (Figure 1). Perhaps the most notable ones have been in the Sacramento Mountains of southeastern New Mexico. Prior to the 1970's, outbreaks in the Sacramentos were small, a few thousand acres at most (Massey et al 1977). However, since 1971 two large outbreaks have occurred. In the early 70's, an estimated 400,000 trees were killed on over 150,000 acres (Massey et al 1977). This outbreak, which occurred in second growth ponderosa pine, resulted in mortality to between approximately 11 and 54 percent of ponderosa pines in sampled stands (Stevens and Flake 1974). Meanwhile, the average diameter of ponderosa pine remained about the same. Overall the outbreak resulted in a shift from ponderosa pine to other species such as Douglas-fir, white fir, southwestern white pine, pinyon, juniper, oak and aspen. Between 1990 and 1992, another outbreak involving both the roundheaded pine beetle and the western pine beetle killed an estimated 100,000 trees over some 87,000 acres. Around the same time, two smaller yet significant outbreaks of roundheaded pine beetle have occurred in the Pinaleno Mountains of southeastern Arizona (Flake 1970, Wilson 1993). We are not aware of any sizeable outbreaks prior to this time in the Pinalenos. We expect that this trend will continue and may extend to other areas in the Southwest, primarily due to increasing tree densities as compared to prevailing conditions present prior to european settlement (Figure 2) (USDA Forest Service 1993).

Western Spruce Budworm

Fire exclusion, grazing, and past logging have had a great effect on southwestern forests by changing stand structure and species composition (Figure 3) (USDA Forest Service 1993). These changes have also affected the nature of some insect outbreaks. An excellent record of the history of western spruce budworm (WSB), *Choristoneura occidentalis* Freeman, outbreaks for southern Colorado and northern New Mexico has been assembled by Swetnam and Lynch (1989). Western spruce budworm outbreaks have occurred in this region at irregular intervals in mixed conifer forests for at least the last 300 years. At least nine outbreaks have been identified in the mixed conifer stands of the Colorado Front Range and Sangre de Cristo Mountains between 1700 and 1983 based on tree ring studies. The results of this study indicate that a change has occurred in the incidence of budworm outbreaks during this century. Though the frequency of moderate to severe outbreaks during this century is not clearly more or less than during previous centuries, the spatial and temporal pattern of occurrence has changed. Outbreaks in the latter half of this century have become more synchronous over the host type. This suggests that recent outbreaks have become more extensive than previous outbreaks (Swetnam and Lynch 1989). There was also evidence suggesting that the most recent outbreak may have been more severe than past ones (Figure 4). This change in severity may result from changes in age structure and species composition, which have favored western spruce budworm, involving widespread establishment of younger multi-storied, shade-tolerant, budworm host susceptible trees resulting from management practices around the turn of the century.

Dwarf Mistletoes

The dwarf mistletoes (*Arceuthobium* spp.) have evolved with their hosts, as evidenced by fossil records dating back to the Pleistocene epoch (Hawksworth and Wiens 1972). More than 2 million acres of National Forest lands in Arizona and New Mexico are infested with dwarf mistletoes (Johnson and Hawksworth 1985). Most southwestern conifers are parasitized by species of *Arceuthobium*, however, the most significant damage occurs to ponderosa pine infected with the southwestern dwarf mistletoe (SWDM), *A. vaginatum* subsp. *cryptopodum* (Engelm.) Hawksw. & Wiens) and Douglas-fir infected with the Douglas-fir dwarf mistletoe, *A. douglasii* Engelm.

The distribution and rate of increase in dwarf mistletoe populations are affected by numerous host, stand and environmental factors including: site quality, host vigor, host age, stand density, stand structure, stand composition, and stand history (Parmeter 1978). Wildfires are one of the primary ecological factors in determining the distribution and intensity of dwarf mistletoes in unmanaged coniferous forests (Alexander and Hawksworth 1976). Relatively complete burns tend to have a sanitizing effect on infected stands, while partial burns can lead to rapid infection of regeneration if scattered infected trees remain following the fire. Fire scar chronologies from southwestern forests for the period from 1700 to 1900 indicate mean fire intervals of 4 to 5 years for ponderosa pine sites and 6 to 10 years for mixed conifer sites (Swetnam 1990). Since severe dwarf mistletoe infection leads to accumulations of dead trees, witches' brooms, and other fuels, the frequent low-intensity fires common in pre-european settlement forests probably reduced dwarf mistletoe in many areas (Parmeter 1978). Surveys of the ponderosa pine forests in Arizona and New Mexico conducted in the 1950's and 1980's (Maffei and Beatty 1988) suggest that the incidence of southwestern dwarf mistletoe may have increased due to human activities such as selective harvesting practices and suppression of wildfires.

Although the basics of dwarf mistletoe control have been known for a long time (Koristian and Long 1922, Pearson 1950), past cutting practices may have exacerbated SWDM infection in southwestern ponderosa pine stands. Light improvement selection cutting was extensively practiced throughout the Southwest until the 1980's (Heidmann 1983). Under this system, mortality losses in virgin stands were reduced by harvesting merchantable trees that were dying or expected to die during the following 20-year cutting cycle. A long-term study of silvicultural control of SWDM on the Fort Valley Experimental Forest, near Flagstaff, AZ (Heidmann 1983) compared the effects of light improvement selection, limited control, and complete control in heavily infected mature ponderosa pine stands (Figure 5). After 27 years, the only effective silvicultural control method was complete removal of infected overstory and understory trees.

Root Diseases

Root diseases caused by *Armillaria* spp.(Fr.:Fr.)Staude, *Heterobasidion annosum* (Fr.) Bref., and *Inonotus tomentosus* (Fr.:Fr.) S. Teng are common in many mixed conifer, spruce-fir and some pine stands throughout the Southwest. A survey of commercial timber-producing lands on six National Forests in Arizona and New Mexico indicated that root diseases and associated pests were responsible for about 34 percent of the trees killed (Wood 1983). After a half century of fire exclusion and selective harvesting, the incidence of root disease is suspected to have increased in mixed conifer stands in the Intermountain Northwest as ponderosa pine, a species that is relatively insect and disease resistant, is replaced by Douglas-fir and true firs, species that are much more prone to infection by root diseases (Hagle and Goheen 1988). Similar shifts in species composition are occurring in southwestern mixed conifer stands (Swetnam and Lynch 1989). Even though direct comparisons of root disease incidence in pre-european settlement and present times are not possible, these diseases have probably increased in southwestern forests due to the greater abundance of susceptible hosts and inoculum created by harvesting.

White pine blister rust

White pine blister rust is caused by the exotic fungus *Cronartium ribicola* J.C. Fisch. This fungus has spread throughout virtually the entire range of western white pine since its introduction to British Columbia in 1910. It was discovered in the Southwest for the first time in March 1990 on southwestern white pine in the Sacramento Mountains near Cloudcroft, New Mexico (Hawksworth 1990). Surveys indicate that this disease is now present throughout most of the range of southwestern white pine on the Lincoln National Forest and the adjacent Mescalero Indian Reservation (Hawksworth and Conklin 1990). The fungus has caused seedling and sapling mortality, as well as extensive branch mortality on all size classes of southwestern white pine in the affected areas. This disease will likely have a major impact on the white pine population in the Sacramento Mountains. Young trees will suffer more damage than larger, older trees since they are more prone to girdling cankers. The gradual decline in southwestern white pine regeneration will have significant impacts on the species diversity of the mixed conifer forests in the Sacramento Mountains. This disease can also be spread, either by man's activities or by windblown spores, to other areas of southwestern white pine, limber pine, and bristlecone pine in the Southwest.

IMPLICATIONS FOR FOREST HEALTH

Prior to european settlement, disturbance events were infrequent and high intensity in some forest types, such as the spruce-fir type (Covington and Moore 1992). Bark beetles and fire were among the major disturbance agents. The same pattern exists today and has many repercussions for management.

In other forests types, such as the ponderosa pine type and lower elevation mixed conifer type, disturbance events were frequent and low intensity (Covington and Moore 1992), predominated by the effects of fire. Since european settlement the patterns of disturbance have changed and have resulted in different forest and insect and disease conditions (Covington and Moore 1992, Swetnam and Lynch 1989).

In the ponderosa pine type, these changes have resulted in higher densities, and canopy closures of ponderosa pine (Covington and Moore 1992). At the same time fire frequencies have decreased and fire size has increased. Both of these changes, along with past management practices, may have resulted in an increase in dwarf mistletoe incidence and severity. Many of these conditions also favor bark beetle outbreaks, and similar to fire, beetle outbreaks in the future may become larger and more intense.

In the mixed conifer cover type, dense, multi-storied, second growth stands predominated by Douglas-fir and white fir, are believed to have replaced more open stands composed of these species and a significant component of ponderosa pine, as a result of selective harvesting, and fire exclusion (Swetnam and Lynch 1989). These stands are now very susceptible to both western spruce budworm as well as root disease.

The introduction of the exotic white pine blister rust fungus into southern New Mexico will have significant impacts on the biodiversity of mixed conifer forests since southwestern white pine shows little innate resistance to this pathogen. Introductions of other exotic pests may have similar disastrous consequences.

Recently the Southwestern Region of the US Forest Service adopted a new resource management philosophy (USDA Forest Service 1992). This change reflects a desire to take a more holistic approach to management of forests in the Southwest, one that is ecologically based. The focus of this new strategy will be on desired future conditions of the land and its human communities at multiple scales, always striving to maintain a balance between sustaining the resource, lifestyle or social goals, and economic goals. This new strategy emphasizes sustainability, multi-resource management, integrated inventories and analytical tools, and (wherever possible) ecosystem management over single species management. Whenever possible, resource management will "mimic the intensity, frequency, and area extent of naturally occurring disturbance events in an effort to maintain biological diversity and keep disturbance events within the ecosystem's absorbing capability or resiliency" (USDA Forest Service 1992).

The long term success of these new strategies will depend, at least in part, upon how well we understand, and incorporate into our management, the effects of insects and diseases on the landscape now and into the future. This will require new knowledge and new analytical tools. New knowledge will be required about insects and diseases, how they affect and have affected ecosystems and ecosystem processes, and how our new management strategies will affect insects and diseases and in turn the landscape. In order to assess implications for ecosystem management we will need to understand these effects at different temporal and spatial scales. Accomplishing this will require the forging of better ties between entomologists, pathologists and specialists and researchers in other disciplines.

CONCLUSIONS

Forest insects and diseases have and will continue to be dominant agents of change in many forest ecosystems. A better understanding of how these agents affect ecosystem functions, processes and linkages is vital to the success of long term ecosystem management.

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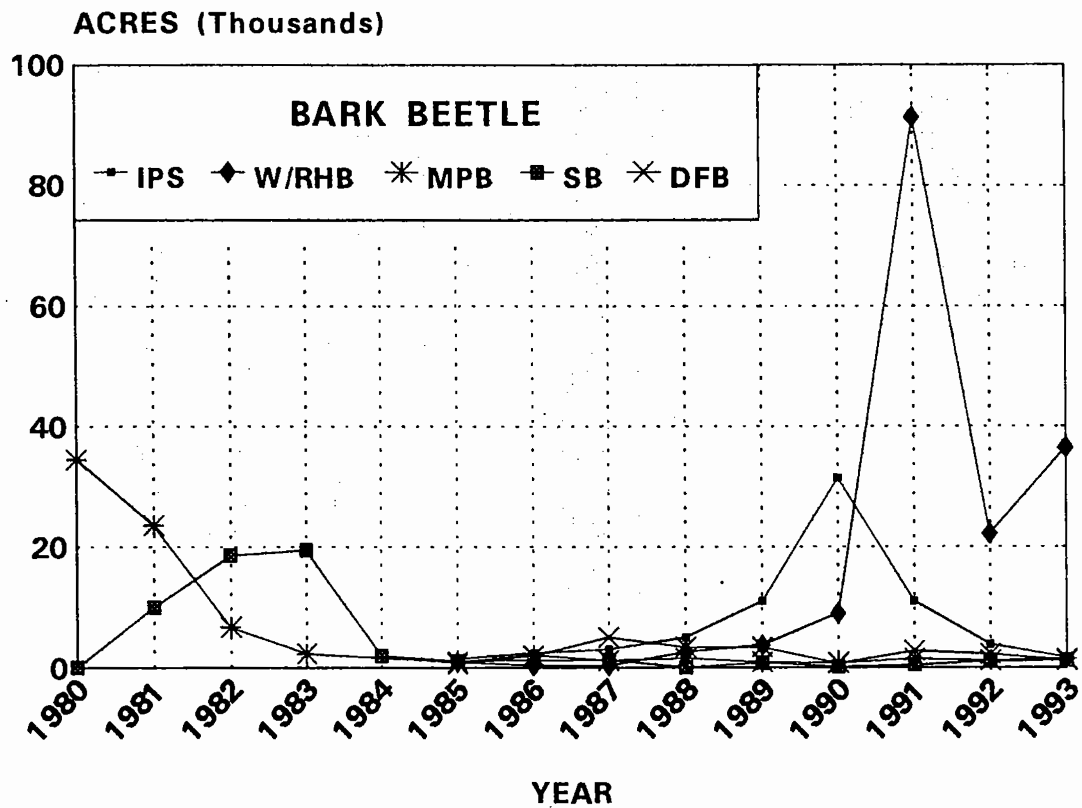
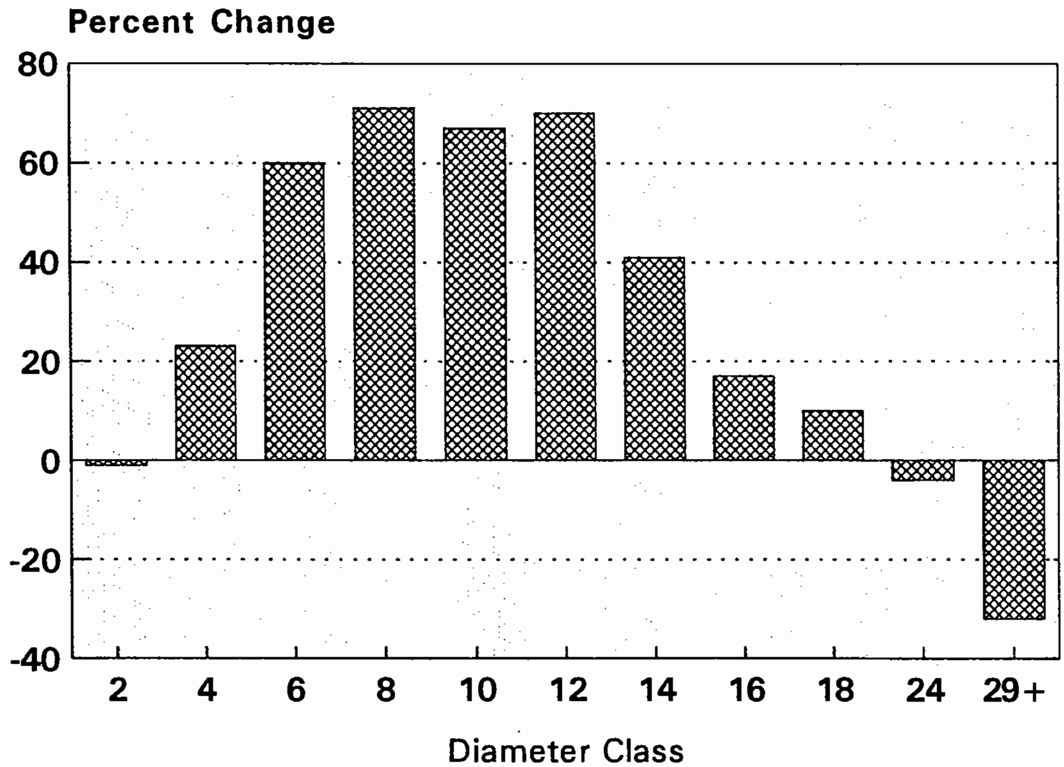
Figure 1. Acres infested with bark beetles in Arizona and New Mexico



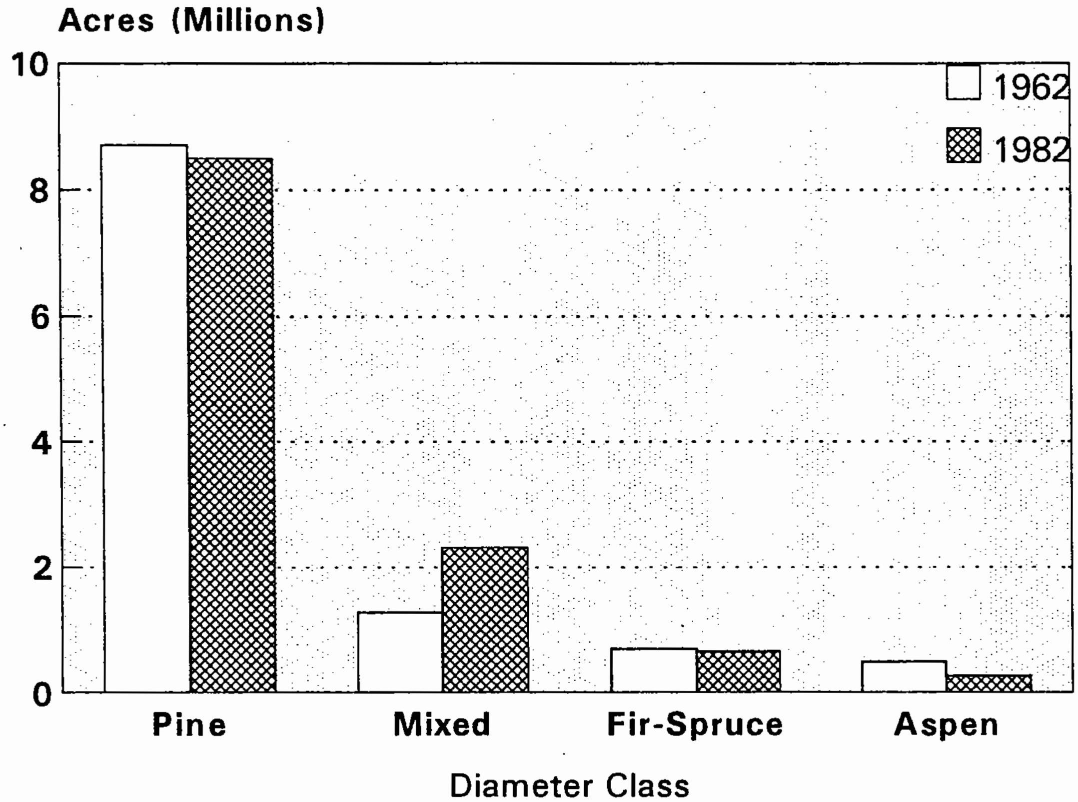
(From aerial survey records)

Figure 2. Percent change in growing stock trees per acre from 1962 to 1982 on timberland in Southwest.



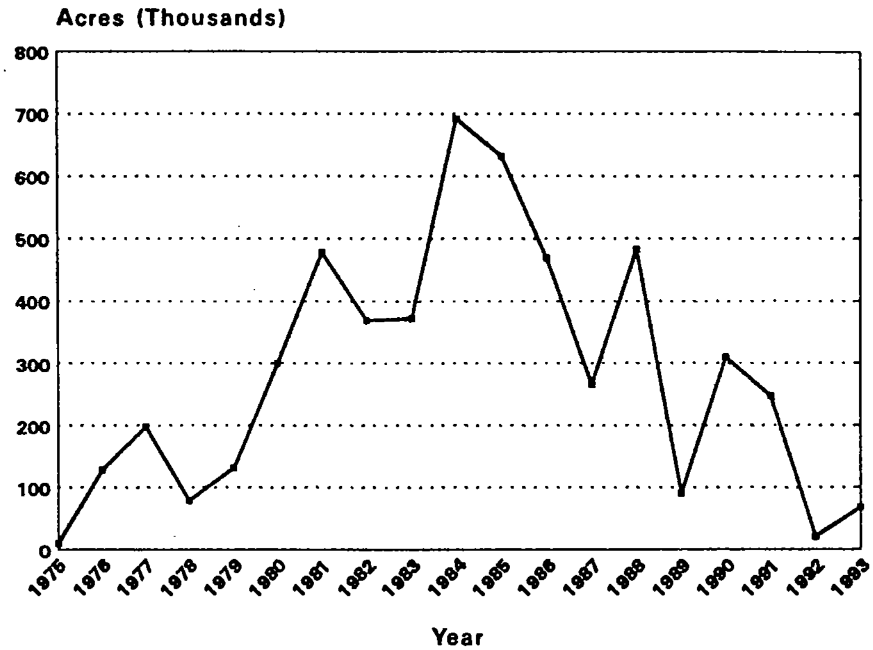
(From USDA Forest Service 1993)

Figure 3. Acres by forest type in the Southwest for all ownerships.



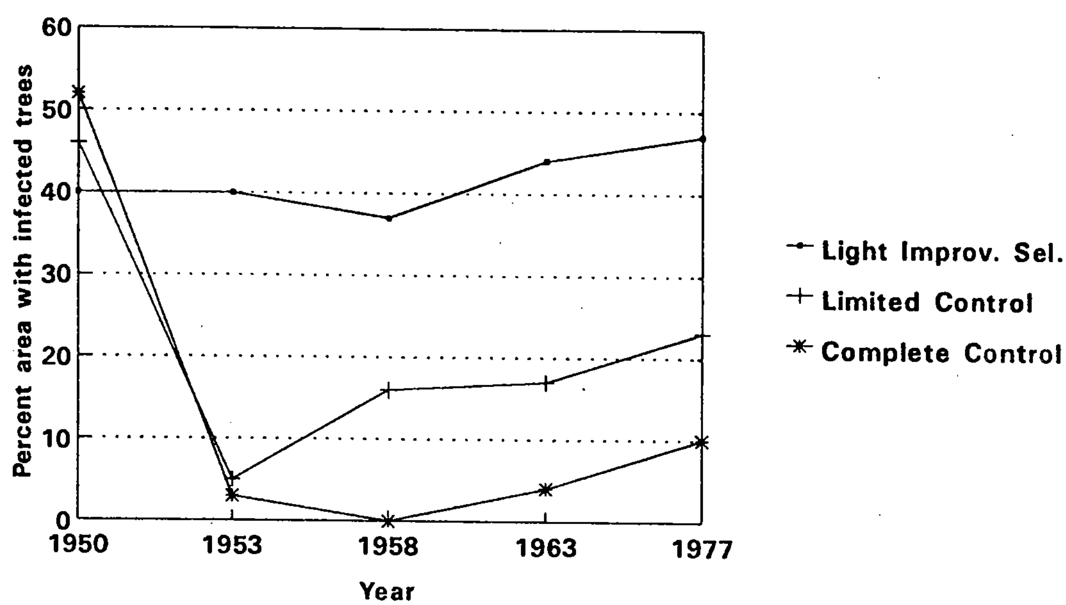
(From USDA Forest Service 1993)

Figure 4. Acres defoliated by western spruce budworm in Arizona and New Mexico.



(From aerial survey records)

Figure 5. Results of a long-term study of silvicultural control of southwestern dwarf mistletoe on the Fort Valley Experimental Forest.



(From Heidmann 1983)

HI-TECH TOYS

Workshop Presenters: Steve Marsh, Ann Lynch, Jeff Beale, Bill Krausmann, Barbara Bentz, Delora Greenlee and Dave Roschke, Ralph White

Laser Tree Measurement and Surveying Instrument

Steve Marsh, USDA Forest Service, Southwestern Region

The Laser Tree Measurement and Survey Instrument (Criterion 400) is currently available from Laser Technology. Since it's introduction it has been used and tested for cruising trees as well as for conducting area traverses. Most of the users would probably agree the instrument is very cost effective for traversing unit boundaries. It's almost as fast as walking and automatically records data for downloading to the DG. The laser has a definite advantage over GPS, since it provides a definite "error of closure" and does not depend on satellite configuration and availability. It is reported, by the District field crews who did the field testing, that it's use reduced the cruising and traversing costs by 50 percent and more.

The Criterion 400 has several modifications that have improved the instrument to make its use more efficient. These modifications make it slightly lighter, more rugged, easier to transport and expands its surveying capabilities. This instrument has been thoroughly field tested in all Regions, on cruising and traversing projects, and found to be field ready and practical.

This instrument's primary functions replace our conventional equipment such as 100-foot tapes, compasses, inclinometers and Relaskops in doing the following tasks:

- navigating to cruise plots (waypoint navigation)
- determining tree heights from any distance to the tree
- determining what trees are in the plot, using any BAF up to 90
- determining if "questionable" trees are "in" or "out" of the plot
- determines where any given diameter on the tree occurs
- determines where any specified height on the tree occurs
- doing logging profiles, stores data (including side-shots if needed)
- used to navigate, either directly or indirectly, to a specified XYZ coordinate location
- stores 20 traverses - 1350 stations - open or closed traverses
- establishes coordinate locations for objects to develop site plans
- has several options in the survey mode of operation for different types of engineering applications

This is only a partial list of its major uses, although they alone make it a worthwhile investment. A unique feature is its extreme accuracy without requiring brushing-out when used with a reflective target.

If you have further questions on this instrument, contact Steve Marsh (505) 842-3249. Questions may also be sent to Steve on the DG, S.Marsh:R03A.

For a current price list, contact Steve Colburn, Laser Technology Inc.,
(303) 649-1000 Fax (303) 649-9710

Visualization and Perceived Scenic Beauty Effects of Western Spruce Budworm Management Alternatives on the Deschutes National Forest

A.M. Lynch, B. Orland, T.C. Daniel, H.M. Maffei, W.B. White

The Deschutes N.F. is experiencing a western spruce budworm outbreak that has persisted for several years. The infestation is affecting the visual quality of highly-used recreation areas. We are developing digital visualization models to generate valid, quantitative, defensible, photo-realistic images of insect damage and various management strategies. A primary objective is to drive the visualization models with existing terrain, vegetation, and pest data, and with projections from vegetation and insect models, rather than with personal opinions on pest effects and damage appearance. 35mm slides are scanned to provide digital data of near-, mid-, and far-view forest scenes. Progression of the outbreak and subsequent forest recovery are simulated, using imaging models based on color signatures and projections from the Forest Vegetation Simulator (Prognosis) and the Budworm Damage Model. Four management alternatives are simulated, including no action, progressive intensive silvicultural treatments intended to rapidly reduce budworm vulnerability (and maintain the low vulnerability condition), conservative silviculture with a more incremental approach, and a Bt treatment, as well as a catastrophic wildfire scenario. The damage and different management scenarios are simulated at several stages until the desired future conditions are reached.

These models and images are intended to be used as a) evaluation tools to provide systematic perceptual assessments of the perceived visual quality during and after an outbreak under alternative management strategies, b) a medium to inform and educate the public, and as c) a research and survey instrument to evaluate pest impacts on recreation. Similar models are being developed for simulating bark beetle effects on the Dixie N.F. and the Chugach N.F.

Future integration with system tools such as the GIS and Integrated Forest Resource Management System (INFORMS) will lead to effective decision-making process involving professional planners, managers and concerned public. In anticipation of greater future needs, the results of this project can be used beyond the Deschutes National Forest to communicate complex environmental processes and resource decisions. This project is a cooperative effort between Universities, Forest Service Research, National Forest Systems, and Forest Pest Management working together toward a common goal.

Demonstration of the TASS-ROTSIM Root Disease Model

J.D. Beale, B.C. Ministry of Forests, Victoria, B.C.

The TASS-ROTSIM model simulates tree and stand growth and yield interactively with the effects of laminated root disease (Phellinus weirii) on coastal Douglas-fir. The TASS and ROTSIM models were developed independently but both use the same single-tree distance-dependant model structure. The models were developed respectively by, Ken Mitchell (BC Ministry of Forests) and the late Bill Bloomberg (Canadian Forest Service).

The model demonstration illustrated several pre-run scenarios of laminated root disease behavior with and without disease controls (e.g. stumping, variable planting densities, variable precommercial thinning densities, and PCT-plus-bridge tree removal) of coastal Douglas-fir plantations growing on a medium site (SI 30 m @ 50 yr BHA). These management scenarios were simulating existing "2nd growth" plantations planted after the "1st pass old growth" harvesting of 40-60 years ago; the "3rd growth" plantations now being established on recently harvested 2nd growth naturally regenerated forests. The differences in initial root disease inoculum loads was simulated through varying the numbers and sizes of stumps remaining after the 1st and 2nd growth harvests. The users then made selections for 2nd and 3rd growth management and disease treatments. An aerial graphical view of the plantation growth and root disease expression (plus key tree and stand growth & yield parameters) were shown at each model iteration. A graphical comparison of stand yield & trees/ha output for all associated scenarios including the one chosen by the users were then viewed to evaluate the treatment effects. An example of the "Fred's Forest" model was also illustrated as an optional way of presenting the TASS-ROTSIM information as it also provided and entertaining yet instructive insight into the economics of the treatment prescriptions in terms of revenue earned or lost as a hypothetical woodlot owner! The basis for the lumber yield, quality and economic evaluation returns was demonstrated by a quick review of the SYLVER program.

I demonstrated the models to two groups both very keen on the tools potential application for reviewing disease behavior and responses to treatment prescriptions - as an aid for impact assessment, stand prescription planning and training. There were a great number of comments regarding the assumptions and data used, some suggestions for improvement and cheers for where we have gotten to and come from in root disease modelling in the last few years! Apart from the minor glitch of not being able to view the demonstration on a video monitor (they got to see it on a Toshiba 4600C laptop), I think most people thoroughly enjoyed the demonstration.

PC-INDIDS

Barbara J. Bentz, INT, Logan Forestry Sciences Lab

INDIDS (Insect and Disease Damage Survey System) was originally developed by W. Bousfield (1980) and later revised by Bousfield, R. Eder, and D. Bennett (1985) to aid managers in prescribing appropriate management strategies when insects and diseases are influencing factors on stand resources. Currently, the use of INDIDS is restricted to the Forest Service Data General computing system and lacks flexibility in many areas, minimizing potential use by the diverse array of Forest Service, state, and private personnel involved in resource management. Based on needs expressed by many, we are currently revising INDIDS to run on the PC platform (DOS or Windows), providing enhanced efficiency of the code, an optional graphical user interface, and more flexibility in data input and results output. All suggestions for revision of the program are being provided by users/cooperators in the Forest Service and state agencies. One recent addition is the capability of inputing RMRIS data directly into PC-INDIDS.

Integrated Forest Resource Management System (INFORMS)

David J. Roschke, USDA Forest ServiceForest Pest Management, Methods Application Group
Delora Greenlee, Management Assistance Corporation of America

One strategic goal of the USDA Forest Service Forest Pest Management (FPM) group is to promote and improve integration of forest pest management considerations with forest and ecosystem management planning. The FPM Methods Application Group (MAG) participates in the development of integrated decision-support tools through the INFORMS project.

Two functioning versions of INFORMS exist: INFORMS-DG and INFORMS-TX. INFORMS-DG runs in the current Forest Service-wide Data General computing environment. INFORMS-DG integrates a variety of resource simulation models; INFORMS-DG also provides the user with the capability to manipulate and display spatial data and to display simulated forest scenes as affected by various management alternatives and natural processes. INFORMS-DG is currently being used by resource specialists and managers for project planning and analysis on the Deerlodge National Forest in Montana and the Idaho Panhandle National Forests in Idaho.

INFORMS-TX is the product of a collaboration between Texas A&M University's STARR Lab, FPM and Management Systems staffs in Region 8, the National Forests in Texas, and FPM-Washington Office. INFORMS-TX is being developed in anticipation of the upcoming procurement of a new workstation-based Forest Service computing environment. INFORMS-TX development is based on the premise that the power and utility of several commercial and public domain software packages can be harnessed through a user-friendly interface to provide resource specialists and managers with a set of sophisticated tools for performing complex planning tasks. INFORMS-TX integrates functions of a geographic information system, a relational database management system, various forest resource models, and expert systems software. INFORMS-TX is in use on the Davy Crockett National Forest in Texas and the Ouachita National Forest in Arkansas, and is being tested on the Wallowa-Whitman National Forest in Oregon.

