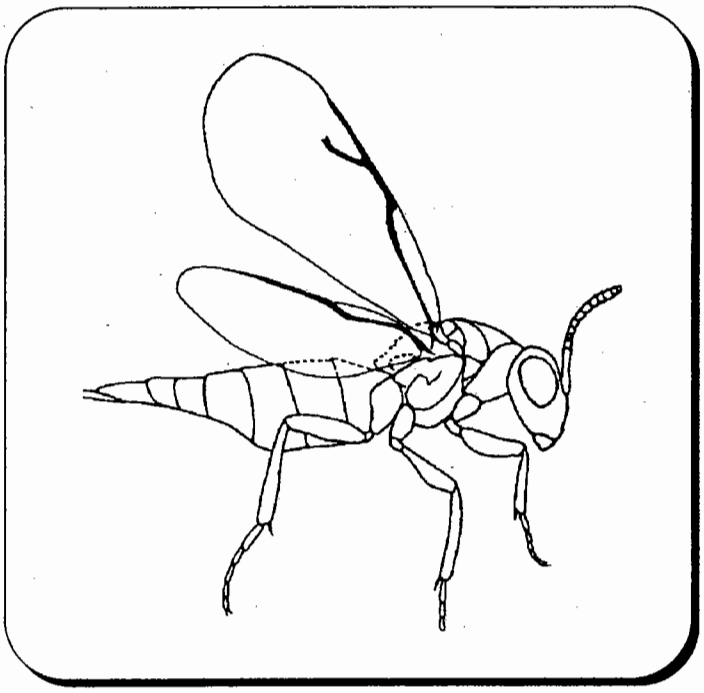
Proceedings

FORTY-FOURTH ANNUAL

WESTERN FOREST INSECT

WORK CONFERENCE



Sacramento, California

February 28 - March 4, 1993

PROCEEDINGS

FORTY-FOURTH ANNUAL

WESTERN FOREST INSECT

WORK CONFERENCE

SACRAMENTO, CALIFORNIA

February 28 - March 4, 1993

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Not for citation

PROCEEDINGS

FORTY-FOURTH ANNUAL WESTERN FOREST INSECT WORK CONFERENCE

SACRAMENTO, CALIFORNIA

February 28 - March 4, 1993

1992-93 WFIWC EXECUTIVE COMMITTEE

Iral Ragenovich, Portland, OR.	Chairperson
Terry Shore, Victoria, B.C.	Past Chairperson
R. Ladd Livingston, Coeur d'Alene, ID.	Treasurer
Jill Wilson, Flagstaff, AZ.	Secretary
Bernie Raimo, Gunnison, CO.	Counsellor (1991-93)
Stafen Lindgren, Delta, B.C.	Counsellor (1992-94)
Nancy Rappaport, Albany, CA.	Counsellor (1993-95)
Mal Furniss, Moscow, ID.	Chair, History Comm.
Torgy Torgersen, La Grande, OR.	Chair, Names Comm.
Staffen Lindgren, Delta, B.C.	Chair, Awards Comm.
Don Dahlsten, Berkeley, CA.	Program (Sacramento)
Dave Wood, Berkeley, CA.	Program (Sacramento)
Dayle Bennett, Albuquerque, N.M.	Program (Albuquerque)

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* Summary not submitted

44th Annual Western Forest Insect Work Conference
February 28 - March 4, 1993
Sacramento, CA

Sunday, February 28, 1993:

5:00 - 8:00 PM — Registration

Monday, March 1, 1993:

8:00 - 10:00 AM — Registration

10:00 - 3:00 PM — Field trip (Inst. of Forest Genetics, USFS Placerville Nursery, Cone and Seed Insect and Nursery problems); plus a tour of a local winery.

3:00 - 5:00 PM — Executive Committee Meeting - **SANTA BARBARA**

4:00 - 6:00 PM — Registration

6:00 - 9:00 PM — Mixer - **REGENCY F**

Tuesday, March 2, 1993:

8:30 - 10:00 AM — Business Meeting - **REGENCY D**

10:00 - 10:30 AM — Founder's Award Address (David L. Wood)- **REGENCY D**

10:30 - 11:00 AM — COFFEE - **OUTSIDE REGENCY D**

11:00 - 12:30 PM — Panel: Managing Introduced Pests.
Moderator: Tom Hofacker.
Panel members: Milt Holmes, Terry McGovern, Dennis Souto, Dave Bridgwater. - **REGENCY D**

12:30 - 2:00 PM — LUNCH - **ON YOUR OWN**

2:00 - 3:30 PM — Workshop Session 1:

A. Ecosystem management: What does it mean for forest insect research (Nancy Rappaport). - **BIG SUR A**
B. History of forest entomology (Mal Furniss). - **BIG SUR B**
C. Bark beetle natural enemies (Fred Stephen). - **SANTA BARBARA**
D. Graduate student papers (Steve Seybold). - **VENTURA**

3:30 - 4:00 PM — COFFEE - **OUTSIDE REGENCY D**

4:00 - 5:30 PM — Workshop Session 2:

A. Recent insect impacts upon levels of timber harvesting (Tom Eager). - **BIG SUR A**
B. Information transfer and video production (John McLean). - **BIG SUR B**
C. New advances in the control of Bark beetles with semiochemicals (John Borden). - **SANTA BARBARA**
D. Multipest surveys and treatment regimes (young stands) (Lorraine Maclauchlan). - **VENTURA**

Wednesday, March 3, 1993:

8:30 - 10:00 AM	Panel: Excluding Exotic Pests. Moderator: Nancy Lorimer. Panel members: Jane Levy, Ron Billings, Richard Orr, Joe Carey. - **REGENCY A**
10:00 - 10:30 AM	COFFEE - **OUTSIDE REGENCY A**
10:30 - 12:00 PM	Workshop Session 3: A. Avian predators of forest insects: research and managment needs. (Paula Kleintjes). - **CARMEL A** B. Urban forest insect management (John Lichter). - **CARMEL B** C. The future of forest entomology (Fred Hain).- **BIG SUR A** D. Importation of unprocessed logs (Ron Billings) - **BIG SUR B**
12:00 - 1:30 PM	LUNCH - **ON YOUR OWN**
1:00 - 3:00 PM	Poster presentation set-up. **REGENCY E**
1:30 - 3:00 PM	Workshop Session 4: A. Ecosystem management: effects on insect diversity (Nancy Rappaport). - **CARMEL A** B. Biosystematics (Steve Teale). - **CARMEL B** C. Bark beetles, fungal, tree interaction (Fields Cobb). - **BIG SUR B** D. Using dendrochronology to determine long-term patterns of defoliator populations (Art Raske). - **BIG SUR B**
3:00 - 5:00 PM	Poster session with authors present (coffee and cocktails). Posters must be down by 5:30 PM. - **REGENCY E**
7:00 - 9:00 PM	BANQUET (included in registration) - **REGENCY D & E**

Thursday, March 4, 1993:

8:30 - 10:00 AM	Panel: Forest Entomology and Society: Case Study of Thinning and Salvage in the Lake Tahoe Basin. Moderator: John Neisess. Panel Members: Bob Harris, Rochelle Mason, Marty McFadden, George Ferrell. - **CARMEL A & B**
10:00 - 10:30 AM	COFFEE - **CARMEL A & B**
10:30 - 12:00 PM	Final Business Meeting - **CARMEL A & B**

TOUR SCHEDULE–PLACERVILLE

44th Annual Western Forest Insect Work Conference Meeting

Monday March 1, 1993, 10:00 AM to 4:30 PM

10:00-10:45 Drive from Sacramento to Placerville Nursery

10:45-12:00: Nursery Tour

---Pat Trimble, USFS: "Background and Nursery Operation"
---Les Ehler, UC-Davis: "Management of Aphids on White Fir Seedlings at Placerville Nursery."
---Safiya Samman, USFS: "Sugar Pine Blister Rust Resistance"

12:00-1:00: Lunch provided at Institute of Forest Genetics

1:00-2:30: Institute Tour

---Chris Nelson, USFS: "Historical Background of Eddy Arboretum and IFG."
---Nancy Rappaport, USFS PSW, Albany, CA & Pat Shea, USFS PSW, Davis, CA: "Impact and Phenology of Seed and Cone Insects of Blister Rust Resistant Western White and Sugar Pine Seed."

---Pat Shea, USFS PSW, Davis, CA: "Bark Beetle Pheromone Projects."

2:30-3:45: Boeger Winery Tour

3:45-4:30: Return to Sacramento

Nursery Staff Contact: Pat Trimble (Manager) (916) 622-9600; (916) 642-5099 (FAX)
IFG Contact: Chris Nelson (BMA) (916) 622-1225; (916) 622-2633 (FAX)
Boeger Winery: (916) 622-8094

WESTERN FOREST INSECT WORK CONFERENCE

44TH ANNUAL MEETING
SACRAMENTO, CALIFORNIA

EXECUTIVE COMMITTEE MEETING
MARCH 1, 1993

Present:

Don Dahlsten, program 93
Dave Wood, program 93
Iral Ragenovich, Chairperson
Terry Shore, Past Chairperson
Ladd Livingston, Treasurer
Jill Wilson, Secretary
Staffen Lindgren, Counselor
Ken Lister, standing in for Bernie Raimo, Counselor
Nancy Rappaport, Counselor
Torgy Torgerson, Chairperson, Common Names Committee

Meeting called to order at 3:00 pm

1) 1992 minutes for Exec comm., initial business meeting, and final business meeting were read, revised and approved as revised. The following amendment was added to the final meeting notes:

Regarding the McGregor Award: Discussion centered on whether the award should be expended to represent more than Mark's passing, ie to honor other people as well or to tag the award to the award committee. This was not passed and the award was tagged to McGregor. The terms of reference were discussed in general. It was decided that WFIWC would formally support and administer the award.

2) New Business

a. Dahlsten mentioned that the Hilton gave us 5 free room nights + 5 free parking passes. Four of the 5 room nights are still available, and 2 of the parking passes. Use of these discussed. Same issue came up in Penticton (92). A decision was made to set a policy regarding use of both the free room credits and parking passes. The policy is as follows: when either of these are made available they will will used according to the following priorities.

1. Credit against meeting charges
2. Make available for Retired members, here out of pocket.
3. Make available for students here out of pocket.

b. Livingston proposed that registration costs be waived for Founders Award recipients in the year following the one in which they are announced. The motion was seconded and approved.

3) Treasurers Report

Livingston presented the treasurers report. See enclosure. Current balance is $3859.76. This doesn't include income and expenses from the Penticton meeting. Our new total will probably be around $6,000.00 according to Ladd's estimates.

Rappaport moved that the treasurers report be approved. This was seconded, however no vote was taken pending the audit.

Livingston discussed the issue of the "overage" in our account. He proposed we maintain a base balance, amount to be determined, and anything in excess of this after meetings could be placed in the McGregor Fund. After some discussion it was decided that this proposal would be brought before the membership.

4) Committee Reports

a. History - no report

b. Common Names. Torgerson reported that the membership remains the same. They currently have one application in to the Ent. Soc. for the Boreal Spruce Beetle, Dendroctonus punctatus.

c. Awards. Lindgren reported that he is the new chair. Founders Award: 3 nominations were received for this year's recipient. Ron Stark was selected, the announcement will be made during the initial Business meeting.

d. Nominating Committee. Committee to be composed of Wilson, Rappaport, and Shore. Two positions open, secretary and counselor.

5) Correspondence

a. Status of USFS insect collections. Ragenovich reported on a letter received from Gary Daterman in August. Combined collections from PNW, PSW, and INT stations are being consolidated at Corvallis. The collection from RM was also supposed to be moved there, however no word yet on it. Funding for housing, maintenance, and curating has moved slowly. They anticipate development of a coop. agreement with OSU under supervision of Jack Lattin. The collection will be maintained as a separate unit. Torgerson reported that the collection is currently located in a hallway, and maintenance, status, and funding are uncertain. He agreed to check on this and report back at the final business meeting.

b. Joint WIFDWC and WFIWC. Ragenovich reported that WIFDWC has accepted our invitation for a combined meeting for March, 1994 in Albuquerque.

c. North American Forest Insect Work Conference. Ragenovich reported that Dennis Souto, Chairperson NE Forest Insect Work Conference wrote us asking for sponsors for another combined meeting. She wrote back and proposed that the meeting be held in 1996, since our joint meeting with WIFDWC might affect our participation prior to that time. During discussion it was

mentioned that the SFIWC may be interested in hosting this meeting. It was agreed that this matter be brought up and the initial business meeting.

6) Other business

a. Logo. The idea of a permanent logo was proposed at the 92 meeting. Livingston brought forward several proposals. These include the original proposal from the Penticton meeting, and a number of others. The Exec. committee proposed adopting the three sided figure sent in by John Stein and allowing each region (Canada, US, and Mexico) fill in the middle.

b. Mark McGregor award. Lindgren reported that Mark's parents have contributed $100 for the award. Steve Burke has prepared guidelines for the award. Pherotech will present a check for $2000 for the award this meeting.

c. Amendments to WFIWC bylaws. Livingston reported on proposed changes to the WFIWC bylaws which would allow US individual contributions to be tax deductible. These will be mentioned at the initial Business Meeting and voted on at the final.

d. 95 meeting. Lister reports that John Schmid proposes the Black Hills.

7) Status of Members

a. Retirees:
Roy Beckwith
Rick Johnsey
Gene Amman
John Schmid

b. Obituaries
Noel Wygant
Ben Howard

WESTERN FOREST INSECT WORK CONFERENCE

44TH ANNUAL MEETING
SACRAMENTO, CALIFORNIA

INITIAL BUSINESS MEETING
MARCH 2, 1993

Chairperson Ragenovich called the meeting to order.

1) Status of members:

A. Retired:
Roy Beckwith, PNW Station
Gene Amman, INT Station
John Schmid, RM Station
Rick Johnsey, State of Washington

B. Other: Galen Trostle has been diagnosed with leukemia, but it is in remission.

C. Obituaries:
Dr. Noel Wygant
Ben Howard

2) Minutes of the 1992 initial and final business meetings read and approved.

3) Treasurers Report:
Ladd Livingston reported that the balance reported prior to Penticton was $4,164.00. Not all expenses for the Penticton meeting have been accounted for yet. The current balance is $3,859.76. The report was accepted.

4) Common Names Committee:
Torgerson reported that the membership remains the same. They currently have one application in to the Ent. Soc. for the Boreal Spruce Beetle, Dendroctonus punctatus.

5) History Committee:
Mal Furniss reported that Boyd Wickman has accepted appointment as co-chairperson of the committee. He is looking forward to publishing accounts of the first western pine beetle control projects that occurred on the Ochoco N.F. and near Yreka, Calif. during 1912-1913.

The committee is seeking to catalog the black-and-white photofile of the former Berkeley Forest Insect Lab. Nancy Rappaport provided photocopies of print cards filed under "personnel." These have served as an example concerning procedural steps and problems involved in cataloging the file that is believed to include 7,000 photos. Further progresss was made recently when Dick Smith located a numerical listing of the photos, which has been misplaced in the move last year to the Albany Forestry Sciences

WESTERN FOREST INSECT WORK CONFERENCE

44TH ANNUAL MEETING
SACRAMENTO, CALIFORNIA

FINAL BUSINESS MEETING
MARCH 4, 1993

Chair Iral Ragenovich called the meeting to order.

1) Jill Wilson read the minutes of the initial business meeting. Minutes were approved as read.

2) PNW/PSW/INT Insect Collection
Nancy Rappaport spoke with Jack Lattin and reported that a cooperative agreement has been established between the Forest Service and OSU to currate and maintain the collection. Funding has been in place since October. Torgy proposed that a letter be sent from the chairperson to Jack Lattin and Charlie Philpot expressing our interest and concern regarding the collection and specifically to ask about: protection of the collection, our desire to be kept informed about the collection, ie when will it be moved out of the hallway and into new quarter, and when it will be available for use. Torgy will draft a letter.

3) Logo
Alan Berryman proposed that we adopt the logo from Penticton. The motion was seconded. Discussion ensued, the motion was not carried, 20 in favor and 20 against.

Nancy Rappaport moved that the logo question be dropped for the time being. This motion was seconded and carried. Steve Seybold mentioned that the triangle design looks like a radiation site.....

4) Amendments to the Constitution for tax exempt status.
Alan Berryman moved we accept the the proposed bylaw changes. The motion was seconded and carried by the membership. Ladd Livingston will proceed with the application to IRS for non profit status.

5) Checking account proposal
Ladd moved that a base amount of $5,000 be maintained, to be increased by 10 percent each year. Any surplus beyond this amount would go to into the McGregor Award fund. The motion was seconded. Much discussion followed. Dawn Hansen asked what would happen if a second scholarship fund was set up. Alan Berryman felt that moneys from the membership should be used to subsidize student memberships or retired members. The McGregor award should be supported by private donations. Steve Burke agreed. John Borden didn't want to give this award special status. The vote was called and the motion was not carried.

Staffen Lindgren moved that a base amount (to be determined) be established with allowance for a 10 percent annual increase. Executive committee would prepare a proposal for the membership to vote on regarding the use of any surplus. Don Dahlsten commented that this should be an executive committee

matter and that there shouldn't be any need for an additional vote by the membership. Peter Hall was not worried about having a surplus. Nancy Rappaport suggested lowering registration costs for students. John Borden proposed amending Staffen's original motion that any excess funds be used to promote the meeting and spent at the discretion of the executive committee. This amended motion was carried by a vote of 24 in favor to 13 opposed.

6) Policy committee proposal
Iral tabled this for the time being

7) Resolutions
John Borden proposed the following:

Whereas many exotic forest pest insects and disease organisms have been intercepted in the past and have caused great biotic disruption and economic loss, and

Whereas no inspection or treatment process can wholly ensure that imported timber is pest-free,

Be it resolved that the Western Forest Insect Work Conference recommends that to reduce the threat of introduction of exotic pests, no importations of whole logs, treated or untreated, be permitted, and that only processed and seasoned products be eligible for importation.

And be it further resolved that the Western Forest Insect Work Conference requests its Executive to tranmit the above resolution to relevant state, provincial and federal officials and politicians.

