Proceedings

of the

53rd Annual Meeting

of the

Western Forest Insect Work Conference

Whitefish, Montana

April 23-25, 2002

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*** Not for Citation ***
Information for Conference Members Only

Articles were reformatted for consistency, but otherwise printed as submitted. Authors are responsible for content.

WESTERN FOREST INSECT WORK CONFERENCE
53rd ANNUAL MEETING
Whitefish, MT

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(And others, without whose help the Conference would not have happened)

<u>Executive Committee</u>

Barbara Bentz, Chair
Mark Schultz, Secretary
Ladd Livingston, Treasurer
Roger Burnside, Counselor
Sandy Kegley, Counselor
Jaime Villa-Castillo, Counselor

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Diana Six

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Marnie Duthie-Hoff

Photographs
David Beckman
Doug Wulff
John Schwandt
Mal Furniss
Sandy Kegley

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David Beckman

Fun Run
John Schwandt
David Beckman
Marcus Jackson

Auction
Karen Ripley
Ladd Livingston

Proceedings
Steve Kohler
Ken Gibson
Sandy Kegley

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FINAL CONFERENCE PROGRAM

WESTERN FOREST INSECT WORK CONFERENCE
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23-25 April 2002

Conference Program

A New Voyage of Discovery: Through the Past, into the Future

Monday, April 22

3:00-7:00 Registration—*Conference Center Foyer*

5:00-7:00 Executive Meeting—*Alpine Room*

7:00-9:00 Welcome Reception—*Continental Divide*, *Conference center*

Tuesday, April 23

7:00-8:00 Registration—*Conference Center Foyer*

8:00-9:00 Initial Business Meeting--*Continental Divide*

9:00-9:15 Welcome to Whitefish—*Continental Divide*
Jane Kollmeyer, Ranger, Tally Lake RD

9:15-10:15 Lewis & Clark Journey through Western Montana—*Continental Divide*
Jim VanDenburg, retired Forest Silviculturist, with guests George Knapp and Chuck Sundstrom

A fascinating introduction to some of the equipment used and hardships encountered as Lewis and Clark made their way through what later became the State of Montana in 1805 and 1806. George and Chuck were dressed in "period" costumes and looked as if they may have been part of the Voyage of Discovery themselves. One of our own, Beverly Buloan, played the role of Sacajawea as they recounted her contribution to the success of the expedition and other encounters with Native Americans.

10:15-10:30 Break—*Continental Divide*

10:30-1200 Panel—*Continental Divide*

Historic Forest Insect Outbreaks in Western National Parks: The Rocky Course Toward More Enlightened Management Policy.

Boyd Wickman, Pacific Northwest Research Station (retired), Moderator

An historic recount of the evolution of National Park policy concerning insects and their control in Canada, Mexico, and the United States with specific examples of historic insect outbreaks and their management in Yosemite and Yellowstone National Parks. Panel speakers include Roy Shepherd, Pacific Forestry Centre, Canada, retired; Mal Furniss, Intermountain Research Sta, retired; Roy Renkin, Yellowstone NP; Jaime Villa Castillo, Mexico Forestry; and Boyd Wickman.

12:00-1:30 Lunch—*Pavilion*

1:30-3:00 Concurrent Workshop Session 1

1A. Status of Forest Insects in the West

Lorraine Maclauchlan, B.C. Ministry of Forests

This workshop will include a number of participants from Regions throughout the west and west-central States and Provinces giving updates on the occurrence and damage of forest insects. These annual reports on the status of forest insects and other damaging agents will give us a more complete picture of the local trends and outbreaks of bark beetles, defoliators and other concerns.