The future direction of INFORMS is to blend proven and new methods of decision-support for use in ecosystem management.

Software/Hardware for Forest Health

Ralph White, R. White Woods Inc. 6872 Winnefired Place, Sannichton, BC, Canada, V8M 1N1

Ralph White presented specifications for the new Paravant RHC-44E and his firms's user-defineable EASYDC Universal Data Collection Software. The new Paravant has several enhancements including:

* a new processor (4 times faster)
* MS-DOS 5.0 operating system
* two PCMCIA 2.0 card drives (type II and III)
* various port configerations for serial, parallel and external monitor/keyboard
* extended battery life
* 16x40 display with large keys for gloved use

R. White Woods inc's EASYDC software has users in Nursery, Research, Ecological, Acid Rain, Forest Genetics, Forest Health, Watershed Management and Inventory applications. Several WIFDWC participants from the British Columbia Ministry of Forests and the Canadian Forestry Service are licensees for EASYDC.

EASYDC allows the user to create up to 80 fields per electronic form all of which can be of various lengths and have answers generated by calculations, pop-up choice list or direct entry. Several forms can be open at once and the user can flip between them. Prompts, help line and validations allow for ease of data collection for novice users. Very simple or extremely complex applications can be quickly developed.

WHAT IS A HEALTHY FOREST?

Workshop Moderators: Tom Kolb and Mike Wagner
Northern Arizona University, Flagstaff, Arizona

The term "forest health" is being increasingly used in the context of natural resource management. However, the term is ambiguous and difficult to define. This workshop was designed to simulate discussion of the meanings of "forest health" and the appropriateness of the term for forest management.

Tom Kolb (NAU) discussed the various meanings of forest health. He pointed out that definitions of forest health range between utilitarian (consistency with objectives) and ecosystem-centered perspectives (perspectives (resilience to change, ecological balance, and the functioning of native organisms). Perceptions of health also increase in ambiguity with increasing complexity of the system to which the concept is applied, ranging from a fairly clear understanding of the health of an individual tree to a more ambiguous understanding of the health of forest ecosystems and landscapes.

Terry Shaw (USFS) gave an overview of two programs designed to measure the status and condition of forest ecosystems: the EPA's /Environmental Monitoring and Assessment Program, and the USFS's Forest Health Monitoring Program. Both programs will utilize thousands of field sampling points located nationwide at an intensity appropriate for regional level analysis of forest condition. Measures will include visual symptoms of tree damage, tree growth efficiency, and landscape pattern.

Greg Filip (OSU) discussed the meanings of "resilience" and "resistance" in an ecological context. Other themes he discussed included: the de pendency of forest health on objectives; the importance of exotic pests as unhealthy agents; the unhealthy consequences of disrupting natural fire regimes; and the role of active management in maintaining a desired state of forest health.

Skeeter Werner (USFS) commented on the biodiversity status of boreal forests in Alaska. Unmanaged and extensivily managed forests tend to have higher biodiversity than intensively managed forests.

Joan McAndrews (USFS) offered that the utilitarian definition of forest health is valuable because it relates to values, but it is not always attractive to ecologically oriented segments of society.

Jim Byler (USFS) suggested that the utilitarian definition of forest health is useful for managment purposes because it is related to values, while ecological definitions are needed for scientific credibility. The appropriate baseline conditions for measuring forest health were suggested to be the structure/composition, insect and disease activities, and successional trajectory of forests prior to Euro-American influence.

Fred Baker (USU) discussed the following topics: the term forest health is rapidly becoming part of forestry jargon; insects and diseases are "normal" influences on forests; notions of forest health must recognize non-equilibrium processes and chaos; and definable standards for measuring forest health are needed.

Through discussion at the workshop it is clear that the term "forest health" is probably not sufficiently precise at present to use as a measure of forest ecosystem status. Additional consensus is required to arrive at a sufficiently precise definition if forest health is to be a meaningful management objective. Questions and dialogue at the workshop amplified the need to clarify the specific meaning of health prior to using it as an objective in any management situation.

THE USE OF EXOTIC ORGANISMS TO CONTROL NATIVE PATHOGENS

Workshop Moderator: Catherine Parks

INTRODUCTION

The goal of our workshop was to address, as a group, a stimulating issue: biological control and the use of exotic organisms to control native pathogens. Parenthetically, the discussion dealt with the deliberate geographic movement of microorganisms from one forest community to another with an intended benefit to the receiving forest community.

There are many dynamic facets of this topic. The discipline of forest pathology knows the devastating impact of introduced foreign organisms. The major forest disease epidemics of this century, chestnut blight, white pine blister rust, dutch elm disease, had a major influence on the maturation of this profession much as the late blight epidemic of potatoes had on agricultural pathology over a century ago. In many ways the forest pathology profession is a contributing partner with agricultural pathology in advancing our understanding of disease. The information presented at the workshop and our discussions included many examples from agriculture--not only pathology, but entomology and weed science, as well. This same topic of exotic organisms is being currently debated in the many disciplines (e.g. agroforestry, sustainable agriculture, range management, and livestock production) with interest in biological control research, development, and application.

Biological control is likely to gain a resurgence of interest in the climate of ecosystem management in forestry. Understanding the role, function, and niches of microorganisms (and how to manipulate them), is not a new revelation to pathologists. There is however, a new support for this direction of study and application given the current climate of natural resource management.

EXAMPLES

Our discussion started by looking at the registration process for importing organisms into the United States and some examples of exotic organisms sponsored by the USDA as biological control organisms. Agriculture and forestry provide a great deal of experience upon which to draw regarding the safe use of microorganisms.

Some examples include:

> *Penicillium bilaji* is an organism that is being sent all over the world to verify its affects as a seed treatment to enhance phosphorus uptake by wheat and canola. Will we someday be applying microbes instead of fertilizer to compensate for nutrient-poor soils?
>
> Agriculture offers years of experience in inoculating seeds with *Rhizobium*; forestry offers experience with inoculating soils of tree nurseries with mycorrhizal fungi. One ectomycorrhizal fungus, *Pisolithus tinctorius*, developed in the southeastern United States is being used in conifer nurseries in 18 countries.
>
> The K84 strain of *Agrobacterium radiobactor* for control of crown gall was developed in Australia, and from that single strain, dozens of countries have gained control of a major plant disease.

The organism that exemplifies what has come to be called a biopesticide, the entomopathogen *Bacillus thuringiensis* (Bt), sells world-wide.

In California scientists have recently been successful at selecting an exotic strain of the rust fungus *Pharagmidium violacium* that causes significant dieback ONLY on the pest Rubus and not on the cultivated blackberry varieties.

Phlebiopsis gigantea (=*Peniophora gigantea*) was the first biological control involving an introduced microorganism for a plant disease into the United States. This organism acts as a biocontrol agent by saprophytically colonizing the stump surface of freshly harvested trees, thus preempting infection by spores of the pathogen, Heterobasidion annosum.

CASE STUDY

Phlebiopsis gigantea was used as a case study in the workshop. This organism was singled out for discussion because there is a new formulation of the organism now produced in Finland from a Finish isolate. There is a growing interest in testing this "exotic" organism as a biocontrol agent in the forests of the United States. It is used operationally in Scandinavia where forest pathologists have found it 98% effective in halting new stump infection of spruce and pine stumps. It is produced by a company in Helsinki who sells it as a dry spore preparation. The price is 30 FinM or about $5 US for 10 g. Ten grams will treat 15-30 m^3 of wood.

There was controversy within the group as to whether this product should be tested. The controversy arose from the fact the product was developed from a Finish isolate of the fungus. Some individuals are concerned that we are introducing a foreign organism that could possibly cause adverse effects in the forest ecosystem. Concerned individuals liken this introduction to that of importing foreign logs as a source of timber. Proponents of the study, on the other hand, pointed out that the organism is used throughout Scandinavia as a stump treatment, decays dead wood in temperate forest throughout the northern hemisphere, and is not known to act as a pathogen anywhere in the world. Additionally, the product has been approved by the Animal and Plant Health Inspection Service (USDA-APHIS), and a U.S. distributer is located in Colorado. The fungus is commonly found in the timber growing regions of the United States. It has been previously tested as a stump treatment in the Pacific Northwest, Northeast, and Southeast Regions of the United States. The past test formulations used a UK isolate (another exotic source). Past testing of this approach to root disease control has been promising, and interest has resurfaced with the new Finish formulation and the growing concern for the potential adverse effects of chemical alternatives.

DISCUSSION

The discussion of the group came to the rhetorical question of "What is exotic?". Do legal boundaries of countries or even continents constitute a prudent biological geographic boundary? Should the community type (eco-type) define like-communities rather than continental boundaries? For example would using a biocontrol organism in Alaska that originated in the Southern United States be more "risky" than using an exotic from a temperate forest of Europe? Is the Finnish *P. gigantea* "exotic" if an organism by that name occurs in the same forests where it will be tested? It was agreed that the increasing use of transgenic organisms may truly constitute the new "exotics" (i.e. nonindiginous to this planet!). Some examples of transgenic organisms currently employed in biological control efforts include: pathogens made more or less pathogenic through gene manipulation; genetic markers, sometimes called "junk genes," used to follow pathogen populations; "ice-minus" bacteria used commercially for frost protection; the endophytic bacterium *Clavibacter xyli* modified by rDNA technology to produce the Bt toxin; "pesticidal plants," such as the commercially grown potato plant--genetically altered to be resistant to leaf roll virus.

The group considered the question "Do we actually have a pure ecosystem left on this planet?". Some felt that because of transglobal travel that we no longer have ecosystems unaffected by exotic organisms. The global occurrence of DDT may support this opinion.

What is our responsibility as professionals in the international science area? Are we learning from the advancements of our colleagues from around the world in the field of biocontrol? Are we being responsible in what we promote as export biocontrol organisms from this country? What organisms may be conveyed in the huge effort by Weyerhauser to establish timber plantations in Russia? What efforts have been made on an international forestry level to control movement of organisms in the widespread plantings of *Pinus radiata* throughout the southern hemisphere? What is an acceptable level of risk associated with the use of any biological control organism? When is the use of naturally occurring products safer than the use of chemical pesticides and more prudent than doing nothing at all? Inclusively, what should be the position of forest pathologists as biological control becomes integrated into resource management in the forests of the world?

We must decide among ourselves, then plant the seeds for policy that we feel is appropriate for the advancement of 21st century biological control. Plant pathology is progressing at a remarkable rate in this area of study. We dare not simply avoid the issue under a guise of being prudent and cautious. We need to progress in a scientifically credible and practical manner to confront these issues. It is our professional responsibility.

DINOSAURS OR DNA -- WHICH WAY ARE WE HEADING?

Workshop Moderator: Boyd Wickman
USDA Forest Service, LaGrande, Oregon

Participants: About 25, including introductory remarks from Liz Blake, Al Stage, Alan Van Sickle, Jan Volney, Alan Berryman, and Dave Wood.

The moderator proposed that discussion continue in the context of "forest health" in ecosystem management and our current professional direction. Some specific questions proposed for discussion included:

1. Are forest entomologists and pathologists losing their identity and leadership in forest health issues?

There were some impressions that we are losing our identity. Part of the problem involves definitions of the terms "forest health" and "ecosystem management." The terms are broad and can mean different things to different scientific disciplines. Pathologists and entomologists are sometimes left out of the forest planning process or not included on special ecosystem management task forces. We need to be more pro-active in defining our role and our contributions to ecosystem management. We also need a better definition of "forest health" and where it fits into ecosystem management.

The Canadians are grappling with definitions of the newest buzz words in the United States. One approach they are taking is contracting with University ecologists to give short courses to bring managers up to speed, to provide ecosystems indices that may relate to insects and diseases, and search for indicator species that relate to forest health. More information on the role of insects and pathogens in ecosystem processes is sorely needed.

2. What kind of research should we be undertaking to remain/become science leaders rather than followers?

Again definitions were discussed and found wanting. There was agreement that a shift from research oriented solely toward timber production has been taking place. Ecosystem management implies we are knowledgeable about ecosystem processes and this is not the case in respect to insects and pathogens. We sold our souls to the "Big Bug Programs" and are now living with that legacy. We are not perceived as being ecologically oriented by current managers and ecologists. To counter this attitude some forest entomologists want to be known professionally as "ecologists" and label their research accordingly. Are we losing pride in our profession?

Our research direction should be toward understanding processes, like bio-energetic cycling, and then modeling the processes so that we have a product to sell to managers.

In the past we hooked our wagon to picturing insects and diseases as villains needing suppression rather than understanding. Consequently much of our past research funding was oriented toward killing critters.

3. Do we need a stronger professional identity and organization with closer pathology/entomology linkage?

The joint pathology/entomology work conferences have always been well attended and well liked. We tend to broaden our outlooks and more fully appreciate the interactions involved with insects and pathogens. For at least 20 years there have been members wanting to combine our two conferences. Some felt that the time may be especially ripe for a union in the context of attention given to forest health and ecosystem management. It was agreed that the moderator propose to the chairs of the two conferences that at least each conference include entomology and pathology in each other's programs with a possible long-term goal of a unified organization.[1]

[1] Footnote: **The proposal was discussed in the final business meetings of each organization. The WFIDWC agreed to including a session on insects and disease interactions at their next conference. The WFIWC agreed to a formal debate on the pros and cons of combining the two organizations at their next conference in 1995.**

SUSCEPTIBILITY/RISK RATING SYSTEMS FOR INSECTS AND DISEASES

Workshop Moderator: Terry Shore
Canadian Forest Service, Victoria, B.C.

Participants: Approximately 50 attendees participated in discussions on various topics related to risk rating, revolving around presentations by five speakers:

Ann Lynch reviewed existing rating systems for western spruce budworm. Risk and susceptibility were presented as the likelihood of an outbreak occurring, with hazard and vulnerability as the probability of damage if an outbreak occurs, and defoliation as a proxy indicator of outbreak occurrence. Western spruce budworm and it's hosts have extensive distributions, encompassing considerable variability. It is therefore not surprising that susceptibility and vulnerability relationships vary throughout these distributions, or that risk and hazard rating systems developed in one place do not perform well in others. Existing rating systems range from simple to complex, empirical to conceptual, localized to encompassing the western portion of the continent. They variously predict or index the likelihood of defoliation, percent defoliation, damage (mortality, growth reduction, topkill), or outbreak frequency. During development and use we need to distinguish between obtaining a full understanding of disturbance ecology, predicting insect and tree population dynamics, and providing guidance for management decisions. The former two concern biological and ecological domains, and the latter includes additional social and ecological aspects. The complexity and data requirements of risk-and hazard-rating systems developed as decision support tools should be optimized, providing the maximum management guidance with the smallest and easiest-to-use amount of information possible.

Eric Smith discussed the difference between statistical analysis and decision analysis, with risk rating systems ultimately needing to be part of a decision analysis. Statistical procedures produce predictive or descriptive representations based on a data set. The "best fit" results have desirable mathematical properties, but do not consider the consequences of different types of statistical errors. Decision analysis is prescriptive, and considers the consequences of errors. Because the costs of being wrong vary, the rating system needs to either take the economic structure of the problem into account, or provide the user with enough information that a proper decision system can be constructed. Smith urged that those contructing or using this system become more familiar with decion analysis techniques to avoid suboptimal decisions.

Jeff Beale discussed the value of risk rating system in forest planning. Risk ratings for damage effects on forest productivity are a requirement of forest management at both the stand and forest level. Some estimate of what the future holds in terms of the probability of a disease or insect infestation, and the degree of damage and yield impacts are important for determining site capabilities, prescription and treatment constraints and forest level planning. An approach to developing a risk rating scheme for forest damage agents using empirical forest-level survey data combined with damage agent biology and behaviour, and ecological succession was discussed using examples.

Ed Holsten discussed the evolution of hazard/risk rating systems for the spruce beetle on the Kenai Penninsula, Alaska. The current system was developed using tree-regression analysis where hazard classes of low, medium and high, based on basal area mortality, were related to stand characteristics. The most important determinant of hazard was percentage basal area of spruce with a dbh > 25 cm, followed by spruce basal area, total basal area, elevation, and aspect. Two main paths in the decision tree led to various outcomes of low (0-10%), low-medium (0-40%), medium-high (11-100%) and high (41-100%) hazard. Using an analytical hierarchy process, factors contributing to risk were evaluated. Stand hazard and windthrow were identified as the two most important factors. The hazard and risk evaluation system has been combined with an introduction, textbook, literature and recommendations for spruce beetle management in an expert system Sbexpert.

Terry Shore discussed the advantages of an heuristic approach over a multiple regression approach for the development of hazard and risk rating systems using the Shore/Safranyik (1992) mountain pine beetle susceptibility and risk rating system as an example. In order to properly evaluate a number of candidate variables using a regression approach, sample stands representing a range of values within each variable would have to be found for all combinations of variables. There would also have to be replicates of each particular combination. This in itself is a nearly impossible task requiring an enormous sample size if stands meeting the requirements could even be found. In addition, these combinations can really only be evaluated fairly if they are all subjected to beetle infestations of equal severity. Finding or creating this combination of conditions is unrealistic. It also ignores the wealth of knowledge that we have on the mountain pine beetle. The heuristic approach uses expert knowledge to identify key factors relating to stand susceptility and risk, and to incorporate these factors in a risk rating model. The model can then be evaluated and fine-tuned by testing it on a mountain pine beetle infestations in a variety of situations.

APPROACHES FOR MODELING THE EFFECTS OF DISEASES AND INSECTS TO MEET THE NEEDS OF FOREST MANAGERS

Panel Moderators: Kathy Sheehan and Jerry Beatty
USDA Forest Service, Pacific Northwest Region

Dawn E. Hansen , Forest Pest Management, Intermountain Region USDA - Forest Service

When forest managers are posed the question, "how can they be helped in doing their jobs?", frequently the answer is to give them more time to get their jobs done. Since we cannot create more time, we should create tools which help forest managers do their jobs more efficiently. With respect to computer models which help predict influences of insects and diseases, there are some common questions which these tools should address.

Based on information gathered from several FPM representatives from 3 Regions and NFS personnel within Region 4, the following are the concerns:

- What are the effects of insects and diseases to the resource?
- How will different management options influence insect and disease activity?
- What is the risk of the resource to future insect and disease outbreaks?
- What are the economic impacts of different management treatments for insect and disease activity?

There are several basic characteristics of models which would help forest managers utilize them most efficiently.

- First and foremost, everyone wants a model to be easy to use. The standards of "what is easy to use" may vary by users and their objectives.
- The users want to have confidence in the model predictions. In order to aid them, it would be helpful if each model was documented with examples of reasonable outputs so users could compare their forest predictions to "base line" data and check for irregular model behavior. Documented sensitivity analyses would also help the user be aware of what input values are most apt to influence output predictions.
- The model options should reflect today's vegetation management treatment options along with reasonable time frames. For example, if uneven-aged management in ten year increments is the silvicultural prescription desired, the model should be able to simulate the action along with the insect and disease interactions with this management every ten years. A range of options should be predicted since there is seldom just one answer to a management concern prompting an action. By providing ranges of possible outcomes, the manager can combine these possibilities with his or her local expertise and values to determine an acceptable alternative for the area.
- The tools of the future must be able to address the landscape level along with ecosystems to incorporate all the spatial dynamics. The current emphasis of examining the possibility of linking the Parallel Processor of the Forest Vegetation Simulator to a Geographic Information System is one example of efforts in this area. Computer graphics will also enhance the outputs of models to aid in interpreting the predictions.

There are lots of questions which can be answered with these tools and the questions can always change.

J. D. Beale, B.C. Ministry of Forestry

Setting the Modelling Objectives: Modelling the effects of forest insects and diseases can be done for many different objectives ranging from estimating the effects on; site and stand productivity, timber quality and yield, tree species successional shifts, insect and disease population behavior, risks to management, and to visual quality. These objectives must then be filtered by (a) the resolution required; forest-level versus.stand-level, and (b) the management questions and accuracy required; general effects (negative impacts or treatment opportunities), or a set of stand crop planning options. Therefore, the general approach to modelling begins with the management questions posed.

In order to effectively evaluate the wide variety of modelling approaches, but at the danger of sounding parochial, I have narrowed the modelling objectives to estimation of timber quality and yield and risks to management at the stand-level perspective since this is generally at the center of why forest management attempts to account for, and manage insects and diseases. This is not to say that I do (or B.C. does) not desire to manage for other objectives, we do, but it serves to bring focus on the topic rather than ranging philosophic all over the modelling-approaches-map!

Evaluating the Approaches: Over the years four major modelling approaches to forest growth and yield have arisen:

(1) mechanistic;
(2) ecosystem;
(3) succession;
(4) mensurational- whole stand and individual tree.

Although there are many important factors that can or will aid in modelling the effects of insects and diseases in the first three approaches noted above, the most significant efforts to date focus mostly on mensurational models. These models have the advantage of being able to incorporate some form of stochastic growth and mortality functions (e.g., SPS), or after-prediction operational adjustments (e.g., TASS-TIPSY. Other models estimate insect and disease effects "interactively", for example, PROGNOSIS plus Western Root Disease model, or TASS-ROTSIM (root rot simulator).

Mensurational models also have an advantage over other approaches, in that many have become widely used and the users can "see" and interpret the output reasonably well.

This is not to say that the mensurational modelling approach is without flaw. For example, mensurational models depend on being able to predict the future based on availability of historical data (permanent sample plots etc.), which is very expensive to capture. And, historical data by its nature means we will not necessarily be able to change prediction responses quickly enough to adequately represent new sets of stand-insect/disease-treatment conditions because modelling approaches tend to focus on stochastic functions compared to biologic process functions. A model that is based on biological functions may tend to be more adaptable to the changing sets of stand and management conditions.

Also, most mensurational models are not particularly accurate in portraying insect and disease conditions spatially, although this would not always be a concern for stand-level modelling, as it is often agent-specific. But, this issue might better be addressed through single-tree distance dependant modelling.

A notable quote on mensurational modelling fits well at this point..."growth and yield modelers comfort is justifiably low regarding predictive accuracy, but, comfort levels will never again be as high given the rates of change in forest practices", Ian Cameron (British Columbia Forest Service, Research Branch, 1994).

Where to go next? Given that modelling objectives are complex and getting more so, and that modelling approaches are already complex *but,* are beginning to converge, I propose that the approach taken to modelling the effects of insects and diseases include more biological processes through the merging of modelling approaches used in the mechanistic, ecosystem, successional and mensurational model. Although this proposal may be sound in itself, there are outstanding issues that while not precluding the proposal, do hinder it. The issues are that forest practices are changing rapidly, and the demand for historical data for model prediction purposes cannot likely be obtained fast enough and, that forest managers urgently need answers for tomorrow's management, not for the year 2005! The complexity and urgency of the types of forest management decisions required, virtually demands that we come up with more flexible and adaptable decision support systems that integrate with our classical modelling tools.

Decision Support Systems (DSS), I believe, are the optimal tools for integrating large amounts of objective and subjective management factors and expert opinion to arrive at a management decision or best-set of options. Growth and yield models would be integrated with the DSS, with the DSS having many hooks in the system to integrate management questions and probabalistic patterns and predictions for other resource production functions. For example, a DSS would be extremely useful for: estimating hazard and risk of insect & disease damage; provision of regeneration stand tending and harvesting recommendations or predicted outcomes, amongst many other resource management issues. Decision support systems should also strive to provide graphical display for input and output interpretations, as well as diagnostic tools and estimates of confidence or risk of error.

In conclusion, the most fruitful approaches to modelling the effects of forest insects and diseases, lies in strengthening the biological reality of our models through a convergence of mechanistic, ecosystem, succession, and mensurational modelling approaches, and, development of linkages to DSS that facilitate diagnosis of problems, selection of best management options given linkage to other resource management factors, graphical interpretations, and confidence and risk values for decision options.

INTERNATIONAL COOPERATION TO MANAGE FOREST PESTS

Panel Moderator: James Ward
Foreign Aid Organization Research, Kenya, Nairobi, Africa

Mechanisms for International Cooperation on Forest Pest Research and Management in North America

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ABSTRACT

For years, international cooperation on forest pest management and research has been a continuously growing activity between the Forest Services of Canada, United States of America, and Mexico. Due to its importance, a number of international mechanisms have evolved to assure and improve collaboration and cooperation on pest related issues of mutual concern and significance for forest ecosystem health in North America. Central to this presentation will be the description of these mechanisms, the existing cooperative linkages, the experience gained throughout the years, as well as the most recent policies for guiding future cooperation between the USDA Forest Service and Mexico's Secretary of Agriculture and Water Resources.

INTRODUCTION

In North America, forestry cooperation has always been a growing and a evolving activity. Three institutions have been the most important actors of this cooperation: Forestry Canada; the USDA Forest Service; and Mexico's Secretary of Agriculture and Water Resources (SARH). Initially, cooperative activities were restricted to scientists and experts from federal government agencies. Since 1960, for instance, collaborative projects have included silviculture, insects and diseases management, timber management and harvesting, watershed and fire management, timber inventories, and information management technologies. Most of these actions focussed on technology transfer, and little was done on scientific research. In contrast to previous years, forestry cooperation is now more diverse and involves scientists and natural resource managers not only from federal and state agencies, but also from universities and nongovernment organizations.

Today, the focus of forestry cooperation is rapidly changing from a commodity oriented strategy of resource utilization, to a more socially-driven ecosystem value approach of resource management. New geopolitical conditions and a growing diversity of participants from different research and academic institutions are inducing these accelerated changes. The Mexican government, for example, is increasingly funding more graduate students and scientists to get advanced degrees abroad, and is promoting more scientific and technological cooperation with institutions in North America.

As a result of these trends, cooperative exchange programs in North America are expanding and diversifying. Forestry Canada, for instance, has been implementing a broad-based multi-million dollar cooperative forestry program with Mexico. Conditions recently created in Mexico by changes made to the law of foreign investment, the law that regulates land property rights, and NAFTA are clearly signaling developed nation governments to update policies for strengthening forestry cooperation with Mexico. Similar trends are applicable to international nongovernment organizations and universities.

This new set of conditions, which creates and emphasizes biophysical and socioeconomic continuities, are making the tasks and linkages of scientists and professionals more global in scope. Scientific research within these new scenarios is gaining widespread support and international significance. From a planetary perspective, and given the inherent complexities in these evolving trends, there is an urgent need for creating and fostering international partnerships between scientists and natural resource managers. By means of these joint efforts, research and management goals will be more achievable and meaningful as far as understanding ecosystems, understanding people and natural resource relationships, and understanding and expanding resource options. This paper, therefore, describes past and current mechanisms for forestry cooperation between Canada, the U.S., and Mexico. It also reports on the most recent policies between SARH and the USDA Forest Service for guiding future forestry cooperation.

U.S./MEXICO MECHANISMS FOR FORESTRY COOPERATION

Research and Technology Exchange Agreements

The USDA Forest Service and SARH have a long history of productive forestry cooperation. In wood products research, for instance, cooperation with Mexican scientists goes back as far as 1911. During the 80's most of these cooperative activities focussed on technology transfer with forestry agencies within SARH: the National Institute for Forestry Research (INIF) and the Under secretary for Forestry and Wildlife Resources (SFFS). First among these forestry cooperative agreements was a MOU signed in 1980 between SARH and the USDA Forest Service.

In 1981, the Rocky Mountain Forest and Range Experiment Station (RMS) and Region 3 signed a MOU on Forestry Research and Technology Transfer with INIF. Later, in 1984, these cooperative activities were reorganized by a Master MOU on Scientific and Technology Cooperation in Forestry signed between SARH and the US-Department of Agriculture (USDA). This Master MOU allows amendments to be added by mutual agreement of the respective Chiefs of the USDA Forest Service and the Under secretary of Forestry. In 1985, a Supplement was appended to the Master MOU in order to organize and facilitate the implementation of specific projects. This agreement is commonly called the 1985 MOU Forestry Supplement. Scientists and managers from different backgrounds have participated in the joint working groups (JWGs) defined under these agreements.

While some of the JWGs of the 1985 MOU Forestry Supplement were working effectively, others were not functioning or were showing a low level of activity. This situation was not related to the master MOU itself, but to the efficacy of the operational mechanisms which drove the 1985 MOU Forestry Supplement. Specifically, the master MOU is a higher level agreement, and as such, provides a foundation for all other agreements signed by forestry agencies within the USDA and SARH. In Mexico, coordination of Forestry Supplement JWG activities has been constrained by frequent leadership shifts in the SFFS. The JWGs of recreation and wildlife, for example, were practically shut down by changes in the functional responsibilities of the SFFS. In 1991 the responsibility for wildlife and parks was returned to SFFS. In the USDA Forest Service, "a major inhibitor has been the lack of formal reporting and oversight mechanisms". In response to these problems, the USDA Forest Service and SFFS decided to revise and revitalize the 1985 MOU Forestry Supplement. As a result of this process, in 1993, both agencies decided to sign and put into action a new MOU Forestry Supplement. The following JWGs were created: (1) Plantation management; (2) Wildlife Management; (3) Land Management Planning; (4)Agroforestry; (5) Natural Forest Management; (6) Natural protected Areas; and (7) Special projects.

Agreement for Forestry Research

Previous agreements on forestry cooperation did not make a clear distinction between scientific research and technology exchange in forestry. In response to this situation, and to INIFAP's decentralized nature, a Letter of Intent on Forestry Research (LOI) was signed on July 24, 1992 in the City of Tapalpa, Jalisco, Mexico. In this agreement, both government institutions share a common mission; "To serve their societies and the global community by developing and communicating the scientific information and technology needed to protect, manage, and use the natural resources and other connected ecosystems." The LOI parties agreed to pursue scientific research in the following areas of mutual interest: (1) Biology of Forest Organisms; (2) Ecological Systems Function and Management; (3) Human Forest Interactions; (4) Wood as a Raw Material; (5) International trade, competition, and cooperation; (6) Tropical Forestry; and (7) Special programs.

North American Forestry Commission

The North American Forestry Commission (NAFC) has also been a vehicle to promote forestry cooperation between Canada, the U.S., and Mexico. NAFC was established in 1959 as a regional commission of the Food and Agriculture Organization (FAO) of the United Nations. In each country, NAFC is represented by the following institutions: Forestry Canada, USDA Forest Service, and SARH (SFFS and INIFAP). Several study groups exist: (1) Fire Management; (2) Tree Improvement; (3) Multilingual Forest Vocabulary; (4) Light Frame Structures; (5) Forest Engineering; (6) Silviculture; (7) Insects and Diseases; (8) Atmospheric Change and Forests; and (9) Neotropical Migratory Birds. Of all these study groups, the group on Insects and Diseases have shown the highest level of activity.

COOPERATION ON FOREST PEST RESEARCH AND MANAGEMENT

Several projects on forest pests have been undertaken under the above mechanisms for forestry cooperation. Forestry Canada involvement in these activities has been through NAFC study group of Insects and Diseases. Cooperation under this study group has been focused on the exchange of technical and scientific information concerning the management of forest pests; the development and publication of technical and scientific materials useful for management of insects and diseases; and the oversight of plant quarantine requirements and issues in forestry. Recently, this study group became an official subcommittee of the North American Plant Protection Organization (NAPPO). Current activities include: (1) provide technical assistance in survey of oak wilt outbreaks; (2) sponsor workshop on mistletoes management in conjunction with the state of Idaho; (3) hold workshop on methodology for risk assessment of exotic pests; and (4) develop technical manual on the insects and diseases of Mexico.

Critical to the successful cooperation on forest pests management and research with Mexico has been the role played by the USDA Forest Service. Most of work done on this area has been through the FS network of Research Experiment Stations. The Rocky Mountain Research Station (RMRS) has had a long history of cooperation on forest pests research and management with Mexico. Interaction with Mexican scientists have included the following activities: (1) field trips to Mexico; (2) training and education on forest diseases; (3) joint publications on forest pest issues; and (4) participation in scientific symposia. Frank Hawksworth, for example, made more than twenty five technical trips to Mexico. In cooperation with Mexican scientists, Frank Hawksworth compiled most of the research contributions between the U.S. and Mexico on Mistletoe.