The resolution was seconded and carried by a unanimous vote.

8) Dave Wood suggested that we explore combining with the WIFDWC. Much discussion followed concerning this proposal: Would this make for too large a meeting? Would it change the nature of this meeting too much? Need to incorporate the concept of forest health. We should continue to meet every 3-5 years.

9) 95 meeting
It was moved and seconded that we accept the invitation from Ken Lister to meet at some location in the black hills. The motion was carried.

10) Committee Reports
Founders Award: Artwork received for Founders Award for Ron Stark

McGregor Award: Contributions needed

Nominations: Jorge Macias - Counselor, Carroll Williams - Secretary

11) Iral thanked a number of people who helped with local arrangements for the Sacramento meeting: Don Dahlsten, Dave Wood, Nancy Rappaport, Steve Seybold, Paula Kleinjes, Tom Eager

12) Ron Billings asked for volunteers for the next NAFIWC: the following people volunteered: Ed Holsten, Jesse Logan, Ann Lynch, Terry Shore

13) Peter Hall offered British Columbia for the site of the 1997 WFIWC

14) Ladd Livingston reminded people to check their address on the mailing list.

15) Bob Lavigne announced that a symposium concerning results of studies on the 1988 fires would be held September 15-17.

The meeting was adjourned.

dynamics in insect population dynamics: in 1989, a year of moderate cone production, insect damage was moderate; in 1990, cone crops were poor and insect damage was severe; in 1991, there was a bumper crop and insect damage was insignificant.

The "window" study revealed that damage mistakenly attributed to seedworms (Cydia spp.) was actually caused by Eucosma sp. near ponderosa. The study also indicated some apparent interspecific interactions, insofar as the damage to continually exposed cones was less than the sum of the damage caused by each species individually. Such competitive interactions can be important in pest management, because treatments aimed at controlling one insect species may simply increase resources available for other species.

Similar studies have been conducted on western white pine and are planned for Port-Orford-cedar. Concurrent with these studies are field and laboratory assays of cone and seed insect pheromones and host attractants: 1) laboratory studies of western cone beetle pheromone stereochemistry; 2) field assays of eastern cone beetle cross-attraction to western cone beetles; and 3) studies of the relationship between cone/foliage volatiles and insect attack. Research that is yet in the planning stages will deal with cone and seed insect problems in uneven-aged stands, where natural regeneration will be increasingly important.

Nontimber tree species and understory vegetation, including threatened and endangered plant species, are also receiving more attention than in the past. Conifer seed orchards in the southeastern United States are routinely propagating nontimber species in response to wildlife and biodiversity concerns, and western tree improvement centers are receiving more and more requests to include nontimber plant species in their regeneration programs. It is clear, therefore, that researchers studying pests of regeneration will be

dealing with a much wider array of taxa, both plant and insect, than in the past. Ecological relationships among these taxa will also receive more emphasis.

Welcoming Remarks
to the
Western Forest Insect Work Conference
Sacramento, California
March 2, 1993

Scott A. Johnson, Chairman
California Forest Pest Council

Good morning and welcome to California's state capital. That's capital with an "a". The capitol with an "o" is just across the street, and I encourage you to visit that beautifully restored building.

When Dr. David Wood invited me to speak to you, he asked me to give you some background on the California Forest Pest Council. Dave asked me to discuss how our group might interface with your group, especially since most of you are forest insect researchers. In particular, what can the Council do to support and promote forest pest research?

The California Forest Pest Council(CFPC) is an organization of professional foresters, land managers, entomologists, pathologists, weed scientists, forest pest managers, and others. Council members work to protect forests from damage from animals, insects, diseases, weeds, and pollution. The Council was founded in 1951 as the California Forest Pest Control Action Council. The California Board of Forestry recognizes the Council as its official advisory body on forest pest matters. The CFPC Executive Committee consists of a chairman, vice-chair, secretary, three at-large members, and chairpersons of the standing committees. The standing committees are: Animal Damage, Disease, Insect, Weed, Southern California Forest Pests, Editorial, and Membership.

The Council meets annually in November for a two-day general meeting, committee meetings, business meeting, elections, and resolutions. Starting in 1991, the Council changed the format of the meeting to include a full-day conference where several speakers address issues focusing on a theme, such as "What is a Healthy Forest?", or "The Status and Future of Forest Pesticide Use in California". The CFPC also publishes the proceedings of the annual meeting. Each standing committee typically holds a field meeting during the summer to discuss pest problems and issues. Both the Society of American Foresters and the California Department of Pesticide Regulation accredit these meetings for continuing education hours.

At the annual meeting, the Council commonly passes resolutions on important forest pest issues. CFPC resolutions typically focus on pest management policy and budget decisions at State and Federal levels. These resolutions, and resultant lobbying, have often had a significant impact on a variety of issues. One example was the 1989 resolution introduced by the Southern California Committee that requested a renewed emphasis on non-chemical pest control alternatives. As a result of this resolution, Hal Walt, then Director of the California Department of Forestry and Fire Protection, and University of California vice-president Lowell Lewis chaired a group that identified forest pest research priorities and needs for these programs at both the state and federal level. This effort has been responsible for increased work with bark beetle pheromones and funding for additional research.

The CFPC regularly reports to the Board of Forestry on forest pest conditions and pest control projects. Council members also played a significant role in the review of slash treatment rules. The Council annually publishes Forest Pest Conditions in California, which is a compilation of Pest Damage Reports and professional observations statewide. CDF and USDA Forest Service staff play a principal role in the production of this report, as well as the proceedings of the annual meeting.

I hope you have found this brief introduction to the California Forest Pest Council interesting. Many of your members are active in CFPC. Please ask them about the Council. We invite you to join us at one of our field meetings, or at our next annual meeting, which takes place on November 17 and 18, here in the Sacramento area. I hope your conference is productive and enjoyable. Once again, thank you for inviting me to join you, and welcome to Sacramento.

Founder's Award Lecture
March 2, 1993

"Bark Beetle, Fungus, and Host Interactions Involved in the Death of Pines in California"

David L. Wood
Department of Entomological Sciences
University of California
Berkeley, CA 94720

Following a reconnaissance trip through California, Oregon, Washington and Idaho in the spring and early summer of 1899, A. D. Hopkins concluded the following: ". . . It is well known that forest trees weakened by disease contribute to the multiplication of their insect enemies. It is also known that insects will attack healthy trees, and that diseases of the bark and wood follow as a result of such injuries. Therefore, in the investigations of unhealthy conditions of forests it is often exceedingly difficult, without some previous knowledge of the habits of the diseases and insects found associated with them, to decide which is to blame for the primary injury. Our present knowledge of the subject, however, indicates that as a rule unhealthy forest trees, like unhealthy animals, present characteristic symptoms, which indicate quite clearly the primary cause of the trouble. The evidence I have been able to gather in the forests of the East and Northwest makes it plain to me that, of the two causes, while many small trees are killed by root diseases, the unhealthy condition of the larger trees is more often due to primary attacks by insects." Hopkins' clearly stated entomological bias sets the stage for my collaborative research with forest pathologists at the University of California, Berkeley.

In 1965, Professor Dick Parmeter, a forest pathologist, was describing his and Paul Miller's pioneering research on a new disease of ponderosa pine stands, variously called x-disease, chlorotic decline, and ozone needle mottle. This disease had been observed since the early 1950's in the San Bernardino Mountains of southern California. They established the relationship between needle symptoms and photochemical air pollutants, in particular, ozone (Parmeter *et al.*, 1963). He and his colleagues hypothesized that insects may be associated with these declining pines. This motivated a major collaborative research effort by entomologists (Stark and Wood) and pathologists (Cobb, Miller, and Parmeter). Upon extensive investigation we found that, as the severity of oxidant injury increased, the incidence of bark beetle infestation by the western pine beetle, *Dendroctonus brevicomis*, and the mountain pine beetle, *D. ponderosae*, increased (Stark *et al.*, 1968). We also found that oleoresin exudation pressure, quantity and rate of flow, and phloem and sapwood moisture content were reduced, while the propensity of oleoresin to crystallize was increased in trees exhibiting advanced symptoms of oxidant injury (Cobb *et al.*, 1968a). We postulated that these conditions favored the successful establishment of these *Dendroctonus* spp. in ponderosa pines injured by photochemical atmospheric pollution (Cobb *et al.*, 1968b).

While investigating the relationship between oleoresin exudation pressure and tree mortality caused by *D. brevicomis* and *D. ponderosae* in the central Sierra Nevada, Professor Fields Cobb and colleagues discovered a root pathogen [*Leptographium wageneri* var. *ponderosum* (Harrington, 1988)] infecting ponderosa pines and they hypothesized that, this pathogen may predispose ponderosa pine to infestation by bark beetles. In early studies of risk factors associated with the mortality of old-growth ponderosa and Jeffrey pine caused by *D. brevicomis* in Lassen Co., California, Wygant (1942), a USDA entomologist, had observed a black staining fungus (identified as *Leptographium lundbergii*) in the roots of some trees. Dr. W. W. Wagener, a USDA forest pathologist, examined these pines, but the importance of the fungus in weakening trees was not determined. Our later collaborative studies in second-growth stands showed a strong association between the occurrence of root pathogens (primarily *L. wageneri* and *Heterobasidion annosum*) and bark beetle infestation of both ponderosa pine (primarily by *D. brevicomis* and *D. ponderosae*) and white fir (by *Scolytus ventralis*), (Cobb *et al.*, 1974). This association was strongest at low bark beetle population levels, i.e., 1-3 trees per mortality group. At higher population densities, symptomless trees are killed as a result of higher levels of bark beetle aggregation pheromones. Thus, where large groups of dead trees occur over a short period of time, the association with root diseases is not as strong.

The discovery of the association between root diseases and photochemical air pollution and elevated levels of tree mortality caused by bark beetles, led to investigations of the host selection behavior of *D. brevicomis, D. ponderosae* and the red turpentine beetle, *D. valens* (reviewed in Wood, 1982). Because disease severity could be objectively classified by foliar symptoms (needles injured by oxidants are shortened, chlorotic mottled, and fewer in number) and sapwood blackstain caused by *L. wageneri*, differential landing rates of bark beetles could be recorded. Moeck *et al.* (1981) showed that the landing rates of *D. brevicomis* did not differ between severely diseased and symptomless trees. The key to this study was the prevention of bark beetle pheromone production by screening the bole into the live crown.

Doane *et al.* (1936) state that *D. valens* ". . . is not considered an aggressive pine killer, although it may do considerable damage to trees and weaken them so that they are more susceptible to other bark beetle attack . . ." Salmon and Bongberg (1942), Keen (1952), and Smith (1971), considered the presence of pitch tubes caused by *D. valens* to be one of many indicators of increased risk of mortality of ponderosa pine and Jeffrey pine caused by *D. brevicomis* and *D. jeffreyi*, respectively. At an early conference on risk rating old-growth ponderosa pines (Whiteside, 1948), Bongberg stated "...that the work of the red turpentine beetles (*Dendroctonus valens*) should be given an important rating as indicating high risk trees and trees to be marked for cutting." These early observations of *D. valens* were generally made in old growth stands. However, Goheen and Cobb (1980), Moeck *et al.* (1981), and later Goheen *et al.* (1985) observed more attacks by *D. valens* on trees severely infected by *L. wageneri* than on symptomless trees. These trees were in second-growth stands, and were not screened to prevent *D. valens* attacks at the root collar.

To explore the interrelationships among *D. valens, D. brevicomis, D. ponderosae* and *L. wageneri*, Owen (1985) established research plots in the central Sierra Nevada. Between June 1981 and November 1983, a significantly higher proportion of ponderosa pines exhibiting *D. valens* pitch tubes were killed by *D. brevicomis* and *D. ponderosae* than trees without such pitch tubes. Also he found that living trees with *D. valens* pitch tubes were more likely to be infected with *L. wageneri* than trees without these pitch tubes. Because *D. valens* rarely kills trees, its unsuccessful attacks may be an early indication of stress caused by root pathogens, and perhaps mistletoe and other agents. Furthermore, *D. valens* and its associated microorganisms may play an important role in the succession of organisms that contribute to tree mortality. As discussed later, *D. valens* vectors *L. terebrantis* which was shown by Owen *et al.* (1987) to be the most pathogenic fungus carried by the three *Dendroctonus* spp. investigated.

Owen (1985) wounded trees in the same manner as Goheen and Cobb (1980), Goheen *et al.* (1985), and Moeck *et al.* (1981) (holes punched to the sapwood surface to assess the presence of blackstain), but excluded *D. valens*-associated attacks by screening the lower trunk and root collar. However, Owen (1985) found no difference in the distribution of trapped *D. valens* between diseased and symptomless trees. These results indicated that the preferences exhibited by *D. valens* for diseased trees likely occurs after landing on the tree. Differential attraction at close range, or differential feeding stimulation, or both behaviors may account for the observations of Goheen and Cobb (1980), Goheen *et al.* (1985), and Moeck et al. (1981).

At this time in our collaborative research, we turned our attention from agents that predispose or weaken trees, i.e., photochemical air pollutants, blackstain root disease, and *D. valens* tunneling activity, to the fungi vectored by tree-killing (*D. brevicomis* and *D. ponderosae*) and tree-debilitating *(D. valens)* bark beetles. Owen *et al.* (1987) wound-inoculated two-year-old ponderosa pine seedlings with fungi isolated from the above *Dendroctonus* species. *Leptographium terebrantis* from *D. valens, Ophiostoma (= Ceratocystis) minus* from *D. brevicomis*, and *O. clavigerum* from *D. ponderosae*, each killed a high proportion of the seedlings. Seedling mortality caused by *L. terebrantis* was greater than that caused by the other two fungi. This was a surprising result in light of the well-known tree-killing habit of *D. brevicomis* and *D. ponderosae* and the non-tree-killing behavior of *D. valens*. *Ophiostoma ips* from *D. valens* and *D. ponderosae* reduced seedling mortality caused by *L. terebrantis* and *O. clavigerum*, respectively. *Ophiostoma nigrocarpum* from *D. brevicomis* produced the same result when inoculated together with the pathogenic *O. minus*. Recently, Harrington (personal communication and see Harrington, 1993, p. 43) has identified the mycangial hyphomycete (previously identified as *O. nigrocarpum*) from *D. brevicomis* as *Ceratocystiopsis ranaculosus*. Perhaps, Owen *et al.* (1987) have unknowingly shown that both *C. ranaculosus and O. nigrocarpum* inhibit the pathogenic activity of *O. minus*. However, further studies with known isolates of these fungi are required before such a conclusion can be made. Thus, each of these three *Dendroctonus* spp. that infest ponderosa pine carries one pathogenic fungus and one fungus that inhibits the effects of the pathogenic fungus in seedling inoculation studies.

The results obtained by Owen *et al.* (1987) with beetle-vectored fungi in ponderosa pine seedlings stimulated our evaluation of pathogenic effects of these fungi in small trees (diameter at breast height = 10-25 cm). Parmeter *et al.* (1989) inoculated four species of fungi vectored by *D. brevicomis* and *D. ponderosae* into *P. ponderosa*. Radial depth of sapwood occlusion at the inoculation site was assayed by standing stem sections in solutions of Fast Green dye. The depth of radial sapwood occlusion was greater for *L. terebrantis* from *D. valens* than for isolates of *O. ips* from *D. valens*, and *O. nigrocarpum* and *O. minus* from *D. brevicomis*. The average sapwood penetration was greater for *L. terebrantis* inoculated alone than when inoculated with *O. ips*. A similar trend (but not statistically significant) was observed when *O. minus* was inoculated with *O. nigrocarpum* from *D. brevicomis* and compared to *O. minus* inoculated alone.

Parmeter *et al.* (1992) proposed that ". . . the rate at which sapwood occlusion extends radially into the xylem should be adequate to account for lethal restriction of flow and for symptom development in trees under beetle attack." They showed that the length of sapwood lesions, depth of sapwood occlusion, and proportion of sapwood occluded (all determined by immersion of log sections in Fast Green dye) increased through the first 9

weeks following inoculation of small ponderosa pines with *O. minus* and *L. terebrantis*. They concluded that the rate of occlusion observed in these experiments was inadequate to account for the early (3-4 weeks in summer) development of crown symptoms in trees following mass attack by bark beetles that vector these fungi.

In another study utilizing the Fast Green dye assessment of sapwood occlusion, ponderosa pines attacked by *D. brevicomis* were periodically sampled over 7 weeks (Hobson *et al.*, 1994). Neither *O. nigrocarpum* nor other bluestain fungi were commonly isolated at the interface of the occluded and functioning xylem. Bluestain fungi appeared to colonize already occluded xylem. In these studies, the second instar larvae of *D. brevicomis* had already turned out into the outer bark before any occlusion of the xylem was apparent.

These recent studies by Parmeter *et al.* (1992) and Hobson *et al.* (1994) indicate either that bluestain fungi are not causing sapwood occlusion or, if they are playing such a role, they may be exporting metabolites at some distance from where the fungi can be isolated. Furthermore, incubation of freshly cut disks eight weeks following inoculation showed almost no discoloration due to pigmented hyphae in occluded areas (Parmeter *et al.*, 1989).

Bark beetles colonizing second-growth ponderosa pines generally occupy specific areas on the main stem in relation to one another, i.e., *I. latidens* and *I. paraconfusus* in the tops or upper crown, and larger branches; *D. valens* in the roots, root collar and lower 3m of the bole; and *D. brevicomis* and *D. ponderosae* in between these species in the upper and lower portion of the tree. Fox and colleagues (1993) reared the California 5-spined ips, *Ips paraconfusus*, from egg (after surface sterilization) to adult in the presence of its vectored fungi (*O. ips* and yeasts) and the pathogenic fungi carried by the above *Dendroctonus* spp. that colonize ponderosa pines. Survival in intact ponderosa pine phloem was reduced by all of the bluestaining fungi, i.e., *L. terebrantis*, *O. minus* and *O. clavigerum*. The lowest survival was observed in the *L. terebrantis* treatment and the highest survival occurred with untreated eggs. Thus, should *I. paraconfusus* become associated with the pathogenic fungi carried by cohabiting *Dendroctonus* spp., its survival may be reduced in the new host. Nevertheless, some progeny will survive in the presence of the newly associated pathogen, indicating the potential at least, for a new fungal association with this bark beetle. In this regard, *L. terebrantis* has been isolated occasionally from *I. paraconfusus* (Fox *et al.*, 1993). These investigators also showed that females reared free of any fungi (readily cultured) did not oviposit in surface-sterilized logs, whereas females reared from naturally-infested trees laid eggs in these logs. Perhaps these vectored fungi produce cues that identify the suitability of the phloem for oviposition.