1B. Fire and Forest Floor Ecology

Nancy Rappaport, PSW Research Station

The following topics will be presented and discussed:
Jim Hanula (USFS, Southern Research Station, Athens, Georgia). **Response of ground-dwelling arthropods to 40 years of dormant season burning in longleaf pine**; Jeff Lemieux (Oregon State University, Corvallis, Oregon). **Effect of prescribed fire on coarse woody debris decomposing arthropods in the southern Cascade Range, California;** Mike Camann, Karen Lamoncha and Neil J. Plant (Humboldt State University, Arcata, California). **Effect of prescribed fire on forest floor oribatids and springtails in the southern Cascade Range, California;** Dave Wood and Dan Stark (University of California, Berkeley), and Andrew Storer (Michigan Technological University, Houghton, Michigan). **Effect of fire on *Dendroctonus valens* and *Hylastes* spp. in the Sierra Nevada;** Jeff Battigelli (Earthworks Research Group, Edmonton, Alberta). **Short-term changes to oribatid mite abundance and diversity in central British Columbia after harvesting and soil compaction**

1C. How to Be a Better Shutterbug

Ron Billings, Texas Forest Service **and Bill Ciesla,** USFS, retired

Learn how to improve your 35 mm and digital photography from close-ups of insects to landscapes (and people too). Ron Billings and Bill Ciesla will share their experiences and techniques with a focus on lenses, film, exposure, composition, filters, and flash. An open forum for sharing photography hints will follow formal presentations.

1D. Roundtable Discussion on Trapping for Sawyers and Longhorned Beetles

Dan Miller, Southern Research Station

This will be an informal, round-table discussion and exchange of personal experiences without formal presentations by participants. To set the mood, the moderator will begin the workshop with a short slide presentation of existing and research trap designs used for Cerambycidae. Then the workshop will be open to all attendees who care to offer their thoughts, experiences or sage advice on various aspects of woodborer traps and their implementation, such as effects of trap design, color, collecting solutions, attractants, as well as client needs and requirements.

3:00-3:30 Break—*Glacier Foyer*

3:30-5:00 Concurrent Workshop Session 2

2A. Fire/Insect Interactions and Marking Guidelines

Joel McMillin, FHP R-3 **& Sheri Smith**, FHP R-5

This session will be organized around 2 main themes: 1) **wildland fire – insect interactions and marking guidelines** and 2) **prescribed fire – insect interactions**. Joel will begin the first part of the session by presenting the results of a west-wide survey on current marking guidelines used by the National Forest System following wildland fires. Sharon Hood (Fire Sciences Lab, Missoula) will present the current status of their lab's work on assessing tree survival following fire. Daniel Cluck (FHP, Region 5) will present the work that has been ongoing in northeastern CA towards the development of marking guidelines. Dave Ganz (UC Berkeley) will complete the formal presentations by presenting his research on prescribed fires/bark beetles/mortality guidelines from Blacks Mountain Research Forest in northeastern CA. The formal presentations will be followed by a general discussion of concerns, needs and opportunities for cross-regional work that may compliment ongoing efforts to obtain additional information in the wildfire, prescribed fire and bark beetle arena.

2B. Forest Insect Damage & Control conflicts with T&E Species or Wildlife Habitat

Beth Willhite, FHP R-6

This workshop will have three formal presentations with time allowed for informal discussion. Presentation topics are as follows: Monitoring of stream shading in bull trout habitat defoliated by the Douglas-fir tussock moth, Conflicts and relationships between the red cockaded woodpecker and the southern pine beetle, Changes in potential fire behavior associated with western spruce budworm defoliation in northern spotted owl habitat.

2C. Potential Exotic Insect Threats in the West and Status of Recent Introductions

Tom Hofacker, FHP WO

Recent increases in global trade have heightened concerns for the introductions of exotic pests such as Asian long-horned beetle, pine shoot beetle, and Asian gypsy moth. Past introductions of exotics such as chestnut blight, white pine blister rust, and European gypsy moth make us aware of our vulnerability. The discussions of this workshop will focus on 1. FHP's current and future role in managing invasive weeds; 2. FHP/APHIS early detection pilot program and results from the program so far; 3. The citrus longhorned beetle situation in Washington State; and 4. A general discussion of exotic insects.

2D. Douglas-fir Beetle in Western US and Canada

Art Stock, BC Ministry of Forests

An informal discussion relative to status of, and management recommendations for, Douglas-fir beetle outbreaks in western United States and Canada.