Currently, the following activities are in progress: (1) a monograph of the taxonomy and host distribution of the dwarf mistletoes of the world. Nearly half of the species occur in Mexico and they are the primary disease agents there; (2) a NAFC sponsored book on the mistletoes and conifers of North America is being co-authored by RMRS scientists; and (3) a computerized bibliography on the mistletoe literature of the world is operational at the RMRS in Fort Collins, Colorado. In addition, Terry Shaw has studied *Armillaria ostoyae* associated with mortality of new hosts in Chuhuahua, Mexico. As a result of these activities, the RMRS has created an extensive network of contacts with Mexican scientists to further improve cooperative activities on forest pests research and management.

Scientists in the SE Experiment Station have also developed significant cooperative research relationships with several Mexican institutions. Cooperative activities have included technical exchange and training in forest entomology (i.e., cone and seed insects) and provide technical assistance regarding pitch canker disease. Planned activities to promote cooperation with Mexican institutions are: (1) participation in joint cooperative research projects; (2) technology exchange; (3) specialized assistance on forest pest problems; (4) formal training exchanges at universities or research locations; and (5) provisions for career development opportunities for scientists of both nations.

Currently, several Mexican institutions are major players in forest pest cooperative research and management with the U.S. and Canada. Within SARH, two of the most important actors are: INIFAP and SFFS. A directory of scientists is cooperatively being developed between USDA Forest Service and INIFAP. This will help to identify U.S. and Mexican scientists working on forest pests problems. Significant interactions also exist with Mexican universities: Universidad Autonoma de Nuevo Leon; Universidad Autonoma de Tamaulipas; Universidad Autonoma Chapingo; Colegio de Postgraduados; Universidad Nacional Autonoma de Mexico; and Instituto Politecnico Nacional. Cooperative research interactions with these institutions are expected to grow and become more diverse.

FOREST ECOSYSTEMS HEALTH

Under the LOI on Forestry Research, forest ecosystems health has been identified as a high priority research areas of mutual interest to both nations. The JWG leaders for the area of "Biology of Forest Organisms" (Terry Shaw and Alberto Gomez-Tagle) reported that a number of problems related to the health of forest ecosystem need attention. Next is a summary of their analyses and recommendations.

On many ejidos in Mexico, repeated fires (often set illegally) are used to directly convert forested land into grasslands for grazing or as a precursor to eventual planting of agronomic crops. These fires can create stress in remaining trees that often lead to pest problems (i.e., attack by various bark beetles) and also result in considerable sedimentation of streams. The fires and associated pest activity kill countless trees that are then cut and sold for a one time economic benefit.

More specific to the biology of forest organisms, there is a loss of species richness and genetic diversity in such burned areas, that, combined, cover thousands of hectares. Even though the true extent and impact of these fires are poorly understood, extinction for some species or biotypes is not an unreasonable expectation if the practice continues unabated.

There is a need to develop information on the biosystematics of species in these areas, as well as the phenology, distribution, and reproductive strategies of plants that are adversely affected by such fires. The effects of fires on the populations and dynamics of pest organisms that may further impact vegetation in burned areas also require attention. There also are significant technology transfer activities and management prescriptions (perhaps including judicious use of fire) needed to indicate how concepts of agroforestry (discussed below) can be utilized to maintain forested lands while also meeting agricultural needs.

Current grazing, cutting, and burning activities over many thousands of hectares of forested land in central Mexico and the American southwest have markedly impacted the ecologically sensitive vegetation around numerous streams and springs. Reduction and loss of this vegetation has apparently led to a depletion of spring and stream water flows as well as a reduction in water quality through sedimentation and eutrophication. Water management activities (i.e. wells, pipes, dams, roads) also must affect the water balance, but the mechanisms by which these effects occur are poorly understood.

More specific to the biology of forest organisms, there is a loss of microinvertebrates, insects, frogs, snakes, migratory waterfowl, and certain mammals. The true impact of the grazing, cutting, and burning activities on these organisms requires elucidation. Additional information also is needed on how best to reestablish vegetation in these impacted areas and thus begin to rehabilitate the riparian habitat. The latter will require specific knowledge of the species indigenous to these habitats and their phenologies, distributions, and reproductive strategies. There also are significant technology transfer activities and management prescriptions needed to demonstrate how to maintain and rehabilitate the affected riparian areas.

There is some considerable pressure on forests in central Mexico to remove the native vegetation so that the land may be converted to grasslands for grazing or managed for production of agronomic crops. On lands experiencing such pressure, the opportunity exists to practice temperate agroforestry rather that permanently convert these sites to grasslands or agricultural fields.

In depth knowledge of the interactions (i.e. synergistic, antagonistic, or neutral) of forest species with species to be cultivated for grazing or agriculture are needed before agroforestry ventures can be established. The ecologies of soils and associated microbes and arthropods also will require study, as well as how the animal brought in for grazing will affect the remaining forest vegetation and indigenous wildlife. There also are some technology transfer activities and management prescriptions needed to demonstrate how to initiate agroforestry operations.

There is a social and economic need to extract commodities, primarily timber, from a considerable portion of the temperate forests in northern and central Mexico. In order to allow for such extractions on a continued basis while also maintaining ecological diversity, we must understand the underlying mechanisms that will allow for sustainable production of needed commodities. We also need to have indicators of stress on these managed ecosystems so that we can implement necessary changes to reduce stress and maintain production.

More information is needed on the silvics of indigenous woody species, their reproduction, growth, maturation, and associated pests, as well as on their individual and collective response to various management actions. Information on the associated, nonwoody vegetation is also needed. The latter may provide specific bioindicators of various ecosystem stressors that may be impacting the managed system. For example, we need to determine if the performance of certain plants might indicate over grazing, low soil moisture or fertility, excessive erosion over burning. There also are some technology transfer activities and management prescriptions needed to demonstrate how to initiate and maintain commodity production and a diverse ecosystem on a sustainable basis.

There is considerable documentation on the effects of air pollution on forest vegetation in parts of Europe and North America. There also is detailed documentation on the effects of waste effluents on water quality and various aquatic organisms. There is a need to quantify the nature and effects of these pollutants and to design systems to deal with pollutant-causing industrial waste. It appears that certain species of Carrizo, Lirio, and Tule may serve as a "biological filter" and remove certain pollutants (i.e. NaOh, ZN, PO_4, NO_3) from contaminated waters. There is a need to better understand the ecology and floristics of these organisms as well as to test their relative abilities to serve as biological filters. If they are found to effectively remove contaminants from polluted waters, then their is a need to determine the mechanisms by which the organisms remove these contaminants. If certain plants are found to be suitable biological filters for removing pollutants from contaminated waters, then there will need to be some continued development and application efforts to utilize this new technology.

There are several examples in North America of the devastation caused to forests by the introduction of exotic pest organisms. How such exotic pests might behave in the forests of Mexico is poorly understood, as is the possible existence of natural enemies to these potential pests. At present, there is specific concern with the potential threat from white pine blister rust to the 5 or 6 species of 5 needle pines in Mexico. This concern has increased with the recent discovery of white pine blister rust on the Lincoln National Forest, only 80 some miles north of the Mexican border. There also is concern with the pinewood nematode - does it exist in the country or not? The presence of this organism could effect the potential export market for wood products. If Pitch canker is an indigenous or introduced disease also requires clarification, as does its distribution and effects on pines in Mexico.

ORGANIZATIONAL STRUCTURE FOR FORESTRY COOPERATION

Recently, the USDA Forest Service and SARH (INIFAP and SFFS) developed a preliminary organizational/administrative structure in order to coordinate better all activities of forestry cooperation. The proposed structure of this organization is as follows: (1) Policy Level Committee (PLC); (2) Executive Committee (EC); (3) Coordination Committee (CC); and (4) Joint Working Groups. The Policy Level Committee is constituted by Forest Service Chief, SFFS Subsecretary; and INIFAP Chief Executive Officer. Executive Committee Members are the following: Deputy Chief, Research, USDA Forest Service; Director General, Forest Protection, SFFS; and Deputy Chief, Forestry Research, INIFAP. The Coordination Committee is integrated by five members of each country, representing their respective institutions. The Joint Working Groups, these are represented by their coordinators under the respective agreements of forestry cooperation: Letter of Intent on Forestry research; Supplement to Memorandum of Understanding on Scientific and Technology Cooperation in Forestry; and North American Forestry Commission.

Under this organizational structure, the PLC provides overall direction and define policies and strategies on the nature of forestry collaboration. The EC is the forum for decision-making of the national representatives under the MOU and the LOI. Forestry cooperation decision-making under NAFC will continue to use the COA organizational structure (Committee of Alternates) of this trilateral agreement. Functions of the EC include: (1) Provides a linkage between policy and operations through communicating policy direction to lower levels and relating operational progress and international programs to agency chiefs; (2) Approve the annual work program, including the program budget; (3) Provides oversight and evaluation of work programs; and (4) Approves changes in working group chairs. The EC meets at least once per year and looks to other opportunities as needed or as they come available.

Several functions characterize the activities of the Coordination Committee. Among them: (1) Serve as the primary body to review project proposals and progress reports from all Joint Working Groups; (2) recommend a program of work to the EC which reflects the interests of the policy and executive levels; (3) Establish guidelines and evaluation criteria for proposals; (4) Ensure communication with working group chairs, including dated for proposal submissions, and progress reports of ongoing activities; and (5) Invite the participation of other organizations, such universities, NGO's, and private industry. The CC meets twice annually. Joint Working Groups, on the other hand, develop proposals and work plans based on the opportunities that emerge and the guidance received from higher levels. In addition, they execute approved project plans, monitor work progress, and prepare and deliver progress reports.

CONCLUSIONS

Through the LOI and MOU agreements, the United States and Mexico have made significant accomplishments in forestry cooperation. Central to these achievements have been the continuous efforts of Policy Level Executives and National Coordinators, Joint Working Group Leaders, and participating scientists. Their work has been fundamental for building up functional relationships for working cooperatively on problems and issues of common interest to both countries. Forestry cooperation between the two countries has created conditions of mutual trust and understanding, but also has generated a synergism for conducting research and technology exchange through partnership. These cooperative activities are benefitting a number of federal and state agencies, universities, forest industries, scientists and technicians, and forest land owners. It is expected that these cooperative relationships will keep growing, evolving, becoming more diverse and complex, and will gain more widespread support from a broader array of potential cooperators.

Evaluation of a Disorder of Neem in Niger

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Neem, *Azadirachta indica*, is a very important tree species widely planted in the Sahel region of West Africa, where it is used for firewood, windbreaks, greenbelts, and as amenity plantings in cities, towns, and villages. In the past two or three years, a serious problem of unknown etiology has been observed affecting neem in an area from Mali in the west to Chad and Cameroon in the east. The problem seems to have appeared more or less synchronously over much of this area and is characterized by the gradual loss of foliage, branch dieback, and finally a general debilitation of the tree and sometimes death. A previous study of the problem in 1991 tentatively identified the cause as infection by the wilt fungus *Verticillium* sp. Observations made during the current evaluation of the problem in Niger did not reveal any symptoms or signs that would indicate infection by *Verticillium*. In fact, no symptoms or signs were seen that would indicate the presence of any type of primary infectious disease. The same was true for attack by primary insects. The absence of any primary pathogens or insects, as well as the symptoms of general tree decline, pointed to an abiotic factor or factors as being the primary cause of the neem disorder. The more or less synchronous appearance of the problem over a very wide geographic area indicated that moisture stress is likely to be the most important factor involved.

Southern Pine Beetle in Honduras: An Example of International Cooperation

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ABSTRACT

The southern pine beetle, *Dendroctonus frontalis* Zimm., is the major forest pest of native pines (*Pinus oocarpa, P. caribaea*) in Honduras. In an outbreak from 1962-1965, believed to be the most devastating epidemic of these pest on record, more than 5 million ac were affected by this insect. The most recent outbreak began in the Yoro District in central Honduras in 1982. Following two years of sporadic control attempts (1982-1983) using felling and burning infested trees or insecticides, the Honduran Forestry Commission (Corporación Hondureña de Desarrollo Forestal or COHOEFOR) launched an intensive detection and control program in 1984, based on my recommendations. During a three-year period (1984-1986), over 2,000 multiple-tree infestations were detected and evaluated. Nearly 1,300 expanding infestations were promptly controlled by means of "cut-and-leave," a control procedure pioneered in Texas. This effective action reduced timber losses to an average of one acre per infestation, compared to an average of 35 ac per infestation in 1982-1983. Despite the fact that nearly three times as many infestations were detected during the 1984-1986 interval compared to 1982-1983, total area affected within the Yoro District was reduced to a total of 1,835 ac (compared to 25,132 ac in 1982-83).

In 1987, COHDEFOR was restructured and the pest control program was de-emphasized. Prolonged delays

between detection and direct control resulted in excessive timber losses as uncontrolled infestations grew to large size. Average area per infestation increased to 11 ac in 1987-1988, a needless loss of timber valued at $300,000. Resumption of prompt direct control since 1988 has reduced per infestation losses to 1984-1986 levels. Training of a COHDEFOR pest management counterpart and field personnel, technical pest management brochures in Spanish, and innovative programs to pay local laborers for control costs with donations of food have contributed to the success of the southern pine beetle control program in the Yoro District and other affected areas of Honduras. Beetle populations have remained low throughout Honduras since 1990.

Requirements for assignments in international forestry also were discussed. Among these are 1) fluency in the native language, 2) at least 10 years of experience in applied forestry or a related field, 3) willingness to travel in remote areas and live under primitive conditions, if necessary, and 4) capacity to make prompt, practical recommendations (written and oral).

Cypress Aphid Project

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The cypress aphid, *Cinara cupressi* (Buckton) was discovered in Malawi, southern Africa in 1986 and is now established in at least eight African countries. The potential to continue spreading elsewhere is great. The aphid is native to India, Europe, the Near East, and most probably North America. It feeds primarily on the outer branches of coniferous trees of the family Cupressaceae.

Major damage in Kenya is occurring in plantations of Mexican cypress (*Cupressus lusitanica*) an important timber tree and also important in agroforestry and as an ornamental (primarily as a hedgerow or living fence). Other species of trees threatened in Kenya include *Juniperus procera*, an important cover species especially in the high elevation watersheds of Kenya and *Widdringtonia nodiflora*, Malawi's national tree (Ciesla 1991).

Here in the U.S., through the cooperation of Regions 2, 4, 5, and 8, *C. cupressi,* has been found on western juniper, *Juniperus scopulorum*. The aphid and some promising parasites and predators have been collected from 1991 to the present and shipped to the Biocontrol Lab in London for rearing and eventual release. Chemical controls are not a viable alternative.

The search and collection for promising biocontrol agents continues. In addition to Europe and north Africa, collections here in North American will continue. This year, through the cooperation of western Regions and the Mexican government, we hope to expand our survey more into the Mexican cypress timber types. Major emphasis will be to continue collections of both the aphid and potential parasites and predators.

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Far East Lymantriid Monitoring Project (1993 Final Report)

Steve Munson and **Donna Leonard,** USFS; **Victor Mastro** and **Terry McGovern**, APHIS, PPQ; **Federal Forest Service of Russia**; **State Plant Quarantine Service of Russia**

ABSTRACT

In 1993 a cooperative monitoring program was initiated by Russia and the United States to determine population levels and flight periodicity of three Lymantriid species (Asian gypsy moth, *Lymantria dispar*, Nun moth, *L. monacha*, and Rosy gypsy moth, *L. mathura*) in the major port areas of Russia's Far East. A variety of monitoring techniques were used to conduct this evaluation. This information will be used to develop a database to determine infestation level and regulatory risk associated with ships and cargo within the port areas.

All three species were at endemic levels within the monitored port areas of Nakhodka, Vostochny and Vladivostok in 1993. Male Asian gypsy moth (AGM) adults were the most abundant life stage collected. The majority of AGM adults were recovered in the port of Vladivostok. Peak flight for AGM occurred from August 20th to September 9th for the three port areas. Peak flight for Nun moth occurred August 13th through September 2nd. Only a few adult rosy gypsy moths were collected in light traps. Approximately an eight week flight period was recorded for AGM and Nun moth. Adult flight began the week of July 25th and ended the week of September 24th.

INTRODUCTION

Exotic insect and disease pests may be introduced to new areas when they are transported along with items of trade and tourism. The United States Department of Agriculture (USDA) has the responsibility of protecting American forests and agriculture and its duties include preventing the introduction and subsequent establishment of exotic pests. These responsibilities are administered by two different agencies within the USDA. The Animal and Plant Health Inspection Service (APHIS) is responsible for preventing the introduction of foreign pests by regulating the entry of plant and animal material into the United States. The Forest Service (FS) is responsible for the protection of forests from the adverse effects of introduced insects and disease. Combined, both agencies serve as the USDA's primary source of technical and operational expertise on the risk associated with exotic pests introductions to the forests and agriculture of the United States.

Key elements of an exclusion program to prevent the introduction and establishment of exotic pests are: knowledge of potential pests in a trading partner country; understanding pest biology and behavior; contacts with colleagues in the native country; and cooperative programs.

Trade between the United States and Russia, already significant, is expected to increase substantially. Since the climate, forest types and forest pests are similar in the two countries, Russia is a potential source of serious forest pest introductions to North America. This has been documented in the pest risk analysis on the proposed importation of logs from Siberia (USDA 1991).

Recognizing the risk associated with introduced insects, the FS and APHIS have established a cooperative project with their respective Russian counterparts, the Federal Forest Service of Russia and the State Plant Quarantine Service of Russia. The primary focus of this cooperative program is to address the risk of introducing Asian gypsy moth (AGM), *Lymantria dispar* (L.), and other *Lymantriid* species *L. monacha* (L.) and *L. mathura* Moore, into North America. This cooperative effort includes the development of a database on these Russian forest Lymantriids and to establish contacts to exchange information and develop cooperative projects in research and pest management operations. The project is expected to mutually enhance technology transfer programs between the two countries.

North American Introductions

The Asian gypsy moth is a separate race of gypsy moth which is distinguished by its host range and the female's flight capability from the race now established in North America. Males have been discovered multiple times in pheromone-baited traps in the United States. It was first observed in 1991 near the Port of Vancouver in British Columbia when egg masses and larvae were detected on Russian vessels. Subsequent pheromone trapping resulted in the recovery of more than 25 male gypsy moths from traps in Washington, Oregon, and British Columbia, which were identified as the Asian strain using mitochondrial DNA analysis. This introduction is attributed to direct trade between the Russia's Far East and North America. Ships infested with egg masses from ports in eastern Russia introduced the pest while visiting West Coast ports when larvae hatched from eggs and were blown ashore. The introduced AGM posed a major threat to forests and agriculture on the North American continent resulting in a multimillion dollar effort to eradicate the infestation.

In July of 1993 the second introduction was discovered in North Carolina when flying female gyspy moths were observed during the unloading of infested containers containing munitions from U.S. military bases in southern Germany. A three year, $9.45 million eradication project was planned to eradicate this new infestation. Prior to this incident, AGM was not known to occur in Europe. This illustrates the ever increasing ease at which pests can become distributed as international trade and movement continues to expand into new markets in eastern Europe and the former Soviet Union.

PEST INFORMATION

Asian Gypsy Moth (*Lymantria dispar*):

In many ways AGM, which is native to eastern Asia, is similar to the European strain of the gypsy moth (EGM) that occurs in the Northeastern United States. Like the EGM, it has one generation per year. Hatch occurs in the spring (April and May) coinciding with bud break of the preferred hosts; *Quercus* sp., *Larix* sp., *Betula* sp., and *Salix* sp. Larval feeding extends into late June or early July with the adult stage active from late July-September. The males are attracted to the same (+)- disparlure as the male EGM. Egg masses are laid in a single mass of 100-1,000 eggs on foliage, tree boles and forest debris. The number of eggs per mass varies according to population density. Russia's Far East AGM egg masses contain fewer eggs than East-European populations of EGM (Turova, 1992).

There are several differences between AGM and EGM:

1. Although host preferences are quite similar, AGM is better able to utilize a wider variety of hosts that includes larch and some coniferous species.

2. AGM females are strong fliers, while the EGM females are flightless. After mating occurs the female may be capable of flying up to 20 miles before depositing eggs.

3. Similar to North American gypsy moth, AGM adult moths are active during the day. However, AGM adults are also active at night and strongly attracted to lights. Egg masses are often found considerable distances from forested areas deposited on well lighted sources such as light poles, buildings and ships because of their night activity.

4. There are four color phases that can be found in the AGM larval stage: yellow, sorrel (reddish-brown), grey and black. The black phase is rare, yellow can be found in some strains while red often appears prior to an outbreak in deciduous forests (Turova, 1992). The EGM larval color phase remains the same regardless of population densities.

Outbreaks of AGM occur at intervals of 6-10 years in Russia's Far East where suppression efforts are seldom used to reduce populations. If suppression tactics are implemented a Russian *Bacillus thuringiensis* (Bt) product is often used in treatment programs. Aerial or ground applications of diflubenzuron or NPV may also be alternatives for controlling AGM populations.

AGM populations are generally controlled by a naturally occurring virus (NPV) and a fungus, *Entomophages*. The most effective parasites in a study conducted by Turova (1992) were found to be *Anastatus japonicus* on the egg stage and *Blepharipa schineri* and *Parasetigena silvestris* on larvae and pupae.

Rosy or Pink Gypsy Moth (*Lymantria mathura*):

The rosy gypsy moth (RGM) is a hardwood and orchard defoliator native to India, China, Japan and the Far East of Russia (Ferguson 1978). The life cycle is similar to *L. dispar* with hatch occurring in the spring, larvae feeding in late spring-early summer, adult flight and mating in mid-late summer. Male and female adults are strong fliers, active at night and attracted to lights. The males are not strongly attracted to (+)- disparlure and population monitoring schemes using pheromone traps have yet to be developed. The females deposit eggs in small multiple masses that are well hidden under bark fissures or in crevices on other objects making them difficult to detect.

Outbreaks of RGM have been reported from Japan, India and the Russian Far East. The outbreak cycle of RGM often coincides with AGM. Outbreak cycles, impacts, natural controls, and management strategies are not well documented in the literature.

Nun Moth (*Lymantria monacha*):

The nun moth is native to Europe, China, Japan, Korea, Tibet, Turkey and the Russian Far East. Preferred hosts belong to the genera *Picea, Abies, Pinus, Larix, and Fagus* (Grijpma 1988). The species has a single generation each year with egg hatch beginning in the spring. Egg hatch coincides with bud break in the preferred hosts. Early instar larvae feed on the newly developing shoots while late instars feed on mature foliage. Larval feeding extends into early summer. Adult flight and mating occur in late summer. Both male and female adults are good fliers, active at night and attracted to lights. Females lay naked egg clusters (70-300 eggs) in crevices and behind bark scales of conifers, primarily on the lower 3.65 m (12 feet) of the bole. Although the males are attracted to (+)- disparlure, thus pheromone monitoring methodology is available (Hanse 1983), they are more strongly attracted to a mixture of the (-) and (+) isomers according to Vic Mastro.

Outbreaks of the Nun moth have been widely reported from across it's range. In Denmark the outbreaks usually occur in stands on poor soils and may be initiated by 3-4 years of high summer temperatures, and low summer rainfall, preceded by low spring temperatures (Bejer, 85). Natural controls include parasites, predators and NPV. Management strategies include insecticides such as; endosulfane, fenitrothion, lindane, diflubenzuron, and Bt (Bejer, 86).

OBJECTIVES

1) Develop and implement a system to assess and reduce the risk of Lymantriid introduction into North

America.

2) Monitor *Lymantria dispar, L. monacha* and *L. mathura* population levels in and around Russian Far Eastern ports with ships trading in North America.

3) Determine when ships are at risk of infestation.

4) Utilize survey information to trigger mitigation measures when unacceptable levels of risk are reached (i.e., increased ship inspection, revision of exclusion guidelines, and reduced port lighting).

5) Construct a database that can be used to determine when control measures are needed to suppress populations in and around ports.

6) Open lines of technology and information transfer regarding pest risk assessment and control. Compile a database for AGM and other Lymantriid species that includes information on life cycles, host ranges, geographic distribution, outbreak cycles, natural enemies, and management practices.

METHODS

FOREST AREA MONITORING

Responsibility: The Federal Forest Service of Russia has the responsibility to implement monitoring procedures for AGM in the forest areas surrounding Vladivostok, Nakhodka, and Vostochny.

Adult Monitoring -Two monitoring zones were established around each of the three port areas listed above.

Zone 1 -- adult male populations were monitored using gypsy moth pheromone baited traps (milk carton type) in a five kilometer radius around each port. In forested sites, traps were placed along designated trapping routes (trap lines) five kilometers in length at 800 meter intervals. Distance between trap lines was two kilometers. The installation of trap lines was confined to forest paths, cuttings, roads, existing fire lines and fire prevention strips.

Zone 2 -- Adult populations were monitored using gypsy moth pheromone baited traps (milk carton type) in a 15 kilometer radius surrounding Zone 1. Procedures to place traps were similar to those described for Zone 1, except distance between trap lines was six kilometers rather than the two kilometer spacing used to place traps in Zone 1. Along the trap lines, pheromone traps were placed at 800 meter intervals.

Within Zones 1 and 2, all accessible traps were checked twice each week during the flight period to record number of AGM adults trapped between each visit. Traps deployed in less accessible locations were checked once every two weeks to record the same information. The number and species of other Lymantriids caught within the pheromone traps were also identified and counted each time pheromone traps were checked.

One light trap site was established in each of the three forested areas surrounding each port. Light traps were installed and monitored one week before expected adult flight for any of the following three species: *L. dispar*, *L. monacha* and *L. mathura*. Each light trap was serviced daily during the adult flight period to record species, number and sex of adult moths caught.

Larva, Pupae and Egg Mass Monitoring

One to four permanent plots were established within the forested area surrounding each port in 1993. Permanent plots were approximately one hectare in size in which 30 host trees greater than 12.7 centimeters in diameter were banded using either burlap, plastic or canvas. Banded trees were inspected twice each week to record larval and pupal stages of the three Lymantriid species mentioned previously. Some life stages of each species found were collected and reared in the laboratory to document the presence/absence of parasites and pathogens.

Egg mass surveys were conducted using fixed and variable radius plots in areas where trap catches exceed 50 or more moths per trap. A fixed-radius plot of 2.52 meters (0.002 ha) was established at these sites where a complete inspection of all substrate (rocks, woody debris, etc.) and understory was conducted. A variable-radius plot (20 BAF) was established using the same plot center to select overstory trees. Trees that were within the 20 BAF plot area were inspected for egg masses. A complete inspection of the tree's bole and leaf surface was used to determine egg mass numbers.

PORT AREA MONITORING

Responsibility - State Plant Quarantine Service of Russia was responsible for monitoring activities conducted in the three primary (Level 1) port areas identified previously and an additional three secondary (Level 2) ports; Vanino, Olga and Petropavlovsk.

Level 1 - Port Monitoring in Vladivostok, Nakhodka, and Vostochny (Level 1 ports have ship traffic that originates within the port with destination points in North America).

Adult Monitoring

Five ultraviolet light traps were placed at each of the three Level 1 ports. Traps were placed to maximize coverage of each port, preferably in areas where other artificial lights did not interfere with the light source used for each trap. Wherever possible, traps were elevated and placed between the first line of port structures and the adjoining forest. Light traps were also placed in areas where previous egg laying activity had occurred. The light traps were installed and monitored one week before expected adult flight of the three *Lymantriid* species. Each light trap was serviced daily during the adult flight to record species, number and sex of the adult moths caught.

A minimum of 20 milk carton pheromone traps were deployed within each of the three port areas. Traps were strategically placed to maximize coverage of the port area. Each pheromone trap was checked daily to record number and species of adult catches.

Egg Mass Monitoring

Up to ten, one meter square egg mass monitoring stations at each port were selected and cleaned to remove the accumulations of old egg masses. These one meter square areas were located on the sides of buildings, on light towers and other surfaces where abundant oviposition had occurred previously. Egg mass deposition sites were checked daily to record number and species of egg masses deposited. After recording this information, the egg masses were removed from the sampling surfaces. While these egg mass sampling sites were located throughout the port areas, several were located close to grain loading facilities due to the direct movement of grain ships between Russia and North America.

Level 2 - Port Monitoring in Olga, Vanino and Petropavlovsk (Ships originating in Level 2 ports primarily travel along the coast of Siberia and Asia, however, some ships may make intercontinental voyages). These ports are located in areas where Lymantriid populations are suspected to occur and a small monitoring program was initiated to document the presence/absence of the Lymantriid complex.

Adult Monitoring

Only milk carton pheromone traps were installed in the Level 2 port areas. In Olga and Petropavlovsk 10 pheromone traps were placed in the port and in Vanino a slightly larger port, 15 pheromone traps were deployed. All traps were strategically placed within the ports to maximize coverage. Each trap was checked daily to record number and species of adult moths captured.

Other Areas - Other known outbreaks of any of the three Lymantriid species within Russian were reported to the United States Animal and Plant Health Inspection Service. These reports included location of the infestation, species, and the number of hectares affected.

Data Analysis

The location of all pheromone traps and permanent plots were recorded on 1:50,000 scale maps. All information collected within and around Level 1 ports was sent to the State Plant Quarantine Service office in Vladivostok on a weekly basis. Level 2 ports reported trap results once every two weeks to Vladivostok. Data were summarized by Plant Quarantine staff and submitted by electronic facsimile (fax) to the United States Animal and Plant Health Inspection Service. Trap data was digitized and entered into a Geographic Information System (GIS) in the United States. Pheromone and light trap data was summarized in tabular and graphic format for reporting purposes.

A risk assessment was conducted for each port using the life stage information collected in both port and forested areas. This information was used to modify (improve) the monitoring efforts for the Lymantriid complex. The data will also be used to determine treatment thresholds for suppression efforts, and to make modifications or adjustments in APHIS's vessel exclusion policy.

RESULTS & DISCUSSION

Due to the problem with trap theft in the urban sites during 1993, no traps will be deployed in the urban areas in subsequent surveys. Zone 1 will begin where the urban area ends and the forest boundary begins to minimize trap losses.

Asian Gypsy Moth - According to the Plant Quarantine Inspection Service of Russia the 1992 AGM flight in the port areas of Vladivostok, Nakhodka and Vostochny began the week of July 15th. Flight initiation was determined using Delta type pheromone traps baited with (+)- disparlure in the level 1 port areas. In 1993, milk carton pheromone traps were used and placed in level 1 ports during the week of July 10th. In forested sites, traps were not deployed until the week of July 17th because of problems associated with shipping the traps from the United States.

In 1993, the flight period began 10 days later than in 1992 with the first AGM adult males caught the week of July 25th in the forested areas. In level 1 ports, traps began to collect adult males July 30th. Peak flight occurred from August 20th to September 2nd in level 1 ports. (Figure 1). In level 2 ports AGM was collected only in Olga where male moth flight began the week of August 13th and ended the week of September 17th. Peak flight for AGM in Vladivostok and Nakhodka occurred during a two week period beginning August 20th and ending September 2nd (Figures 2 and 3). However in Vostochny, peak flight did not occur until the week of August 27 and continued through September 9th before declining (Figure 4). The duration of male moth flight was approximately eight weeks in all level 1 ports. Male moth flight ended between September 25-27 for all ports. The majority of male moths were caught in Vladivostok where 3,038 males were recovered in pheromone and light traps. The fewest number of males were caught in Vostochny (330).

The two light traps installed in Vladivostok forested areas captured 55 male and 4 female Asian gypsy moth's. Only one AGM male was collected the week of July 29th in Vladivostok, with moth flight increasing significantly the week of August 6th (Figure 5). In the Vostochny light trap, 25 male and 2 female AGM's were collected.

Egg mass surveys were conducted from September 25 to October 25 on 428 fixed and variable radius plots. Within the variable radius plots, 2,507 overstory trees were sampled. No egg masses were found in either the fixed or variable radius plots.

Within the seven permanent plots, only nine larvae of AGM were recorded. Seven of these were found in the four permanent plots installed near Vladivostok. The other two larvae were observed in the plots installed near Nakhodka. All larvae were collected and reared in the Laboratory of Forest Protection in Khabarovsk. Three of the larvae were parasitized by *Blepharipa* sp. In and near the permanent plots, three to ten milk carton traps were installed. The average catch per trap was: Vladivostok - 16, Nakhodka - 23 and Vostochny - 6.