Stephen and Dahlsten (1976a, b) determined the arrival pattern of associated insects on ponderosa pines during the concentration phase of host colonization (Wood, 1982) by *D. brevicomis*. Generally, predators arrive during this phase in response to pheromones, e.g. *exo*-brevicomin attracts *Temnochila chlorodia* (reviewed in Wood, 1982). However, parasites, such as *Roptrocerus xylophagorum* (Hymenoptera: Torymidae) and *Dinotiscus burkei* (Hymenoptera: Pteromalidae), arrive during the establishment phase, some 4-6 weeks after initial attacks have occurred. Parasitoids attack their bark beetle hosts, usually during the late larval stage. Dahlsten and colleagues (unpublished data) initiated field studies to test the hypothesis that beetle-vectored fungi may be producing attractants that natural enemies use to locate beetle-infested trees. Logs were inoculated with *D. brevicomis* females, *O. ips, O. minus*, *O. nigrocarpum*, an unidentified basidiomycete and a combination of all four fungi. In one test, three species of hymenopterous parasitoids (*Coeloides* spp. and *Rhopalicus*) (families Braconidae and Pteromalidae) which parasitize bark beetles were trapped in significantly larger numbers at logs colonized by a combination of all fungi than at controls. These results are encouraging, because they indicate that the critical timing observed between these natural enemies and their prey, may be a result of cues emanating from trees inoculated with fungi carried by bark beetles during host colonization.

Returning to a familiar theme, our present research addresses agents that predispose pines grown primarily in coastal, urban areas to infestation by bark beetles. In 1986 pitch canker disease, caused by *Fusarium subglutinans*, was discovered in Santa Cruz Co., CA, infecting Monterey, bishop and Aleppo pines (McCain *et al.*, 1987). Studies by Correll *et al.* (1991, 1992) concluded that the *F. subglutinans* pathogenic to pines is a specific form and designated it *F. subglutinans* f. sp. *pini* (hereafter *F. s. pini*). They also showed that the California population included only five vegetative compatibility types (VCG) compared to 45 distinct VCGs isolated from a Florida population. Their studies suggested that this pathogen may be a recent introduction to California.

The sequence of symptoms of pitch canker disease in Monterey pines appears to begin with tip dieback which is followed by the occurrence of large bole cankers that produce copious amounts of resin. *Ips paraconfusus* generally kills the tops of large diseased trees, and soon thereafter, the entire tree is killed by *I. paraconfusus* and *I. mexicanus*. In native stands of Monterey pine, *I. plastographus maritimus* replaces *I. paraconfusus*. Thus, pitch canker appears to weaken trees and/or makes them more attractive to native *Ips*. spp.

Although this pathogen appears to be endemic to the southeastern U.S., it is potentially much more destructive to forests of western North America than prior introductions, i.e., white pine blister rust, Dutch elm disease and chestnut blight. The host range of these pathogens is limited to a few species. In California *F. s. pini*

has been isolated from twelve pine species and *Pseudotsuga menziesii* (Douglas fir) (Storer *et al.*, in manuscript). The native pine species infected in California are *Pinus attenuata* (knobcone), *P. contorta contorta* (shore), *P. coulteri* (Coulter), *P. muricata* (bishop), *P. ponderosa* (ponderosa), *Pinus radiata* (Monterey), *P. radiata* x *attenuata* (Monterey x knobcone), *P. sabiniana* (Digger), and *P. torreyana* (Torrey). The non-native pine species infected in California are: *P. canariensis* (Canary Island), *P. halepensis* (Aleppo), and *P. pinea* (Italian stone) (McCain *et al.*, 1987; Storer and Dallara, 1992).

Fox *et al.* (1990) have found that pitch canker probably increases the abundance of *Ips* spp. in Monterey pine in Santa Cruz Co., CA. *F. s. pini* has been isolated from *Ips* spp. emerging from *F. s. pini*-infected trees. *Ips* spp. also inoculated this pathogen into wind-broken trees and thus produced reservoirs of the fungus. Experimentally contaminated *I. paraconfusus* transmitted this pathogen to seedlings and mature pines, and pheromone-induced attacks resulted in cankers on large trees (Fox *et al.*, 1991). Also transmission of this pathogen from adults to progeny was demonstrated by Fox *et al.* (1991).

Early observations of the disease in Monterey pine in the Santa Cruz area showed that new infections were often associated with cones (M. E. Schultz and T. R. Gordon, unpublished). Because the Monterey pine cone beetle, *Conophthorus radiatae* (Coleoptera: Scolytidae), attacks living cones, we initiated studies of the association of the pitch canker fungus with this beetle (Hoover, *et al.*, 1994). In samples of cones taken from June, 1990 through September, 1991, we found that 25% of *C. radiatae* and 30% of *Ernobius punctulatus* (Coleoptera: Anobiidae) adults were carrying propagules of *F. s. pini*. *E. punctulatus* is a common associate of *C. radiatae* that oviposits on or in cones infested with *C. radiatae*. Furthermore, the percentage of cones containing contaminated *C. radiatae* larvae and adults was greater when *E. punctulatus* progeny were also contaminated than when *E. punctulatus* was not. Interspecific transmission may be significant in the epidemiology of this pathogen because we found both species together in 26% of the cones sampled. The parasitoid, *Cephalonomia utahensis* (Hymenoptera: Bethylidae), was observed parasitizing late instar larvae of *E. punctulatus* and thus may be another source of interspecific transmission.

In December, 1992 we isolated *F. s. pini* from bishop pine in southern Mendocino Co., about 150 km north of San Francisco (Dallara and Storer, in manuscript). In 1993, we confirmed the presence of the pathogen in two of the three native stands (Monterey peninsula and Ano Nuevo point) of Monterey pine found on the central coast of California (Storer *et al.*, 1994). These new infections appear as dead tips in the crowns of the trees. *Pityophthorus* spp. are usually found infesting *F. s. pini*-infected tips in landscape plantings of these pine species. In early studies, Fox (in Wood *et al.* 1990) found greater than 10% of trapped *Pityophthorus carmeli* carrying propagules of *F. s. pini*. Hoover *et al.* (1994) have found up to 12% of *Pityophthorus* spp. trapped at cone whorls were carrying propagules of *F. s. pini*. *Pityophthorus carmeli, P. nitidulus*, and *P. setosus* have been found to carry this pathogen when emerged from symptomless and infected Monterey pine branches (Dallara, unpublished). Also these species infest other conifers in central, coastal California (Dallara, unpublished).

During the course of our six-year investigations, we have documented significant range expansion of *F. s. pini*. In Mendocino Co. infected bishop pines are intermixed with shore pine and Douglas-fir. These coastal conifers are all native stands. Infections reported from Monterey pine Christmas tree plantations in San Diego and Los Angeles Counties have increased since the pathogen was first discovered there in 1988 (Correll *et al.*, 1991).

Our concerns about range expansion of the pitch canker fungus in California are twofold:

1) Endemic populations of some California pine species are very small. Monterey pine is limited to three coastal populations on the central coast. Torrey pine is limited to one mainland population in San Diego Co., and the northern distribution of Coulter pine occurs in small isolated stands in the San Francisco Bay Area.

2) Some of the most widely distributed conifers in North America have been found naturally infected in the Santa Cruz area, i.e., ponderosa pine, shore pine and, recently, Douglas-fir . Infected landscape plantings of Monterey pines are in close proximity to intermixed native stands of ponderosa pine, knobcone pine and Douglas-fir. Douglas-fir and ponderosa pine are the most abundant lumber species in western North America. We have recently found that several beetle species share many of these conifer hosts (Hoover *et al.*, 1994; Dallara, unpublished). Furthermore, we have isolated *F. s. pini* from some of these species.

In summary, I have given a brief overview of our collaborative research on bark beetle, fungus, and host interactions involved in the death of pines. Photochemical air pollution, blackstain root disease, and tunneling by *D. valens* were shown to be associated with increased mortality of ponderosa pines caused by *D. brevicomis* and *D. ponderosae*. The role of fungi vectored by *Dendroctonus* spp. in causing the death of pines was described. *Ophiostoma minus,* carried by *D. brevicomis*, *O. clavigerum* carried by *D. ponderosae*, and *L. terebrantis* carried by *D. valens* kill seedlings. *O. minus* and *L. terebrantis* cause interruption of water conduction in the xylem of small

trees. However, bluestain fungi (*Ophiostoma* spp.) are not frequently isolated from non-water conducting sapwood in *D. brevicomis*-killed ponderosa pines. Other fungi vectored by these *Dendroctonus* spp., when coinoculated with pathogenic fungi, decreased the effect of the pathogenic fungi on seedling mortality and water conduction in small trees. The pitch canker fungus kills tree parts, i.e., limbs, branch tips, and cones and creates large cankers on the main stem. Together these effects increase the probability of tree mortality caused by *Ips* spp. This interaction is related to the bark beetle interaction with the blackstain root pathogen. A root-infesting bark beetle, *Hylastes macer*, is probably a vector of *L. wageneri* in ponderosa pine (Goheen and Cobb, 1978). This root pathogen predisposes ponderosa pines to infestation by *Dendroctonus* spp. Similarly, *Pityophthorus* spp. and *C. radiatae* are likely vectors of a pathogen that predisposes Monterey pines to infestation by *Ips* spp.

Logging activity has undoubtedly increased the breeding material available for *H. macer*. This activity may have created a larger vector population for *L. wageneri*, with a concomitant increase in the incidence of blackstain root disease. Similarly, human activity is probably responsible for the recent introduction and spread of the pitch canker fungus in California. In this non-coevolved system, the increasing incidence of this disease is likely a result of increased abundance of the many potential bark beetle vectors identified to date (i.e., *Conophthorus* spp., *Ips* spp., *Pityophthorus* spp.). This increased abundance is probably a result of the new association with this pathogenic fungus that results in the death of cones, twigs, branches, tree tops and ultimately the death of the entire tree.

Since 1970, the above research was conducted under USDA Regional Research Project - W-110, "Interactions Among Bark Beetles, Pathogens, and Conifers in North American Forests." In 1993, this project was reorganized under RRP-W-187, with the same title. The knowledge generated from this long term cooperative research project was summarized by W-110 scientists in a recently published book entitled, "Beetle-Pathogen Interactions in Conifer Forests" (edited by T. D. Schowalter and G. M. Filip, 1993, Academic Press, N.Y. 252 pp.). These studies clearly demonstrate the tremendous complexity of the interactions among insects, fungi and conifers.

I acknowledge with deep appreciation my collaborators: university colleagues - Bill Bros (San Jose State University), Fields Cobb, Don Dahlsten, Tom Gordon, Dick Parmeter, Ron Stark; graduate students - Paul Dallara, Joe Fox, Ken Hobson, Kelli Hoover (San Jose State University), Ken Lindahl, Henry Moeck, Don Owen; post-doctoral researchers - Joe Fox, Andrew Storer. My wife, Caroline, encouraged and supported my efforts in these very enjoyable and facinating scientific explorations of forest biology. I also thank my nominators and the WFIWC Awards Committee for selecting me for the Founder's Award. Reviews by Fields Cobb, Don Dahlsten, Paul Dallara, Tom Gordon, Don Owen, Dick Parmeter, Steve Seybold, and Andrew Storer improved this manuscript.

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ECOSYSTEM MANAGEMENT: WHAT DOES IT MEAN FOR FOREST INSECT RESEARCH?

Moderator: N. G. Rappaport

PARTICIPANTS: L. Merrill (recorder), K. Clancy, T. Hofacker, I. Ragenovich, T. Torgersen, J. Wilson, J. Logan, T. Rogers, J. Cavey, J. Barry, D. Schultz, R. Lavigne, L. MacLaughlin, R. Bridges, N. Lorimer, F. Stephen,

Attendees: More that 50 people attended this workshop.

Background was first provided on the perspectives of both the USDA Forest Service and the Ecological Society of America.

The USDA Forest Service perspective: Ecosystem Management (EM) means using an ecosystem approach to achieve the multiple-use management of National Forests and Grasslands. Its aims are to restore ecosystems while meeting the needs of people. EM is different from multiple-use management in that EM focuses on ecological processes (trophic interactions, nutrient cycling) rather than commodities.

The USDA Forest Service is developing a structure for an EM-based approach to land management; a national strategy and definitions and principles have already been developed. An important component of EM is the characterization of the desired future condition of forest ecosystems (land, people, and resources). To this end, inventory analysis provides a measure of what exists today; historical analyses provide information on past ecosystem conditions and processes by which ecosystems reached their current status.

The ESA (Ecological Society of America) perspective: The ESA has developed a program called the Sustainable Biosphere Initiative (SBI), the role of which is to define needed areas of EM research and to enhance collaborations between universities and agencies. Research priorities identified by the SBI are global change, biological diversity, and sustainable ecological systems. Development of science policy and the importance of research-based policy decisions are major issues with which the SBI is dealing. The SBI is described in a report of the ESA, "The Sustainable Biosphere Initiative: an Ecological Research Agenda," by J. Lubchenco et al. (Ecology 72(2): 371-412, 1991). Individuals interested in exploring institutional linkages and collaboration should contact the SBI at 2010 Massachusetts Ave., NW., Suite 420, Washington, D.C. 20036.

Extensive discussion ensued:

Examples of interacting processes were given and the importance of understanding ALL trophic interactions was emphasized. Torgersen described how a narrow area of forest management can have a wide range of consequences. For example, snag management for pileated woodpecker habitat may be a useful indicator of forest health. Relatively little is known about the pileated woodpecker, for example what size and number of snags are needed. These birds require hollow living Douglas-firs and true firs for roosting to escape cold; this is also true of goshawks. Ninety-five percent of their diet is ants, which are important predators of western spruce budworm (WSB). About 11 species of ants in the West are WSB predators; Campanotus spp. are most important in both groups. Nine species of ants that are WSB predators live in

WORKSHOP: BARK BEETLE NATURAL ENEMIES

MODERATOR: Fred Stephen

This workshop focused on current or planned research involving natural enemies of *Dendroctonus* and *Ips* bark beetles. Attendance was about 30-40 people.

Scott Salom from Virginia Tech University, Blacksberg, VA, discussed population manipulation of southern pine beetle infestations using behavioral chemicals, especially verbenone.

Ron Billings, of the Texas Forest Service, discussed their system for Southwide monitoring of southern pine beetle trends through use of the ratio of the clerid, *Thanasimus dubius*, to southern pine beetle. In most cases prediction of expected levels of beetle activity for the next summer can be accurately predicted by examining the ratio of beetles to clerids, with higher levels of clerids associated with a lower probability of SPB activity.

Darrell Ross, Oregon State University, Corvallis, OR, presented proposed research that will be directed to evaluating the clerid, *Thanasimus undatulus*, associated with Douglas-fir beetle.

Fred Stephen, University of Arkansas, Fayetteville, OR, presented a hypothesis that southern pine beetle populations are not effectively regulated by their natural enemies (primarily parasitoids) because ecosystem simplification (pure, even-aged, dense stands of pine) caused by intensive forest management has virtually eliminated flowering understory plants. They are hoping to test that hypothesis in the near future.

Pat Shea, USDA Forest Service, Davis, CA, discussed their past several seasons trap collections that relate to monitoring of western pine beetle flight and activities of the trogositid, *Temnochila virescens*.

John Reeve, USDA Forest Service, Pineville, LA, explained research plans for evaluating the effects of different clerid density on populations of southern pine beetle.

Tom Eager, University of California, Berkeley, CA, discussed his research on three *Ips* species and the complex of natural enemies they share. The response of natural enemies were measured towards new beetle/tree associations, created by forcing *Ips* beetles into hosts they would normally not attack. Generally, natural enemies relying upon the bark beetle aggregation pheromones (primarily early-arriving predators) are at a disadvantage in the novel associations, while the more generalist parasitoids which arrive later tend are still able to locate their hosts.

Workshop: Graduate Students in Forest Entomology: What are they up to?

Tuesday March 2, 1993, 2:00-3:30 PM

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

Participants: (28) Including Barb Benz, Sally Bertram, Suzie Blatt, John Borden, Alejandro Camacho, Paul Dallara, Maya Evenden, Marita Lih, Staffan Lindgren, Jorge Macías-Sámano, Joel McMillin, Dave Overhulser, Tim Paine, Lisa Poirier, Therese Poland, Mark Schultz, Andrew Storer, Elizabeth Tomlin, Mike Wagner, Dave Wood.

The workshop was attended by twelve graduate students including five who each presented 15-minute summaries of completed or proposed research. Sally Bertram (University of California, Riverside) described her studies on the effects of the inhibitors verbenone and ipsdienol on the landing and attack behavior of the western pine beetle, *Dendroctonus brevicomis* on ponderosa pine in Sonora, CA (Stanislaus National Forest). She has found that these compounds, when released from lures placed on pheromone-baited standing trees, significantly reduce the landing rate and attack density of *D. brevicomis*.

Marita Lih (University of Arkansas) presented her studies on the southern pine beetle, *Dendroctonus frontalis*, population dynamics in relation to season, tree size, and infestation development. She has evaluated changes in the number of infested trees in mortality groups, particularly in the winter and spring, in relationship to brood stage distributions, to within-tree residence time, adult emergence, and to host tree diameter.

Joel McMillin (Northern Arizona University) outlined a series of greenhouse experiments that determined the effects of water stress on host plant biomass partitioning, host plant resistance, and herbivore performance. The experiments employed ponderosa pine, *Pinus ponderosa*, seedlings as the host and the sawfly *Neodiprion gillettei* as the herbivore. Among other things, Joel has found a significant reduction in *N. gillettei* survival by applying a high level of water stress (seedlings watered only once every 4 weeks) during the seedling shoot growth (but not root growth) period. Fecundity of surviving sawflies was also lower under this treatment regime. Needle toughness, as a measurement of host resistance, was also measured in these experiments and it increased in accordance with declines in survival and fecundity.