Nun Moth - The flight period began the week of July 29th in the port of Vladivostok (Figure 2). The first male moth was captured in Vostochny the week of August 8th (Figure 4) and in Nakhodka the week of August 18th (Figure 3). Peak flight for Nun moth occurred August 13th to September 2nd (Figure 6) with 793 males collected in Level 1 port areas. Most of the adults collected during this period were found in the port of Vladivostok (611). The light trap near Vladivostok captured 61 moths (49 males and 12 females), but in Vostochny only 2 males were caught. No egg masses nor larvae of the Nun moth were found during the egg mass survey or within the permanent plots. A few nun moths were caught in milk carton pheromone traps installed in and near the permanent plots, the average catch per trap was: Vladivostok - 8, Nakhodka - 0, and Vostochny - 2.

Rosy Gypsy Moth - Since the pink gypsy moth doesn't respond to (+)- disparlure, no adult moths were captured in any of the pheromone traps. Of the two light traps installed near Vladivostok and Nakhodka, the Vladivostok trap caught 50 male and 10 female rosy gypsy moth adults (Figure 8). No adult moths were caught in the Nakhodka light trap. Only two larvae were found in the Vladivostok permanent plots. No egg masses were observed in either the egg mass survey or within the permanent plots.

CONCLUSIONS

Although no suppression efforts will be needed in 1994, the Lymantriid monitoring program will be continued until AGM populations reach outbreak status. This will permit an assessment of the monitoring strategies to determine if any of these techniques are able to predict population increases. Monitoring information will be used to develop a database for determining when suppression tactics and other risk reduction procedures are necessary to prevent or reduce on-ship infestations.

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The authors would like to thank their Russian colleagues for their expertise in the development and installation of monitoring strategies, data collection and summary, and written field reports. From the Federal Forest Service of Russia - Andrey Raspopov, Alexy Popov, Dr. Valeri Golovanov, and Dr. Michail Kascheev; Moscow Forest Protection - Dr. Vasili Tuzov, Dr. Tatiana Pechenina, and Dr. Sasha Baburina; Far Eastern Forest Scientific Research Institute (Laboratory of Forest Protection) - Dr. Galina Yurchenko, Dr. Galina Turova, Dr. Dimitri Chelishev, Dr. Marina Moiseenko, and Dr. Tatiana Manokvasova. From State Plant Quarantine Inspection Service of Russia, Primorski Region - Dr. Tamara Freiman; All-Russian Research Plant Quarantine Institute (Forest Quarantine Laboratory) - Dr. Andrey Orlinski, Dr. Andrey Shamaev and Dr. Sergey Muhanov. We would also like to thank our American colleagues who have worked with us to initiate the monitoring program: Dr. Dan Kucera and Dr. Nancy Lorimer, USDA Forest Service and Ms. Jane Levy, USDA Animal, Plant, Health Inspection Service.

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Figure 1. Pheromone traps - L. dispar ports Vladivostok, Nakhodka, Vostochny

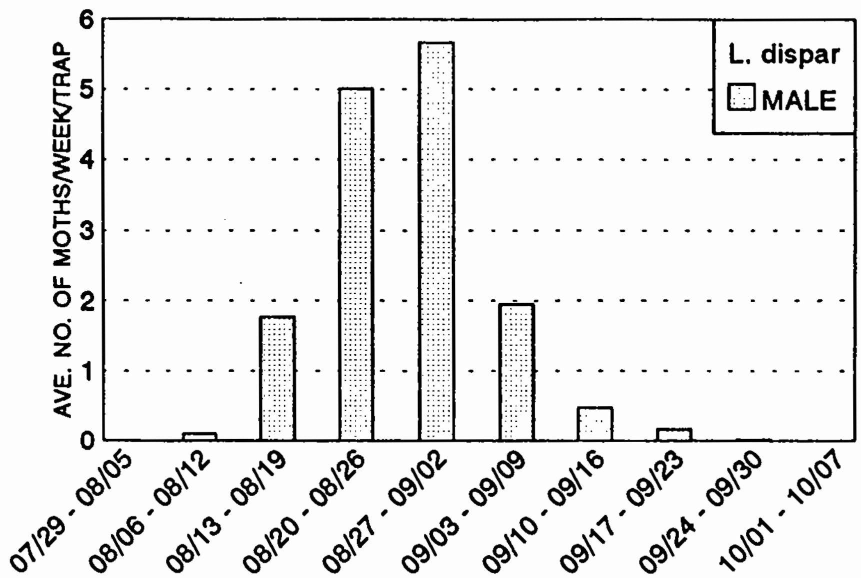
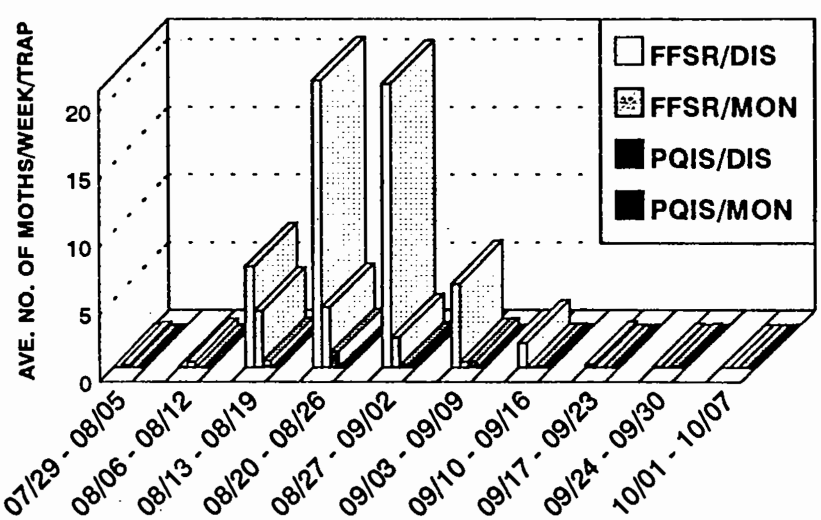
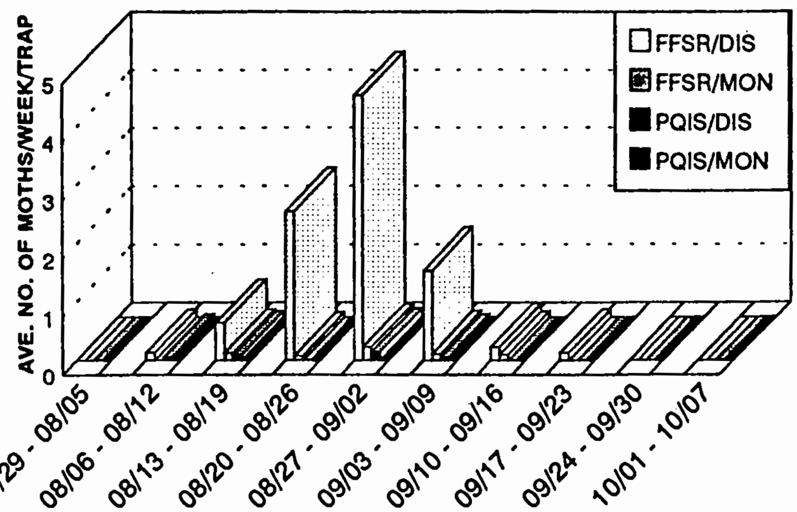


Figure 2. Male moth flight periodicity for L.dispar & L.monacha port of Vladivostok - 1993



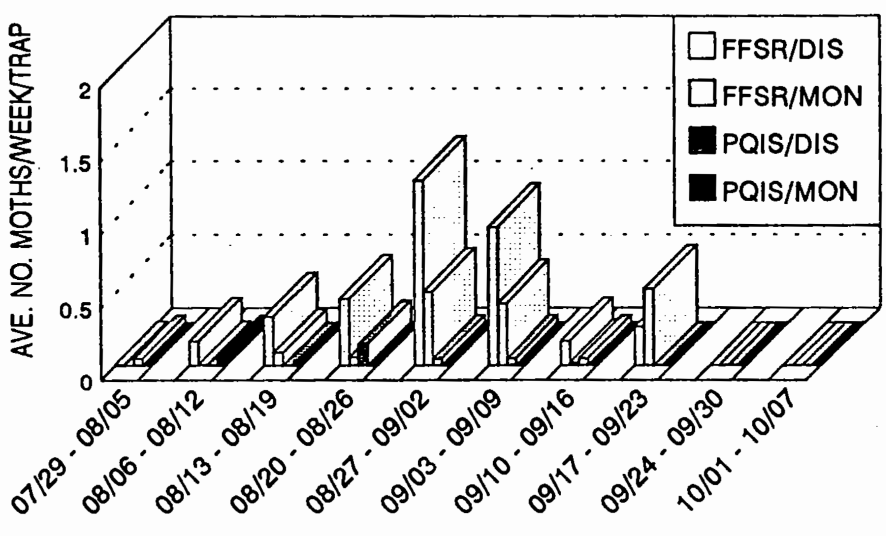
FFSR = Federal Forest Service of Russia, DIS = L. dispar
PQIS = Plant Quarantine Inspection Service, MON = L.monacha

Figure 3. Male moth flight periodicity for L.dispar & L.monacha port of Nakhodka - 1993



FFSR = Federal Forest Service of Russia, DIS = L. dispar
PQIS = Plant Quarantine Inspection Service, MON = L. monacha

Figure 4. Male moth flight periodicity for L.dispar & L.monacha port of Vostochny - 1993



FFSR = Federal Forest Service of Russia, DIS = L. dispar
PQIS = Plant Quarantine Inspection Service, MON = L. monacha

Figure 5. 1993 Light traps - L. dispar
Ports of Vladivostok, Nakhodka and Vostochny

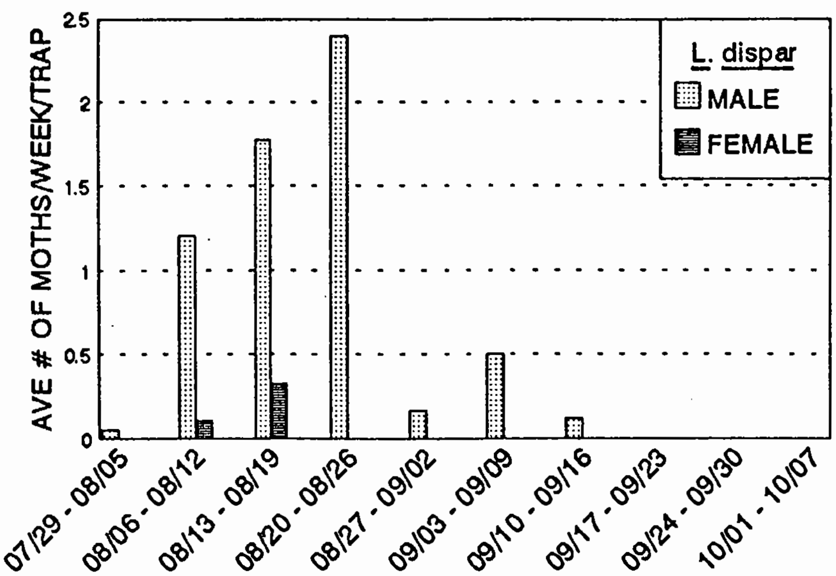


Figure 6. Pheromone traps - L. monacha
Ports of Vladivostok, Nakhodka and Vostochny

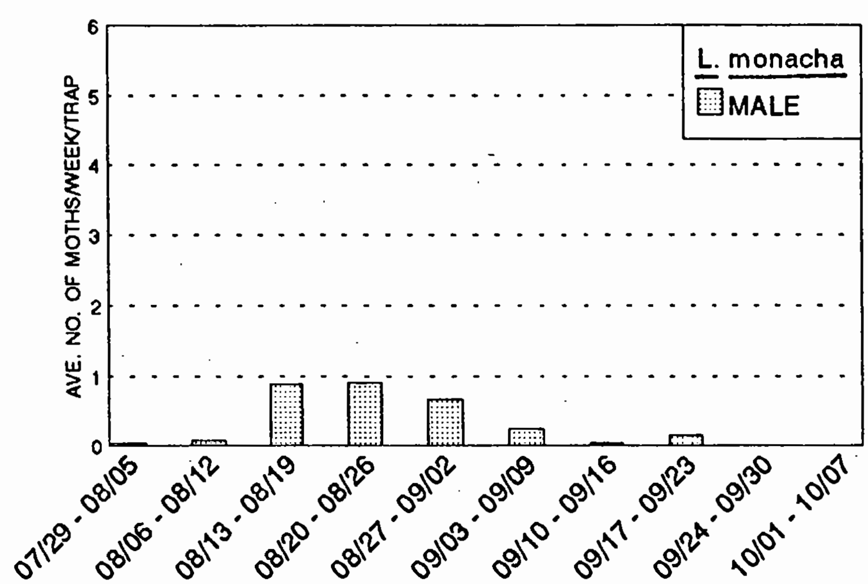


Figure 7. 1993 Light traps - L. monacha
Ports of Vladivostok, Nakhodka and Vostochny

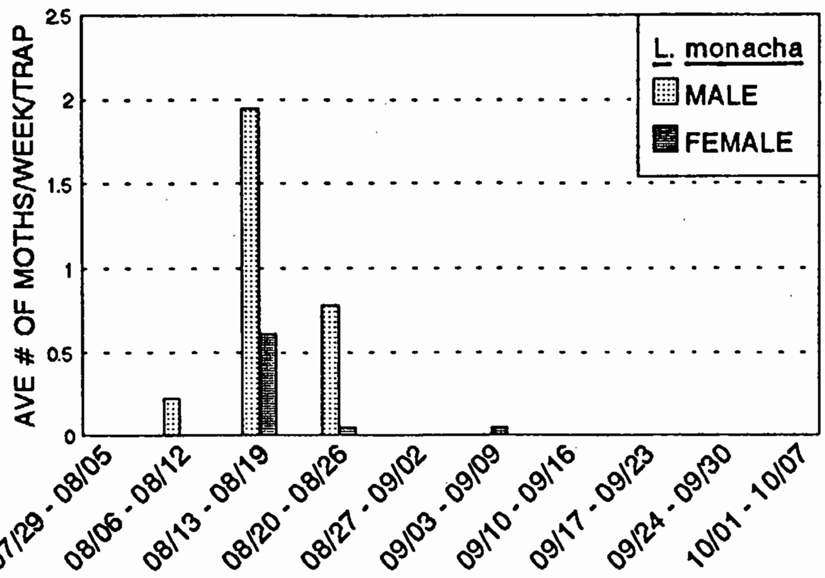
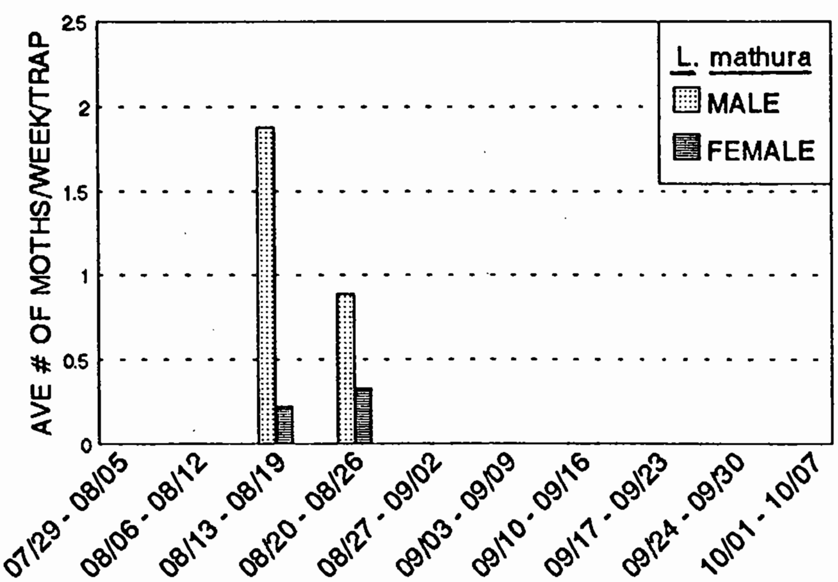


Figure 8. 1993 Light traps - L. mathura
Ports of Vladivostok, Nakhodka and Vostochny



ECOSYSTEM MANAGEMENT

Panel Moderator: Iral Ragenovich
USDA Forest Service, Portland

In the past couple years there has been a major shift in emphasis from managing on a stand basis for individual species or objective, to the context of managing at a landscape level while taking all of the parts and pieces of an ecosystem into consideration. The Chief of the Forest Service recently announced that in the future the US National Forests will be managed through ecosystem management.

The three speakers for this panel will be addressing:

1. Developing guidelines for assessing ecosystem needs, and how to integrate these with economic and social needs in the context of ecological principles,
2. Ecosystem management in the context of land-use management and examining the issue of information management, and
3. Application of ecosystem management from the perspective of a private land manager.

An Ecological Basis for Ecosystem Management.

Dr. Merrill Kaufmann, Principal Plant Pathologist, USDA Forest Service, Rocky Mountain Forest and Range Experiment Station

An Ecosystem Management Study Team was established by the Southwestern Region and the Rocky Mountain Station to examine concepts for ecosystem management. The Study Team developed a General Technical Report (in press) that will be available in late June, 1994.

The Study Team's document focuses on guiding principles clearly founded upon the principles of conservation biology, and relates the application of these principles to the human dimension. Economic and social needs of humans often lie outside ecosystem capabilities and may need adjustment to improve the likelihood of ecosystem sustainability.

We address ecosystem needs by outlining an ecosystem needs assessment. This assessment involves a step-by-step analysis of existing and reference conditions and coarse- and fine-filter analyses to determine ecosystem needs, all done in the context of applying the guiding principles at appropriate spatial and temporal scales. The identified ecosystem needs are integrated with economic and social needs in a decision space in which the ecological principles can be used as a primary filter for evaluating how alternative decisions support or fail to support ecosystem sustainability.

We also discuss adaptive management and note that management decisions must result in a form of implementation that is testable in some sense, to help determine whether or not an action produces results consistent with the guiding principles. This process helps identify key monitoring requirements for evaluating ecosystem management practices.

Ref: Kaufmann, M. R., R. T. Graham, D. A. Boyce, Jr., W. H. Moir, L. Perry, R. T. Reynolds, R. L. Bassett, P. Mehlhop, C. B. Edminster, W. M. Block, and P. S. Corn. 1994. An ecological basis for ecosystem management. USDA Forest Service Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

General Technical Report RM-000 (in press).

Ecosystem Management in an Information Society

Dr. Robert Coulson, Professor, Knowledge Engineering Laboratory, Department of Entomology, Texas A & M University and **Hannu Saarenmaa**, Finnish Forest Research Institute, Helsinki, Finland

The objectives of the presentation were (i) to consider the concept of ecosystem management within the context of basic ecological science, (ii) discuss the concept within the broader context of land-use management and environmental management, and (iii) examine the critical issue of information management.

Ecosystem Management and Ecology. Part of the confusion about the concept of ecosystem management centers on the vague definitions applied to the term ecosystem. For example, a common perception is that an ecosystem is an environment around an organism of interest, e.g., the forest ecosystem, an apple orchard ecosystem. Basic ecology textbooks define ecosystem to be the biotic community plus the abiotic environment We suggest that a functional definition of ecosystem management should include consideration of basic processes associated with all ecosystems: primary production, consumption, decomposition, and abiotic storage. Traditionally, ecosystem functionality has been examined or characterized through studies of nutrient cycling and energy flows. As a working definition of ecosystem management, we propose the following: orchestrated modification or manipulation of primary production, composition, decomposition or abiotic storage.

Ecosystem Management and Landscape Ecology. The emerging discipline of landscape ecology is beginning to address how knowledge of landscape structure, function, and change can be applied in land-use and environmental management. We suggest that when the discussion of ecosystem management moves from philosophy to practice, the landscape (a cluster of interacting ecosystems (ecotopes), will be unit of focus. Landscape management can be considered as the orchastrated modification and manipulation of landscape, structure, function, and rate of change.

Information Management. Regardless of the specific issue in land-use management, the current information base is too large and complex to be effectively or efficiently dealt with using conventional tools. Computer based tools to order, organize, integrate, interpret, and deploy the information base are essential.

Ecosystem Management/Forest Health: An Industrial Forestland Perspective

Dr. Will Littke, Project Leader Forest Pest Management Research, Weyerhaeuser Company

The objective of this presentation is to provide insight into the role and responsibility of private forestland ownership in development, implementation and monitoring of ecosystem management. It would be impossible to describe such a management perspective outside of the realm of other forestland ownership's and management styles, however, private timberlands have unique roles and responsibilities which are distinct from public forests. And any proposals which coordinate activities across landscapes must comply with existing antitrust laws.

Weyerhaeuser, as a corporate entity, has direct responsibility and stewardship over some 6 million acres in the U.S. and lease of 3 million acres in Canada. On this land we have obligated ourselves to follow environmental stewardship goals. These are: 1) Continuous improvement as environmental stewards and of economic value of the forests we manage; 2) Actively listen and act on public expectations; 3) Communicate consistently on our forest stewardship goals, practices, accomplishments.

This adaptive transformation in our forest management perspective has occurred as a result of key shifts in the interrelationships between stakeholders of forest resources (both public and private); essentially from positions of competition or adversarial to that of cooperation and sharing of common goals.

The 1987 Timber, Fish and Wildlife Agreement in Washington State, brought together regulatory agencies, tribes, industry and environmental groups to bring consensus and framework to management of forests and other resources. The framework of this agreement has paved the way for discussion to further define the role private forestland should play in the context of ecosystem management. Next, the Pack Forest Principles clarify the role private forestland should play by establishing key building blocks for future cooperation. These building blocks include: voluntary commitments; regulatory responsibility; and responsibility of other land owners. Key roles for private forestry lands are jobs, protection of soils, protection of habitats and other resources, provide habitats, and cooperation at the landscape level.

Any discussion of forest management must include a statement on the health condition of current and future forests. This could be a key point of difference, depending on our individual definitions of forest health, our resource management objectives and the role our organizations play in society. Forest Health can be one of the measurement tools which we use to gauge past performances, or justify future operations as they relate to ecosystem management objectives. Five important elements that are part of the overall forest health definition are that forests are: 1)dynamic systems, 2) resilient if properly prepared for change, 3) defined by site specific objectives and also in broader contexts, 4) measusrable systems from which to gauge actions and reactions, and 5) parts of broader landscape alliances of similar and dissimilar units and management styles

By establishing these elements and their relative importance, we begin to lay the framework of a monitoring and assessment process. The next challenge will be to implement this into more comprehensive planning processes with larger spatial scales. How can all this be combined into a blue-print of future forest management on private land? The best fit seems to be within the context of up and coming watershed analysis and habitat management planning processes. This approach will integrate the TFWA, Pack Forest Principles, and Forest Health into a single "ecosystem management" approach.

Watershed and habitat management planning processes are based on a multi-step resource management decision-making process. The effects of the WSA and HMP planning process is having profound current and future implications to how Weyerhaeuser conducts forestry operations on it's land, and it's relationship to adjacent ownerships. Weyerhaeuser's commitment to a new way of thinking and approach to the forest resource management decision making process has been borne-out by recent developments such as the Tolt Watershed Analysis. We view watershed analysis and habitat management planning as key initial steps to successfully integrate forest management on private lands into ecosystem management.

To this end we have made:
1. voluntary commitments to perform WSA's and HMP on Weyerhaeuser holdings
2. commitments to complete additional WSA's and HMP in the immediate future
3. commitments to communicate internally and externally to share ideas and results

In summary, the Pack Forest Principles state in defining the responsibility of private forest to society that: "private forest landowners recognize and accept significant ecological responsibilities in return for regulatory stability and an acceptance of the basic economic principles that are necessary to maintain productive working forests".

FUTURE NEEDS FOR SEED, CONE, AND REGENERATION WORK UNDER ECOSYSTEM MANAGEMENT

Workshop Moderator: Chris Niwa
USFS,

Participants: About 25

Nancy Campbell and Sandy Kegley described the role of whitebark pine in upper elevation ecosystems throughout much of the West. Whitebark pine contributes to watershed and recreational values, and cones provide food for wildlife. Clark's nutcrackers are the main agents of seed dispersal, squirrels cache cones, and grizzly bears often raid caches, utilizing whitebark cones as a major food source in the important fall months. Mortality caused by spill-over populations of mountain pine beetle from lower elevations and white pine blister rust have caused a decline in the distribution of whitebark pine. A study will be initiated this year to determine which cone and seed insects are present and their relative impacts on whitebark pine cone and seed production. Steve Hagland, Scott Cameron, and Jaime Flores discussed management of pinyon pine for nut production. The BIA has initiated a study of silvicultural treatments for pinyon pine management; and a cooperative study with the RMS to determine the feasibility of pinyon pine seed orchards. They found that areas in which leave trees were picked solely on the abundance of their cone crop produced more seeds than basal area cuts where trees were picked using traditional growth and form characteristics.

Since 1985, there have been 5 pinyon pine symposia in Mexico, mainly concentrating on ecology and protection. In most years 70-80% of the nut crop is destroyed by insects. The 4 most abundant pests are *Leptoglossus occidentalis*, *Conophthorus cembroides*, *Retinia arizonensis*, and *C. terminalis*. At this time, research is directed at transforming selected natural stands into seed production areas and the development of management plans which protect the existing crop.

Paul Hennon reported on the reduction in the range of Alaska yellow cedar due to harvesting, a decline (cause unknown), and non-regeneration on some harvested sites. He is presently conducting cone enhancement, seed germination, and seedling establishment studies. The shoot blight fungus, *Apostrasseria*, kills terminal and side shoots, this stunts seedlings and appears to put them at a competitive disadvantage with other vegetation.

Roger Sandquist showed a video describing the NW native species program in R-6. It is providing a diverse range of seedlings for watershed restoration, wildlife forage, and erosion control (eg. red alder, cottonwood, bitterbrush, ceanothus, manzanita, big leaf maple, willows, and grasses). There are likely to be new pest problems accompanying the culturing of these species. A recent example is the cottonwood willow borer in willow. Although lindane is effective for this insect, managers chose to use nematodes targeted against larval and pupal stages.

EXPERIMENTAL APPROACHES TO INVESTIGATING THE ROLES OF INSECTS AND DISEASES IN FOREST ECOSYSTEMS

Workshop Moderators: Karen Clancy and Detlev Vogler
USFS, Flagstaff, AZ and University of California, Berkeley, CA

Presenters: James Byler, Robert Coulson, Thomas Kolb, Richard Smith, Detlev Vogler, and Michael Wagner

Approximately 50 people participated in this workshop. Mike Wagner got the ball rolling by talking about the key roles that insects and diseases play in forest ecosystems, focusing on disturbance, succession, and nutrient cycling. Tom Kolb followed with a discussion on ecophysiological approaches to assessing impacts of insect herbivores in forest ecosystems. Tom's comments centered on establishing mechanistic linkages between herbivory and physiological responses of the vegetation remaining after defoliation. Jim Byler spoke next about the ecosystem manager's/plant pathologist's perspective on what we want and need from research into fungi and other forest microorganisms. Then Dick Smith gave the Washington DC perspective on what we want and need from research into forest microorganisms, emphasizing the potential threat that introduced insects and diseases present to our forest ecosystems. Det Vogler talked about how molecular approaches to phylogeny and population genetics of fungi may provide a perspective on the relationships of these fungi across continents (i.e., how the molecular scale may illuminate the global scale). Finally, Bob Coulson spoke briefly about landscape level issues, or how to define ecosystems and management units.

A lively discussion followed. Some of the topics covered included the following:

- What is an ecotone versus an ecotype?
- How do we organize information for decision making, for example in Geographical Information Systems? Do we have enough information about forest ecosystems and we just need to organize and use it, or do we still need more information?
- How do we define units in ecological systems?
- How do we manage fragmented ecotypes; should we use principles from the theory of island biogeography?
- How do we discern the patterns of activities of insects and diseases in time and space so that we can make predictions of the effects that they will have on succession and other ecological processes? This effort involves some aspects of risk ratings. In order to predict future landscape patterns we must understand the functions that insects and diseases have in forest ecosystems and how they interact with other ecosystem components.
- An ecophysiological approach is necessary to develop this understanding; entomologists and pathologists need to work more closely with ecophysiologists.
- Below-ground processes are very important, and may be the key missing piece to understanding the roles of insects and diseases in forest ecosystems.

INCORPORATING FOREST HEALTH INTO ECOSYSTEM MANAGEMENT

Workshop Moderator: Joan McAndrew
USDA Forest Service, Washington, DC

Presenters: Richard S. Smith, Cathy Dahms, R. Ladd Livingston, Thomas H. Nicholls.

The theme of this workshop was to show from several different perspectives how ecosystem management is changing perceptions of forest health and approaches to managing for it. Four speakers presented their views on some of the challenges that ecosystem management must address.

Exotic pests

Dick Smith noted that exotic pests pose a particularly serious threat to ecosystem management goals for sustaining native ecosystems and their biodiversity. This threat challenges the perception that the practice of ecosystem management will greatly reduce the impacts of forest pests and the need for pest management research and operations. We will not be able to reach or sustain a desired future condition of forest health unless we are successful in managing current and future exotic pest problems.

Forest health restoration

Cathy Dahms presented a slide series describing the Forest Health Restoration Initiative on National Forest System lands in the Southwestern Region. Under the theme "Our Choice to Make", this initiative encourages cooperative planning by managers, researchers, and the community to respond to rapidly changing conditions in southwestern timberland, woodland, and chapparal ecosystems that have resulted in a continuing decline in forest health.

Financial returns

Ladd Livingston explained Idaho's constitutional mandate that the lands received from the federal government at the time of statehood must be managed to secure maximum long term financial return for school systems and other state institutions. This mandate gives emphasis to both a healthy income and to maintenance of the land itself, with extra consideration to "long-term" management. Idaho, therefore, is evaluating ecosystem management to determine what elements will help meet those objectives.

A more holistic view of forest health

Tom Nicholls' presentation, "From Board Feet to Bird Feet: The Meaning of Forest Health", emphasized the need for a more holistic view of forest health under ecosystem management, one that looks at more than just tree health and considers the beneficial as well as the negative effects of forest insects and diseases, especially with regard to wildlife and biodiversity. This holistic view of forest health challenges agencies and people of different disciplines to think and work together in new and diverse ways to ecologically manage forest and wildlife resources for multiple values.

Discussion with the audience followed the presentations. Topics included the extent to which efforts to control exotic pests can be justified ecologically and economically, and alternative approaches taken by Washington in applying ecosystem management on its state forestlands, which are managed under a constitutional mandate similar to that in Idaho.

ECOSYSTEM MANAGEMENT CASE STUDIES

Workshop Moderator: Liz Blake
NEPA Coordinator, Long Valley Ranger District, Coconino National Forest (R3)

Participants: Approximately 30 people

Forest health aspects of ecosystem management in Southwestern Idaho.

Jim Hoffman (Plant Pathologist) and **Ralph Thier** (Entomologist),FPM, Boise Field Office (R4)

Record-breaking levels of bark beetle and defoliating insect activity,coupled with high intensity, extensive fires on the Boise National Forest,Idaho, prompted forest managers to develop a strategy to define, restore,and improve the health of the forest ecosystem. Monitoring long- and short-term impacts of low precipitation on fire occurrence and insect outbreaks (frequency/intensity) became a key concern in considering the need to revise the Forest Plan.

Rx for Ecosystem Management.

Bill Armstrong (Forester) Espanola Ranger District, Santa FeNational Forest (R3) and **Dave Conklin** (Forest Pathologist) FPM, New MexicoZone (R3)

Recently projects were designed to improve forest/ecosystem health, whileproviding fuelwood, vigas, etc. for economically depressed communities innorthern New Mexico. Trees were thinned in dense timber stands and fire wasre-introduced into the forest ecosystem with resulted in controlling dwarf mistletoe infection in the project areas. The human dimension played animportant role in deciding how to meet the landscape needs while benefitingthe local communities.