Lisa Poirier (Simon Fraser University) presented her studies and planned studies of the importance of larval spit in interspecific interactions of eastern and western spruce budworms. She has developed a series of larval behavioral assays of feeding repellency caused by larval saliva and has tested laboratory-reared *verses* wild *Choristoneura fumiferana* larvae. She also plans to investigate whether the crude salivary extract may inhibit oviposition and influence flight behavior of adult females. She intends to pursue chemical isolation of the active components and has shown that methanol and distilled water as solvents have more promise than pentane and hexane, which both appear to influence larval feeding behavior in control studies.

Therese Poland (Simon Fraser University) described her completed studies of cross-attraction and host partitioning of lodgepole pine, *Pinus contorta latifolia* by two sympatric bark beetles, *Ips pini* and *Pityogenes knechteli*. She also offered a plan of her proposed dissertation work to isolate and identify the fungal associates and pheromonal components of the five-species guild of bark beetles that colonize spruce in British Columbia. Ultimately, using the spruce beetle, *Dendroctonus rufipennis*, as the centerpiece of the association, she hopes to uncover various inhibitory interactions among the beetle species, their pheromones, and fungi that may all lead to a practical control of *D. rufipennis* through competitive displacement.

WORKSHOP: RECENT INSECT IMPACTS UPON LEVELS OF TIMBER HARVESTING

Moderator: Tom Eager

Participants: Bruce Hostetler, John Swanson, Scott Warner, John Wenz and Jamie Ziegler

For the past several years, the activities of forest insects have received considerable attention from the public and the media. Large scale pest outbreaks and changing climatic conditions have combined to cause significant tree mortality in several regions of the western United States. The response by forest managers to reduce losses has included salvage sales as well as attempts to alleviate mortality by reducing stocking in high risk areas. The need for timely application of these measures has drastically altered the planning process in many forest areas. In addition, there has been a great deal of public debate as to the efficacy of these activities.

The Lake Tahoe Management Unit is a prime example of the situation outlined above. This highly visible area has been subjected to high mortality, primarily losses of white fir and Jeffrey pine due to bark beetles. Although there has been an intensive effort to produce long term plans for this area, the activities of pests frequently confound these plans. This area can be considered an urban forest, and the intertwined interests of residents, developers and management agencies frequently clash with each other as well as the conditions imposed by drought, insects and disease and fire.

The history of the region reveals that the current forest can hardly be considered pristine. Human activities are evident on a pre-historic scale and these influences have increased enormously since the coming of European settlers. Fire and climatic history also reveal that rather than a stable ecosystem, the Lake Tahoe Basin has had a dynamic past with dramatic changes in the vegetation and landscape. The problem becomes how to deal with these ecosystem processes while satisfying diverse human desires.

The current situation in the Blue Mountains of Oregon has also received increased attention from the public. Widespread mortality due to spruce budworm and the mountain pine beetle has caused the implementation of extensive salvage logging operations. Again, these unforeseen circumstances have played havoc with the long term planning process. Many critics see the current state of the forest as a result of many years of improper management. Fire exclusion, highgrading and improper stocking have all contributed to a forest structure which is unstable.

The management of private timberlands is not as subject to the scrutiny of the public. With fewer conflicting values private timberland managers are able to achieve more clearly defined objectives. A strict regimen of vigilance combined with the ability to move quickly once a problem is detected allows many private firms to undertake more direct control of pest problems.

Many pest problems are actually "people problems". Conditions inherited from the past, changing environmental parameters and conflicting human goals combine to make pest management a difficult and emotionally charged arena. Clearly there is a need for increased participation of the various client groups as well as more direct interaction between scientists, policy makers and the general public.

WORKSHOP: Information Transfer and Video Production
MODERATOR: John A. McLean
PARTICIPANTS: Panel of Andy McClelland, Michael Valenti, Torgy Torgeson, John McLean and Hanu Saarenmaa; 40 other members of the conference.

Getting the message across is a primary concern once the research has been completed and we reach out to our user communities. Slide shows, videos and multimedia formats are all tools that can be used, each addressing its own audience. The object of the workshop was to explore the medium and its appropriate use to convey the message.

Andy McClelland regaled us with a cockroach's view of the world created by man. His cockroach suit complete with authentic headwear was matched by an excellent set of graphic slides he had developed on his own PC. He reminded us, by example, that a different view of the world can be taken that can be highly motivating to audiences of all ages and backgrounds.

The use of videotape has become more popular but Michael Valenti pointed out very clearly that good video production is a painstaking process. Michael presented many basic principles for "working the bugs out of your video technique". These were based on a series of articles by Drex Rhoades entitled "The Reluctant Videographer" (available from Washington State University, Information Department).

Two members who have produced videotapes to explain their work discussed some of the challenges they faced. Torgy Torgeson reviewed his experiences with **Natural Enemies of Forest Insect Pests**. He would try for more live footage and improved graphics, a job that would require the input from professionals. John McLean reviewed his experience in producing **Tiny Beetles - Expen$ive Ta$te$**, a record of some of his current ambrosia beetle research. Some major pluses for him were to have the input from professional graphics experts who were able to give life to graphics and give advice on more novel presentations that are now available with today's technology. He highly recommended involving professional video producers in a project as they know instinctively what makes the best copy.

The need to review complex databases and simulation models has brought about a need to involve multimedia resources and to have these accessible to PC users in their offices, laboratory or the classroom. Hanu Saarenmaa reviewed his experience in developing a multimedia front end to an extensive database on Integrated Forest Health Management that is under development by his team in Finland. They have tried to embrace an electronic encyclopedia approach that includes an image database, audio comments for images, hypertext, digital video, CD-ROM format targeted to future hardware platforms.

The medium should match the message. We have many technologies available to us. The need is to accumulate the required information in as high a standard as possible (use of tripods with video cameras, for example) so we have good primary product from which we can construct our messages. Future workshops on improving techniques for information acquisition and presentation are recommended.

WORKSHOP: NEW ADVANCES IN THE CONTROL OF BARK BEETLES WITH SEMIOCHEMICALS

Moderator: John H. Borden

This heavily-attended workshop dealt with four areas in which recent advances in the applied use of semiochemicals against bark beetles are very encouraging. Renewed interest and considerable success in mass trapping of Douglas-fir beetles was reported. A precept of this approach is that spill-over attacks on standing trees must be anticipated and can be viewed as silvicultural opportunities, e.g. in converting to a group selection system. Lack of complete efficacy of verbenone as an operational antiaggregant for *Dendroctonus* spp. has recently led researchers to blend verbenone with other known or potential antiaggregants. Examples are the blending of green leaf volatiles (GLVs) (characteristic of deciduous trees) with verbenone against the southern pine beetle, and the use of GLVs and ipsdienol with verbenone against the mountain pine beetle. Another new tactic is to combine the applications of antiaggregants with attractants in a "push-pull" technique. Promising applications are combining MCH with baited traps against Douglas-fir beetles, and verbenone with baited trees against mountain pine beetles and southern pine beetles. An operational push-pull program followed by mass trapping alone has apparently been successful in saving the last remaining natural stand of Torrey pine from lethal attacks by the California fivespined ips. The new biological control tactic of semiochemical-induced competitive displacement of aggressive bark beetles by secondary species is in its infancy. Promising results with pine engravers displacing mountain pine beetles were reported, but it is clear that much more research will be necessary to develop and fine tune this tactic. The vigorous ongoing research in the applications of semiochemicals against bark beetles is characteristic of a pest management field that is in the exponential developmental phase.

Workshop summary: Multipest surveys and treatment regimes

Moderator: Lorraine Maclauchlan, Entomologist
BC. Forest Service, Kamloops, British Columbia

The theme of the workshop was techniques used to quantify pests; their impacts; and the determination of forest management opportunities in light of pests and multipest complexes. Forest health surveys are done for a variety of "end-goals". One of these goals is to input into higher planning phases of forest management and inventory planning. The Pest Incidence Survey in The Kamloops Forest Region is a forest health inventory based on a statistical sampling of the forest inventory to quantify pests, their impacts and problem forest types. The survey methodology involves stratifying all Crown forested land into sample units based on Inventory Type Groups (43 ITG's). Dependent on how much area (ha) is occupied by each ITG, a proportional sampling is done in that particular ITG. The survey records tree species, density, stands statistics, biogeoclimatic zone and pest occurrence and severity. Using the GIS system, the occurrence of particular pests, pest complexes, tree species or problem type groups can be identified.

Mike Schomaker, Forest Health Coordinator
Colorado State Forest Service
Fort Collins, Colorado
Environmental Monitoring Assessment Program is underway on approximately 160 forested plots in Colorado (CO). Funding levels have required statisticians to develop a one quarter interpenetrating design from the base number of national grid hexagonal plots in each state. These plots are evenly distributed, as a triangular grid subsample of the entire grid of plots, across the forested portions of CO. This design allows full coverage of the state on an annual basis while measuring only one fourth of the total plots. In 1992 CO measured approximately 40 plots. Every fifth year these plots will be visited for remeasurements.
Based on 1991 pilot study results from California and CO, 1992 measurements were taken for mensuration; crown classification; damage and mortality; photosynthetically active radiation; soils; stemwood and dendrochronology; vegetation structure; air pollution bioindicator plants; lichens; global positioning; and off-subplot mortality survey. Three of these measurements were considered to be implemented on the subplots (mensuration, crown classification, and damage and mortality. Other measurements were taken on four 1/24th acre circular subplots. Aerial photography and interpretation of all 1992 plots was conducted to enhance the ground survey information.

John W. Dale, Entomologist
State and Private Forestry, USDA
San Francisco, CA
Surveys in the Pacific Southwest Region have been oriented to single or multipest situations. Examples of single pest surveys are those that track Port-Oxford-cedar root disease and sugar pine blister rust. Multipest surveys frequently take the form of biological evaluations that may use sampling schemes, or 100% coverage in recreational settings

such as campgrounds. These surveys include animal damage as well as insect and disease pests. Competing vegetation is also noted. Aerial surveys of defoliation or tree mortality usually have been conducted to designate areas of salvage, not as dead tree counts.
A new survey is the EPA/Forest Service project known as EMAP (Environmental Monitoring and Assessment Program). This effort will require supplemental monitoring information from various sources, one of which may be the re-establishment of the permanent forest inventory plots, which would gather pest information as well as the usual mensurational data.

Iral Ragenovich, Entomologist
Cooperative Forestry/Forest Pest Management
Portland, Oregon
Traditional timber stand inventory information was used as the data base for the Forest Plans and the Pacific Northwest. However, these inventories did not adequately account for losses from insect and disease and, often times, did not record mortality. Also, when insect and disease information is taken during inventories or stand exams there is often discrepancy in consistency and quality between Forests and even between crews. Also, Forest Pest Management has several pest models that can interact with PROGNOSIS growth and yield model to project impacts from insects and diseases; however, data is not currently collected in a format that can be used by the models.
The Okanogan Special project was designed to determine the level of plots and supplementary plots that would be needed to obtain more accurate information if stands or substands were the primary sampling unit. Data were collected at three sampling intensities, and information was collected on the basis of groups of major pests: root diseases, bark beetles, western spruce budworm, and dwarf mistletoes. Results are currently being analyzed.

Peter Hall, Provincial Entomologist
BC Forest Service
Victoria, BC
Approximately 2300 stands were treated under an expanded stand tending program in BC between 1984 and 1989. Treatments included spacing, pruning, fertilization, alone and in combination with other treatments. Stand age ranged from newly planted to 40 years old. In 1991, Forestry Canada implemented a survey of 228 of these stands to assess the occurrence of various potential pest agents. In each stand, a minimum of 10 randomly placed circular plots were established at least 50m apart. Damaging agents identified in these stands included: winter damage; stems rusts; mammals; root rots; root collar and terminal weevils; mistletoes; and, others. Levels of damage or occurrence were not included in the survey; nor did the survey report pest complex occurrences correlated with stand treatments. Future multipest surveys should establish damage in response to expected treatments so that specific treatments can be avoided or modified in response to expected pest occurrence.

PANEL: EXCLUDING EXOTIC PESTS

Moderator: Nancy Lorimer

Panelists: Richard Orr, Joe Cavey, Ron Billings

The Forest Service and the Animal and Plant Health Inspection Service (APHIS), in cooperation with the states and with Canada, have several important programs for the exclusion of forest pests from North America. Accidentally introduced pests are costly in terms of resource impact, and reactive pest management programs are costly in terms of dollars and person-hours. Pro-active programs to exclude exotic pests are more cost effective protection for our forest resources.

Log imports are a potential source of pest introductions. No general regulations currently exist for importing logs and other unmanufactured wood products. APHIS is developing regulations that will establish an organized system for importing wood under conditions adequate to prevent the introduction of forest insects and diseases.

Meanwhile pest risk assessments by the Forest Service and regulations by APHIS have been completed for Siberia and New Zealand, and a third is nearly complete, for Chile. The team toured logging and shipping sites, talked with local forest protection experts, surveyed the literature, and assembled a list of possible quarantine pests. The pests were sorted and subjected to the formal structure of the risk assessment process.

APHIS is trapping at U.S. ports for exotic beetles of the family Scolytidae. These potentially destructive pests could enter the U.S. on dunnage, the rough wood, often with bark, used to pack and block goods in shipment. The exotic Scolytids were chosen by a rating system as target pests. Rating factors included potential for transport, likelihood of establishment, potential damage, and availability of a pheromone. Beetles in traps at ports will give early warning of a threatened introduction.

Several programs have been designed for keeping the Asian gypsy moth (AGM) out of North America. APHIS' vessel inspection guidelines specify that ships calling at Russian far eastern ports during months of moth flight must be examined by port authorities. AGM-infested ships are denied entry to U.S. waters.

Problems with pests in shipping may go beyond importing wood products, beyond dunnage, and beyond AGM-infested ships. Containers, the large railcar sized boxes used to ship goods, may be a source of pest introduction. The two agencies will cooperate on a pest risk assessment of containerized shipping.

AGM exclusion programs extend all the way to the source of the pest in the Russian far east. A technical team from the U.S. will design an AGM population monitoring system with their Russian counterparts. Moth trapping, burlap banding of trees, and egg mass surveys will alert interested parties to climbing population levels. Rising AGM populations will trigger appropriate control and quarantine measures.

WORKSHOP:

AVIAN PREDATION OF FOREST INSECTS: RESEARCH AND MANAGEMENT NEEDS

MODERATOR: Paula K. Kleintjes

PANELISTS:

Alan A. Berryman (Theory of population regulation by avian predators and its application)
Michael A. Valenti (Effects of avian predation on a cicuitous beneficial insect)
Torolf R. Torgersen (Avian predation of forest insect pests; mgt. opportunities)

The importance of insectivorous birds in forest ecosystems is well known but often taken for granted. Moreover, past and present management practices in both temperate and tropical forests threaten populations of insectivorous birds. These threats potentially decrease avian predation pressure upon forest insect pests. This workshop discussed how we can enhance populations of avian predators for the regulation of forest insect pests through; a better understanding of predator-prey processes, innovative research, improved management practices and better communication and collaboration between forest entomologists and wildlife biologists.

A . Berryman stressed the fundamental functional and numerical responses of birds to changes in prey density. Because avian predators can exhibit strong behavioral responses, such as switching to feed upon abundant species or moving into an area of high prey abundance, birds are capable of regulating pest populations at very sparse densities. It was also noted that abundance does not necessarily mean "available" because of variability in prey size, palatability, ease of capture etc....In addition, because birds do not have strong reproductive responses to prey density, prey populations can escape regulation if their numbers become dense enough. With these considerations in mind, two ideas were suggested for using birds to our benefit.
a) Increase bird populations- by increasing bird densities through nestbox establishment or habitat enhancement we can deepen the so-called "predator pit" and thereby reduce the probability of escape of pest populations to outbreak levels, i.e. manipulate birds to prevent pest outbreaks.
b) Decrease bird populations- by decreaseing numbers of birds through exclusion cages, we can set off eruptive outbreaks of beneficial insects that can then control pest species. Because eruptive outbreaks, once initiated, spread on their own accord over large areas, bird exclosures need only be large enough to allow the beneficial insect population to rise above the outbreak threshold.

M. Valenti gave an example of how the second idea above was put into practice in a manzanita brushfield in northern California. The larvae of Synaxis cervinaria (Lepidoptera: Geometridae) defoliate greenleaf manzanita, a shrub that inhibits the reproduction, growth and survival of ponderosa pine. Regulating agents (natural enemies) of the geometrid keep its numbers at low, innocuous levels. Experiments with exclusion cages have shown that avian predators and ants significantly impact the survival of uncaged larvae. This serves as a good example for quantifying the impact of avian predation. It was further suggested that in this case, birds could be manipulated to decrease their numbers in order to increase S. cervinaria survival. The result would be an outbreak of the insect thus an increase in the defoliation of manzanita shrubs which would then favor the establishment and growth of ponderosa pine.

T. Torgersen stressed that forest managers should take into consideration the variable habitat requirements of a diverse avifauna and the ecological interconnectiveness of the forest ecosystem. He emphasized the importance of structural diversity, particularly the dead wood component of the living forest, as it relates to wildife, insects and current timber management practices. He noted that an assemblage of 32 species of birds prey on western spruce budworm and Douglas-fir tussock moth larvae. Of these 32 species, 20 are neotropical migrants. Furthermore, two resident species, the Mountain Chickadee and Red-breasted Nuthatch, are secondary cavity nesters and primary predators of the defoliators. Both species are dependent on primary cavity nesters, such as the Pileated Woodpecker, to provide cavities and therefore they are also dependent on a well developed dead wood component within the forest. Moreover, Pileated Woodpeckers are not only dependent on large snags for nesting but also on downed logs for foraging. Large downed logs provide nesting sites for ants, (e.g.Camponotus sp.) which

compose up to 95% of the Pileated Woodpecker diet. The interconnectiveness of insectivorous birds, ants and dead wood is apparent. Management guidelines exist for dead wood retention but it was suggested that these be refined based on the ecological requirements of all organisms involved.

P. Kleintjes suggested the need for more collaboration between forest entomologists and wildlife biologists, particulary with regard to conservation of neotropical migratory birds. Many migrants are insectivorous and have been attributed to the regulation of forest insect pests. On their temperate breeding grounds these birds depend on insects for feeding young (especially Lepidoptera larvae). Problems can surely arise if a forest is managed for an insect pest without consideration of the impacts on wildlife and vice versa. The audience was asked whether much entomologist-wildlife biologist collaboration exists and the answer was "not really". It was re-iterated that collaborative research and management efforts must be conducted in order to conserve bird populations and consequently regulate insect pest populations. It only seems appropriate at a time forest research and management emphasizes 'biodiversity' and 'forest ecosystem management'.

Urban Forest Integrated Pest Management Workshop

Moderator: John Lichter, US Forest Service, Center for Urban Forest Research

A group of approximately 60 enthusiastic urban and natural forest professionals gathered for this workshop devoted to urban forest pest management.

Patricia Lindsey, Landscape Horticulture Specialist, UC Cooperative Extension, spoke to the importance of urban forest health as it relates to integrated pest management. Urban vegetation is under considerable stress, due to the combined impacts of poor or limiting soil volumes, temperature extremes, wounding, conflicts with utilities and poor management. Pat stressed the need to understand and mediate these impacts, for they lead to increased insect and disease susceptibility and premature tree mortality. Pat suggested that to this end, various design and tree establishment issues should be considered by the urban forest manager or IPM practitioner, such as species selection, tree configuration and spacing, rooting volume, surface treatment, nursery stock quality, site preparation and management.

Following Pat, Pavel Svirhra, Horticulture Advisor, UC Cooperative Extension, Marin County, summarized research pertaining to the selection of landscape trees as part of an integrated approach to urban pest management using as an example his research with London plane trees and anthracnose and powdery mildew resistance. Through the testing of young trees in containers grown under the canopy of mature California sycamores (with high populations of the fungus), Svirhra determined that the London plane cultivar 'Bloodgood' was highly resistant to anthracnose, yet very susceptible to powdery mildew. In contrast, 'Yarwood' exhibited strong resistance to powdery mildew. In addition, Pavel covered results of investigations into sycamore scale management research. Pavel finished by suggesting that in selecting landscape trees, consideration should be given to species or cultivar tolerance to insects, diseases and the urban environment.

Bill Olkowski, Technical Director for the Bio Integral Resources Center (BIRC), rounded out the program with a history of this non-profit followed by a discussion of the future of urban IPM. BIRC is devoted to research and education regarding least toxic pest management. Bill noted that obtaining funding their work, which includes importing biological control agents and developing IPM programs for municipalities, is challenging. However, they have combined resources from several cities and focused on spot treatment to achieve their goals. Bill suggested that the information regarding IPM and least toxic pest management is not getting into society and that the University can play a role in stimulating this. They should be promoting the development of an independent community of professionals who provide these types of services, especially since extension is having a tough time surviving, Olkowski, recommended. Bill finished his discussion by suggesting that IPM policies need to be implemented by city administration and that contract specifications should include monitoring before pest treatment.

WORKSHOP: THE FUTURE OF FOREST ENTOMOLOGY

Moderator: Fred P. Hain

The workshop was an open discussion of the current decline in both the teaching of, and research support for forest entomology. The audience also addressed what steps forest entomologists can take, both individually and collectively, to improve the status of our profession. The following is a synopsis of the discussion.

Forestry education has historically placed a high priority on subjects related to forest production. As this subject matter became more complex, additional courses were added to the forestry curriculum at the expense of forest biological subjects. The decline in forest biology is seen most dramatically in the subjects of forest entomology and forest pathology. Most forestry schools require less than a full semester of these subjects. Many schools combine entomology and pathology into one course; some even include fire control. In a number of schools the requirements are so loose that a student can obtain a degree in forestry with no knowledge of entomology whatsoever. The result has been that an entire generation of foresters has been educated with only minimal understanding of the biology of the forest ecosystem they are managing. Many of these foresters are now in policy making positions and continue to emphasize forest production over forest biology. Their attitude regarding forest entomology is that "the only good bug is a dead bug." Entomology to them frequently means "pest management" and they seek "silver bullet" solutions to pest problems that usually require long-term silvicultural solutions. The advice of forest entomologists is sought only when outbreaks occur - a time when entomologists can provide the least amount of helpful information.

It would be unfair to place the blame for the decline of forest entomology squarely on the shoulders of foresters or forestry schools. We as forest entomologists must accept our share of the blame. We frequently forget that we are "foresters first." We have an image amongst foresters of being "micro-focused and alarmist." Many of us, especially in academic circles, spend most of our time communicating with other entomologists. We tend to be more active in professional entomology societies than professional forestry societies at both the national and local levels. Frequently we have not played an active role in the development of the forestry curriculum.

It should be pointed out that forestry schools have been wrestling with the intensive 4-year forestry curriculum for a number of years. The number of courses that foresters are expected or required to take has grown exponentially, and may have reached a point where it can be argued that we are training foresters, not educating them. Forestry faculty have discussed options such as a 5-year curriculum or a 1-year non-thesis Masters degree. However,

since forestry is not a high salary profession, both ideas could put the profession at a competitive disadvantage with other career choices. Thus, forestry is caught between a rock and a hard place.

What can we do to bring entomology back into forestry? First we must recognize that we are foresters first; that the primary purpose of all our activities is to benefit forestry. Therefore, we should all improve our communications with foresters, both locally and nationally. This would include such activities as attending local chapter meetings and national meetings of the Society of American Foresters (SAF), and participating in forestry-related field trips (entomology questions almost always come up).

We need to demonstrate to foresters that entomology is more than pest management. Entomologist have an important contribution to make in forest ecosystem management and landscape ecology, research in global change and biological diversity, and other forestry-related topics.

Perhaps the most useful step we can take at this time is to become more involved in SAF affairs. There is an SAF Forest Pest Management Working Group (there is a suggestion that the name be changed to SAF Forest Health Working Group). The working group is one of the sponsors of the North American Forest Insect Work Conference. If the group were larger, technical sessions at the annual SAF convention could be organized. To prevent isolation of the group and to improve communications with other working groups, joint sessions with the ecology or silviculture working groups might also be arranged. Finally, those entomologists with such interests should be encouraged to participate in the administration and policy of SAF.

In the past, many forest entomologists were disenchanted with SAF and dropped their membership. However, with society's increasing concerns about environmental degradation and forest health, SAF recognizes the forestry profession's overall responsibilities. SAF is currently going through a metamorphosis, and now is the time for entomologists to have an influence on the "new" SAF.

Workshop: IMPORTATION OF UNPROCESSED LOGS

Moderator: Ron Billings

Participants: Greg DeNitto, Andy Eglitis, John Kliejunas

The importation of unprocessed logs into the United States and Canada, particularly for processing on the West Coast, has become a contentious issue in recent years. The purpose of this workshop was to discuss the pest risk associated with importing unprocessed logs from New Zealand and Chile.

Greg DeNitto, forest pathologist with USDA Forest Service, Redding, CA discussed the approach taken to assess the risk of pests on imported logs of *Pinus radiata* and Douglas-fir from New Zealand. In this case, all pest analyses were approached from the assumption that proposed New Zealand industry mitigation measures would be implemented before importation of logs would be allowed. Seven pests that may be introduced despite these mitigation measures were analyzed in detail using the APHIS risk assessment process. Estimated risks are as follows: low for *Kalotermes borneri* and two *Platypus* species, moderate for *Leptographium truncatum* and *Prionoplus reticularis*, and moderate to high for the *Sirex noctilio/Amylostereum areolatum* complex.

Andris Eglitis, forest entomologist, USDA Forest Service, Bend, OR, briefed the audience on insect pests that may be associated with unprocessed logs of *Pinus radiata* exported from Chile to the U.S. In contrast to the New Zealand assessment, the Chile Pest Risk Assessment team evaluated pest risk under the assumption that no mitigation measures would be applied to imported logs. Among Chilean insects on *P. radiata* logs, a high pest risk potential was given to the introduced bark beetle *Hylurgus ligniperda*, while moderate risk was assigned to the bark beetles *Hylastes alter*, and *Othotomicus erosus*, the native weevils of the genus *Rhyephenes*, the pine bark anobiid *Ernobius mollis*, the siricid *Urocerus gigas*, wood-boring beetles of the genera *Buprestis*, *Colobura* and *Callideriphus* and two species of termites (*Neotermes* sp. and *Porotermes* sp.). The siricid *Sirex noctilio* has yet to be discovered in Chile.

John Kliejunas, forest pathologist, USDA Forest Service, San Francisco, CA reviewed the pathogens on *P. radiata* logs in Chile and their pest risk potentials. Among the more important groups of pathogens assessed in detail were needle diseases, *Diplodia* shoot blight, stain fungi and root diseases. Of these, only the stain fungi (*Ophiostoma* spp.) were ranked as moderate or high pest risk potential on imported logs. On logs of native hardwoods (*Nothofagus dombeyi* and *Laurelia philippiana*), the stain fungi were ranked at moderate or high pest risk.

Ron Billings, forest entomologist, Texas Forest Service, briefly summarized potential insect pests associated with native hardwood logs in Chile. Of particular concern are bark and wood-boring beetles of the families Buprestidae, Cerambycidae and Curculionidae. Insects that attack living trees of *Nothofagus* are unlikely to find suitable hosts in the U.S. if introduced on unprocessed logs; thus, these insects were rated at low risk.

The final portion of the workshop was devoted to questions from the 15-20 members in the audience. Concern was expressed about the potential for introducing unknown pests or of a more virulent strain than those already present in the U.S. Mitigation protocols to minimize the pest risk associated with importing unprocessed logs from Chile are pending completion of the pest risk assessment.

ECOSYSTEM MANAGEMENT: IMPACT ON INSECT DIVERSITY

Moderator: N. G. Rappaport
Organizer: R. A. Werner

Participants: L. Merrill (recorder), T. Torgersen, D. Ross, A. Berryman, G. Ferrell, R. Lavigne, F. Stephen

Attending: J. Barry, L. Merrill, L. Ren, A. Eglites, I. Ragenovitch, S. Blatt, S. Tait, S. Smith, B. Bentz, L. Rasmussen, D. Bartos, P. Kleintjes, J. Rios, J. Wilson, D. Schultz, D. Hart, T. Bowen, E. Holsten, R. Bridges, L. Ehler, J. Neisess, D. Overhulser, N. Lorimer, J. MacLain, S. Huddle, F. Shon

Torgersen discussed functional diversity with respect to two defoliators, the Douglas-fir tussock moth (DFTM) and the western spruce budworm (WSBW). About 60 species of parasitic hymenoptera have been identified from DFTM, including Hyposoter masoni and Telonemus californicus; 50% of eggs were parasitized by this species when DFTM populations were low. But much crucial information is completely lacking, such as what what are the other hosts of T. californicus and how it survives between DFTM outbreaks. It is extremely important in regulating outbreaks, but we know next to nothing about it.

True bugs are also important predators in forest ecosystems, but are little-studied. Spiders are also important; some feed on WSBW and DFTM; attempts have been made to quantify their role, but it's been difficult. Numerically, the number of species of spiders is far higher than any other taxa on grand fir foliage in the southern Cascades. But we don't know, for example, what is the impact of prescribed burning on spider populations.

Ants are the dominant predator on WSBW; about 11 species feed on WSBW. We're just beginning to learn what clearcutting, log removal, etc. does to the ant community. Ants not only prey on WSBW, they also tend aphids, so they can sustain themselves when prey are scarce. Campanotus sp., a major predator, goes for the largest diameter logs in the stand; ant mounds reach enormous sizes and may last 50 years. What about Formica obscuripes? Should we be protecting these mounds too? The Chinese have managed ant mounds for thousands of years.

Thirty-two species of birds are known to prey on WSBW and DFTM; some are secondary cavity-nesters, some are primaries. Pileated woodpeckers forage on ants in down logs. So birds, spiders, and ants are all important predators of defoliators. What will Ecosystem Management (EM) do to them?

A few participants were of the opinion that we don't know enough to manage ecosystems, so whatever we do will be detrimental. We can never do all the research needed. Therefore we should take the Gaia approach: stay out and leave it alone, and not worry about a few species going extinct. Others felt that managers must assume there will be effects, and must manage with this in mind.

Most particpants felt that "playing God" was dangerous. Assuming that we can do better than nature is terribly risky, for instance draining the swamps in Florida and the consequent impact on the Everglades. In forest ecosystems, for example, we should limit ground disturbances, because that's likely to be

important and is easy to limit. We should leave more wood on the ground, leave unmerchantable trees to fall down on their own. As for salvage, we should leave out the large wood. However, we CAN produce a stable ecosystem that we can take products out of.

The minority camp reiterated that stability is what's important, not biodiversity. England was given as a classic example in which ecosystems were changed dramatically and were drastically simplified, yet are stable. The loss of a few species was not a concern to this group of participants.

Darrel Ross described the Genesis Project, which is studying how prescribed burning affects forest health in eastern Oregon mixed-conifer stands. A research prospectus for the Genesis Demonstration Area, Malheur NF, is in the early stages. Chris Niwa (PNW), Roger Ottmar (PNW), Robin Rose (OSU), Darrell Ross (OSU), Greg Filip (OSU), and Torgie Torgersen are among those involved. Various forest management activities are being assessed: harvest methods, site preparation, regeneration, stand maintenance. Effects of fire on forest ecosystem componenets (air quality, human health, animal damage, etc.).

An overview: the demonstration area covers 6,000 acres with oldgrowth areas; there is a viewshed from highway 26; there are shelterwood and seed tree harvests; prescribed fire for site preparation; stand will be regenerated to seral tree species. The current status of work is as follows: the experimental design calls for 11 replicates split into burn/no burn; replicates are 10-50 acres in size; there will be baseline sampling of soils, insects, and fuel loads.

Ross also described the research of his new graduate student from Czechoslovakia, who will work on spiders and ants. Bob Lavigne described his work following the 1988 fires in Yellowstone NP on macro- and micro-arthropod fauna in soil litter (both burned and unburned areas). He has 3 years data on litter fauna in clearcut vs uncut stands, and in stands tractor-logged vs. oxen-logged.

Fred Stephen (University of Arkansas, Fayetteville) presented a hypothesis for discussion: that ecosystem simplification in the southern U.S. has resulted in high populations of southern pine beetles (SPB). Native Americans in the southeastern U.S. used fire frequently; there was high biological diversity in the flora of the forest floor. Now, there is a monoculture of loblolly pines and the understory environment is nearly sterile. SPB has 7-9 generations per year; there is no diapause in the south, and beetles fly throughout the year. So there are lots of larvae constantly available for parasitism. There are about 6 species of larval parasitoids, and these species are all synoogenic (few eggs are ready when the female emerges, so food sources are important for egg development). The understory flora could be very important for the efficacy of bark beetle control because it provides nutrition for developing eggs.

Some questioned that there is any evidence suggesting that parasites have bark beetle regulating capacity. With all the bark beetle species that have been looked at, parasites are very limited in their numerical responses.

George Ferrell described a long-term ecosystem study that is underway at Black's Mountain Experimental Forest (BMEF) in California. BMEF comprises 2-3,000 acres of eastside pine, where the California pine risk rating system was developed. This study will assess intermediate solutions as well as the "no management vs. traditional management" scenarios. There is already a lot of historical data on stand structures at Black's Mountain. PSW Research Station is conducting a long-term ecological study at BMEF involving wildlife biologists, silviculturists, soils people, two entomologists, and statisticians. Treatments consist of 200-300 acre plots, some structurally diverse, some structurally simplified, with periodic prescribed burns (ca. every 12 years) vs. no prescribed burns (also grazing vs. no grazing). They're trying to put back into place the ecological processes formative for eastside pine type; for example they want to manipulate bark beetles to get them to make small group kills (thought to be a natural process). It was pointed out that the time scale for this kind of process is long - 20 years minimum.

WORKSHOP: BIOSYSTEMATICS

Moderator: Steve Teale

Participants: J. Powell, S. Seybold, S. Lindgren. S. Teale

Biosystematics, particularly species-level problems, are of fundamental importance to forest entomology. While many non-systematists tend to take taxonomy for granted, one only needs to consider the conifer-feeding *Choristoneura* species to see that systematics provides a basis on which the research and management of forest insects is built.

Jerry Powell reviewed the relationships and interactions among the currently recognized taxa in the conifer-feeding *Choristoneura*. The subspecies *retiniana retiniana* (Walshingham, 1879) (syn. *lindseyana* Obraztsov, 1962 and *viridis* Freeman, 1967) occurs in Siskiyou and Modoc Counties, CA and *r. spaldingiana* Obraztsov, 1962 occurs in the Sierra Nevada, Tehachapi, So. California Mts., and the Great Basin Ranges. *C. carnana carnana* (Barnes & Busck, 1920) occurs in the Transverse Ranges, So. California; *C. carnana* "Sierra Nevada populations" occur along the westside Sierra Nevada below 1600m; and *C. carnana californica* Powell, 1964 occurs in the N. Coast Ranges to Mt. Shasta. *C. occidentalis*, Freeman 1967 is found from British Columbia and Washington to Montana, Nevada, New Mexico and Arizona. The *lambertiana* subspecies are distributed as follows: *l. lambertiana* (Busck, 1915) - So. Oregon and No. California; *l. subretiniana* Obraztsov, 1962 Sierra Nevada (above 1600m), Warner Mts. and E. Oregon; "Northern Rocky Mountain populations" - Idaho, Montana and Wyoming; *l. ponderosana* Obraztsov, 1962 - Southern Rocky Mountains, W. South Dakota, Utah, No. Arizona and So. Nevada; "coastal populations" - coastal Oregon and Washington.

An interesting situation exists involving *C. retiniana* and *C. carnana.* These species are sympatric in California with complete reproductive and pheromonal isolation. However, this separation breaks down farther north in Oregon where the pheromones from southern populations will attract both species.