Overview of some "Ecosystem Management" efforts in the South-CentralSierra Nevada of California.

John Wenz (Entomologist) FPM, South Sierra Shared Service Area, Stanislaus National Forest (R5)

Three projects in the Lake Tahoe and Sierra Nevada areas that reflect current ecosystem thinking and conduct of implementation were presented. During planning for these projects, strategies were developed for ecosystem sustainability that considered the needs and impacts of California spotted owl, recreation use, livestock grazing, past timber management, fire suppression, short- and long-term weather patterns, and insect and disease problems. Involvement of local residents and governments, and interest groups was emphasized as an important component of the planning process for these and future forest projects.

POSTERS

Moderator: Dave Conklin, USDA Forest Service, Albuquerque, New Mexico

Utah Cooperative Gypsy Moth Program

Forest Pest Management, Ogden Field Office Personnel

Gypsy moth was first discovered in 1988 in the Mount Olympus Cove area of Salt Lake City, Utah. Smaller infestations were found in Provo Canyon and east Bountiful. Infested areas were mountainous terrain covered mostly with Gambel oak, Quercus gambelii, and some maples, Acer spp. Canyon winds and mountainous terrain with many slopes greater than 70% make trapping and treatment some of the most difficult in the country. The program includes quarantine of infested areas, treatment with the biological insecticide Bacillus thuringensis, (B.t.), pheromone trapping, special projects, good cooperative working environment with numerous local, state, and federal agencies, and strong public information/education.

The first aerial treatment of gypsy moth in Utah was in 1989 on 1,190 acres. Over the next four years the acres treated were 20,064, 29,925, 15,718, and 5,100. In 1994, approximately ten acres are scheduled for ground treatment with three applications of B.t. The increase in trapping efforts from 237 mountain traps in 1989 to 4,210 in 1993 provided a better trap network for detecting gypsy moth population locations and sizes. Moth catches have decreased from 2,274 in 1989 to 5 in 1993.

Numerous special projects have been conducted in conjunction with the Utah Gypsy Moth Eradication Project from 1990 to 1993. These include: Environmental Fate of B.t. Spray Applied in Mountain Terrain; Detection, Quantification, and Persistence of B.t. in Mountain Soil; Penetration and Deposition of B.t. Spray in Maple Canopy; Release and Capture of Sterile Gypsy Moth in Mountain Terrain; Drift/Dispersion and Effect of B.t. in Mountainous Terrain on Non-target Lepidoptera; Effects of Temperature and Relative Humidity on Gypsy Moth Pupae; and Extensive Studies on the Distribution and Sensitivity to B.t. of Non-target Lepidoptera. For more information, contact John Anhold (801-476-9732) at the Ogden Field Office.

Cooperators of this Eradication Project include the Utah Department of Agriculture, USDA Forest Service (Forest Pest Management, Region 4; Wasatch-Cache National Forest; and Uinta National Forest), USDA Animal and Plant Health Inspection Service, Utah State University Extension Service, Utah Division of Lands and Forestry, Salt Lake City Forester, Utah Lepidoptera Society, and others.

Use of Invasive Treatments to Control Laminated Root Rot in Living Douglas-fir: Effects on Tree Growth and Survival

Harrington, C., USDA-Forest Service Pacific Northwest Research Station, 3625 93rd Ave. S.W., Olympia, WA 98512 and **W.G. Thies**, USDA Forest Service Pacific Northwest Research Station, 3200 Jefferson Way, Corvallis, Oregon 97331

We report on an experimental approach to control laminated root rot (*Phellinus weirii*) - injection of biocides or chemical fumigants into living trees -- and the effects of these biocides on subsequent growth of Douglas-fir trees. Fifteen trees were randomly assigned to each of nine treatments. Two fumigants chosen for treatment -- chloropicrin and methylisothiocyanate (MITC) -- were each applied at several dosages; while Vorlex (active ingredient -- MITC) was applied at one dosage.

During the 9-year study period the control treatment had 80% survival. The higher dosage chloropicrin treatments caused substantial mortality (< 30% survival). Some treatments increased survival, the lowest dosage chloropicrin treatment and all MITC treatments had 100% survival. All of the injection treatments killed some tissues around the injection sites. Death of the vascular cambium was more common than death of the cork cambium resulting in fluted lower boles. The lowest dosage chloropicrin and the 3 MITC treatments resulted in the least damage.

Height growth was greatest for untreated trees, however, growth in the lowest dosage chloropicrin and MITC treatments was not significantly less. Upper stem growth was greatest for the untreated trees and least for the high chloropicrin and Vorlex treatments. At the same dosage, chloropicrin and Vorlex had significantly greater negative effects on tree height and diameter growth than MITC.

MITC increased survival of infected trees, and at low dosages was effective in reducing infection levels without causing significant growth reductions; future trials with MITC are clearly warranted.

Suitability of Hosts for Asian and North American Populations of the Gypsy Moth

Michael E. Montgomery, USDA Forest Service, Northeastern Center for Forest Health Research Hamden, Connecticut 06514

The suitability of 46 host plants was compared for gypsy moth from Asia (Siberia, Russia), and North America (Massachusetts). The hosts tested included species native to Asia, Europe, and eastern and western North America. First instar gypsy moth larvae were used for the bioassay because this stage is most sensitive to host plant quality. Larvae were reared from hatch for 10 days. Data recorded were the initial and final weight of the larvae, survival, and percentage molted to the second instar. These tests were conducted in the USDA Forest Service Quarantine Laboratory at Ansonia, Connecticut.

The Russian larvae were larger at the end of the 10-day rearing period for 39 of the 40 species where both biotypes survived. The Russian larvae also developed faster with more larvae in the second instar at the end of the 10 days. The growth rate of the two populations were well correlated (r = 0.90) with the growth rate of the Asian being twice as large on average. The greatest differences occurred on *Pseudotsugae menziesii, Robinia pseudoacacia*, *Acer rubrum*, and *Prunus serotina*, hosts of intermediate suitability, where the growth of the Asian larvae was from 4.5 to 5.8 times greater.

In sum, Asian populations of gypsy moth can be expected to grow faster and survive better on most hosts than gypsy moth currently established in North America.

Effectiveness of Western Pine Beetle Semiochemical Baits Applied to Scorched Ponderosa Pines

R W. Thier, Forest Pest Mgt. Boise Field Office, Boise ID and **Steve Donnelly**, Council Ranger District, Payette National Forest, ID

Semiochemical attractants are used to attract western pine beetles (*Dendroctonus brevicomis* LeConte) and others to living trees planned for harvest. The technique is similar to the trap-tree or trap-crop approach where insects are contained and subsequently removed or treated. Following wildfire, beetles may attack scorched trees and resulting beetle populations can cause further tree mortality. Often trees are salvaged after wildfire to capture economic value and mitigate buildups of bark beetles. We attempted to expand the practical application of semiochemical baits to scorched trees by manipulating western pine beetles into scorched ponderosa pine trees to be salvaged following wildfire.

Plans for salvage of scorched trees followed the 1992 Windy Ridge Fire on the Payette National Forest, Idaho. Prior to beetle flight in 1993, we selected 24 scorched ponderosa pine sample trees in planned salvage removal areas. Selected trees were uninfested and at least 15" DBH. They were spaced at least 1 chain apart. We randomly selected 12 trees for bait treatment. We attached one bait to the tree's north side and another on the south side 6' above ground level. The remaining unbaited trees made up the experimental control.

In August, following beetle flight, we evaluated the treatment. We counted entry holes on two 6" by 6" panels of bark surface at DBH; one on the tree's east side and one on the west side. We applied a T-test to the counts of entry holes on the treated and untreated sample trees. Baited treatment trees sustained an average of 5 attacks on the sampled area compared to an average of 0.5 attacks on the sampled area on the unbaited controls. All the baited trees were attacked but only three of the unbaited controls were attacked. There were no significant differences between treated trees and control trees with respect to diameter, percent bole scorch or percent crown scorch.

Results of this test expand the application of western pine beetle baits to scorched ponderosa pines. When baited, scorched ponderosa pines will likely attract western pine beetles and can be used like trap-trees to manipulate beetles into trees planned for salvage.

Manipulating species as a strategy for mitigating effects of laminated root rot in regenerated coastal stands: study installation

Thies, W.G., USDA-Forest Service Pacific Northwest Research Station, 3200 Jefferson Way, Corvallis, OR, 97331

Laminated root rot is the most important natural disturbance agent in coastal Oregon forests. This disease causes both tree mortality and loss in growth resulting in openings in stands. Nearly all conifer species appear to be susceptible to some degree. The relative susceptibility of six commercial conifer species to laminated root rot is being tested in four geographically separated sites in the Oregon Coast Range. The tested species are douglas-fir, grand fir, western hemlock, noble fir, western white pine, and western redcedar. Each species is being tested by planting seedlings over both undisturbed inoculum and over reburied inoculum. Full expression of the disease in the tested species may require 15 years. Additionally, natural inoculum is being studied to determine its distribution and infectivity relative to its size and condition.

Western budworm history in a gis

G. A. Van Sickle, Nicola Parfett and D. Clarke, Pacific Forestry Centre, Canadian Forest Service, Natural Resources Canada, 506 West Burnside Road Victoria, B.C.V8Z 1M5

A cartographic history of western budworm defoliation from 1909 to 1993 in British Columbia was created within a geographic information system (GIS) by the Canadian Forest Service's Forest Insect and Disease Survey. Over 330 maps and records were input to a common spatial database using ARC/INFO on a workstation. Western budworm was visibly active during seven infestations over 55 (65%) of the 85 years.

Areas of defoliation are identified by frequency classes as a guide to future management. Of all known infested areas, slightly more than 40% occur in stands with a frequency of defoliation of 5-10%. About the same size of area had a 10-15% frequency of infestation. Possible relationships with ecological classification, forest cover, climatic conditions, etc. can be analyzed. More detailed maps for selected areas, year or years of infestation, and overlays can be created. In addition, a wide range of insect and disease distribution maps can be produced using more than 700 000 records within the FIDS Infobase for the Pacific and Yukon Region.

"MOTHRA": The moth that ate Southern Idaho

Julie Weatherby, Entomologist, Forest Pest Management, Boise, ID, **Tom Barbouletos**, Forester, Forest Pest Management, Boise, ID, **Brian Gardner**, Biological Technician, Forest Pest Management, Boise, ID, **Phil Mocettini**, Biological Technician, Forest Pest Management, Boise, ID

In 1992, Douglas-fir tussock moth (*Orgyia pseudotsugata* (McD.)) populations defoliated more than 400,000 acres of forests in Southern Idaho. This outbreak was not anticipated. The early warning system, which utilizes pheromone baited sticky traps to alert land managers to increasing populations, did not detect the impending outbreak. Impact plots were installed to document and monitor the effects of the defoliation upon the vegetation. Data from the impact plots revealed that more than 80 percent of the Douglas-fir and grand fir trees which were greater than 90 percent defoliated in 1991 died by the fall of 1993. In very heavily defoliated stands in the Douglas-fir habitat types of the Boise River Drainage stocking was reduced by 66 percent.

HOW TO PRODUCE VIDEOS ON A SHOESTRING (Without tripping over them)

Workshop Moderator: Drex Rhoades

Presenting the workshop by way of lecture and discussion, the moderator used overheads, slides, video vignettes and live camera demonstrations to teach methods of producing quality low-budget video and camera techniques. In addition, the moderator provided a backup system--supplying handouts that covered most of the lecture material in case the moderator fainted mid-sentence. About 10-15 people attended.

The driving idea behind the lecture was that quality video production doesn't have to cost you an arm and a leg, but only a few strands of hair and your ability to see long distance. The moderator attempted to persuade the audience to use his time-honored techniques to shoot their own footage for their next production.

The moderator divided the workshop material into two possible scenarios: (1) Hiring a professional to produce a videotape, and; (2) Insanely attempting to do it yourself. The bulk of the lecture orbited the latter.

Dealing with a video professional is akin to dealing with a used car salesman. It is entirely possible to haggle with a professional video producer if you know how to work one against another.

There are three places to find the hungry video producer: (1) Production Houses, both large and small, advertise in the "yellow pages." Examples are wedding videographers and commercial producers; (2) In-house Production facilities, within large companies, often have staff who operate their own businesses on the side. Examples are private defense contractors, news stations and universities; (3) Uncle Joe. He taped Buddy's wedding--now he's ready to move into the big time (Beware Uncle Joe).

If you're going to produce yourself, you should know there are three major elements to producing a video: Pre-Production: research, scripting and planning; Production: field shooting and interviewing; and Post-Production: mainly editing and graphics.

The moderator explained that the best area in which to save money is in the Pre-Production stage. Time spent in planning and scripting translates into more spare change. The second best way to save money is to tape the footage yourself--risky, when evaluating quality versus cost. The last place to save money is in the Post-Production stage. A professional editor can be a lifesaver when working with amateur video. This is no place to learn the ropes.

Although there was very little time left for working on video techniques, the moderator concluded the workshop with the main concepts behind correct composition and continuity.

TREE HAZARD COMMITTEE WORKSHOP SUMMARY

Workshop Moderator: John Pronos

PARTICIPANTS: Ralph Zentz, John Pronos, Alison Berry, Keith Sprengel

A Tree Hazard Committee was formed at the September, 1993, Western International Forest Disease Work Conference in Boise, Idaho. The need to increase and improve communication among those active in tree hazard management situations was identified. The intent of this Committee is to have workshops on tree hazards at future WIFDWC meetings.

There are many published guides in the West that describe how to identify tree defects and numerically rate the degree of hazard. However, establishing a uniform and consistent program that utilizes these guides, and documents the required information is often more difficult. The purpose of this workshop was to present examples of effective, functioning tree hazard management programs and the methods necessary to maintain data. Examples from both urban and forest situations were included.

RALPH ZENTZ, Assistant City Forester, Fort Collins, Colorado:

Fort Collins has a very thorough tree management plan that includes over 27,000 trees. Hazard tree identification and monitoring are part of that program. Other activities covered include planting, maintenance, preservation, ornamentals, public education, pest monitoring, and tree inventory. All stages of tree growth are included, beginning with the inspection of planting stock and the location where the trees will be planted.

Program documentation includes a computerized inventory system for all trees, plus forms for defective tree ratings, defective tree priority analysis, and tree failures. Trees that receive high ratings for defect and target are analyzed for possible corrective action. High use areas are inspected on an annual basis, but high risk individual trees may be visited more often.

JOHN PRONOS, Plant Pathologist, Forest Pest Management, Sonora, California:

The National Park Service, Western Region, which includes California, Nevada, Arizona, and Hawaii, recently adopted their 1993 Guidelines for Managing Hazardous Trees. This document is intended to standardize hazard tree procedures in 45 units scattered throughout the Western Region. Development of the guidelines began in 1987 because there was no uniform approach to hazard management and because of high costs due to property damage and litigation.

The 1993 Guidelines are very detailed and cover both tree inspection and treatment, with an overall goal to reduce accidents. Each unit Superintendent is responsible for implementing the program which requires preparing an annual work plan and identifying developed zones. The hazard plan is part of an overall unit vegetation management plan. Regular inspections are recommended on a 2-year cycle for major sites and 3-year cycle for roadside trees. A 7-point system is used for rating tree hazard. Requirements for individual tree tagging, mapping, and record keeping are determined by the actual hazard rating score. Standard forms for documenting tree inspections and failures are provided. Some of the larger National Parks maintain their inventories with dBase III programs, and utilize AUTOCAD software to produce site maps.

DR. ALISON BERRY, Department of Environmental Horticulture, University of California, Davis:

The California Tree Failure Report Program (CTFRP) began in 1987 and has been maintained since then by the Environmental Horticulture Department at UC-Davis. It was patterned after the efforts of Dr. Lee Paine (USDA Forest Service, Pacific Southwest Research Station), who collected tree failure data in the 1960's and 70's from many forested recreation areas of the West, primarily California. The CTFRP receives its data from over 400 cooperators, with strong representation from city and regional park management personnel and private tree companies located mainly in the San Francisco Bay Area counties.

The data form used by the CTFRP is very detailed and complete. Since the program focuses on ornamental and residential trees, it records data on conditions that are not normally collected for forest trees. Examples of such information include the maintenance history (type and quality of pruning) and soil/root conditions (irrigation history, type of ground cover at base of tree, etc.).

Information from more than 1300 failures is currently in the database, and typically over 200 reports are added each year. Monterey pine, Monterey cypress, and oaks make up the bulk of the reports, with branches accounting for the most frequent failures. Analysis of the data has produced interesting patterns of failures linking tree species, structural characteristics, site and stand relationships, and weather.

KEITH SPRENGEL, USDA Forest Service, Forest Pest Management, Portland, OR:

In 1992, Region 6 (Washington, and Oregon) FPM published its "Long-Range Planning for Developed Sites in the Pacific Northwest: The Context of Hazard Tree Management" as a guide to managing developed recreation sites. Most western Forest Service Regions do not have a standardized method to deal with hazard tree management and data. This manual covers all aspects of vegetation management in recreation sites, and includes direction on the types of data that should be collected for hazardous trees.

There are many existing databases in the Pacific Northwest that include information on hazard trees, but they are maintained at the National Forest

(also National Parks) or Ranger District level. It is not surprising that these databases are in a variety of computer and hard copy formats. Region 6 FPM is trying to establish a standardized system for hazard tree rating and monitoring, using PARADOX/WINDOWS software for data management. Spatial data (stem mapping) can be interfaced with tabular tree inventory and defect data to produce visual representations (site maps) of developed facilities.

WHAT'S NEW IN SEMIOCHEMICALS OF FOREST INSECTS

Workshop Moderator: Steve Seybold
USDA Forest Service, PSW Research Station, Albany, CA

Participants: Appoximately 30, including Dave Beckman, Dayle Bennett, Ron Billings, Karen Clancy, Jesus Cota, Gary Daterman, Jaime Flores, Ken Gibson, Rich Goyer, Ed Holsten, Staffan Lindgren, Ladd Livingston, Dan Miller, Judy Pasek, Bert Quisumbing, Iral Ragenovich, Nancy Rappaport, Dave Schultz, Pat Shea, Brian Strom, Skeeter Werner, Vicky Wesley, and Jill Wilson.

The moderator began with an introduction that emphasized his intent on having a discussion that addressed new developments in the semiochemical field from different geographic and ecological perspectives. In keeping with the overall meeting theme of ecosystem managment, he asked the attendees to consider how the biotic portions of forested landscapes are webbed together by information-bearing behavioral chemicals. In other words, how are semiochemicals involved in information transfer within and between trophic levels and how do they coordinate energy transfer between trophic levels occupied by autotrophic (producer) and heterotrophic (consumer) organisms?

Commercial and Regulatory Aspects of Semiochemicals

Staffan Lindgren (Phero Tech Inc., Delta, B.C.) and **Bert Quisumbing** (Hercon Environmental Co., Emigsville, PA)

Staffan gave an overview of the types of semiochemical-based products available commercially and distinguished between semiochemicals delivered from discrete release devices for trapping or tree-baiting verses those broadcast or otherwise released for disruption or antiaggregation. From a regulatory standpoint semiochemicals in the latter class are used with the intent to mitigate the effects of forest pests, hence face registration requirements. Phero Tech mainly markets semiochemicals in the former class and these are exempt from Environmental Protection Agency (EPA) regulations. Currently, semiochemicals in the latter utilization class deal principally with the management of lepidopterous pests and do need to be registered by the EPA. Hercon has several lepidopterous semiochemicals registered in this class. Phero Tech has no bark beetle antiaggregation products in the latter class registered for use with the EPA. Staffan and Bert also discussed the improving regulatory climate for semiochemicals at the EPA. Over the last three or four years, the EPA has been developing a white paper (position paper) that gives the basis for loosening or waiving the regulatory requirements for the development and useage of semiochemicals pertaining predominantly to Lepidoptera. Though they may apply, these developments have not emphasized bark beetle semiochemicals because EPA has a limited chemical and toxicological database for bark beetle semiochemicals.

EPA is gradually releasing the components of this white paper through announcements in the Federal Register. Following suggestions by the USDA Forest Service and the American Semiochemical Association, in January, 1994, EPA announced that pheromones in solid matrix dispensers could be tested on acreages not to exceed 250 acres at release rates not to exceed 150 grams/active ingredient/acre/year without an experimental use permit. This was an increase from a 10-acre exemption in place prior to the announcement. EPA defines solid matrix dispensers as readily seen materials placed by hand in the field such as rubber septa, trilaminate sheets, tapes, tags, wafers, microcapillary tubes or fibers, twist ties, or ropes. This does not include beads or Hercon's flakes.

Thus, the announcement is not a blanket relaxation of regulations. Bert and Staffan hinted that EPA may have other announcements to make in the future. Bert provided copies of the EPA Federal Registry announcement to the attendees and both Staffan and Bert provided literature on products currently available from their respective companies.

Staffan discussed the marginal nature of markets in the semiochemical field and underscored how crucial it is for companies to get exclusive licensing for new products coming out of university and government research labs in order to protect each company's potential market share. University licensing agents and government technology transfer officers differ in their flexibility in this process. Some universities tend to lump semiochemical companies in with the biotechnology industry, hence have more lucrative expectations. In these cases they charge large, up-front fees (e.g. $25,000 at the University of California) for an option on an undeveloped invention or idea. Dwindling resources at these institutions have forced them to sell their technology before they have a patent so they can pay for the patent process. This situation is difficult for small semiochemical companies and Staffan indicated that he thought that it would change as the agents involved learned to distinguish between the semiochemical and biotech industries.

The Interruptant Activity of 4-allylanisole

Brian Strom and Jane Hayes, USDA Forest Service Southern Forest Experiment Station, Pineville, LA

A compound called 4-allylanisole (also known as estragole or methyl-chavicol) produced by the host loblolly pine, *Pinus taeda*, repells the southern pine beetle, *Dendroctonus frontalis*, in an interaction between the first (producer) and second (herbivore) trophic levels. The activity of this compound was discovered through work on host selection behavior of *D. frontalis* and its preference for fungicide-treated trees. These trees had decreasing levels of 4-allylanisole in oleoresin coincident with increasing levels of bark beetle attack. Laboratory and field behavioral studies that compared 4-allylanisole to another *D. frontalis* interruptant, 66%-(-)-verbenone, indicated that 4-allylanisole equaled or exceeded verbenone in interruptant activity. Limited studies also indicated no apparent synergism between the two interruptants. Verbenone differs from 4-allylanisole in that the former appears to afford some sex specificity (towards male *D. frontalis*) in its interruptant activity, while 4-allylanisole affects both sexes equally. Aggregation of *Ips pini* (Wisconsin) and *Dendroctonus ponderosae* (Oregon) to pheromone baited traps was also interrupted by this new antiaggregant. These insects were successfully repelled in laboratory assays as well. In all field tests, selected major predators (e.g. species in Cleridae, Trogositidae, and Histeridae) were counted and apparently not affected by the addition of 4-allylanisole. Current work is proceeding on protection of individual high value trees from *D. frontalis* attack using commercially available 4-allylanisole, on investigations of structural analogues of 4-allylanisole to optimize activity, and on studies to determine the role(s) of naturally occurring levels of 4-allylanisole on host selection.

Aggregation Behavior of the Arizona Five-Spined Ips, *Ips lecontei*, and Associated Forest Insects

Steve Seybold, University of Nevada, Reno

Results of field studies in south central Arizona were presented. He described two field experiments in a pure ponderosa pine stand that utilized various doses of commercially available racemic ipsdienol and enantiomerically pure (4S)-(-)-ipsenol (synthesized by Prof. Kenji Mori, Tokyo University). These experiments indicated that *I. lecontei* is attracted to a male-produced aggregation pheromone in the field, but that the combination of (-)-ipsenol and racemic ipsdienol in the naturally-occurring compound ratio and enantiomeric composition does not attract significantly more *I. lecontei* than the male-infested log. In fact, a limited dose response to the combination of the two compounds and conflicting results of the response of *I. lecontei* to the highest combined dose in two concurrently run experiments suggest that the pheromone activity of combined ipsenol and ipsdienol is only partial. There was no response to either compound alone. Steve showed GC-MS evidence for the production of ~80%-(-)-*cis*-verbenol in a fractionated extract of *I. lecontei* male-produced volatiles and hinted that this may be a necessary third component in the aggregation pheromone of *I. lecontei*. Traces of this compound may have been present in an active laboratory fraction tested in 1988.

Three other forest insects responded in these field assays. *Ips latidens* was not cross-attracted to male *I. lecontei* in Arizona, but responded to (-)-ipsenol alone. This response was interrupted by racemic ipsdienol. Since male *I. lecontei* produce racemic ipsdienol, this beetle is able to effectively compete with *I. latidens* by excluding it from the second trophic level niche that would normally be available to either species. This confirms the work of Wood et al. with *I. paraconfusus* in the ponderosa pine system of California and Miller et al. with *I. pini* in the lodgepole pine system in British Columbia. *Temnochila* spp. (Coleoptera: Trogositidae) was attracted to male *I. lecontei* in both experiments and responded to (-)-ipsenol, but not to racemic ipsdienol alone. Racemic ipsdienol did not interrupt the response to (-)-ipsenol. Steve put this kairomonal response by a third trophic level carnivore to a pheromone component of a second trophic level consumer in the context of previously published results that showed that *T. chlorodia* responded to (-)-ipsdienol and exo-brevicomin in California. If the *Temnochila* spp. trapped in Arizona is *T. chlorodia*, then it is clearly not only an extremely generalist predator, but also a generalist in kairomone sensitivity.

Finally, individuals of both sexes of a fungivore, *Plesiocis cibrum* (Coleoptera: Ciidae), aggregated in response to (-)-ipsenol and were not interrupted by racemic ipsdienol. The response to the combination of ipsenol and ipsdienol increased with dose. This insect feeds and develops in the fruiting bodies of *Cryptoporus volvatus*, which appear on trees and logs long (usually the following season) after they have been colonized by bark beetles. Interestingly, *Temnochila* spp. caught in the same funnel trap as *P. cibrum* readily fed on the ciids in the trap cups. Adult *T. chlorodia* have been observed in *C. volvatus* fruiting bodies and are suspected to be capable of vectoring the fungus to new trees and logs. They may be feeding on *P. cibrum* in these fruiting bodies. Steve posed the question of why a saprophytic consumer would respond to a bark beetle pheromone component when the appropriate life stage of its saprophyte host does not appear until long after the bark beetle life cycle is complete---i.e. the timing for this semiochemical-mediated link does not seem advantageous for *P. cibrum*.

Management of the California Five-Spined Ips, *Ips paraconfusus*, and the Pine Engraver, *Ips pini*, in Slash Using Semiochemicals

Pat Shea , USDA Forest Service Pacific Southwest Research Station

These studies, conducted at two sites in California, exploited semiochemicals normally used by these parapatric species for interspecific competition to prevent colonization of piled slash. In June and July of 1992 in a 35-45 year old ponderosa pine plantation on the Stanislaus National Forest in south central California, Pat and his colleagues treated piled slash with three doses of semiochemicals (in bubble caps) intended to prevent *I. paraconfusus* from colonizing the slash. These compounds were racemic ipsdienol and 86%-(-)-verbenone. After counting the number of attacks per square foot and peeling bark from infested slash pieces to verify that Ips were under the bark, they found that all treated piles were attacked, though the attack rates were all less than one-third of the rates for the untreated piles. Surprisingly, all of the attacking beetles in the treated piles were *I. pini*, which were thought to be less abundant in this area.

In 1993, Pat and his cooperators conducted a similar study in a 30-35 year old ponderosa pine plantation at McCloud Flats on the Shasta National Forest in northern California. This is an area where *I. paraconfusus* and *I. pini* are known to be more broadly sympatric. In this study, they included racemic ipsenol in some of the treatments in order to interrupt the response of *I. pini* and used only one dose of bubble caps (10). Earlier work in this area by Martin Birch and his colleagues had shown that *I. paraconfusus* produces (-)-ipsenol and (+)-ipsdienol, which interrupt *I. pini*, and *I. pini* produces (-)-ipsdienol, which interrupts *I. paraconfusus*. In addition, these compounds are components of each species' respective aggregation pheromone. At McCloud Flats, Pat and cooperators found that both species infested the control piles, though they allocated themselves to separate piles. They also found that *I. pini* attacked any pile that was baited with racemic ipsdienol, even if racemic ipsenol was present. *I. paraconfusus* did not attack any of the treated piles. Piles treated with 86%-(-)-verbenone and racemic ipsenol were unattacked by either species. Pat concluded that in their zone of sympatry in California, *I. paraconfusus* will generally outcompete *I. pini*, but if man excludes *I. paraconfusus* using semiochemicals, *I. pini* will come in and take advantage of the available substrate. He plans to repeat studies this year in areas where only one species is present.

A discussion followed as to why *I. pini* attacked the treatments with racemic ipsdienol (low level attraction to 50%-(-)-ipsdienol, followed by production of natural aggregation pheromone by the colonizing males). Dan Miller (Phero Tech Inc.) raised the question of whether *I. pini* is that aggressive in California and that perhaps letting it colonize the slash to exclude *I. paraconfusus* could be an effective control measure. Participants from Idaho, Montana, and California responded that *I. pini* can be aggressive at times and that perhaps this was a risky approach. Jill Wilson (USDA Forest Service, Flagstaff, Arizona) and Vicky Wesley (Northern Arizona University, Flagstaff) contrasted their slash management studies for *I. lecontei* and *I. pini* on the San Carlos Reservation in Arizona with Pat's studies in California. They are working on slash piece size, insolation exposure, and moisture content as it relates to brood productivity, but hope to eventually try some work with semiochemicals as is being done in California.

Preliminary Field Studies on the Attraction of the Roundheaded Pine Beetle, *Dendroctonus adjunctus*, to Semiochemical-Baited Funnel Traps

Jaime Flores, University of Nuevo Leon, Linares, Mexico

This work is being carried out in cooperation with Pat Shea and Marion Page (USFS-PSW) and the ultimate objective is to find an attractant and then interrupt the response to the baited funnel traps with an antiaggregant. Jaime described in detail the distributions of the four economically important species of *Dendroctonus* (*adjunctus, frontalis, mexicanus*, and *rhizophagus*) in Mexico and noted that *D. adjunctus* is mainly a pest on *Pinus rudis* and *Pinus hartwegii* in central Mexico. Normally it attacks small clusters of three to five trees, but the infestations can grow over larger areas into spots. Unlike the classic *D. frontalis* spots, the spots of *D. adjunctus* do not have a clear growing front, but contain populations of trees in different stages of infestation mixed throughout the stand. *D. adjunctus* have also been quite damaging in Arizona and New Mexico as well as in Guatemala.

Jaime's central Mexican trapping site has been in a national park called Nevada de Colima near the west coast of the state of Jalisco. Pine stands in this park have been decimated by five years of *D. adjunctus* attack as well as overgrazing and other social problems. Since it is a national park, Mexican regulatory agencies have discouraged the use of traditional control methods and demanded methods with less environmental impact that do not use insecticides or machinery. Semiochemical-based trapping is compatible with this policy.

As possible attractants Jaime tested the bicyclic ketals frontalin and *exo*-brevicomin and three monoterpenes (alpha-pinene, beta-pinene, and myrcene). The experiments, which contained high and low doses of the bicyclic ketals, consisted of seven total treatments randomly distributed in each experimental unit and replicated five times. Preliminary results indicated that the high release rates of *exo*-brevicomin and frontalin were the most attractive and the addition of monoterpenes appeared to have a minimal effect on the response. A high response was elicited by any treatment that contained frontalin. Companion studies conducted concurrently in Arizona and New Mexico by Shea and colleagues have also shown that the monoterpenes do not increase the trap catch, but these studies did not demonstrate a dose effect from the bicyclic ketals.