A roughly analogous situation seems to occur among populations of *Ips pini.* Staffan Lindgren presented some of Dan Miller's work on pheromone variation among *I. pini* populations. Previous work found that populations were pheromonally specific: eastern (New York) *I. pini* used racemic ipsdienol and western (California) populations used predominantly the *R*-(-) enantiomer. Dan's work showed that these two population types come together in southern B.C. In a population producing predominantly *R*-(-), there was no specificity in response based on enentiomeric composition suggesting that there could be introgression between these pheromone types. This is similar to the *Choristoneura* situation above, except that the *Ips* populations are generally parapatric rather than sympatric.

Steve Seybold discussed the role of a second pheromone component, lanierone, in interpopulational specificity of *Ips pini* populations. In collaboration with Steve Teale, he found that lanierone is not produced by, and has only a minor effect on the response of a California population. Eastern (e.g. New York) populations produce lanierone and their response to ipsdienol is strongly synergised by it. The role of lanierone in southern B.C. populations remains to be determined. The question of introgression between the eastern and western populations is important because the two populations were once considered different species (*pini* and *oregonis*, respectively) based on morphological characters. From a management point of view this pheromone variation is also very important: *I. pini* pheromones are being used for monitoring and control and it is essential that the locally correct component blend is implemented.

Bark Beetles - Fungal - Tree Interactions

Fields W. Cobb - Moderator

Moderator Comments: The topic of this workshop is more relevant than ever, especially with the present emphasis on "ecosystem management". This is the exact terminology that those who have been trying to work within the scope of this area have been using for more than two decades. Success in ecosystem management necessitates the integration of knowledge of all agents of the forest. We cannot sit back and let the foresters go by. Not only will it be a disaster for us but for the resources as well.

The abstracts below are the only ones available at press time. For that the moderator apologizes.

Gary Slaughter - U. C. Berkeley - "Root Disease and Bark Beetle Modeling"

The annosus root disease model, a modification of the western root disease model, is being developed by the Methods Application Group (Bov Eav) in Fort Collins, Colorado, with their Canadian contractor Environmental and Social Systems Analysts Ltd. (Werner Kurz). In cooperation with the Rocky Mountain Station (Terry Shaw) and Region 5 Forest Pest Management (Susan Frankel). The model is designed to predict the effects of annosus infestations on future growth and yield in California and southern Oregon forests. This model has a significant bark beetle component. Four types of bark beetle behavior are simulated, dependent on the following critera: I - density of susceptible stems; II - windthrown stems as refugia for beetle populations; III - stems infected by root disease; IV - stems infected by root disease, with infected and uninfected stems on the periphery of root disease areas, are more likely to be attacked once an outbreak is initiated.

Andrew Storer - U. C. Berkeley - "Pitch Canker and Bark Beetle Vectors"

Research on pitch canker disease of pines has been ongoing at UC Berkeley since 1988. Currently Dave Wood and Tom Gordon, post-doctoral researcher Andrew Storer and graduate student Paul Dallara are collaborating on the projects. Pitch canker is caused by *Fusarium subglutinans* f. sp. *pini*. Among the insects implicated in its transmission are twig beetles (*Pityophthorus* spp.), bark beetles (*Ips* spp.), the cone beetle (*Conophthorus radiatae*), and the dry twig and cone beetle (*Ernobius punctulatus*). Infections initiated by twig beetles, cone beetle and dry twig and cone beetle result in fading of branch tips. Infections initiated by bark beetles on larger branches and the bole result in resin soaking of the wood and copious pitch exudation. The disease is most prevalent in Santa Cruz and Alameda Counties. Its range extends from the Golden Gate to Pebble Beach with isolated outbreaks in San Luis Obispo, southern California, and southern Mendocino Co.

Standard plots are assessed to characterize the pattern of disease spread within trees, and within sites currently showing high, low or zero infections. Plots with zero infections are observed bimonthly to monitor the arrival of the fungus in that area. Plots heavily infected with pitch canker are routinely visited every four months. Populations of *Ips* bark beetles are being monitored by placing Monterey pine logs in the areas affected by the disease. These logs are left in the field for four weeks before being dissected. *Ips* species are identified and the occurrence of pitch canker propagules on the beetles is assessed. In August 1992, over 75% of logs were attacked, all by *Ips mexicanus*. About 5% of the beetles were carrying propagules of pitch canker fungus.

Pitch canker fungus has been isolated from Monterey pine Christmas tree farms in Los Angeles and San Diego counties. At one site in Los Angeles County, an estimated economic loss of over $10,000 occurred in 1992. Infections on Christmas trees occur low on the bole of the tree, with associated resin exudation. The mode of transmission among Christmas trees is being investigated as are possible measures for alleviating the problem.

A benomyl resistant strain of pitch canker fungus has been produced. Such resistance affects a single gene. Comparisons between this strain and the wild type are being made to ensure that no differences exist prior to release of the fungus on *Ips paraconfusus*. This experiment will provide information on the rate of spread of this new fungal associate within this *Ips* species and into other *Ips* species populations, and it will provide insights into the nature of the development of insect-fungal associations.

Paul Dallara - U. C. Berkeley - "Pitch Canker and Tip Mortality"

To examine the role of twig-inhabiting arthropods in the spread of pine pitch canker disease in central coastal California. Asymptomatic green branch tips are cut and hung in tree crown as bait every six weeks and subsequently placed into individual emergence chambers. All emerged organisms are killed. Samples are plated onto *Fusarium* selective medium and colonies are screened for *Fusarium subglutinans* f. sp. *pini*. Collections have been made in native stands and landscape planting of *Pinus radiata*, *P. ponderosa*, *P. attenuata*, and *Pseudotsuga menziesii*. Symptomatic branch tips of *P. radiata* have been collected also. Preliminary results indicate that

Scolytid beetles in the genus *Pityophthorus* are the most abundant inhabitants of all *Pinus* twigs. *Pityophthorus carmeli, P. setosus*, and *P. nitidulus* have all been found in *Pinus radiata*, while *P. murrayanae aurulentus* has been found in *Pinus ponderosa* and *P. attenuata*. *Taenioglyptes pubescens* (Coleoptera: Scolytidae) is the most abundant insect in *Pseudotsuga menziesii*, but it has also emerged from *Pinus radiata*. Members of the genus *Lasconotus* (Coleoptera: Colydiidae) have also emerged in relatively large numbers from *P. radiata* and *P. ponderosa*. Insects emerging from *P. radiata* that have been found to carry inoculum of *F. s. pini* include *P. carmeli, P. setosus, P. nitidulus*, and *Lasconotus pertenuis*. Continued collection through a two year period is expected to yield patterns of insect feeding preferences and degrees of polyphagy; this information will be used in combination with disease transmisjsion studies to predict geographic spread and host range expansion of pitch canker.

Don Owen - CA Dept. Forestry and Fire Protection, Redding - "Pitch Canker and Associated Beetles"

Dave Adams and I established three plots in the Santa Cruz area. A total of 97 trees were monitored for tree vigor, pitch canker severity, and bark beetle activity from 1987 to 1992. Trees were rated for pitch canker as follows: 0 = no pitch canker evident and 1-6 = increasing levels of infection. At the beginning of the study, 39 trees had little or no pitch canker (rating of 0 or 1) and 58 had moderate to high levels of infection (ratings of 2-6). During the 5 years of monitoring roughly half the trees showed a significant increase in pitch canker severity (an increase of 2 or more rating points), including 17 trees which died. The remainder of the trees showed little or no increase in pitch canker severity (a maximum increase of 1 rating point), including 8 trees which never showed any evidence of infection. On two plots, a history of attacks by the red turpentine beetle (*Dendroctonus valens*) often preceded tree death, while on the third plot this did not occur. All trees that died were infected with pitch canker and colonized on the main stem by the red turpentine beetle and *Ips paraconfusus* and/or *I. mexicanus*.

Mike Wagner, Northern Arizona U. - "Hypotheses on Bark Beetle Biology"

Evolutionary adaptations and phylogenetic constraints of two very different eruptive bark beetle species were discussed. *Dendroctonus ponderosae* is gregarious and prefers to attack stressed, mature trees while *Dendroctonus rhizophagus* is solitary and prefers to attack vigorous young growing trees. Gregariousness, presence of aggregation pheromone, adult female ability to assess host quality, and symbiotic fungi are all evolutionary adaptations that are likely different between these bark beetle species. Bark beetles may serve as a good model to test theories related to why some species are eruptive and others relatively stable.

Peter Lorio, So. For. Exp. Sta., Pineville, LA - "Modeling the Interactions"

Interactions among bark beetles, pathogens, and conifers may be considered as a triangle with all three corners impacting on each other. Another triangle of interactions among the tree invading organisms (bark beetles and pathogens), the trees themselves, and the environment may be considered. If the trees are themselves considered important elements in either of these two triangles, then it is essential to consider the possible effects of the environment on the outcomes of interactions between the invading organisms and the trees. In order to have the best opportunity to evaluate interactions among invaders, for example, as in inoculation studies, it is essential to assess the effects of environmental conditions prior to and during the study, and to understand the effects of ontogenetic stage of the trees, which can alter physiological conditions to either favor or disfavor invading organisms.

Tim Paine, U. C. Riverside - "Response of Mycangial Fungi Resin Constituents"

Dendroctonus jeffreyi and *D. ponderosae* are sympatric species over portions of their geographic ranges. However, *D. jeffreyi* is monophagous on *P. jeffreyi* while *D. ponderosae* is highly polyphagous. Both species carry mycangial fungi that are very similar in appearance. Growth of the two mycangial fungi and of *Leptographium terebrantis* (associated with the polyphagous, non-tree killing *D. valens*) in the presence of oleoresin constituents of host and non-host conifers was tested by placing individual chemicals on agar growth medium and by growing cultures in saturated atmospheres of the chemicals. The fungus associated with *D. jeffreyi* showed greater tolerance for chemical constituents placed on the medium than the other two fungi, and growth after three days was enhanced by heptane, the dominant constituent of *P. jeffreyi* oleoresin. Growth of all three fungi was reduced by resin constituents when presented as saturated atmospheres. Results suggest that the influence of the tree on growth of symbiotic fungi of bark beetles during initial attack may be different than after colonization is complete. The difference in the responses of apparently related species of mycangial fungi may provide some new insight into evolutionary history of these beetle/mycangial fungus/host tree systems.

Workshop: **The use of Dendrochronology in Forest Insect Studies.**

Moderator: **Arthur G. Raske**

Participants: **A. Lynch, L. Maclauchlan, J. Wenz, R. Alfaro (T. Shore), and A. Raske.**

We first reviewed the various forest insect studies in North America that use dendrochronological methods. The general topics included ecological history of today's forests, quantifying impacts of disturbances, and quantifying the impact of insect control measures. Two researchers with important studies were not represented at the workshop: Dr. B. Wickman, La Grande OR, has studied the history of insect outbreaks in the Blue Mountains of Oregon, and has related the frequency and severity of these outbreaks to changes in fire frequency and logging practices. Dr. L. Konkey, Dartmouth NH, is studying the ecology of old-growth red spruce and balsam fir stands in Maine, and the influence of the eastern spruce budworm on their development.

Anne Lynch presented her work with Tom Swetnam that has reconstructed the frequency and extent of past outbreaks of the western spruce budworm in Colorado and New Mexico. Dendrochronological methods permit the reconstruction of past environmental phenomena. They used challenging quantitative statistical techniques that allow trended time-series data (= tree-ring chronological data) with unequal variances from different tree sizes, species, and ages of trees, and from different sites, to be compared. The spatial and temporal scales of the resulting data encompass the phenomena of interest to the workshop. The workshop discussed the multi-century, regional-scale patterns of forest disturbances. Nine regional outbreaks of the western spruce budworm were identified between 1690 and 1989. The average outbreak duration was about 11 years. These outbreaks were more synchronous among stands in this century than during earlier centuries, and the most recent outbreak was unusually severe. These results support the hypothesis that human-induced changes in forest character have led to more wide-spread and intense outbreaks. It was noted that periods of increased and decreased budworm activity coincided with wetter and drier periods respectively; in particular spring precipitation. Discussion centered on the relation between weather and outbreaks of the eastern spruce budworm where the opposite has been reported: increase associated with drier and decrease with wetter periods.

John Wenz used dendrochronological techniques to evaluate treatment efficacy of B.t. sprays to reduce the damage caused by defoliation of the Douglas-fir tussock moth. He sampled both host and non-host trees. The ring-widths of over 900 cores have been measured and the data is being analyzed. Plans are to re-sample the trees to determine the long-term effects of forest protection measures.

Studies by Lorraine Maclauchlan of the Ministries of Forests (Province of British Columbia) focus on the relationship between levels of annual defoliation by the western spruce budworm and quantity of growth-loss and tree mortality. A total of 32 permanent plots in the Interior Douglas-fir biogeoclimatic subzones are used to monitor severity of defoliation and will be used to monitor growth and yield. A system has been designed from the dendrochronological records which project the growth of uneven-aged stands characteristic of interior Douglas-fir. This system reads forest inventory files and simulates infestations of varying severity and duration, and then projects losses in total stand volume of harvestable trees. The plots are now being re-measured for growth, mortality and ingrowth to be correlated to the relative amount of defoliation and budworm population levels to define a model that will relate populations to expected losses in each layer, or age class of Douglas-fir stands. The unique character of the study is the application of dendrochrological methods to an all-age forest.

Another study on the impact of the eastern spruce budworm in British Columbia is led by Rene Alfaro who is measuring ring widths and other parameters to determine the effects of defoliation on stand structure and growth. A total of 18 white spruce stands are being sampled in northern British Columbia where this spruce budworm has been at high population levels for 7 years. Ring width data is also being used to identify past outbreaks that occurred as early as 1860.

Studies to relate the severity of damage by the eastern spruce budworm to growth-reduction of balsam fir and black spruce began in Newfoundland in 1975. Data from permanent plots have now been combined with the results of stem analyses to quantify relationships between severity of damage, growth reduction and growth recovery. Discussion focused on the methods used to derive expected growth since control plots were lacking (due to the extensive and severe nature of the outbreak that severely damaged the control plots). An average growth-age curve (ring width through time) was produced which reflected the inherent growth pattern of the trees through time for the sites in the sample. The inherent-expected ring widths for a given tree during the outbreak years was adjusted to the average growth of the tree 10-years prior to the outbreak. An independent analyses correlated the pre-outbreak growth of trees with 28 weather parameters. This correlation was used to modify the inherent-expected growth for each of the outbreak and post-outbreak years in respect to more favorable weather for growth or less favorable as determined by the correlation. In general both fir and spruce did not recover the pre-outbreak growth rate, even up to 9 years after the termination of the outbreak. Of special interest was that the percent growth reduction of ring width at DBH was very closely correlated to the percent reduction of ring volume for the whole tree. This means that the conclusions of past impact studies, whose measurements were taken at DBH only, are reasonably accurate.

PANEL: FOREST ENTOMOLOGY AND SOCIETY: CASE STUDY OF THINNING AND SALVAGE IN THE LAKE TAHOE BASIN

Moderator: John Neisess

Panelists: Robert Harris, Rochelle Nason, Martin McFadden and George Ferrell

LAKE TAHOE INSECT AND MORTALITY SITUATION

Robert Harris, Forest Supervisor
Lake Tahoe Basin Management Unit

HISTORY: Pre-settlement forests (1840's) at Lake Tahoe were characterized by a open stand of large Jeffrey and sugar pine conditioned to 8-10 year cycles of low intensity natural fires. The forest was adapted to cycles of drought and higher than average moisture periods with fir limited by light natural underburnings. During the Nevada Comstock era (1860-1890's) most of the pine was removed for shoring lumber in the Virginia City mines. Nearly 2 billion board feet of pine was harvested which equates to the standing volume of timber we see today. Restocking was left to the natural seeding from the predominately white fir that remained. This natural seeding was accelerated by periods of above-normal precipitation and the aggressive fire suppression of the early 1900's. Most of the lands in the Basin (80%) were in private ownership until the 1970's and experienced additional logging in the 1950's as well as grazing, gravel mining, and development. National forest lands accounted for the other 20% and were mostly the high-alpine wilderness areas. Today through land acquisition, purchase, and donations the national forest and state park lands are 85% of the Basin area. By the 1970's environmental concerns for the Lake's clarity had grown because of the impacts caused by uncontrolled development and un-mitigated development. At this time, the Basin entered a 20 year period of significant regulation including severe limitations on vegetative management. The stage was now set for the overstocked, even-aged fir and pine stands to be weakened by 6 years of drought and the subsequent attack by the fir engraver and Jeffrey pine beetles.

TODAY: 20% of the stand is dead since 1989, or 400 million board feet. This has occurred mostly in the mixed conifer with white fir predominance in the north, west, and south shores. Some stands have reached 80% mortality. In 1992 evidence of significant mortality in the east shore Jeffrey pine has surfaced. Initial efforts have been to address areas easily accessed and environmentally compatible with commercial salvage (ie. north shore), to coordinate defensible space and fuel break efforts adjacent to developed areas, and for hazard tree reduction within the forest/urban intermix and in highly developed recreation areas. Many tools were used to evaluate the significance of the mortality and to plan priorities. They included satellite imagery to map changes in canopy and the Ignition Management System which uses GIS for combining analyses of fire occurrence, fire hazard (fuel loading and topography), and values at risk (property, watershed, wildlife, and visual).

LONG-TERM STRATEGY: The approach has been to address treatments necessary for ecosystem health and to work toward public consensus. At Tahoe, treatments will integrate wildlife objectives with stand health (thinning and replanting to pine), fuel loading and hazard reduction, and watershed restoration. The Basin will remain a non-timber-commidity producing forest.

CONSTRAINTS ON STRATEGIES: (1) Cumulative watershed effects caused by existing development along the Lake shore and the highly sensitive granitic soils limit equipment and access which results in the need for high investments to make treatments; (2) T & E species, such as Goshawk, California Spotted Owl, and Bald Eagle, nest or forage in many areas of the forest and require extensive inventories and studies before treatments can begin as well as seasonally limit many areas for entry; (3) CULTURAL RESOURCES require extensive field work because of the significant pre-historic and historic resources within the Basin which translates to high investment costs and time frames because not much inventory exists; (4) COSTS TO TREAT STANDS is very high compared to value of products removed, ie. $500 to $1000/acre investment costs in many of the acres needing treatment and there is very little opportunity to use traditional timber sale contracting to pay for treatments.

WORKING WITH THE PUBLIC ISSUES AND CONCERNS: Five themes have evolved since the magnitude of the tree mortality became visible in 1989 and the first significant logging began:

(1) Fire hazard posed by large numbers of dead tress on slopes adjacent to and within developed areas was recognized and reinforced by the Oakland Hills fire of 1991 and the Cleveland Fire (Eldorado NF) of 1992. Environmentalists countered that history did not show the basin to have a severe fire history and the concern was hype used to promote logging.

(2) Logging brought concerns for visual and soil impacts from large scale operations that was seen as out of character for operations and constraints in the Basin. Science based decisions were challenged, and today there is significant resistance to the removal of fuels and stand thinning because of the concern for soil compaction and disturbance.

(3) "Snap shot versus movie" is the emotionalism involved with large scale operations and their appearance at the time of activities. The Basin is in everyone's backyard and used by 20+ million visitors a year. The concerned public has a difficult time comprehending the current impacts as acceptable and necessary to achieve a healthy, vigorous forest that will meet all ecosystem objectives, but some years beyond today.

(4) Cutting all the big trees and green trees. The initial logging was done using commercial timber sales on the north shore where the timber did pay its way and the non-commercial fuel wood and thinning was accomplished 2-4 years after the commercial harvest. Also, as the mortality was occurring and marking was underway, research studies were used to predict mortality on trees that had green needles but had not died. The public did not understand the sequencing of work over time, nor accept the scientific basis for the prescription that marked trees that were perceived to be alive.

(5) What is the desired state and how to maintain it in an urban intermixed forest in a highly sensitive area? This remains an open issue now that the preservation era and drought have proven the need to establish and manage the forest to reflect what history tells us. It is difficult to give the answer to the public because the role of prescribed fire and/or mechanical treatments have not been clearly studied within the context of the environmental sensitivity of the Basin. Current efforts involve the public, agencies, research, and academia working together to set the future direction for the health of the ecosystem. In the interim, all the agencies are cooperating to inform, interpret, and involve the public.

RESTORATION AND PRESERVATION OF THE LAKE TAHOE BASIN FOREST

Rochelle Nason
League to Save Lake Tahoe

Lake Tahoe is both a national treasure and a national tragedy. It is a uniquely beautiful mountain lake area that certainly would have become a national park had it been protected from development at an early stage. Instead, it has been severely exploited for commercial purposes and, as one result, the Lake has lost approximately 25% of its original clarity.

In recent years, hundreds of millions of dollars of public funds have been invested in environmental preservation and restoration of the area. Today, however, the Forest Service, which is now the largest landowner in the Basin, must begin making a significant further investment in forest management to protect all the investments that have gone before--or risk all of the progress that has been made at Lake Tahoe.

Past abusive logging practices and subsequent fire suppression in the Lake Tahoe Basin have left a grim legacy of overcrowded, insect-infested forests lacking their original mix of species and age classes. Sugar pines, and very large trees of other species, which were abundant in the original forest, are now quite rare. The local population and visitors are disturbed by the sight of the dead trees, and are fearful of catastrophic fire.

The forest Service needs to adopt a forest management strategy appropriate to the area that is, in effect, an inhabited park. For forest lands surrounding residential and commercial areas, it must create buffer zones for protection from fire, while implementing an aggressive prescribed burning program for forest lands a safe distance from those areas.

Logging can be an appropriate management technique--to create buffer zones, prepare an area for prescribed burning, or substitute for fire where prescribed burning is impossible--but such logging must preserve the largest trees and snags in all but the most exceptional circumstances and must observe the highest standards of water quality protection.

Financial considerations must not be permitted to dictate the taking of large trees or the relaxation of water quality controls. Additional public funds may be needed now to implement the kind of management the League recommends, but such funds would be a wise investment both in terms of protecting the progress that has already been made and in terms of Tahoe's importance as a scenic and recreational resource for the future.

BARK BEETLE REMEDIATION TASK FORCE

Martin J. McFadden, Jr.
Pacific Energy

California Senate Resolution 34, sponsored by Senator Dan McCorquodale and Senator Rose Ann Vuich, established the Bark Beetle Remediation Task Force in early 1992, to perform research, conduct hearings, evaluate solutions, and develop a comprehensive legislative program to limit further depredation by pests of California forests. The Task Force was composed of 15 persons from a broad spectrum of interested parties.

Three major barriers to comprehensive programs of forest health management were identified: (1) economics, (2) the lack of authority to use public resources for forest health improvements, and (3) addressing the long term problem of forest health on an ad hoc basis.

The short term recommendation was to perform salvage logging, followed by fuels reduction treatment. Salvage harvest should be conducted immediately to preserve high value products, especially lumber. Revenues generated from salvage should be used to offset the cost of fuel reduction treatments where this was already permitted by law.

The long term recommendation was to begin an aggressive program of stocking control treatments, with the goal of reducing stand densities to increase tree vigor and restoring historical distribution of conifer and non-conifer species.

Recognizing environmental sensitivities of large scale work in both the short and long term recommendations, the Task Force determined that a pilot program in the Lake Tahoe Basin Management Unit, involving a stewardship contract, might overcome the barriers identified. If the environmental sensitivities of the Lake Tahoe Basin could be properly addressed in the stewardship program, the Task Force believed that the stewardship program would be a model for use by other National Forests in California to address the problem of forest health.

Senate Joint Resolution 51, introduce by Senator McCorquodale and enacted by the California Legislature on September 10, 1992, formally requested stewardhip contracting authority for Region 5 in the Lake Tahoe Basin Management Unit. That authority was granted by Congress and the President on October 5, 1993

PREDICTING SUSCEPTIBILITY OF WHITE FIR DURING THE DROUGHT-CAUSED OUTBREAK OF THE FIR ENGRAVER AT LAKE TAHOE

George T. Ferrell
Pacific Southwest Forest and Range Experiment Station

Risk-rating systems predicting probability of white firs being killed by the fir engraver are available but had not been tested during a drought-caused outbreak such as the one which occurred recently at Lake Tahoe in the central Sierra Nevada. The old systems were developed during non-drought periods and use crown characteristics as predictors. In 1987 at the beginning of the drought, 633 firs were characterized in 6 stands at Lake Tahoe to test these systems during a drought. Also measured were a growth efficiency index and the stem reaction to the pathogenic fungus vectored by the beetle, both of which were thought to be more rapidly responsive to drought than crown characteristics. By 1989, virtually all the study firs had been attacked by the beetle and 230 were killed. On a basal area basis, this ranged from 5 to 68% of the firs growing in the study stands. Of the candidate predictors, all appeared useful for predicting which firs would die in the first year, but none was sufficiently accurate over the two years of the study. Evidently, as the drought intensified, entire stands of firs, and not just a few individual firs, became susceptible. But fir mortality was predicted with sufficient accuracy on a stand basis using basal area of fir, or of all trees, in the stand as predictors. Results indicated that predictions on a stand, rather than an individual tree, basis are more useful during protracted droughts like the one recently experienced in the central Sierra Nevada.

Cellular Reactions of Resistant and Susceptible Norway Spruce Clones to Threat by Bark Beetle Vectored Funji

Alan Berryman, Erik Christiansen and Trygve Krekling

Department of Entomology, Washington State University, Pullman, WA 99164-6382

Three clones of Norway spruce were mass inoculated at different doses with *Ophiostoma clavigera*, a highly pathogenic fungus vectored by *Ips typographus*. The three clones showed dramatic differences in resin production and blue staining. Transmission electron micrographs taken from tissues 0.5mm from points of infection showed dramatic differences in the contents and swelling of phloem parenchyma and ray cells.

HOST SELECTION OF THE MOUNTAIN PINE BEETLE *Dendroctonus ponderosae* Hopkins IN THINNED AND UNTHINNED PONDEROSA PINE *Pinus ponderosa* Dougl. STANDS

David M. Braun* and Robert I. Gara**

ABSTRACT

Research on the host selection of the mountain pine beetle (MPB) took place in second-growth ponderosa pine stands near Cle Elum, Washington. Thinning studies took place in four 70-90 year old stands. The basic technique was to bait trees in the center of treatment plots with mountain pine beetle tree bait (beta-myrcene, trans-verbenol, and exo-brevicomin; Pherotec Inc., Delta, B.C.) and observe host finding by sampling attacks and attacking beetles via trapping on baited and other trees. Treatments included no thinning, thinning about baited trees to leave the immediately surrounding trees in certain diameter and distance ranges, and thinning entire .25 ha. plots to different spacings. Results indicate that the critical factor in spread of the MPB from initially attacked trees is inter-tree distance, and not diameter. At one site, wide spacing (8 m.) treatments had only baited trees killed, whereas unthinned plots at the same site had up to 30 trees killed. The vigor of trees successfully attacked (killed) was significantly less than vigor of trees unsuccessfully attacked or not attacked in lower MPB population areas, but was not in higher population areas, reflecting the impact of MPB population level on host selection behavior. Some evidence was found for *a priori* host selection based on tree characteristics connected to low vigor in low MPB population areas.

*David M. Braun, Doctoral Candidate, Univ. of Washington College of Forest Resources.

**Dr. Robert I. Gara, Professor, Univ. of Washington College of Forest Resources

Submitted poster for:
Western Forest Insect Work Conference
28 February - 4 March 1993

LORIO, PETER L., JR., MATTHEW P. AYRES, and JAMES P. DUNN. Southern Forest Experiment Station, USDA Forest Service, Pineville, LA, 71360, USA. Moderate water deficit in loblolly pine (*Pinus taeda* L.) reduces growth, but enhances resistance to the southern pine beetle (*Dendroctonus frontalis* Zimm.)

We evaluated the effects of soil water regimes on loblolly pines using rain shelters (to prevent soil water recharge), natural precipitation, and irrigation plus natural precipitation. Our hypotheses, based on plant growth-differentiation balance, were: (1) water deficit would reduce growth more than photosynthesis, increase carbon commitment to oleoresin synthesis (↑ differentiation), and increase resistance to beetle attack, and (2) irrigation would increase cambial and shoot growth, reduce carbon commitments to oleoresin synthesis, and reduce resistance to beetle attack. Measurements included height growth, cambial growth, photosynthesis, xylem water potential, oleoresin exudation from bark wounds, and the success of attacking southern pine beetles. A wide range of calculated soil water storage and cumulative daily water deficits was established prior to inducing beetle attack. Xylem water potential was lowered, and oleoresin yields increased, in trees with reduced water availability. Height growth and bole cambial growth increased with increasing water availability, but photosynthesis was unaffected. Beetle gallery length and eggs per 500 cm^2 increased ~60% with increasing water availability. The number of eggs per attack (a determinant of beetle population growth) was 2-6 times higher in irrigated compared with sheltered trees and was negatively correlated with oleoresin yields.

A COMPARISON OF THREE TECHNIQUES FOR ANALYZING THE ARTHROPOD DIET OF CAVITY NESTING BIRDS. Paula K. Kleintjes and Donald L. Dahlsten. Division of Biological Control, University of California, Berkeley, CA 94720

Abstract. - Photography, fecal sac and gut analysis were compared for their effectiveness in quantifying the composition of arthropod prey in Plain Titmouse (Parus inornatus) and Chestnut-backed Chickadee (P. rufescens) nestling diets. Fecal sac and gut analyses were adequate for determining the presence of prey items but photography produced the most quantitative and taxonomic information. Photography was considered to be the most effective and complete method for determining the diet of cavity nesting young whereas fecal sac analysis was considered adequate for supplementary information and for when photography was not feasible.

Visualization and Perceived Scenic Beauty Effects of Management Alternatives for Western Spruce Budworm.[1]

by A.M. Lynch[2], W.B. White[3], B. Orland[4], H.M. Maffei[5], and T.C. Daniel[6]

A western spruce budworm outbreak has persisted for several years on the Deschutes National Forest in central Oregon. The infestation is affecting the visual quality of highly-used recreation areas. This project evaluates perceived scenic quality during and after the outbreak under various management strategies.

Digital visualization models are being developed to generate valid, defensible, photo-realistic images of different levels of budworm-caused defoliation and tree mortality. A primary objective is to base the digital simulation models on vegetation, pest, and digital terrain data, and on Prognosis and Budworm Damage Model projections. Two budworm scenarios are simulated for each photo point, one as the current outbreak is expected to proceed, and one with more substantial tree mortality. Five management scenarios are simulated for the "expected" outbreak: two silvicultural treatments, one *Bt* spray, one no-action alternative, and a landscape-scale wildfire. Several temporal stages are simulated for the management scenarios until the desired future conditions are reached, and analogous intervals are simulated for the untreated scenarios. These images are then used as:

1) evaluation tools to provide a systematic assessment of the perceived scenic beauty during and after an outbreak of alternative management strategies,

2) a medium to inform and educate the public, and

3) a research and survey instrument to evaluate pest impacts on recreation.

Future integration with decision-support tools such as GIS and the Integrated Forest Resource Management System (INFORMS) will lead to an 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 cooperation between Universities, Research, National Forest and State and Private Forestry working together toward a common goal.

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[1]Poster presented at the Western Forest Insect Work Conference, 1-4 March 1993, Sacramento CA.

[2]USDA Forest Service, Rocky Mountain Station, Fort Collins CO.
[3]USDA Forest Service, Forest Pest Management, Methods Applications Group, Fort Collins CO.
[4]University of Illinois, Department of Landscape Architecture, Urbana IL.
[5]USDA Forest Service, Deschutes National Forest, Bend OR.
[6]University of Arizona, School of Renewable Natural Resources, Tucson AZ.

POSTER ABSTRACT

John A. McLean, Forest Sciences, University of British Columbia
Title (Videotape): TINY BEETLES - EXPEN$IVE TA$TE$

The 1990-92 Ambrosia Beetle Task Force showed that ambrosia beetle caused losses on the non-cedar saw log inventory of MacMillan Bloedel Ltd was in the order of $11 million during 1991. Surveys of 2250 log booms showed an average of 14% of the logs to have been attacked by ambrosia beetles. The estimate of total losses to the coastal logging industry in British Columbia is in the order of $120 million per annum.

Results of the surveys, as well as the first ever videotape of live ambrosia beetles in their galleries, will give the viewer an appreciation of ambrosia beetle biology as well as the challenges faced by the coastal forest industry as it works to get logs to the mills quicker. The valuable clear outer layers of the logs need to be preserved so they can be cut into the premium lumber grades the sawmill industry depends on for profitable operation of their mills. Management strategies to reduce ambrosia beetle impacts are discussed.

Integrated Forest Resource Management System

David J. Roschke
USDA Forest Service
Forest Pest Management, Methods Application Group

Abstract: A strategic goal of the USDA Forest Service Forest Pest Management (FPM) group is to promote and improve integration of forest pest management with forest planning processes. The FPM Methods Application Group (MAG) sponsors the development of integrated technologies through the Integrated Forest Resource Management System (INFORMS) project. Two functioning prototypes for INFORMS exist. INFORMS-DG runs in the current Forest Service-wide Data General computing environment. It integrates a variety of resource simulation models with the ability to manipulate and display spatial data, and the ability to display simulated forest scenes as affected by various management alternatives and natural processes. INFORMS-DG is currently being used for project planning and analysis on the Deerlodge National Forest in Montana, the Wallowa-Whitman National Forest in Oregon, and the Idaho Panhandle National Forests in Idaho. INFORMS-TX is under development in Texas in anticipation of the upcoming procurement of a new, workstation-based Forest Service computing environment. INFORMS-TX is based on the concept that the power and utility of several commercial and public domain software packages can be linked together through a user-friendly interface to provide the user with a set of commonly needed functions to perform specific tasks. INFORMS-TX integrates functions of a geographic information system, a relational database management system, various forest resource models, and knowledge base software. INFORMS-TX is in use on the Davy Crockett National Forest in Texas.

Poster Abstract

44th Annual Western Forest Insect Work Conference
Sacramento, California

Ground Application of MCH and Mass Trapping Reduces Douglas-fir Beetle Infestation in Small Stands

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Oregon State University
Corvallis, OR 97331

and

Gary E. Daterman
USDA Forest Service
PNW Research Station
Forestry Sciences Laboratory
3200 Jefferson Way
Corvallis, OR 97331

An application of MCH bubble capsules combined with baited Lindgren funnel traps was tested for protecting small areas from Douglas-fir beetle infestation. The study was installed in northeastern Oregon in an area with a high beetle population. The study design included six replications of paired plots; one treated and one check. Plots were circular in shape and one hectare in size. Treated plots had about 150 MCH bubble capsules stapled to trees around the perimeter. In addition, treated plots had 3 or 4 clusters of 4 baited Lindgren funnel traps located in openings or non-host type stands about 75 m from the plot boundary. Traps were baited with frontalin, seudenol, M-col, and ethanol. Both treated and check plots had a cluster of three traps baited with a very low concentration of frontalin and seudenol located at the center of the plot to monitor beetle flight. Significantly fewer Douglas-fir beetles were caught in monitoring traps on the treated plots than on the check plots throughout the beetle flight period. The ratio of clerid predators to Douglas-fir beetles was greater on the treated plots than on the check plots. The percentage of Douglas-fir greater than 20 cm dbh that were mass attacked by the Douglas-fir beetle was reduced by more than 80% on the treated plots. There was no indication of spillover directly adjacent to the plots, but there was spillover around the trap clusters outside of the plots. These results suggest that it will be feasible to develop pheromone based strategies to protect small, high-valued stands from infestation by the Douglas-fir beetle.

A PRELIMINARY EXAMINATION OF WHITE PINE WEEVIL HAZARD POTENTIAL IN THE MACKENZIE BASIN UNDER CLIMATE CHANGE

Brian G. Sieben[1] and David L. Spittlehouse[2]

(1) Graduate Student
U.B.C. Forest Sciences, Vancouver B.C.
(2) Forest Climatologist
Research Branch,
British Columbia Ministry of Forests, Victoria B.C.