A comparison of the populations of *D. adjunctus* from central Mexico and the southwestern United States shows differences in cuticular hydrocarbon phenotype of the adults, differences in flight period, and differences in population density. The Mexican population has three unique dimethyl-branched cuticular hydrocarbons, and while both populations are univoltine, the Mexican population flies for a brief period in November and December. The southwestern US population flies earlier (in the summer), for a longer duration, and the flight ends before the Mexican flight begins. The population density (hence, the trap catch) at Nevada de Colima was quite low relative to that in the southwestern US. This was perhaps due to the "soft" control procedures applied in the park and to the diminishing quantity and quality of host material remaining there. Jaime felt that the lower population density in the central Mexican site may have been the reason why the results indicated dose-response effects of bicyclic ketals in Mexico, but not in the southwestern US.

The session ended with a brief discussion of the comparison of semiochemicals called green leaf volatiles derived from the foliage of deciduous non-host trees and the repellent 4-allylanisole from host pines. Staffan Lindgren described the repellent activity of these green leaf volatiles and ongoing studies in John Borden's lab looking at the combinatorial effect of verbenone and these volatiles. Staffan expressed that in a practical sense no one interruptant seems to be effective enough alone for control, but multiple inhibitory messages made up of aggregation pheromones from competitive insect species, general antiaggregants (i.e. verbenone), non-host compounds like green leaf volatiles, and host interruptants like 4-allylanisole might be efficacious. The moderator concluded that early work in semiochemicals began by isolation of compounds from individual bark beetles taken out of the context of their ecosystem. By testing the effects of combinations of compounds originating from all trophic levels, current studies are emphasizing a more realistic picture of all of the information-bearing molecules that are impinging on the organism of choice. This promises to yield more effective and practical semiochemical-based control measures, especially if the various trophic level sources of new semiochemicals are clearly defined through rational isolation programs.

INSECT AND DISEASE INTERACTIONS

Workshop Moderator: David L. Wood
University of California, Berkeley, CA

Summary of Pitch Canker Disease in California

David L. Wood, Department of Environmental Science, Policy and Management, University of California, Berkeley, CA 94720

Pitch canker disease was first identified in California at New Brighton State Beach, Santa Cruz County, in 1986. The limited genetic diversity of the pathogen, *Fusarium subglutinans* f. sp. *pini* suggests that it is a recent introduction to California. By the beginning of 1992, it was recorded as far north as San Francisco and as far south as San Diego County. Since then it has been found in the three native mainland Monterey pine stands, a native Bishop pine stand and planted Monterey pine over 100 miles north of San Francisco, and urban plantings of Douglas- fir. Twelve pine species, including three exotic species from Europe, have been found infected in nature. Recent studies suggest that Monterey pine branches with cone whorls are more likely to become infected with the pathogen than branches without cone whorls. Uninfected trees in areas with high levels of pitch canker infection were less likely to become symptomatic than uninfected trees in areas of low infection. Trees in areas with high levels of infection were more likely to develop bole cankers than were trees in areas with low levels of infection. The pitch canker fungus has been isolated from 8 species of twig, cone and bark beetles (Scolytidae), one species of dry twig and cone beetle (Anobiidae), one weevil species (Curculionidae) and one moth species (Sesiidae). Further details of recent research at the University of California, Berkeley can be found in the following publications:

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Interrelationships Among Twig Beetles (Scolytidae: *Pityophthorus* spp.), Pitch Canker Disease, and Conifers in Central Coastal California

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The role of twig-inhabiting arthropods in the spread of pine canker fungus in central coastal California is currently being investigated. Asymptomatic green branch tips are cut and hung in tree crowns as bait at eight week intervals and subsequently placed in sterile individual emergence chambers. All emerged organisms are killed and samples are placed on a Fusarium selective medium. Fungal colonies are screened for the presence of *Fusarium subglutinans* f. sp. *pini* (hereafter *F. s. pini*), the causal agent of pitch canker disease. Collections have been made in native stands and landscape plantings of *Pinus radiata, P. ponderosa, P. attenuata, and P. menziesii*. Symptomatic branch tips of *P. radiata* have also been collected; fungal isolations of emerged inhabitants are performed as described above.

Preliminary analysis indicated that Scolytid beetles in the genus *Pityophthorus* are the most abundant insect inhabitants of Pinus twigs. *Pityophthorus carmeli, P. setosus*, and *P. nitidulus* have all been found infesting native and adventive *Pinus radiata*, while *Pityophthorus murrayanae aurulentus*, *P. carmeli*, and *P. nitidulus* have been found in native *Pinus ponderosa* and native *P. attenuata*. *Cryphalus pubescens* (Coleoptera: Scolytidae) is the most abundant insect in native *Pseudotsuga menziesii*, but has also emerged from *Pinus radiata* in the course of this study. Members of the genus *Lasconotus* (Coleoptera: Colydiidae) have emerged in relatively large numbers from *P. radiata* and *P. ponderosa*. Insects emerging form adventive *P. radiata* that have been found to carry inoculum of *F. s. pini* include *P. carmeli, P. setosus, P. nitidulus* and *Lasconotus pertenuis*. One *P. carmeli* individual emerged from native *Pinus ponderosa* was found to carry *F. s. pini* inoculum.

Continued collection of infested branches through a two year period is expected to yield patterns of flight seasonality, insect feeding preferences, and degrees of polyphagy. This information will be used in combination with data from fungal transmission experiments to define the role of twig beetles and their associates in the geographic spread and host range expansion of pitch canker fungus.

Defensive Chemicals Produced in Spruce by Bark Beetle Vectored Fungi

Barbara Illman, USDA Forest Service, Forest Products Laboratory, Madison, WI 53705-2389

Richard Werner (PNW) and I have a collaborative effort to identify defense chemicals produced in spruce against attack by *Dendroctonus rufipennis* and its symbiont fungus *Leptographium albietinum* on the Kenai peninsula in Alaska. We have found changes in methanol-soluble chemicals in Sitka, white and Lutz spruce following artificial inoculation of *L. albietinum*. By using HPLC and GC/MS, we found several phenols in the fungal-induced hypersensitive reaction zone (HR) of the host bark/phloem tissue. Several unknown chemicals were found in tissue outside the HR that were not in the HR. Our study will compare the defense response of 80-100 year old Sitka and white spruce trees with their natural hybrid, 50-60 year-old Lutz spruce trees, in order to better understand heritability of the defense response.

Erik Christiansen, A. Berryman, and colleagues at the Norwegian Forest Research Institute (NISK), are studying the defense response of Norway spruce to *Ips typographus* and symbiont *Ophiostoma polonicum*. During a trip to Norway in the fall of 1993, we visited colleagues at NISK and toured their unique spruce trees. The trees have been characterized for resistance and susceptibility to beetle/fungal attack and for cellular, physiological responses to attack. Results from the two research groups will provide information about the physiology, chemistry and inheritance of spruce defense to beetles and symbiont fungi.

Red Turpentine Beetle Attacks Associated with Pruned White Pine in North Idaho

Sandra Kegley and **John Schwandt**, Idaho Panhandle National Forest, USDA Forest Service, Coeur d'Alene ID 83814

The red turpentine beetle is a common secondary bark beetle that is most frequently found at the base of large ponderosa pine that have been attacked by other bark beetles, or in freshly cut stumps. However, during 1992 and 1993, eight of nine young white pine plantations that had been precommercially thinned and pruned to reduce blister rust contained attacks by the red turpentine beetle. Attacks were found in nearly all stands, but numbers of attacks varied widely from less than 2% of trees to over 41%. New attacks may occur as long as 3 years after the thinning, but seem to taper off after the first 2 years. Time of year thinned/pruned did not seem to have an effect on beetle attacks but will continue to be evaluated.

Since attacked trees can be killed, foresters are concerned about losing crop trees. Although we only found mortality in one of three districts surveyed, it was as high as 10% of the residual white pine in one plantation, and averaged about 4%.

Pruning of white pine is often recommended to reduce current blister rust infection levels, as well as lower future infection rates. A small study was initiated to monitor severely pruned trees (trees pruned up to the top whorl), paired with normally pruned trees (pruned up to 8 ft or 50% of the crown). After only 6 months, red turpentine beetles had attacked twice as many severely pruned trees as the normally pruned trees and the attacks were more extensive in the severely pruned trees.

Nearly all (95%) of the attacks were in trees with diameters greater than 1.5 inches, so this may be an additional argument for treating stands quite early.

Since this is an unusual role for this bark beetle, and we are precommercially thinning and/or pruning several hundred acres of stands with white pine each year, plans call for continued monitoring as well as additional surveys of recently pruned plantations.

TRANSLATING PREDICTED EFFECTS OF INSECTS AND DISEASES INTO TERMS AND MODELS USED BY NON-TIMBER RESOURCES

Workshop Moderators: **Jerry Beatty and Kathy Sheehan**
USDA Forest Service, Pacific Northwest Region

Blakey Lockman (Forest Pest Management, Missoula MT) reported **"Modelling Root Disease Impact in the Coeur d'Alene River Basin"**. FPM pathologists worked with silviculturists and hydrologists to model the effects of root diseases on vegetation and to link those changes to the overall impact on the watershed. Stands in two districts were stratified by forest cover type. Compared to survey records from the 1930's, Douglas-fir cover type has increased from 10% to 55%, grand fir type has increased from 13% to 23%, and western white pine has decreased from 43% to 4%. Using aerial photographs, root disease was detected on 98% of the Douglas-fir and grand fir cover types in the analysis area, and 62% was severely impacted (severity class 3 and 4).

The Forest Vegetation Simulator (FVS) and the Western Root Disease Model (WRD) were used to project volume and crown competition factor (CCF) curves for each habitat type group. Current Forest Plan yield estimates far exceed what is projected for these disease-impacted areas. CCF was chosen to represent the canopy, with a CCF of 100 assumed to reflect crown closure and a reduced severity of rain-on-snow events. CCF curves from one of the subdrainages were then integrated with a watershed model to show the projected changes in peak water flow caused by forest cover reduction from root disease. Without intervention, peak flows were projected to increase gradually over several decades, creating serious water quality and fisheries concerns. Additional simulations using FVS and WRD predicted that silvicultural treatments could produce greater volumes which translate into reduced peak water flows in the future.

Ann Lynch (Rocky Mountain Station, Fort Collins CO) presented **"Using Traditional Models to Drive Visual Effects Models"**. Operational use of visualization models is dependent upon integration of the two systems, and engenders circumstances new to our modeling efforts. First, biological response models are being used to drive perception response models. Second, modeling scales are incongruent: the visual models operate on digital pixels encompassing biological scales which range from leaves and twigs to distant landscapes, all of which may be present concurrently, while the vegetation and pest models operate at individual-tree and stand scales. Third, visualization empowers the believability and comprehension of traditional model output, possibly more than the projection merits. Increased ability to communicate traditional model output will result in increased interest in and demand for long-term projections. Recently, during a project for the Deschutes N.F., the Forest Vegetation Simulator and the Budworm Damage Model (FVS & BDM) were used to provide vegetation and pest-effects estimates for visualizing budworm damage and management (see Lynch et al., this proceedings). Projections ran for 150 years, with multiple calls on the BDM. Difficulties arose when the visualization models required input out-of-synch with FVS cycles, "scheduled" budworm outbreaks began in one FVS cycle and ended in another, silvicultural treatments were scheduled mid-cycle, and the visualization required more detailed FVS output. The most serious problems incurred were with the regeneration models, and are not unique to this project: no FVS regeneration sub-model exists for most locals, and the BDM small-tree submodel mortality predictions are extreme.

Dan Miller (Phero Tech Inc., Delta, B.C., Canada) discussed "**Socioeconomic analysis of the mountain pine beetle control program in British Columbia**". A multiple-accounts approach was used in assessing the value of the mountain pine beetle control program in British Columbia. The purpose was to clearly identify tradeoffs for all resource values - timber and non-timber. Regional and national perspectives were identified separately. The accounts included environment, community, economic development, government finances, and First Nations. Resource analyses of timber values were determined with a broad, generalized model based on the Shore/Safranyik rating systems. Estimates of tree mortality over an epidemic at the landscape level were correlated directly with the susceptibility rating index. Consultations with representative stakeholder were used to assess impacts of various mortality and treatment scenarios, based primarily on scale of impact (single tree versus thousands of hectares). Visualization of expected mortalities over visual quality objectives served to facilitate impact assessments by stakeholders. In all accounts, there were clear benefits of an appropriate control program relative to a "no control" scenario.

FACTORS THAT TRIGGER BARK BEETLE OUTBREAKS

WorkshopModerator: **Kenneth Hobson**

The objectives of this workshop were to:

1) List hypotheses which explain bark beetle outbreaks (acknowledging that not all theories will be mutually exclusive).
2) Hear empirical observations which these theories should explain. 3) Identify important research questions which can test these hypotheses.

The large number of participants in the workshop was evidence of the continuing interest in this topic. Theories on factors that trigger bark beetle outbreaks were solicited to capture different facets of the phenomenon. We sought to consider the diversity of triggering mechanisms of different bark beetle species, in different host species, in different regions. The intent was to consider which proximal causes might be united with common theory containing sufficient detail to be maximally useful.
Theories (facets) of the rise of epidemics which were mentioned included:

1) Stress, such as drought, weakens oleoresin defenses of trees, increases the likelihood that trees will die if attacked by bark beetles and increases bark beetle reproductive success.

2) Food (phloem) abundance and quality increases and beetle reproductive rate increases. Many large diameter trees with thick phloem with optimal moisture increase oviposition, brood survival and quality.

3) Bluestain fungi: balance between mutualistic and antagonistic effects of symbiotic microbes vectored by beetles is shifted by host moisture, change in the most common species or races of bluestain vectored by beetles, or other process so that beetle survival and reproduction is altered.

4) Natural enemy guild collapse allows increase in beetle survival and reproduction.

5) Genetic change in predisposition or physiological ability of beetles to disperse causes local concentration of beetles and initiation of mass attacks.

6) Secondary bark beetle populations which normally provide dispersal cues for primary bark beetles drop as appropriate host material is used up; without dispersal cues density of beetle attacks around brood tree increases and triggers mass attacks.

7) Competing bark beetle species, cerambycids and buprestids increase or decrease, decreasing or increasing reproductive success of primary tree-killing bark beetle species through resource competition and entomocide.

8) Climate acts directly on beetles providing good or bad conditions for overwintering, dispersal and host colonization.

9) Focal trees production by lightning, fire injury, root disease etc.. precipitates mass attacks and concentration of beetle population.

10) Disturbance such as: windthrow, volcanoes, avalanche etc.. providing a sudden increase in host material.

11) Disease, viruses and bark beetle pathogens can keep beetles low until they escape them.

12) Migration in from other outbreak areas.

Empirical observations which were listed included:

Drought:
** 1987-1992 in California precipitation down to 50% of normal; white fir killed by Scolytus. [D. Owen]
** 1940's and 1950's in California minimum 2 years of 20-30% below normal precipitation required for killing ponderosa by Dendroctonus brevicomis (WPB) and white fir by Scolytus; low spring (April/May) precipitation was more important than low winter precipitation; pressure bomb measurements at 18-20 bars was threshold of susceptibility in white fir; spring drought also important for Ips killing ponderosa [R. Hall & G. Ferrell]. ** Ips avulsus, I. grandicollis and Dendroctonus frontalis (SPB) in southern U.S. kill loblolly pine in river bottoms and urban settings with infrequent drought [T. Nebeker] Comment that these trees normally have abundant water, shallow roots, and therefore greater vulnerability to drought [C. Williams]. ** Dendroctonus ponderosae (MPB) attack high elevation lodgepole along stream banks or edges of ponds and lakes in drought; comment that this may be due to thicker phloem. [D. Wood]
** late 1970's drought in California first attacks on ponderosa were from Ips paraconfusus followed the next year by WPB and the following year by WPB attacking ponderosa without Ips. [D. Wood].
** California drought near Quincy ponderosa mortality first; then white fir in later drought years [C. Williams].
** Ips attack during seasonal fall droughts in California foothills of Sierra Nevada [D. Wood].
** Phloeosinus attack incense cedar with drought [D. Wood]. ** Moisture stress in unthinned stands (all species) increases mortality [D. Schultz].

Disturbance:
** Dendroctonus pseudotsugae (DFB) outbreaks in Idaho start with windthrow, then last 2-3 years unless additional stress like defoliation is common when outbreaks last an additional 2-3 years [L. Livingston]. ** DFB outbreaks in w. Oregon associated with windthrow [D. Bridgewater].

Climate:
** low temperatures keep MPB in check in lodgepole in Idaho [B. Bentz] ** MPB outbreaks in Montana lodgepole with warm temperatures 1927-1931 in Big Hole Valley; since then suppressed perhaps by normal low temperatures despite abundant susceptible hosts; [J. Evenden via K. Gibson]

Migration:
** MPB outbreak in Montana lodgepole in Big Hole Valley in 1927 set off by migration in from other outbreak areas on the Salmon NF [J. Evenden via K. Gibson].

Predators & Parasitoids:
** asynchrony of natural enemies and SPB increases beetle success mediated by climate and other unknown elements [R. Goyer; and P. Turchin's work mentioned by D. Wood].
** Enocleris can reach very high population densites, eat every bark beetle in sight and plausibly can be a controlling agent [A. Berryman].

Competing Species:
** MPB pop'n increase in ponderosa until cerambycid and buprestid borers infested the same stands [McCambridge

via Amman & Hobson].

Host Availability:
** MPB pop'n builds first in largest lodgepole then spreads into smaller diameters [K. Gibson].
** Ips typographus outbreaks in Scandanavia require an abundance of food [S. Lindgren].

Stress:
** DFB is sustained in w. Oregon in root disease centers [D. Bridgewater]. ** MPB increases in stressed white pine in central Vancouver and DFB increases in Vancouver stressed hosts [N. Alexander]. ** defoliation in n.e. U.S. converts complex sugars to simple sugars in roots which then can be invaded by Heterobasidion, further increasing susceptibility to beetles [C. Williams].
** MPB is outcompeted by Ips pini for limited food until stress makes more hosts suceptible and creates outbreak [S. Lindgren]

Bluestain Dynamics:
** MPB building populations has moderate blue stain in Utah lodgepole; collapsing
MPB population had very little [B. Nash & G. Amman via K. Hobson]. ** SPB building population has very little bluestain in Texas loblolly; collapsing SPB population has high bluestain in moist phloem [R. Billings & J.R. Bridges via K. Hobson].
** proportion of pathogenic fungi carried by MPB, WPB and D. valens varies over time and could be trigger for beetle outbreak [D. Owen & J. Fox via K. Hobson].

Food:
** MPB in Utah lodgepole increased with good spring precipitation 1979-1980 after dry period with low MPB 1976-1978 [G. Amman via K. Hobson]. ** MPB in Arizona Kaibab ponderosa increased with high precipitation and high phloem moisture [Blackman via Amman & Hobson]. ** WPB and MPB in e. Oregon ponderosa increase after drought is over [D. Bridgewater].

Additional comments included:

J. Logan: Multiple causality is likely and bark beetles are not necessarily predictable by a "simplistic world view".

A. Berryman: We should recognize 1) necessary conditions for outbreaks (beetles, susceptible hosts) and 2) sufficient conditions (temperature, predators, reproductive rate). We should measure tree as stress integrator. Control of sufficient conditions does not control problem and sufficient conditions do not have to be met to cause outbreaks.

L. Livingston: Practical approach that answers land managers' questions requires more than "necessary" conditions.

B. Bentz: We should keep separate the concepts of "triggering an outbreak" and "sustaining an outbreak".

INSECTS AND DISEASES AFFECTING PINYON-JUNIPER WOODLANDS

Workshop Moderators: **Jose F. Negron** (USFS/RMFRES) & **Pete Angwin** (USFS/FHM)

With the new mandate of ecosystem management within the Forest Service, new emphasis in conservation of biodiversity, and the concerns for long-term sustainability and health of the pinyon-juniper ecosystem there has been renewed interest in this area. Little is known about the role played by insects and diseases in this system and there is a need to better identify the needs for studies in this topic.

Overview of the pinyon-juniper ecosystem.

Jerry Gottfried, USFS, Rocky Mountain Forest and Range Experiment Station, Flagstaff, AZ.

The pinyon-juniper woodlands cover over 47 million ares in the western United States. Management has been inconsistent over the past 100 years, and is still controversial. The woodlands can be managed for multiple benefits and products including wood products, pinyon nuts, wildlife habitat, forage production for livestock, recreation, watershed values and archeological site protection. Ecosystem management strategies are being developed that integrate human, biological, and physical components to achieve sustainability of all resources.
Pinyon-juniper woodlands are not homogeneous and are represented by over 70 habitat types in Arizona and New Mexico. Stand composition and density are influenced by climate, site potential, physiography, history, and geography. In the Southwest, stands are usually found from 4,500 to 7,500 feet in elevation where annual precipitation ranges from 12 to 22 inches. Colorado pinyon, *Pinus edulis*, and one or several species of junipers, *Juniperus* spp., are found in southwestern stands.

In addition to fire and anthropomorphic activities, diseases, parasites, and insects impact the woodlands. True mistletoes, *Phorandendron* spp., affect junipers while a dwarf mistletoe, *Arceuthobium divaricatum*, impact pinyons. Intensive studies on a 120-acre site in east central Arizona found that an average of 19 pinyon trees per acre contained dwarf mistletoe infections, and 10 one-seed juniper, *J. deppeana*, trees per acre contained true mistletoes. Most of the infected pinyon trees were less than 7.0 inches d.r.c. while most of the infected one-seeded juniper were between the mid-size classes.

Ips spp. attacks can cause extensive mortality. Cone insects will become more important as the interest in commercial pinyon production and in partial harvesting of woodlands for multiple resources increases.

Pilot Woodlands Management Program

Steve Haglund, USDI, Bureau of Indian Affairs, Albuquerque, NM. Bureau of Indian Affairs

The Bureau of Indian Affairs is conducting this pilot woodlands management program. Historically, the primary use of woodlands has been for personal use of fuelwood and pinyon nut gathering. The purpose of the pilot program is to explore the feasibility of tribal economic development through management and utilization of woodland resources and to study the potential for resource enhancement through woodland management.

As part of the program, the Bureau is in the process of installing long-term uneven-aged stocking studies on four reservations. Data from these studies will enable foresters to assess the response of woodland forests to treatment and to determine which stocking levels are optimum for a variety of management objectives. Pinyon nuts are the woodland product thought to have the most potential commercial value. In order to study treatment effects on pinyon nuts the Bureau is cooperating with the Rocky Mountain Forest and Range Experiment Station in a series of nut production studies. The study plots are located adjacent to the uneven-aged stocking studies and consist of one acre plots where all trees except the best cone producers are harvested. The number of cones are counted on each tree within the plot and on a number of sample trees within each of the stocking study plots. The main objective is to determine the effects of stand density on nut production.

Ecologically based management activities are being implemented and monitored in order to learn more about treatment effects and benefits. Data collected from formal and informal treatment studies will provide valuable information for future management.

PJ Disease Activities in Colorado

Pete Angwin, USFS, Forest Health Management, Gunnison Service Center, Gunnison, CO.

Major diseases of concern in the PJ type:
Blackstain Root Disease- *Ceratocystis* (*Leptographium*) *wageneri*
Armillaria Root Disease- *Armillaria spp.*
Pinyon Pine Dwarf Mistletoe- *Arceuthobium divaricatum*
Juniper True Mistletoe- *Phoradendron juniperinum*
Cedar-Apple Rust- *Gymnosporangium spp.*
Abiotic Diseases- Winter drying, redbelt, overirrigation, chemical damage, etc.
Animal/Human Damage

Most of the work that's been done through the years, at least by R2 Forest Health Management (FHM) and the Rocky Mountain Station (RMS) has been with blackstain, Armillaria and the mistletoes:

Blackstain

1942: James Meilke first identified blackstain in Mesa Verde NP (MVNP), described fading trees, root-root spread via root contacts and grafts, and crescent-shaped stain patterns.
He concluded that *Ips* beetles associated with the mortality were secondary.
1944: Meilke set up a permanent plot at MVNP to monitor progress of blackstain. Disease progression has been monitored to the present, and although some trees are still dying along the edge of the plot, new trees are regenerating within the plot and are not becoming infected.
1975: Landis and Helberg ran an aerial survey which identified the range of blackstain over most of the western slope. In addition, they described cultural characteristics, characteristics of the fungus in wood, noted associations with bark beetles, but did not establish vectoring relationships.
1978: James and Lister ran an aerial survey, concentrating on MVNP. They identified at least 175 active centers. Highest infection center densities were found along the edges of mesas and in areas of concentrated public use. In addition, they also set up 7 additional tracking plots (similar to Meilke's)- over
the first 6 years, they found spread characteristics similar to those seen by Meilke.
1982-87: Sharon evaluated 3 methods to control spread (tree removal, soil fumigation, mechanical barriers). None of the methods were successful. He concluded that the buffer zone was not wide enough or that insects carried the fungus across the buffers.

Armillaria

In general, not a lot done- mostly surveys and descriptive work.
1976: Johnson, Landis and Gillman ran aerial surveys that identified the range of *Armillaria* in pinyon, which is restricted to east side of the continental divide.
They also identified *Armillaria* on Rocky Mountain Juniper (*J. scolporium*)-first time identified on juniper in the US.
Concluded that the overall impact of *Armillaria* is minimal on PJ type, cited potential benefits to wildlife.
1993: R2, FHM currently working on a survey of biological species of *Armillaria* on various hosts from throughout the Region. Pinyon pine isolates are included in the assessment.

Mistletoes

Most work with mistletoes in PJ in the Rocky Mountain Region is descriptive and taxonomic.
1972: Hawksworth and Weins- Biology and Classification of Dwarf Mistletoes
Some projects Frank was working on before he died:
A chapter on Silvics and Use of Pinyon Pine for an Encyclopedia on Trees of the World (with Peter Schutt)- included much on insects & diseases of pinyon pine.
Treatise on taxonomy of the mistletoes (with Del Weins)- included pinyon dwarf mistletoe.

So far, all of the work described has concentrated on activities of R2 FHM and RMS. Other active players include Fort Lewis College and Colorado State Forest Service:

Fort Lewis College

Dr. Paige Lindsey- has been informally involved with taxonomics and floristics of fungi on pinyon pine, particularly in down and dead wood.
1975: Gilbertson and Lindsey, "Basidiomycetes that decay junipers in Arizona"
1987: Described a new species of *Aleurodiscus* on pinyon pine
1988: Published a check-list for Colorado wood rotting basidiomycetes, including host data and wood decay characteristics.

Colorado State Forest Service

Because the State Forest Service has responsibility for state and private jurisdictions, they often receive calls regarding insect and disease problems in PJ woodlands. I asked District Foresters from the 5 Colorado Districts that contain PJ woodlands to list the most important PJ disease problems that they encounter. Insect problems (such as bark beetles and pitch borers) were always mentioned first, but when I asked them to concentrate on diseases and other conditions, the results, in order of importance were as follows:
1. Problems connected with human activity, including:
-Pinyon in transport (moving insects and disease, including dwarf mistletoe, turpentine beetle, Ips beetles, pinyon pitch borer.)
-Overirrigation of transplants and pinyon near homesites.
-Pesticide damage.
-Salt damage.
-Compaction and root severing associated with homebuilding in PJ woodlands.
2. Animal damage:

-Porcupine
-Deer and elk browse
-Cattle- overgrazing and compaction
3. Root disease:
Comments mostly regarded blackstain in the west slope districts (particularly the Durango district).
4. Environmental disorders:
Winter drying and redbelt (mostly episodic).
5. *Gymnosporangium* rust:
Mostly episodic. Not much of a management concern, looked upon as a botanical curiosity.
6. Mistletoes:
Again, not much of a management concern, more of a botanical curiosity.

Forest Health Monitoring

For the past 3 years, the Colorado State Forest Service, Region 2 FHM, and the RMS have been involved with the nationwide effort to install Forest Health Monitoring plots. To date (end of 1993 field season), 9 of 90 plots throughout the state have been installed in the PJ cover type. By the end of the 1994 field season, the total number of plots in the PJ type will be 21 of 137 plots.

A genetic basis to community structure: interactions of pinyon pine, insect herbivores, mycorrhizae, birds, and mammals

Thomas Whitham, Dept. of Biological Sciences, Northern Arizona University, Flagstaff, AZ.

Very little is known about the genetic nature of community structure. Although a few studies have examined how insects respond to resistant and susceptible host trees, I am aware of no studies that have broadened the community to include a plant's mycorrhizal fungal mutualists, and their birds and mammals. I believe our studies show how the distributions of these diverse taxa map onto the underlying genetic structure of the plant population and that this structure is caused by the impact of environmental stress and a keystone herbivore on pinyon pine. These studies ultimately raise issues dealing with community stability and the conservation of stress and insect tolerant plant genotypes.

In brief, our studies argue that since the eruption of Sunset Crater, plants have encountered a new stressful environment for which they are not yet adapted. These stressful conditions have resulted in increased susceptibility to a keystone herbivore whose impacts on these trees is altering the rest of the community. Thus, the combined impacts of environmental stress and herbivory on pinyon pine is affecting the genetic make up of the community. Three implications should be considered:

1. Community Responses to Species Loss--If communities are loose assemblages of species, then the loss of one species may not have ripple effects on the rest of the community. However, if there are genetic linkages as we have shown in our pinyon studies, the loss of any member of a coadapted complex of species could have major impacts on the rest of the community. One might predict that such communities might be very susceptible to perturbations, especially novel man made ones for which no adaptations have occurred.

2. Conservation of Marginal and Boundary Populations to Preserve Stress-Tolerant Genotypes--Plants at their boundaries, both elevationally and geographically, may represent arenas of intense selection where rapid evolution may occur. The stressful environment of Sunset Crater may harbor the most drought tolerant strains of pinyon pine and the most resistant strains to herbivores. In preservation, I think we're often more concerned with preserving the

centers of dominant plant's distributions where they are most pristine, rather than their boundaries where they are often most stressed. Our studies argue that the boundaries should be considered as well.

3. Stressed Plants as Refugia for Insects and their Parasites--If plants in marginal or boundary environments have reduced defenses due to stress, insect pests may survive here where they could not survive elsewhere. If true, then such marginal environments may represent refugia for species that could not survive elsewhere. Although one may not want to conserve pest species, these same sites may support economically important parasitoids which would be important to preserve.

Insects affecting pinyon pine seed and cones in Mexico
Jaime E. Flores-Lara, Facultad de Ciencias Forestales, Universidad Autonoma de Nuevo Leon, Linares, Nuevo Leon, Mexico.

Jaime was in attendance at the conference and has conducted work with seed and cone insects of Mexican species of pinyon graciously accepted making a few remarks for the workshop. Scott Cameron, Texas Forest Service, provided some slides to Jaime which he showed illustrating the impact of *Ips* beetles in an outbreak in Texas. Insects are an important factor in limiting pinyon nut production in Mexico. Of particular importance are various species cone beetles in the genus *Conophthorus*, cecidomyid flies in the genus *Contarinia*, a coreid bug, *Leptoglossus occidentalis*, the coneborer, *Eucosma bobana*, and the coneworm, *Dioryctria albovittella*.

Pinyon-Juniper Ecosystem Management Strategy
Earl Aldon, USFS, Region 3, Albuquerque, NM. Region 3

Unfortunately we had used our allotted time and Earl was not able to cover this topic. He did provided a series of handouts to the attenders. The Region 3 Pinyon-Juniper Ecosystem Management Strategy will establish a long-range scientifically based management program for P-J ecosystems that provide multiple uses and values desired by the public in a manner that is environmentally sensitive. The strategy will try to achieve:

- Improvement of long term soil productivity
- Water quality that meets state standards
- Wide range of plant and animal diversity
- Sustainable ecosystems
- Recognition of P-J's uses, products, and benefits
- Visually desirable mosaic of vegetation condition on the landscape
- Riparian areas managed for their potential and uniqueness
- Threatened, endangered, and sensitive plant and animal habitats protected
- Historic and prehistoric cultural values protected
- Management that is sensitive to lifestyle as well as ecosystem needs

Conclusion

There are still numerous unanswered questions relating the basic biology, ecology, impacts, and interactions of insects and diseases in the pinyon-juniper ecosystem. The new mandate for ecosystem management and questions raised by the participants and attenders of this workshop further stresses on the need for continuing and augmenting work on this important ecosystem.

GRADUATE STUDENT/SPECIAL PAPERS

Moderator: **Joel McMillin**, School of Forestry,
Northern Workshop Arizona University, Flagstaff, AZ

Defoliation of hybrid poplars by a leaf-cutter bee (Hymenoptera: Megachilidae).
Scott Nugent and **Michael R. Wagner** (Northern Arizona University).

The influences of host genotype, planting date, and leaf position on defoliation by leaf-cutter bees were examined under field conditions. Percent defoliation for each leaf blade position was measured on seven *Populus* genotypes over five planting dates. Both host genotype and planting date had significant affects on the amount of defoliation. Preliminary data indicates that the pattern of defoliation with respect to leaf blade position may be occurring at the sink-source transition period in leaves.

The role of oleoresin flow in initial colonization of southern pine beetle and inoculation of blue stain fungus.
T. Evan Nebeker, **Robert Tisdale**, and **John Hodges** (Mississippi State University).

During recent years we have developed a methodology that allows us to manipulate the constitutive (primary) defensive system of *Pinus*. Oleoresin flow was significantly interrupted for 3, 6, and 12 days. These treatments were designed to duplicate, in the tree, the physical wounding effect of bark beetles as they attack over a period of days. After which the flow was allowed to return. Total egg gallery constructed by the southern pine beetle (SPB) was significantly shorter in trees where the resin flow was not interrupted. Significantly more egg gallery, that was free of resinosis, was observed in trees where the flow was interrupted for 6 and 12 days. Similar results were obtained from the inoculations. However, differences in the hypersensitive response is dependent on time of year and physiological state of the tree. These results suggest that tree improvement programs should consider selections of loblolly pine families that have increased resin production to reduce their susceptibility to SPB attack.

Distribution constraints on southwestern pine tip moth, *Rhyacionia neomexicana*.
Lia Spiegel and **Peter Price** (Northern Arizona University).

This study separates the importance of host quality and insect life history traits in the distribution constraints of the southwestern pine tip moth. Experimental manipulations resulted in the development of heavier male pupae on large shoots versus small shoots and heavier pupae of both sexes on trees larger than typical sized host trees. These data suggest that insect life history traits are limiting tip moth distribution and plant quality is not.

The variation and heritability of needle toughness in ponderosa pine.
Lizong Ren and **Michael R. Wagner** (Northern Arizona University).

Needle toughness is the most important resistant trait in ponderosa pine to the pine sawfly, *Neodiprion fulviceps*. Needle toughness varies significantly among different seed sources. Progeny tests of seedlings from both half-sibling and full-sibling families indicate that: 1) needle toughness is a heritable trait; 2) the heritability is 8% in half-sib families and 22% in full-sib families; 3) male parents contribute more to the needle toughness value of their offspring than female parents; and 4) compared to the heritability of morphological and chemical traits in other pine species, needle toughness in ponderosa pine is moderately heritable.

Experimental use of neem seed extract for mountain pine beetle control.
Leo Rankin, **Ken Naumann**, and **Murrey Isman** (British Columbia Forest Service and University of British Columbia).

Extracts of seeds of the neem tree, *Azadirachta indica*, have shown a number of properties useful for the management of insect pests. This study evaluated the effects of neem seed extract (NSE) on mountain pine beetle in lodgepole pine. Preliminary results indicate that 1) NSE does translocate when injected into young Douglas-fir trees, and 2) field trials with hack and squirt injection of NSE in baited mass-attacked beetle trees caused decreases in the numbers of surviving larvae per unit area of bark and per unit area of adult gallery length. The mortality increased with increased NSE dosage. The effects of the highest NSE dose were not as effective as the application of MSMA at the recommended dose. However, neem appears to be safer for natural enemies than most conventional insecticides.

Effect of overstory density on *Ips pini* brood production in ponderosa pine slash.
Jaime Villa-Castillo and **Michael R. Wagner** (Northern Arizona University).

The study was developed to provide information about microclimate conditions prevailing in small logs subjected to different amounts of sunlight. Colonization and brood development of *Ips* were measured on logs after opening the forest canopy at four different intensities. We concluded that any amount of shade can provide suitable microclimatic conditions for *Ips* bark beetle brood production, whereas logs exposed at sunlight intensity were significantly less attacked.

THE FUTURE OF DWARF MISTLETOE RESEARCH: WHAT ARE THE NEEDS?

Workshop Moderators: Terry Shaw & Mary Lou Fairweather
USFS, Juneau, AK and USFS, Flagstaff, AZ

Participants: Bob Mathiasen, Jerry Beatty, Helen Mafei, Dave Conklin, Bob Gilbertson, Mike Manthei, Paul Hennon, Bob Gilbertson, Dick Smith, Ken Russell, Dave Schultz, and others.

This was an informal workshop in which all attendees were encouraged to participate. Some researchers and FPM folks had previously sent lists of dwarf mistletoe (DM) research needs to Mary Lou; these were summarized and made available for viewing during the workshop in order to stimulate thoughts and discussion.

Dave Conklin brought up the first topic: Monitoring the effects of understory burning on DM. There are large scale understory burns being prescribed that happen to contain DM infection. However, pre-treatment data is needed in order to monitor the effects of heat and smoke on DM incidence. Dave Schultz reminded us that fire is not used or even considered near many urban areas due to smoke limitations.

Paul Hennon brought up the second topic which was: How does stand opening, which occurs naturally through the canopy gap process or through alternative harvesting patterns, influence the reproductive biology of DM? This topic was blended with: What ecological functions does DM provide in our forests (e.g., enhancing structural diversity and wildlife habitat)?; Can these be quantified?; Can alternative silviculture allow us to manipulate disease levels where these characteristics are maintained but timber values are not unduley reduced?; and more information is needed on animal/DM interaction.

Other topics discussed included:

- How predictable is DM intensification under the new silvicultural strategies?
- How do/should we quantify DM infection levels across a landscape and will the developing DM model handle the landscape level?
- How is woody vegetation affected by DM's on a long-term basis?
- What are the limits of stand conditions and sanitation prescriptions in which silvicultural control of DM can succeed under uneven-aged management? What do we consider to be successful?
- How do we quantify DM infection in pinyon pine and what are the effects on seed production?
- etc., etc.

It was suggested that the majority of topics discussed could be handled through the technology development program. However, many people felt there are still research questions which need to be answered. We came up with more questions than we did answers and realized that we have some good topics for the FY95 WIFDWC.

Other research topics suggested but not discussed during the workshop:

-The early studies of amino acid components of dwarf mistletoes and their hosts should be continued using contemporary molecular methods.
-Ultrastructural studies of the host-parasite interface should be expanded to gain a better understanding of these interactions.
-Efforts to effect in vitro culture of dwarf mistletoes should be continued.
-The role of birds in long-distance dispersal is poorly understood and requires additional study.
-Experimental studies to determine the cause of host exclusion should be a fascinating area for future

study.

-The effective distance and mode of pollen transport should be investigated experimentally.

-Chromosome numbers should be determined for the species not yet studied: *A. durangense*, *A. globosum* subsp. *globosum*, *A. guatemalense*, *A. monticola*, *A. oaxacanum*, *A. pendens*, *A. siskiyouense*, *A. tsugense* (shore pine race), *A. vaginatum* subsp. *vaginatum*, and *A. yecorense*) and all the Old World species (except *A. oxycedri* and *A. juniperi-procerae*). Detailed analysis of the karyotypes of various species, however, would be especially valuable.

-The possibility that sex chromosomes might occur in *A. douglasii* and *A. gillii* should be studied.

-A thorough analysis of sexual dimorphism should be undertaken.

-Crossing experiments should be carried out between closely related species, e.g., *A. apachecum-A. blumeri* and *A. campylopodum-A. occidentale*.

-Any aspects of the biology of the Asian species should be investigated.

-The study of molecular systematics should be continued. This offers a powerful methodology to elucidate species relationships that are often unclear in highly reduced groups.

-The relationships and taxonomic status of several Mexican and Central American taxa require clarification: (1) the small plants of *A. globosum* subsp. *globosum* around El Salto, Durango, in comparison with the other populations of this subspecies in the Sierra Madre Occidentál, (2) the "stocky" populations of *A. rubrum* in the vicinity of Altares, in northern Durango, (3) the occurrence of *A. aureum* subsp. *petersonii* in southern Oaxaca, (4) establish the identity of the dwarf mistletoe in El Salvador, (5) determine the taxonomic status of the populations in Belize that are tentatively retained in *A. aureum* subsp. *aureum*.

-Establish the northern distributional limits of *A. pusillum* especially in Ontario and Quebec.

-Studies on the upper elevational distribution of *A. americanum* (Laut) and *A. larisis* (Mathiasen) should be completed; including the question of whether natural populations of *Larix lyalii* are infested by *A. larisis*.

-Physiology - effects of parasitism on carbon allocation and formation of secondary compounds.

-Physiology - mechanisms and conditions which control maturation and formation of aerial shoots (latency) and systemic infections (esp. in Grand View population of ponderosa pine).

-Physiology - selective susceptibility (relative to host) to systemic herbicides.

-Biological control - examination of Asian candidates for biological control.

-Systematics - utility of using host-preferences of mistletoes to discriminate among related taxa of host species (esp. Abies); and re-evaluation of host-pathogen associations in light of newly proposed revision of Pinaceae.

-Genetics - mechanisms of host resistance and potential for improved breeding programs.

-Silvicultrual control under uneven-aged management - what the limits of stand conditions and sanitation prescriptions in which silvicultural control can succeed.

-Ecology - a re-examination of the ecolgy of dwarf mistletoe in relation to fire, wildlife, biodiversity, riparian zones, ecosystem resiliance, and other Ecosystem Management issues.

-Inventory/effects - pinyon mistletoe (how to rate, effects on seed productions); juniper mistletoe (?).

-Invertory/modeling - patterns of mistletoe spread and intensification, especially in stands of mixed species and age classes.

-Base research program - should there be support for continuation of taxonomic and literature reference services.

DWARF MISTLETOE SUPPRESSION PROGRAM ACTIVITY REVIEW

September 19 - October 1, 1993
Submitted by Dave Johnson

I. Introduction

A. Project Reviewed

The Dwarf Mistletoe Suppression Program

B. Previous Reviews

This program was reviewed by Forest Pest Management personnel from the Western Regions on December 15 to 17, 1987, in Salt Lake City, Utah.

C. Objectives of Review

1. Examine program effectiveness in meeting program objectives
2. Determine status of dwarf mistletoe effects modeling
3. Verify that the program meets biological, economic and environmental standards
4. Consider future direction for the program

D. Review Team

Tom Hofacker, FPM-Washington Office
Dave Johnson, RR-Region 1
John Kliejunas, FPM-Region 5
Joe Lewis, FPM-Washington Office
Dennis Murphy, TM-Washington Office

E. Other Participants and Contacts

Forest Service R-1

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Mary Lou Fairweather
Steve Gunzel
Marlin Johnson
Tom Schmeckpeper
Borys Tkacz

Forest Service R-5

James Allison
Mike Landram
John Neisess

Forest Service R-6

Jerry Beatty
Jim Hadfield
Max Ollieu

Bureau of Indian Affairs in R-1

Tom Corse
Dennis Dupuis

Consolidated Salish and Kooteni Tribal Forestry in R-1

Ralph Goode
Ken Trickey

Forest Service Rocky Mountain Station

Brian Geils

Other Agencies in R-3

Bob Cain, New Mexico State University, Cooperative Extension Service

II. Background

A. Dwarf Mistletoe in the Western United States

Dwarf mistletoes are parasitic plants that attack many species of conifers. Their impact has been of special concern in the western United States because they can reduce the growth rate of commercially valuable tree species and increase mortality rate and susceptibility to insect attacks and wildfires. Recent estimates are that more than 22 million acres of commercial forest land is infested resulting in annual losses in growth and mortality at 382 million cubic feet.

B. The Dwarf Mistletoe Suppression Program

Suppression efforts have been conducted for several decades to reduce the impacts of these organisms. At the 1988 FPM Staff Directors meeting, it was agreed that the major role of FPM should be to provide biological assessments, training and planning assistance and that funding for the dwarf mistletoe suppression program should be reduced to a maintenance level by 1994. Regional and United States Department of the Interior funding requests and allocations for dwarf mistletoe suppression for 1989 - 1993 are shown in Appendix A.

III. Commendations

A. All Regions are working to incorporate dwarf mistletoe management into ecosystem management.

B. All Regions' training and technology transfer programs are excellent.

C. All Regions have good working relationships with customers (BLM, BIA, and NFS).

D. Region 1 has translated dwarf mistletoe model outputs into simplified information that field personnel can use.

E. Region 3's public involvement/outreach efforts are excellent (signing along Arizona trail on the Kaibab National Forest, "Unnatural Forest" video, and public involvement on the Tonto National Forest).

F. Region 5 is doing an excellent job of following administrative requirements, keeping records, and focusing their dwarf mistletoe program on areas where the benefits are highest.

G. Region 6 has fully integrated their dwarf mistletoe suppression into their timber management program. No FPM funds have been spent for dwarf mistletoe suppression on National Forest System lands during the last several years.

IV. Findings and Recommendations

A. Finding: The dwarf mistletoe model is not being used extensively by forests/districts because:

1) PROGNOSIS and the dwarf mistletoe model are very complex;

2) PROGNOSIS and the dwarf mistletoe model have no spatial component;

3) PROGNOSIS and the dwarf mistletoe model do not incorporate effects on non-timber resources;

4) PROGNOSIS and the dwarf mistletoe model have not been validated for many stand conditions and treatments.

Recommendation: Discuss remedial action(s) to address this situation at the next dwarf mistletoe modeling meeting (two members of the Review Team will participate in this meeting). Regions should continue efforts to validate and calibrate models.

B. Finding: Areas where silvicultural treatments to suppress dwarf mistletoe can be carried out are declining. The increasing use of uneven-age management practices to meet ecosystem management objectives will likely increase future dwarf mistletoe incidence and severity in single species stands. This is likely to adversely affect the attainment of long-term management objectives where dwarf mistletoes cannot be adequately suppressed. For example, uneven-age management practices on the Flathead Indian Reservation have increased mistletoe severity to the point where the Reservation is considering moving to even-age management.

Recommendation: The Regions should continue to explore the use of measures other than silviculture (for example: use of ethephon, pruning, basal burning, development of resistant stock) to control dwarf mistletoe in situations where and where effective silvicultural treatments are not practical. The Regions need to monitor suppression treatments to determine the effectiveness of dwarf mistletoe suppression where uneven-aged management is being conducted. In situations where adequate dwarf mistletoe suppression cannot be achieved, suppression projects should be discontinued or even-age silvicultural systems should be used.

C. Finding: Several years ago the FPM Washington Office delegated responsibility to the Regions for ensuring that Forest Service Manual requirements for economic and environmental analyses are met. Currently, many dwarf mistletoe suppression projects do not meet requirements for economic and environmental analysis. In some instances economic and environmental analyses are not being done, in other instances the analyses are inadequate. The quality of the analyses vary greatly from project to project. In many cases these analyses are not submitted to the Regional Offices.

Recommendation: The Regions should strengthen oversight measures to ensure that administrative requirements are being met.

D. Finding: Economic analyses are based-mostly on benefits of fiber production. Benefit/cost ratios are less than 1:1 in some cases.

Recommendations:

1. Determine if additional guidelines are needed for dwarf mistletoe economic analysis procedures.

2. WO gather examples of good dwarf mistletoe economic and environmental analyses and distribute to Regions.

3. WO establish a team of economists, pest managers and resource managers to determine ways to evaluate the benefits of dwarf mistletoe management relative to resources other than timber.

4. In order to minimize the number of dwarf mistletoe suppression projects that have benefit/cost ratios less that 1:1, the Regions should strive to ensure that all quantifiable benefits are accounted for. Economically efficient projects should receive the highest priority for funding.

E. Finding: Annually, the Forest Pest Management Washington Office allocates suppression funds to the Regions as part of the final budget advice. In the western Regions the bulk of these funds were historically used to fund dwarf mistletoe suppression projects. This is still true for most of the western Regions. Most Regions have not reduced their funding of dwarf mistletoe suppression to a maintenance level because of shifts in the suppression program to new situations (e.g., developed sites, fire rehabilitation areas), and because of reductions in the availability of other funds (e.g., KV and timber management funds) to accomplish dwarf mistletoe suppression. Because of these changes and the anticipated increasing cost of accomplishing dwarf mistletoe suppression under ecosystem management, dwarf mistletoe suppression funds will continue to be needed by most western Regions. Most Regions would like the current funding arrangement to continue and some Regions would like a modest increase in their funding for dwarf mistletoe suppression. Bureau of Indian Affairs personnel expressed very strong interest in continued funding of their mistletoe suppression programs.

Recommendation: WO should continue funding dwarf mistletoe suppression at the current level and consider a modest increase in "final budget advice" funding of mistletoe suppression if sufficient funds are available.

F. Finding: Some Regions are providing FPM funds to help support multi-resource inventories while others are not.

Recommendation: WO-FPM should determine appropriate role of FPM financial support for multi-resource inventories.

G. Finding: Region 3 has an excellent public information/outreach effort for their dwarf mistletoe program.

Recommendation: The Review Team encourages Regions to consider Region 3 public information/outreach type efforts where similar opportunities exist.

V. Observations

A. Over 65 per cent of the base FPM suppression funds provided to Region 6 in the final budget advice are being used to meet Regional Office overhead and salary expenses.

B. With the current emphasis on ecosystem management, Regions need to more closely monitor dwarf mistletoe suppression projects to insure that treatments are meeting resource management objectives.

C. Only Regions 3 and 5 are conducting 5 and 10 year post-suppression monitoring of dwarf mistletoe suppression projects.

D. Region 3 has reduced their emphasis on funding dwarf mistletoe pre-suppression surveys and increased their emphasis on funding dwarf mistletoe suppression projects.

E. The current dwarf mistletoe suppression program is being carried out entirely in recreation areas and suitable land base. No projects are being conducted on non-suitable lands. This may change under the ecosystem management concept.

F. Region 1 is funding dwarf mistletoe suppression projects that do not meet their current DM funding guidelines.

WIFDWC DWARF MISTLETOE COMMITTEE REPORT, 1993 - 1994

Submitted by Bob Mathiasen

I. Taxonomy, Hosts, and Distribution

a. Western hemlock dwarf mistletoe (A. tsugense subsp. tsugense - western hemlock race) was found parasitizing lodgepole pine (Pinus contorta var. latifolia) near Trinity, Chelan County, WA (near the confluence of Phelps Creek and the Chiwawa River) approximately 26 km north of Lake Wenatchee. Several infected lodgepole pine were found growing near heavily infected Pacific silver fir. Infection levels on lodgepole pine indicate it is an occasional host of the western hemlock dwarf mistletoe at this location. Although artificial inoculations have demonstrated that lodgepole pine is susceptible to the western hemlock dwarf mistletoe, this is the first report of natural infection on lodgepole pine by this mistletoe.

   Infection of Pacific silver fir and subalpine fir was greater than 90% in the Trinity stands indicating these tree species are principal hosts there. This is the first report of western hemlock dwarf mistletoe on subalpine fir. All other reports of hemlock dwarf mistletoe on subalpine fir are based on parasitism by the mountain hemlock dwarf mistletoe (A. tsugense subsp. mertensianae).

   Other trees observed to be rarely infected by the western hemlock dwarf mistletoe in the Trinity area were: Engelmann spruce, western white pine, and mountain hemlock. This is the first report of the western hemlock dwarf mistletoe on these hosts in Washington.

b. The western hemlock dwarf mistletoe was found rarely parasitizing mountain hemlock near Wapinita Pass, Clackamas County, OR, approximately 17 km south of Mount Hood. This is the first report of the western hemlock dwarf mistletoe on mountain hemlock from Oregon. Other reports of hemlock dwarf mistletoe on mountain hemlock in Oregon are all based on parasitism by the mountain hemlock dwarf mistletoe (subsp. mertensianae).

c. The mountain hemlock dwarf mistletoe (A. tsugense subsp. mertensianae) was found rarely parasitizing lodgepole pine (Pinus contorta var. latifolia) near McKenzie Pass, Deschutes County, OR. This is the first report of the mountain hemlock dwarf mistletoe on lodgepole pine. Although only one small tree was infected, there were several infected branches that produced several mistletoe shoots each.

d. A western hemlock infected by the mountain hemlock dwarf mistletoe (A. tsugense subsp. mertensianae) was located approximately 4 km southeast of Shuksan, Whatcom County, WA, near the Mount Baker Highway at Bagley Creek. Although there were many western hemlock growing hear heavily infected mountain hemlock and Pacific silver fir, only one infected western hemlock was observed in the area. Therefore, western hemlock should be classified as a rare host of the mountain hemlock dwarf mistletoe. There were several infections on the western hemlock, but only a few infections had produced shoots.

A short research note reporting the above host/parasite combinations for hemlock dwarf mistletoe has been prepared for publication by the Rocky Mountain Research Station. (Bob Mathiasen, Idaho Department of Lands)

II. Physiology and Anatomy

a. Publications scheduled to come out soon include: the USDA Agriculture Handbook with Del Weins (should be published this year), a North American Forestry Commission practical guide to mistletoe management (with numerous other contributors), and several misc. papers on pinyons, Viscum, and effects on wildlife. (B. Geils, USFS, RM, Ft. Collins, CO).

III. Life Cycles

a. An 11-year-old gray jay, better known as the Canada jay, camp robber, or whiskey jack, has become the oldest recorded banded gray jay living in the wild in the U.S according to the USDI Fish and Wildlife Service Bird Banding Office. This record was documented in a study by Dr. Thomas H. Nicholls of the North Central Forest Experiment Station, St. Paul, MN who has been studying bird vectors of dwarf mistletoe on the Fraser Experimental Forest in Colorado in cooperation with the late Dr. Frank Hawksworth of the Rocky Mountain Station. Nicholls banded the bird at a ground elevation of 9,500 feet in 1982 and retrapped it 14 times in the intervening years in the same location where it was originally banded. It was found to be carrying dwarf mistletoe seeds of Arceuthobium americanum on two occasions when it was retrapped; two seeds in 1983 and one seed in 1986. In their studies of dwarf mistletoe vectors on the Fraser Experimental Forest, Nicholls and Hawksworth documented that the gray jay was the most important bird vector of A. americanum, a serious disease on lodgepole pine. In 1993, Nicholls also retrapped 14 other banded gray jays on the Forest ranging in age from 7- to 9-years-old. Over the years, several of these birds were also found to be carrying dwarf mistletoe seeds explaining how isolated infection pockets develop in otherwise healthy stands far-removed from local spread from infection centers.

These results indicate a relatively long life span for a vector of dwarf mistletoe and a resident bird that lives under extreme winter weather conditions at high elevations. It survives these harsh conditions because it has a rather unique way of preserving food. Gray jays possess two large mandibular salivary glands, one on each side near the base of the bill. The jay shapes its food into an oval pellet, or bolus, with its tongue and permeates it with saliva. The sticky saliva is used to glue food pellets to vegetation during the non-winter months where they dry to form a hard protective covering around the food. And best of all, gray jays can remember where they store most of their food enabling them to survive the long winters on the Fraser Experimental Forest and elsewhere. (Tom Nicholls, North Central Exp. Sta., St. Paul MN).

IV. Host-Parasite Relations

a. A study initiated in 1991 to determine the approximate ages and heights at which young western larch are first infected by larch dwarf mistletoe in the Inland Empire is continuing. An additional 100 and 270 larch saplings were sampled during 1992 and 1993, respectively. The 270 saplings were located on the Flathead Indian Reservation in western Montana. Results indicate that most western larch saplings are infected by the time they are nine years old when growing near heavily infected overstory trees. Most trees are taller than breast height before they are infected. The study has been expanded to include infection of young larch near infected seed trees. So far only three seedlings have been found growing near infected seed trees. The seedlings were seven years old. Infection of larch regeneration in the plots around several larch seed trees will be monitored for several years. Information on whether or not there is a "lag" period for aging larch dwarf mistletoe infections is being obtained from artificial inoculations. In 1992 and 1993 several hundred larch dwarf mistletoe seeds were placed on young western larch near Priest River, Idaho. Successful infections will be dissected after several years to determine how long it takes before annual rings become distorted as a result of mistletoe infection in larch. (Bob Mathiasen, Idaho Department of Lands)

b. Infection of noble fir and western hemlock by the western hemlock dwarf mistletoe (A. tsugense subsp. tsugense) was examined on Mary's Peak, Benton County, OR, just west of Corvallis. Infection does appear to be much greater on noble fir than western hemlock as previously reported by Frank Hawksworth and Del Wiens. Plots placed around heavily infected noble fir confirmed this observation; over 95 percent of the noble fir were infected while only 50-65% of the western hemlock were infected. Studies of this population are continuing. (Bob Mathiasen, Idaho Department of Lands; Jerry Beatty, USFS, FPM, R6; G. Filip, Oregon State Univ.)

c. Heavy infection of Pacific silver fir and noble fir by both subspecies of the hemlock dwarf mistletoe was observed near Wildcat Mountain and on the H.J. Andrews Experimental Forest (near Frissell Point). Plots placed around heavily infected western hemlock indicated that 100% of the noble fir and Pacific silver fir larger than 10 cm in diameter were infected at two locations - one representing parasitism by the western hemlock dwarf mistletoe (subsp. tsugense) and one representing parasitism by the mountain hemlock dwarf mistletoe (subsp. mertensianae). Investigations of the host/parasite relations of the hemlock dwarf mistletoe in these areas is continuing. (Bob Mathiasen, Idaho Department of Lands; Greg Filip, Oregon State Univ.; Katy Marshall, Oregon State Univ.)

d. Additional quantitative data is being collected on the host relationships of the larch dwarf mistletoe (A. laricis) in northern Idaho and western Montana. Temporary circular plots (6 m radius) are placed around heavily infected western larch in mixed conifer stands and the following data recorded for each tree larger than 10 cm in diameter: species, dbh and DMR. This information will be used to better evaluate the natural host susceptibility classifications for the larch dwarf mistletoe in the Inland Empire. (Bob Mathiasen, Idaho Department of Lands)

e. A study to quantify the level of parasitism on subalpine fir by the Douglas-fir dwarf mistletoe (A. douglasii) in the Pacific Northwest was started in 1993. Quantitative data was collected from new areas where Douglas-fir dwarf mistletoe was discovered on subalpine fir in Washington. In 1994 additional data will be collected from areas where this host-parasite combination has been previously reported in Idaho and Washington. (Bob Mathiasen, Idaho Department of Lands).

f. From 1991-93 several field surveys were conducted in the locations where J.R. Wier collected larch dwarf mistletoe on alpine larch (Larix lyallii) in 1914 and 1916 (near Scotchman Peak, MT and near Lolo, MT). Populations of alpine larch were examined on Carlton Ridge (near Lolo) and on Savage Mountain (near Scotchman Peak) without locating any additional infections of larch dwarf mistletoe on alpine larch. Alpine larch primarily occurs at elevations above 5000 feet and larch dwarf mistletoe seldom reaches this elevation in western Montana or northern Idaho. No areas were located where infected western larch were growing sufficiently close enough to alpine larch to allow cross infection to occur. Therefore, I have not been able to confirm parasitism of alpine larch by the larch dwarf mistletoe up to now. Additional surveys of the Savage Mountain population of alpine larch are planned for 1994. (Bob Mathiasen, Idaho Department of Lands)

g. Field data was collected in 1993 from sixteen permanent plots Targhee National Forest in eastern Idaho. The 100-tree plots representfour replicates of four spacing level regimes established and thinned in 1983. Plots are remeasured every 5-years. Objectives of the long-term study are to determine: 1) the effects of pre-commercial thinning on growth of dwarf mistletoe infected lodgepole pine; 2) the changes in dwarf mistletoe incidence and intensity over time; and 3) the effects of dwarf mistletoe parasitism on growth and mortality of lodgepole pine trees. (J. Hoffman, USFS, FPM, R-4, Boise)

V. Effects on Hosts

a. 20-year plot data from Douglas-fir located on the Okanogan NF and Malheur NF are being analyzed. In part, we will use dendrochronological techniques to evaluate growth patterns of DM infected trees and to quantify impact of defoliator outbreaks on the trees. (Catherine Parks, PNW, La Grande; Bob Tinnin, PSU, Portland; Brian Geils, USFS, RM, Fort Collins).

VI. Ecology

a. AZ FPM evaluated the incidence, effects, and impact of southwestern dwarf mistletoe in 17 environmental analysis areas, each comprising about 10,000 acres. The evaluation (3420) letters were often used in consultation with Fish and Wildlife Service for the recovery of the Mexican spotted owl which was listed last January. (M.L. Fairweather, USFS, FPM, R-3, Arizona Zone).

VII. Control

- Chemical

a. Evaluation of field tests of the plant growth regulator, ethephon, has shown that significant abscission of dwarf mistletoe shoots occurs within a few weeks after application. Tests conducted in the Black Forest north of Colorado Springs, Colorado in 1988 on ponderosa pine dwarf mistletoe showed abscission rates of 73 to 98 percent with mid-June, mid-July and mid-August applications of the chemical at rates of 2200 and 2700 ppm ethephon in water with a spreader-sticker.

Examination of trees five years following treatment showed development of immature shoots on all treatments and some development of mature shoots with fruits. It is also interesting to note that 34 percent of the original branch infections have died as a result of breakage, girdling by rodents, and other natural agents during this time. (D. Johnson, USFS, FPM, R-2).

- Genetic

a. Ponderosa pine parent trees produced in 1965-67 by grafting from 6 previously identified dwarf mistletoe resistance candidates are growing in the Badger Hill Clone Bank. These trees are of pollen and cone bearing age. Controlled-crosses between each of the six parents were made this spring. A half-diallel with selfs and five reciprocal-crosses was used as a design. About 350 flowers were unbagged after pollination.

In August, interested parties including Dr. Robert Scharpf, Dr. Jay Kitzmiller and Dr. James Allison met on the Lassen National Forest. Discussions were held in the field near the location of the six original resistant parent trees. Topics revolved around the development of efficient methods of selecting and testing ponderosa pine parents resistant to dwarf mistletoe.

In December, six ponderosa parents, grafted at the Badger Hill Clone Bank, were artificially inoculated. Each parent was inoculated with 300 dwarf mistletoe seed. Three parents were from the aforementioned resistance candidates. Three were susceptible controls.

The August meeting provided the foundation for a project proposal. Short-term plans include 1) completion of controlled crosses between resistant parents, 2) selection of 60 new resistance candidates and controls from the Lassen and Plumas National Forests, 3) monitoring of artificial inoculation at Badger Hill, and 4) with Dr. Scharpf, investigation of mistletoe patch grafts as a resistance screening technique. A patch of active dwarf mistletoe infection would be grafted into resistance candidates and controls. This technique might improve on the estimated 3-5 years required by artificial seed inoculation to evaluate resistance. Long-term plans include grafting of newly selected parents and continued evaluation of previously grafted materials. Finally, genetic inheritance will be evaluated using both artificial inoculation and field plantings of controlled-cross seedlings.

All short and long-range plans will depend on funds to supplement the rapidly decreasing Genetic Resource Program budget. (Dr. Jay Kitzmiller, USFS R-5 Geneticist, Genetics Resource Program, Dr. James Allison, USFS R-5 Pathologist, Forest Pest Management, Paul Stover, USFS, R-5 Zone Geneticists, Eldorado N F, Genetics Resource Program, Chuck Frank, USFS, R-5, Zone Geneticist, Klamath N F, Genetics Resource Program, Dr. Robert Scharpf, USFS (emeritis), c/O, Institute Forest Genetics, 2480 Carson Rd., Placerville Ca. 95667).