The white pine wevil, *Pissodes strobi* (Peck), causes growth reductions in forest plantations of pine and spruce in western Canada. Potential white pine weevil development hazard was examined in the MacKenzie River Drainage Basin of northwestern Canada under the present climate and a 2.2^{o} C climate warming scenario. Previous studies have found that 785 degree days above 7.2^{o} C are required betwen May and September to complete the weevil's life cycle. Heat sums were derived from Environment Canada climate station normals. Maps were produced with three hazard classes: high, medium ad low. Under the present climate, low elevation sites in the three western provinces and sites along the MacKenzie River as far north as Fort Good Hope are at risk. With a 2.2^{o} C warming, most sites in the western provinces will have sufficient heat for weevil development, as well as a significant portion of the northern basin including low elevation sites up to Fort McPherson. The climate change scenario resulted in the area of the high hazard class increasing from 30 to 64%. Further studies will examine the difference between leader and air temperature and improved spatial interpolation of temperature data.

A NEW WHITE FIR PEST: CONTROL OF ESTABLISHED APHID COLONIES ON NURSERY SEEDLINGS

John D. Stein and Carline R. Trummer
USDA Forest Service, Pacific Southwest Research Station
Albany, CA 94701

Abstract.— Damage by a woolly fir aphid (*Mindarus* sp. nr. *victoria* Essig [Homoptera: Aphididae]) was first reported in white fir (*Abies concolor* [Gord. & Glend.] Lindl. ex Hildebr.) nursery beds at Placerville, California, in 1987. It soon became apparent that the biology of this aphid was different from that of other species of *Mindarus*. Feeding morphs were present throughout the growing season and exacerbated the damage impact upon white fir seedlings in the nursery. The 47% cull rate attributed to this aphid in 1987, resulted in a total loss of $204,000 (nursery plus site preparation cost). To reduce aphid damage to nursery seedlings, 11 different insecticide formulations were tested for aphid control during 1988 and 1989. One application of acephate, chlorpyrifos, diazinon, dimethoate, esfenvalerate, cyfluthrin and fluvalinate in the Spring significantly reduced aphid infestations until midsummer. Two applications of acephate, chlorpyrifos, diazinon, dimethoate, and fluvalinate were effective in reducing aphid populations throughout the growing season. Carbaryl, azadirachtin, and soap were apparently not effective against this aphid in the nursery environment.

Poster presented at the Western Forest Insect Work Conference, Sacramento, CA, March 2-5, 1993.

A Poster To Be Presented At

The 44th Annual Western Forest Insect Work Conference
28 February - 4 March 1993
Hyatt Regency, Sacramento at Capitol Park

A NOVEL APPROACH FOR BIOLOGICAL CONTROL OF COMPETING VEGETATION. GREENLEAF MANZANITA: A CASE STUDY.

Michael A. Valenti
Department of Entomology
Washington State University
Pullman, Washington

ABSTRACT

Native shrubs often inhibit or suppress the establishment and growth of more valuable native conifers. Current methods of competing vegetation control (e.g., mechanical removal, fire, herbicides) have many drawbacks including high costs, environmental risks, poor efficacy, and political sensitivity. Biological control offers an alternative to currently employed control practices. Using native herbivorous insects to control native plants is a novel approach to biological control since the insects and plants have coevolved. However, if the regulating forces of certain native herbivores are disrupted, an increase in the number of herbivores may cause severe damage to the native target plant. Such a method seems feasible because humans have a long history of triggering native insect outbreaks on desirable native plants.

Comparison Metabolic Fate of Carbaryl-Naphthyl-1-^{14}C in Two Scolytidae Beetle Species

H. Zhong, F.L. Hastings, F.P. Hain and W.C. Dauterman[1]

Dept.of Entomology & Toxicology[1]
North Carolina State University
Raleigh, NC 27695

ABSTRACT

Adult southern pine beetles (SPB), *Dendroctonus frontalis* Zimmerman, and spruce beetles (SB), *Dendroctonus rufipennis* (Kirby), were treated topically with carbaryl-1-naphthyl-^{14}C and the metabolism was studied. Methylolcarbaryl was the major metabolite in both beetle species. It reached 5.02% in SPB internal extracts at 8 hours and 0.87% and 3.47% in SB internal extracts at 8 and 24 hours. SPB metabolized ^{14}C-carbaryl and excreted its metabolites faster than SB. Other methanolic extractable metabolites were tentatively identified from both species as: 4-hydroxy-1-naphthyl methylcarbamate, 5-hydroxy-1-naphthyl methylcarbamate, 1-naphthyl methylcarbamate, 1-naphthol, 1,4-naphthalenediol and 1,5-naphthalenediol. Several unidentified metabolites were also present.

BANQUET, HONORING DR. RALPH C. HALL

Ralph Corbin Hall, 93, a charter member of the WFIWC was invited to the banquet with his son, Jim (Corvallis) and daughter, Judy (Berkeley).

M. Furniss traced "Doc's" biography (see Preface in commemorative issue of H.E. Burke's 1946 recollections) and recounted stories of events at Hat Creek Field Station during 1950-1954. These included Ralph's loss of his pocket watch to an automatic-flush toilet at U. Michigan. Incidents at Hat Creek involved unknowingly junking the Hall family's bedsprings (stored in the garage stall), an episode with a marauding bear that came into camp, and the time that three local Atseugi Indians took after Georg Pronin, an immigrant Russian Lepidopterist, thinking him to be a spy.

Others who recalled events involving Ralph were Ron Stark (who was outmaneuvered by Ralph in a court case between the Klammath tribe and the U.S. Government), Dave Wood, George Ferrell (Ralph owes him pipe tobacco), Alan Berryman (can't match Ralph's unaided predictive ability), and Jim Hall. Bob Stevens and Boyd Wickman were unable to attend but sent messages.

CONSTITUTION
OF THE
WESTERN FOREST INSECT WORK CONFERENCE

Article I Name

The name of this organization shall be the Western Forest Insect Work Conference.

Article II Objects

The conference is organized exclusively for charitable, educational, religious, or scientific purposes within the meaning of section 501(c)(3) of the Internal Revenue Code.

The objects of this organization are (1) to advance the science and practice of forest entomology, (2) to provide a medium of exchange of professional thought, and (3) to serve as a clearing house for technical information on forest insect problems of the western United States and Canada.

Article III Membership

Membership in this organization shall consist of forest entomologists and others interested in the field of professional forest entomology. Official members shall be those who pay registration fees.

Article IV Officers and Duties

The Officers of this organization shall be:

(1) A Chairman to act for a period of two meetings, whose duties shall be to call and preside at meetings and to provide leadership in carrying out other functions of this organization.

(2) An Immediate Past Chairman, who shall assume office immediately upon retiring as Chairman without further election; whose duties shall be to fill the chair at any meeting in the absence of the Chairman; to act until the election of a new Chairman.

(3) A Secretary to act for a period of two meetings whose duties shall be to keep a record of Executive Actions, record minutes of Executive Committee and conference business meetings, to maintain committee correspondence, and to send out notices, reports, and proceedings. The Secretary is charged with the responsibilities of coordinating preparation of the proceedings (amended Feb. 28, 1967, Las

Vegas, NV and Sept. 15, 1989, Bend, OR).

(4) A Treasurer, who is a non-voting member of the Executive Committee, to act for an indefinite term, whose duties shall be to keep a record of funds collected and disbursed, to issue monies for approved purposes, to maintain a record of members, committees, and officers, and to provide mailing lists and/or labels as needed. The Treasurer will provide financial records for inspections by a two-member Executive audit team, comprised of the Chairman and Immediate Past Chairman annually prior to the Executive Committee meetings (amended Sept. 15, 1989, Bend, OR).

(5) An Executive Committee of six members consisting of Chairman. Immediate Past Chairman, Secretary, Treasurer, and three Counsellors elected from the membership. Terms of office for the three Counsellors shall be staggered and for a period of three meetings each. The duties of the Committee shall be to carry out actions authorized by the Conference; to authorize expenditures of funds, and to establish policies and procedures for the purpose of carrying out the functions of the organization. The Conference registration fee will be set by the Local Arrangements Committee in consultation with the Secretary, Treasurer, and Chairman (amended March 4, 1965, Denver, CO and Sept. 15, 1989, Bend, OR).

The officers shall be elected at the Annual Meeting. Their periods of office shall begin at the conclusion of the meeting of their election.

The Chairman shall have the power to appoint members to fill vacancies on the Executive Committee occurring between meetings. The appointment to stand until the conclusion of the next general meeting.

It is the responsibility of a Counsellor, should he be unable to attend an executive meeting, to appoint an alternate to attend the executive meeting and to advise the Chairman in writing accordingly. The alternate shall have full voting privileges at the meeting to which he is designated.

Article V Meetings

The objectives of this organization may be reached by holding at least an annual conference and such other meetings as the Chairman, with the consent of the Executive Committee, may call. The place

and date of the annual meeting shall be determined by the Executive Committee after considering any action or recommendation of the conference as a whole. The secretary shall advise members of the date and place of meetings at least three months in advance.

Article VI Proceedings

A record of proceedings of the conference shall be maintained and copies provided to members in such form as may be decided as appropriate and feasible by the Executive Committee.

Article VII Amendments

Amendments to the Constitution may be made by a two-thirds vote of the total conference membership attending any annual meeting.

Article VIII Article of Dissolution

Upon the dissolution of the Conference, the Executive Committee, shall after paying or making provisions for the payment of all the liabilities of the Conference, dispose of all the assets of the Board exclusively for the purposes of the Conference in such manner, or to such organization or organizations organized and operated exclusively for charitable, educational, religious, or scientific purposes as shall at the time qualify as an exempt organization or organizations under section 501 (c)(3) of the Internal Revenue Code of 1986 (or as the Executive shall determine. Any such assets not so disposed of shall be disposed of by the Court of Common Pleas of the county in which the principle office of the Board is then located, exclusively for such purpose or to such organization or organizations, as said Court shall determine, which are organized and operated exclusively for such purposes.

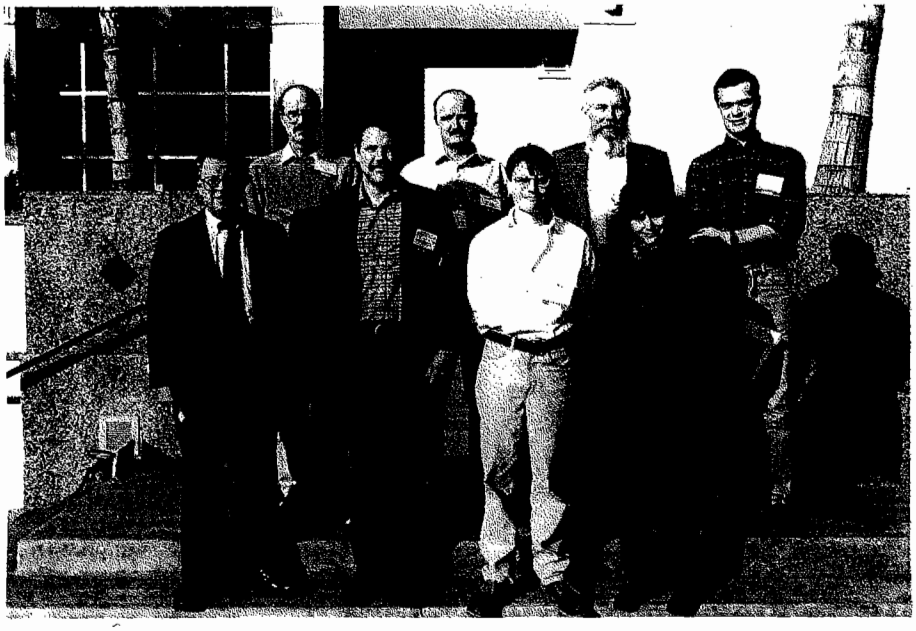
Prepared by Richard Washburn
March 20, 1969
Revised 4 March 1993

Registration List

44th Annual Western Forest Insect Work Conference
Sacramento, California
February 28 - March 4, 1993

Ayers, Matt
Bartos, Dale
Beckman, David
Berryman, Alan
Bertram, Sally
Billings, Ron
Blatt, Suzie
Borden, John
Borys, Robert
Braun, David
Bridges, Bob
Brooks, Julie
Burke, Steve
Burns, Dave
Burnside, Roger
Cain, Robert
Camacho, Alejandro
Cavey, Joe
Celaya, Bob
Clancy, Karen
Cobb, Fields
Cota, Jesus A.
Dahlsten, Don
Dalara, Paul
Dale, John
DeMars, C.J.
Eager, Tom
Eglitis, Andres
Ehler, Les
Evenden, Maya
Ferrell, George
Forey, Dan
Furniss, Mal
Goyer, Rich
Hain, Fred
Hall, Peter
Hanlon, Chris
Hansen, Dawn
Hart, Dennis
Hastings, Felton
Hayes, Jane
Hobson, Ken
Hofacker, Tom
Hollinger, Margot
Holsten, Edward
Hostetlet, Bruce
Huddle, Scott
Huebner, Dan
Johnson, Kathleen
Johnson, Scott
Kleintjes, Paula
Knapp, Andy
Koerber, Tom
Lavigne, Bob
Lih, Marita
Lindgren, Staffen
Linit, Marc
Lister, Ken
Livingston, Ladd
Logan, Jesse
Lorimer, Nancy
Lorio, Pete
Maclauchlan, Lorraine
Macias, Jorge
Marshall, Jack
Mask, Roy
McIntosh, Rory
McLean, John
McMillin, Joel
Merrill, Laura
Mocettini, Phil
Mohamadou, Aw
Montgomery, Michael
Nebeker, Evan
Neisses, John
Nugent, Scott
Orr, Richard
Overhulser, Dave
Owen, Don
Paine, Tim
Peterson, Robin
Poirier, Lisa
Poland, Therese
Powell, Janine
Ragenovich, Iral
Rappaport, Nancy
Raske, Arthur
Rasmussen, Lynn
Ravlin, Bill
Reeve, John
Ren, Lizong
Rios, Jesse
Robertson, Allen
Rogers, Terry
Roschke, Dave
Ross, Darrell
Rowney, Dave
Saarenmaa, Hannu
Salom, Scott
Sanchez-Martinez, Guillermo
Schomaker, Mike
Schultz, Dave
Schultz, Mark
Seybold, Steve
Shea, Pat
Shon, Fay
Shore, Terry
Sieben, Brian
Sinnott, Molly
Smith, Eric
Smith, Sheri
Souto, Dennis
Starbrough, Dwight
Stark, Ron
Stephen, Fred
Stipe, Larry
Storer, Andrew
Teale, Steve
Tomlin, Elizabeth
Torgersen, Torolf
Valenti, Mike
Vandygriff, Jim
Villa, Jaime
Wagner, Mike
Wenz, John
Wesley, Victoria
West, Doug
West, Lorne
Whitehead, Armand
Wilson, Jill
Wood, Dave
Zhong, He

Front Row, L-R: Elizabeth Tomlin, Lisa Poirier, Mohamadou Aw, Guillermo Sanchez-Martinez. Second Row: Lizong Ren, Therese Poland, Laura Merrill, John Neisses, Tom Hofacker. Back Row: Scott Nugent, Joel McMillin, Torolf Torgersen, Mal Furniss, Maya Evenden.



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Front Row, L-R: John Borden, Molly Sinnott, Bob Celaya, Ladd Livingston. Second Row: Mike Wagner, Dan Forey, Eric Smith, Terry Shore. Back Row: Darrell Ross, Bruce Hostetler, Steve Teale.

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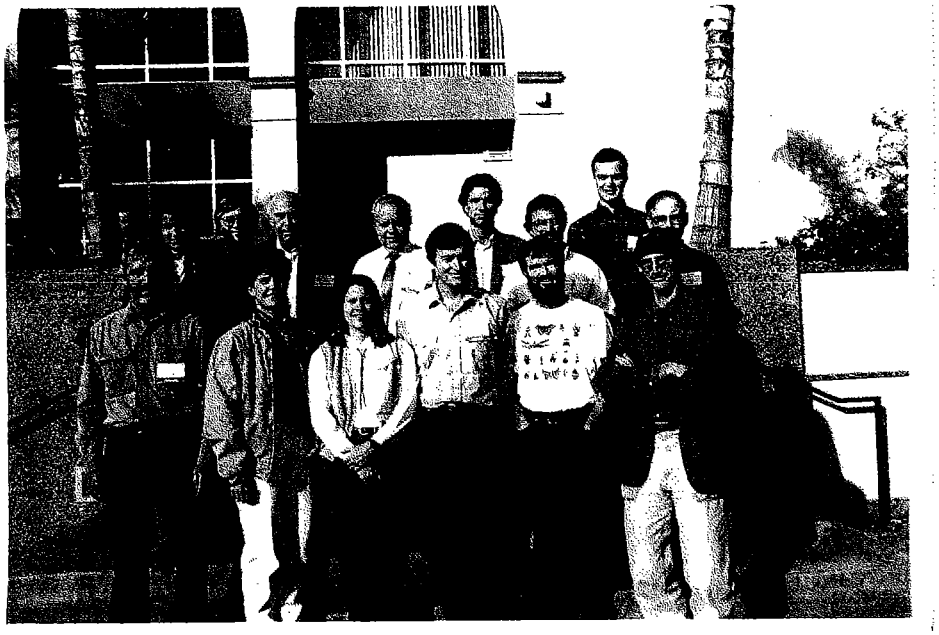
Front Row, L-R: John Reeve, Dave Schultz, Jorge Macias, Marita Lih, Peter Lorio. Back Row: Ron Stark, Matt Ayers, Barbara Bentz, Tim Paine.

Front Row, L-R: Ken Lister, Fred Stephen, Felton Hastings, Jesse Rios, Dave Roschke. Second Row: Julie Brooks, He Zhong, Lorne West, Pat Shea, Mike Schomaker. Back Row: Janine Powell, Dawn Hansen, Bob Lavigne, David Braun, Staffen Lindgren, Dave Overhulser.

Front Row, L-R: Iral Ragenovich, Jesse Logan, Karen Clancy, Ed Holsten. Back row: Peter Hall, Margot Hollinger, Lorraine Maclauchlan, Fred Hain, Hannu Saarenmaa, Chris Hanlon.



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