- Silvicultural

a. Plans are to treat 1,703 acres of dwarf mistletoe infested stands on the Arapaho and Roosevelt; Grand Mesa, Uncompahgre and Gunnison; medicine Bow; Pike and San Isabel; Routt; and White River National Forests (P. Angwin, D. Johnson, USFS, R-2).

b. About 1110 acres on National Forest lands and 1500 acres on Indian lands were treated in Forest Pest Management-funded DM control projects in New Mexico in 1993. Treatments included intermediate thinnings, removal of infected residuals, and clear cuts. (David A. Conklin, USFS, FPM, R-3, New Mexico zone).

c. Five-thousand acres were treated for dwarf mistletoe suppression on 10 national forests in the Intermountain Region (R-4) in 1993. Dwarf mistletoe pre-suppression surveys were completed on 15,100 acres. (J. Hoffman and J. Guyon, USFS, FPM, R-4).

d. About 1700 acres of National Forest lands were treated with DM suppression moneys in Arizona in 1993. Treatments included intermediate thinnings and removal of infected residuals in burned areas. (M.L. Fairweather, USFS, FPM, R-3, Arizona Zone).

e. Inyo NF, Mammoth RD. 20 acres in the Twin Lakes Campground were treated for control of lodgepole pine dwarf mistletoe. Infections in the treatment area were light to moderate. 590 trees were either broom or branch pruned, and 73 trees were removed. Pines ranged from 10-14 inches dbh. This was the first dwarf mistletoe suppression project involving lodgepole pine in a R-5 recreation area.

f. Angeles NF, Mt. Baldy RD. 33 acres in the Crystal Lake Recreation Area were treated for control of western dwarf mistletoe in Jeffrey pine. 280 trees were pruned and 20 trees were removed.

g. Cleveland NF, Descanso RD. 89 acres in the Burnt Rancheris, Wooded Hill, and Horse Heaven campgrounds were treated for control of western dwarf mistletoe in Jeffrey pine. 250 trees were pruned and 133 trees were removed.

h. Los Padres NF, Mt. Pinos RD. 70 acres in the Mt. Pinos Campground and organizational sites were treated for control of western dwarf mistletoe in Jeffrey pine. 600 trees were pruned and 200 trees were removed.

i. San Bernardino NF, Arrowhead, Big Bear, and San Gorgonio RDs. 196 acres in developed recreation areas were treated for control of western dwarf mistletoe in Jeffrey pine. 500 trees were broom-pruned or removed. (J. Kliejunas, USFS, FPM, R-5)

VIII. Surveys

a. Presuppression surveys for dwarf mistletoe are planned for 16,741 acres on the Arapaho and Roosevelt; Medicine Bow; Pike and San Isabel; Routt; and White River National Forests (P. Angwin, D. Johnson, USFS, FPM, R-2).

b. Stanislaus NF, Groveland R-D. Presuppression surveys were completed on 15,045 acres that were part of the 1987 Stanislaus Complex wildfire. Survey data will help the District decide on treatments in areas already replanted and areas yet to be planted. (J. Kliejunas, USFS, FPM, R-5).

IX. Modeling

a. Dwarf Mistletoe Model Improvements:

The Interim Dwarf Mistletoe Impact Modeling System is available on all 14 western variants of the Forest Vegetation Simulator (FVS).

The "Interim Dwarf Mistletoe Impact Modeling System: Users Guide and Reference Manual" (USDA Forest Service, Forest Pest Management/Methods Application Group, Report No. MAG-91-3, 92 pages) was revised June 1993, reflecting changes and corrections to both the model and the manual. This revision replaces the previous March 1992 version.

Mistletoe model workshops were held November 17-19, 1992 and November 30 -December 1, 1993, both in Fort Collins, CO, to review improvements and refinements to a new spread and intensification section of the mistletoe model. The report on the latter workshop, "The New Dwarf Mistletoe Spread and Intensification Model: Final Model Review Workshop Report", was published in February, 1994.

In principle, the new model is able to simulate infections in multi-species, multi-storied stands. Some parts of the simulation are explicitly spatial while other parts are statistical simulations. Users are provided many keywords that will alter the model's behavior. The new model is undergoing final revisions and testing, and will be available later in 1994.

An electronic working group was set up in February, 1994, to enable model builders, maintainers, users, and researchers to more effectively exchange comments, information, and data sets, while evaluating the dwarf mistletoe model. The group includes persons on the U. S. Forest Service's internal (Data General) computer system as well as persons on the Internet.

For more information on the dwarf mistletoe model, contact J. Adams, (303) 498-1727. (J. Adams, USFS, FPM/Methods Application Group and G. Shubert Management Assistance Corp. of America).

b. Five new permanent plots were established on three national forests in Region 4 (Intermountain Region) in 1993 to expand the database needed to validate and calibrate the dwarf mistletoe extension of the Forest Vegetation Simulator model. Ten plots were remonitored on four National Forests for the same purpose. The database was created by FPM-MAG to house data from all types of permanent plots, including data from timber and range plots. (J. Guyon, USFS, FPM, R-4, Ogden)

c. Efforts are underway to develop default values for the new DM model for how DM fills up the crown-thirds of host trees. Twenty-six permanent plots from R-4 and three plots from R-3 were run through a program that sorts out the DMR data by crown-thirds and summarizes these data. Debugging and error checking for this program are underway. (John Guyon, USFS, FPM, R-4, Ogden and Fred Baker, Utah State University, Logan Utah)

d. Data from 8 R-4 stem-mapped permanent plots was sent to Greg Shubert of MAG. These data will be used to help develop autocorrelation default values for the new DM model. (John Guyon, USFS, FPM, R-4, FPM, Ogden and Greg Shubert, contractor with USFS, FPM, MAG, Fort Collins, CO)

e. work is in progress on improving mortality and spread/intensification functions for the mistletoe models; as well as developing techniques for better relating the cumulative, ecological effects of mistletoe infestation on certain wildlife species. (B. Geils, USFS, RM, Ft. Collins, CO).

X. Miscellaneous

a. Basal fire was used for recruitment of wildlife snags on the Valle Vidal Unit of the Carson National Forest. About 100 old infected residuals were burned in January 1993. Long-term monitoring is planned to determine 1) time to mortality, 2) snag longevity, and 3) wildlife use. Results from 1987 and 89 projects on the Gila NF show that the method was successful in achieving quick mortality, but recent observations suggest that snag longevity may not be greater than that achieved with mechanical girdling. (David A. Conklin, USFS, FPM, R-3, New Mexico zone)

b. Several of our "Pest Trend Impact Plots in the West" plots have been established in areas recently treated to control or suppress DM. This will allow us to collect information, not only for model validation, but more directly, to monitor the results of recent projects. (David A. Conklin, USFS, FPM, R-3, New Mexico Zone).

c. Several of our "Pest Trend Impact Plots in the West" plots have been established in areas recently treated to control or suppress DM and in areas deferred from treatment. We are checking these plots every two years for mortality and resurveying completely every 5 years. Most of our plots are in areas infested with southwestern dwarf mistletoe, but we have a few in Douglas-fir DM-infested areas. we will only set up a few plots in 1994. (M.L. Fairweather, USFS, FPM, R-3, Arizona Zone).

d. Other continuing efforts are to maintain herbarium services, monitor and report on various permanent plot systems, beta-test the mistletoe model, and provide literature-search services on mistletoes. (B. Geils, USFS, RM, Ft. Collins, CO)

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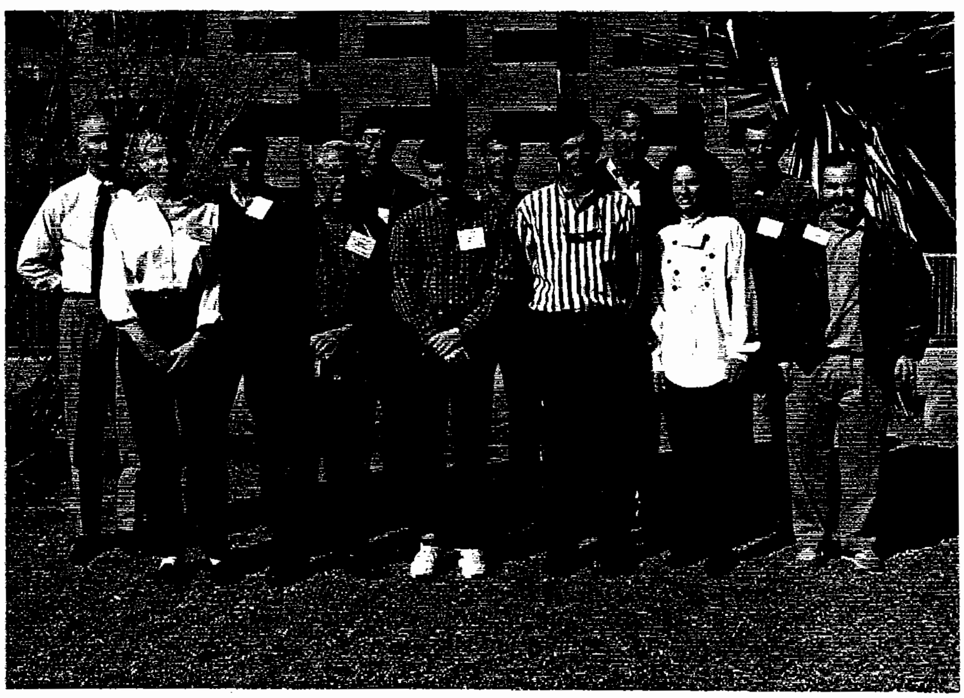
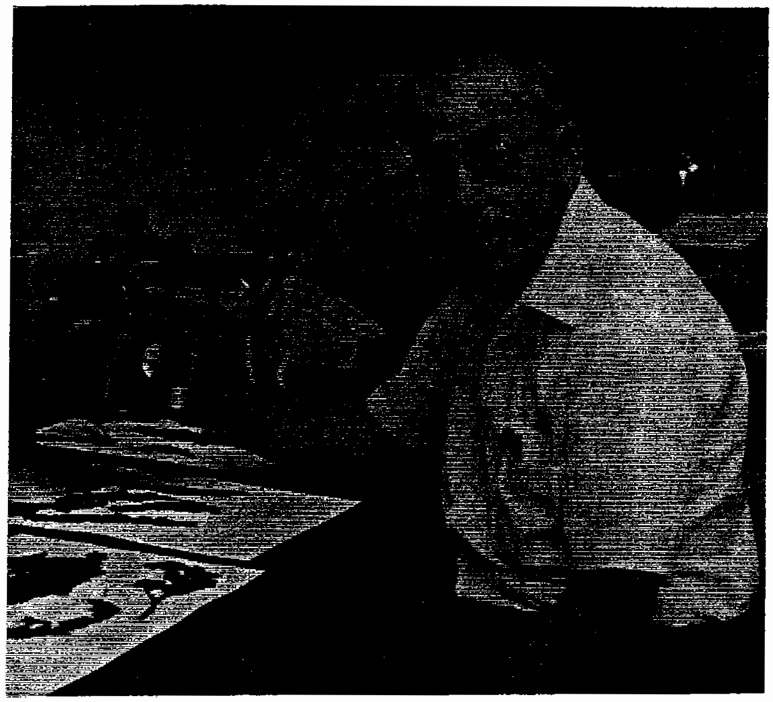
Front Row: Diane Hildebrand, Barbara Illman, Dick Smith, Jim Byler, Pete Angwin, Blakey Lockman, Alice Ratcliff, Dan Omdal, Rich Dorset
Back Row: Mary Lou Fairweather, Allan Van Sickle, Jeff Beale, Terry Shaw, Jerome S. Beatty, Bill Jacobi, Bob Mathiasen, Dave Conklin



Front Row: Jodi Gray, Bob Gilbertson, Paul Hennon, Borys Tkacz, Susan Frankel, Ralph White
Back Row: David Gray, Nolan Hess, John Lundquist, Bill Woodruff, Tim Paine, Bob Cain

Appendix I: Obituary for Frank Hawksworth and Memorial Fund Letters



This volume Is dedicated to Frank G. Hawksworth

Frank G. Hawksworth
1926-1993

Frank G. Hawksworth, 66, a 35 year resident of Fort Collins, died Friday, January 8, 1993, at Poudre Valley Hospital. He was a pioneer member of WIFWDC. He greatly influenced the character and evolution of our organization, and we will miss his guidance and counsel. Our meetings will not be the same without his warmth and wisdom.

Frank was born on April 30,1926, in Fresno, California, the son of William and Elsie Hawksworth. He received a BS in forestry from the University of Idaho in 1949, and MS (1952) and Ph.D. (1958) degrees from Yale.

Dr. Hawksworth, a highly respected and admired scientist, retired from the US Forest Service's Rocky Mountain Forest and Range Experiment Station in 1990 with 43 years of federal service. He authored over 200 scientific publications on forest diseases. He was the world's authority on dwarf mistletoes, the most damaging parasites in forests of western North America. His research on mistletoes enabled him to travel, conduct research and cooperate on projects with scientists and managers throughout the world. His work on these pests did not stop with the publication of scientific information. He maintained constant contact with foresters, scientists, and practitioners at all levels of government, industry, university, and private practice to assist them with on-the-ground management problems. His kindness, concern for others, and quality work were especially appreciated by Mexican foresters, who affectionately knew him as "Dr. Frank". Frank's unique combination of brilliance, humility, and endless wit earned him a special place in the hearts of forest scientists and managers internationally.

Dr. Hawksworth was a member of the Society of American Foresters, International Union of Forest Research Organizations, International Council on Parasitic Seed Plants, Western International Forest Disease Work

Conference, and Sigma Xi. He received Superior Service and Technology Transfer Awards from the US Department of Agriculture, and the Outstanding Forestry Research Award from the Society of American

Foresters.

Frank s commitment to the science of forest pathology did not stop with retirement. He maintained an office at the Research Station and volunteered over 1000 hours of his time each year since retirement. He also completed drafts of two books and this 40 year history of the Western International Forest Disease Work Conference. Frank s love of his science was an inspiration to the numerous students and colleagues who were fortunate enough to have known and worked with him. Many forest pathologists will remember how, when they were students or youthful unknowns, Frank listened to their ideas with patience, encouragement and genuine interest. His enthusiasm for science carried over into other aspects of his life as he was an active birder with a personal sighting list of over 500 species, an avid post card collector, and an all-around family man. He set an exceptional example for us all.

Frank Hawksworth s Career -Excerpts from Buchanon's History of Forest Pathology of the West

Frank G. Hawksworth first went to work for the division of Forest Pathology in late 1949 at Albuquerque, New Mexico for Dr. Lake S. Gill who immediately set him to work researching dwarf mistletoe problems in the Grand Canyon area. Frank previously had a "checkered" career in blister rust in the California Sierra during the summers and had worked as a summer assistant on the University of Idaho pole blight research crew in 1948. After graduating in 1949 he was rehired by the University on a more permanent basis to continue on that project. In the Fall of that year however, Dr. Buchanan, recognizing his potential as a researcher, recommended him to Dr. Gill. Fortunately for both of them, Lake was able to hire Frank immediately because one of his technicians, Pete Millenbaugh, had just decided there was a better future in the Post Office Department as a local letter carrier. Hawksworth and Hinds thus became Lake's two technical aides.

"In making idle conversations with some of his Department of Interior compatriots one day, Frank allowed as how a good man could make a round trip trek across the grand canyon between daylight and dark of the same day. Having vowed he thought it could be done, Frank felt obliged to prove his point. So, early in the morning on Thanksgiving Day, 1950, he set out for the South Rim, walked to the Canyon bottom thence up to the North Rim. He then turned right around and made the trip in reverse. This involved a vertical descent and ascent of about 13,000 feet. The 45-mile trip took him 18 hours and to date there is no evidence his record has ever been broken.

"Frank only worked a couple of years on dwarf mistletoe problems among the Mescaleros Apaches when he took off for one year to earn his Master's degree at Yale University. Then the army pulled his number out of a bowl in 1954, but kept him only briefly before they released him because of his chronic asthmatic condition. Frank really didn't get a chance to settle down to his mistletoe work even then for in 1956 it was back to Yale again for residence requirements for his Ph.D."

"When he returned this time, he found himself stationed at Fort Collins, Colorado to where headquarters had been changed upon consolidation of the Southwestern and Rocky Mountain Stations....Frank was then moved up the line and has served as the equivalent or as project leader ever since. With all of these interruptions, reorganizations, and moving about, he has made a lasting contribution already to dwarf mistletoe knowledge. He has done some fascinating, interesting and important research based largely on imagination, initiative, and ingenuity ...

Prepared by, Terry Shaw and Dick Parmeter

Colorado State

University

Department of Plant Pathology
and Weed Science
FortCollins,Colorado 80523
(303) 491-5261
FAX: (303) 491-0564

July 12,1993

Dear Colleague:

We were all saddened and shocked by Frank Hawksworth's recent death. Frank had a long and dedicated career in plant pathology and forest management and was a major force in information generation and dissemination in the West.

To recognize his accomplishments and continue his mission to educate others, his family had requested that a memorial scholarship fund be established in the Department of Plant Pathology and Weed Science at Colorado State University. Much to our benefit, Frank was active in teaching and advising graduated students as an affiliate faculty remember in this Department for over 30 years. The Scholarship will be for graduate students in the area of forest ecosystem and pest management

We desire the fund lo be self sustaining with the interest used as the scholarship. The minimum amount required for a sustaining fund at Colorado State University is S 10,000. The fund h is been established and we ate over 40 percent of the way to meeting our goal. We heartily thank those of you who have helped lo date.

If others would like to donate, please send checks to the Department of Plant Pathology and Weed Science, Colorado State University, Fort Collins, C0 80523. Checks should be made out _ Colorado State University Foundation. In the memo section of your check, please indicate that the donation is in memory of Frank Hawksworth.

We also need ideas on how to raise more funds for this worthy cause. Can we do something at this year's WIFDWC? Can you think of any possible corporate sponsors? Any and all ideas to assist in the fund raising effort would be appreciated.

We also would appreciate hearing from you about Frank. We will he compiling a collection of stories and impression of Frank in a scrap book as part of our attempt to keep future generations as enthused as be was about life, people and his science.

Attached is a draft of the scholarship criteria for your comments and a copy of Frank's obituary.

If you have questions or ideas and wish to call us please do so at (303) 491-6927.

Sincerely,

Gary. Mclntyre
Department Head

Bill Jacobi
Associate Professor

Terry Shaw
Research Plant Pathologist
and Project Leader/U.S. Forest Service

David Leatherman
Assistant Staff Forester
Colorado Stale Forest Service

HAWKSWORTH MEMORIAL GRADUATE STUDENT SCHOLARSHIP

Number and Value:	One at earned income
Class and Major:	Any graduate student who has completed at least one semester and is currently enrolled in a graduate program in the Department of Plant Pathology and Weed Science or Forest Sciences. Field of study should be in pest management or forest ecosystem management.
Resident Requirement:	None; can be other than a U.S. citizen.
Award Based On:	High academic achievement and ability, dedication to the field of plant pathology or forest management, participation in departmental and University activities, and proven ability lo work cooperatively with others.
Selected By:	Designated representative of the Department of Plant Pathology and Weed Science, Colorado State Forest Service, and USDA Forest Service, Rocky Mountain Forest and Range Experiment Station .
Terms:	Maintain high academic performance and continued need for financial assistance.
Apply:	Department of Plant Pathology and Weed Science, C120 Plant Science Building.
Form To Be Used:	Letter of application to the Department of Plant Pathology and Weed Science. Include transcripts for all post secondary education, three letters of support from academic or research associates, and evidence of achievement in award criteria.
Application Due:	February 1, 1994.

The preceding information is an accurate reflection of criteria established for selection of a recipient for the 1994-1995 academic year in the College of Agricultural Sciences at Colorado State University.

Signature　　　　　　　　　　Date

Colorado
State

University

521 University Services Center
Fort Collins, Colorado 80523
(303) 491-7328
FAX: (303) 491-0234

January 10, 1994

Mr. Ken Russell
Western Intl Forest Disease Conf
1111 Washington Street Southeast
P.O. Box 47000
Olympla, WA 985047000

Dear Mr. Russell:

On behalf of our students, faculty, and staff, thank you for your gift of $800.

Your contribution is an investment in land-grant higher education. benefiting individuals as well as society. Colorado State University strives to continue opening its classroom doors in the spirit of making education available to all who have the will and ability to learn.

No great university has ever resulted from the efforts of a single person but rather from the combined efforts of many. Your private support combined with that of many other Colorado State University alumni and friends helps to build a greater university than state funds alone can build.

Since its founding in 1870 Colorado State University has remained state-assisted rather than state-supported. Less than 26 percent of the University's operating support is provided by the state. The current and future success of Colorado State University rests increasingly on private contributions such as yours.

We **appreciate your generosity and commitment.** Your continued support will help us enhance educational opportunities for all.

Sincerely,

Kirvin L. Knox
Associate Provost for
Agriculture and Public Service
Dean of the College of
Agricultural Sciences

:ds

February 4, 1994

Dear Ken,

On behalf of the Hawksworth family, I would like to thank WIFDWC for the contribution to Frank's Memorial Fund at CSU.

Attending those meetings was always a highlight for both of us. The scientific contacts, friendships, and fun memories meant much to one and all.

Needles to say, Frank would have been pleased that you chose to honor him in this manner. We as a family hope this scholarship will provide some measure of support for future scientists. Thanks again for helping to make it possible.

Sincerely,

Peggy Hawksworth & family

Appendix II: Obituary for Galen Trostle

Galen Trostle, retired Forest Service entomologist, died on September 15,1993 at his home in Lincoln City, Oregon after a courageous bout with cancer. Galen was born and raised in Southern California and attended Washington State University until World War II called him to service in the U.S. Navy. After the War, he completed his studies in forestry and entomology at Washington State University, graduating in 1946. Galen's earliest professional assignment was as an entomologist on the 1947 Douglas-fir tussock moth spray project in Idaho. He continued working with the Bureau of Entomology and Plant Quarantine, Division of Forest Insect Investigations at the Coeur d'Alene, Idaho laboratory until the "Forest Insect Investigations" branch was absorbed by the U.S Forest Service in 1954. At that time, Galen transferred to the Pacific Southwest Station in Berkeley, California working on forest insect surveys. He later transferred to the Forest Pest Management unit of Region 4, in Ogden, Utah. He was assigned to Region 6, Forest Pest Management and the Douglas-fir tussock moth RD&A program in Portland, Oregon in 1974, and later served as the supervisory entomologist for Forest Pest Management. He retired there in 1979. Galen was a contract entomologist on the 1990 Western Spruce Budworm project in the Blue Mountains when he became ill. He served as chairman of the Western Forest Insect Work Conference for 1975-1976, and was serving on the History Committee at the time of his death. We have lost a valued friend and Work Conference memeber with his passing.

Appendix III: Forest Pathology and Entomology Trivia

Compiled by: Borys Tkacz, Jerome Beatty, Dave Bridgewater, and Bruce Hostetler

1. What is the common name for *Razoumofskya robuata*, a common forest parasite?

   Southwestern dwarf mistletoe

2. Who created the "root disease gnome", what does he have in his hand and why, and how many publications has he appeared in?

   Concept: Mike Marsden, Artist: Tracy Wager, Four so far: GTR INT-267, Research Papers RM-303, RM-306 and RM-308.

3. What is the host of *Phoradendron hawksworthii* and where is it found?

   Junipers in southern NM and western Texas into Mexico

4. Which forest entomologist not only goes by the nickname "Duck" but also does research in Disneyland?

   Don Dahlsten

5. Which retired forest pathologist introduced a WIFDWC panel on Diseases of Arid and Semi-arid Areas by saying "the topic is one about which I am singularly uninformed"?

   Larry Weir

6. Name two pathologists who are "deadheads" (i.e., fans of the Grateful Dead for you non-baby boomers). Bonus point: Where did the Grateful Dead play last weekend?

   Pete Angwin and Mike McWilliams, Phoenix, AZ

7. Name the pathologist known as "Dr. Biomass" (clue: he is highly sought after for standing on the bumpers of trucks that get stuck in snow).

   Terry Shaw

8. Which forest entomologist has been spotted cruising down the highway on his Harley with a mountain bike strapped on the back?

   Ed Holsten

9. Name the Forest Service Region with the largest forested acreage and smallest insect and disease staff.

   Region 10 - Alaska

10. Which forest pathologist's last name means "weaver" in a foreign language? Bonus Point: spell the last name correctly!

Borys Tkacz

11. Which forest entomologist read the sign on his Forest Service lifevest "jerk to inflate and did indeed jerk it for no apparent reason?

Andy Eglitis

12. Which woodswise forest entomologist locked himself in the back of a truck and had to use his trusty Swiss Army knife to get out? Bonus Point: Where is the knife that saved his life?

Terry Rogers, ??

13. Name the forest pathologist who after reporting on the world's largest dwarf mistletoe control project (85,000 acres) went on to spray more acres of defoliators than most entomologists? Bonus Point: Where was the worlds largest dwarf mistletoe control project?

Jim Hadfield, on Mt. St. Helens in 1980

14. What causes "Kinky disease" of pine?

Caused by the initial attack of a plant feeding mite *Trisetacus campnodus* followed by a secondary attack by the fungus *Sclerophoma pithyophila* on shore pine in British Columbia.

15. List the year and location for the previous combined WIFDWC/WFIWC meetings.

1954 in Berkeley, 1975 in Monterey, and 1989 in Bend. Jill: this is the fourth combined meeting!

16. Who gave a WIFDWC paper on harvesting the power of exploding dwarf mistletoe seeds as an alternate energy source? Bonus Point: How many kilowatts could be harvested in Arizona and New Mexico?

R.C. Thobium (a.k.a. Frank Hawksworth), 67,000 kilowatts

17. Which organisms have older fossil evidence: bark beetles or dwarf mistletoes? Bonus Point: name the epoch of oldest evidence for each.

Dwarf mistletoes. Eocene (38-53 million years ago
Bark beetles. Oligocene (26-38 million years ago

18. Which w i d e l y traveled forest pathologist, using his heavily accented Spanish, asked a startled Mexican shopkeeper if she had any billy-goat cheese? Bonus Point: What was he really asking for?

Terry Shaw

19. Who was the only person to be awarded the WFIWC Ethical Practices Award three times?

Walt Cole

20. Who was the only person to be awarded the WIFDWC Social Achievement Award more than once?

Stuie Andrews

21. Name the two infamous Forest Service Washington Office entomologists who engaged in a baked potato throwing fight at a formal WFIWC banquet in Ogden, UT and were threatened with legal action by the hotel?

Jack Whiteside and Jack Bongberg

22. Which early entomologist was photographed in a aerial photograph in which he is seen standing on the top of a tree topped at 90 feet to mark the corner of a spray block?

Walt Buckhorn

23. Which sibling forest entomologists were known for their exploits as collectors of insects from mountain snowfields in the Pacific NW?

Robert and Malcolm Furniss

24. Which forest pathologist has published on fungi in snowbanks?

Bob Gilbertson

25. A renowned forest entomologist "shot an arrow into the air. It fell to earth" into the arm of his supervisor! Name the "shooter" and the "shootee."

Mark McGregor and Dick Washburn, resp.

26. Name two introduced forest insects for which the population here in the US consists entirely of females?

Balsam wooley adelgid (*Adelges Picea*) and pear thrips (*Taeniothrips inconsequens*)

27. Name the ultimate softball playing entomologist: while on a work trip, he got on a jet after work, flew back to his home town to play in a game, then jetted back to the work site.

Andy Eglitis

28. Which bark beetle was nicknamed "the pine beetle logging company" by Martin in 1935?

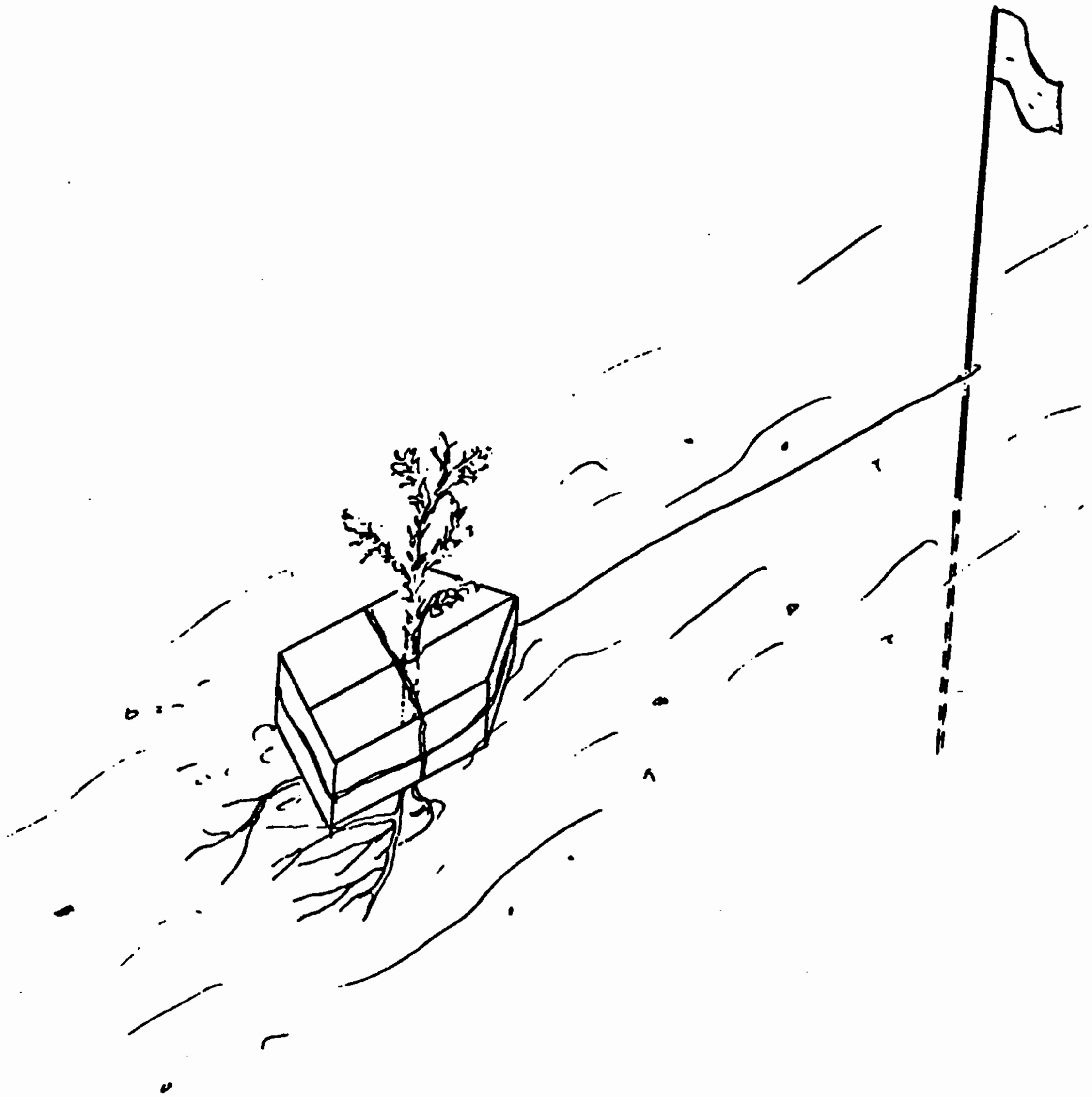
Western Pine Beetle (*Dendroctonus brevicomis*)

29. Which two entomologists managed to get a 4x4 buried in the mud ... right next to an excellent trout stream ... while they were supposedly working on a gypsy moth project?

Bill White and Dave Holland

30. What is this?

Bioassay for *Phytophthora lateralis*



Appendix IV: Fun Run

Tuesday, March 8, 1994

Officiated by Dayle Bennett

The second pentennial Entomologist versus Pathologist 5K fun run was held Tuesday afternoon in a residential area west of Old Town. As luck would have it, the day was one of the coldest days of the entire winter in Albuquerque. In spite of the blustery conditions that accompanied the race, about 15 hardy runners turned out to participate in the event. Darrel Ross led the pack and finished first in a time of 21:12, giving the men's title back to the entomologists. Marylou Fairweather won the women's division, thus retaining top woman runner honors for the pathologists. A slow moving duo of pathologist, Bob Mathiason and Greg Philip, gave special emphasis to the "fun" aspect of the fun run as they paced themselves throughout the course and finished with a time more comparable to the "rate of spread" for Armillaria than for a typical 5k race. Thanks is given to the many volunteers who helped organize and safely conduct this event.