5:30 Fun Run (2 miles)—*Start at Fitness Center*

7:00-9:00 **Poster Session** (authors present), **Silent Auction**, and **Ice Cream Social**—Glacier Foyer and Glacier Room

Wednesday, April 24

8:00-9:30 Concurrent Workshop Session 3

3A. Spruce Beetle Ecology and Management

Barbara Bentz & Matt Hansen, RMRS

The following topics will be presented and discussed: **Spruce beetle suppression strategies in northern Utah**, by Steve Munson, FHP Ogden; **History and future of MCH for managing spruce beetle**, by Richard Werner, PNW; **Understanding and forecasting the increased risk from univoltine broods**, by Matt Hansen, RMRS Logan; **Linking individual host selection behavior and population dynamics**, by Kimberly Wallin, RMRS Logan; **Interpreting trap data**, by Jose Negron, RMRS Fort Collins; and **Predicting spruce beetle caused mortality from pheromone traps**, by Barbara Bentz, RMRS Logan.

3B. National Fire/Fire Surrogate Program: Opportunities for Research

Mike Wagner, Northern Arizona University

This workshop will describe the objectives, design and status of the National Fire/Fire Surrogate Research Project. Contributors will describe the status of research in California and Montana. Finally, examples of how data from this experiment may be used to assess treatment effects will be presented. The workshop will consist of 4 brief informal presentations followed by discussion.

3C. Direct Suppression of Native Defoliators: Does it make sense?

Paul Flanagan, FHP R-6

Outbreaks of native defoliators continue to be aerially suppressed with pesticides on some federal and tribal lands. However, as early as the 1950's the effectiveness of this practice was questioned by entomologists. Evidence from recent decades suggests that efficacy is short-lived, ineffective or even counter-productive. This session features insights of entomologists representing three agencies: Karen Ripley, Washington State Department of Natural Resources; Peter Hall, British Columbia Ministry of Forests; and Bruce Hostetler, USDA Forest Service, State and Private Forestry, Forest Health Protection.

3D. How Can We Lead the Public in the Direction We Want Them to Go?

Ralph Thier, FHP R-4

True to form, Thier will moderate this workshop in a strictly informal manner; no slides, no PowerPoint, no napping! Thus, attendees need to bring their thoughts and experiences about working with that all-important audience - the public and their agents. Ultimately this audience shapes what's important, policy and actions regarding forest insects.

9:30-10:00 Break—*Glacier Foyer*
Group Photos—*Outside (weather permitting)*

10:00-11:30 *Panel -- Graduate Student Papers—Continental Divide*

Diana Six, University of Montana, Moderator

1. **Brytten Steed** and Michael Wagner
   Northern Arizona University, Flagstaff, AZ
   Seasonal pheromone use by the bark beetle *Ips pini* in northern Arizona and western Montana.
2. **Beverly Bulaon** and Mike Camann
   Humbolt State University, Arcata, CA
   Semiochemical control of mountain pine beetle in whitebark pine forests with green leaf volatiles and verbenone
3. **Monica Gaylord** and Michael R. Wagner
   Northern Arizona University, Flagstaff, AZ
   Preliminary findings on bark beetle flight and ponderosa pine physiology in northern Arizona
4. **Aaron Adams** and Diana L. Six
   School of Forestry, University of Montana, Missoula, MT
   Competition among yeasts and filamentous fungi associated with the mountain pine beetle
5. **Michele Eatough-Jones** and Timothy D. Paine
   Department of Entomology, University of California, Riverside, CA
   Changes in insect herbivore communities along an ozone and nitrogen deposition gradient in the San Bernardino Mountains
6. **Paul Bosu**, Michael R. Wagner, Fredric Miller and Steve Campbell
   Northern Arizona University, Flagstaff, AZ
   Resistance of elms (*Ulmus* sp.) and elm hybrids to the elm leaf beetle (*Pyrrhalta luteola*) under field conditions in east central Arizona
7. **Stephanie Sky Stephens** and Michael R. Wagner
   Northern Arizona University, Flagstaff, AZ
   Using ant community structure as indicators of forest health

11:30-5:00 Field Trips (sack lunch in field provided)

1. *Glacier National Park/Flathead National Forest*—History of the park and how they respond to insect outbreaks, **Dawn LaFleur,** Glacier National Park**;** Hazard Trees in Campgrounds, **John Schwandt,** R-1 Forest Pathologist; District Response to Fire and Bark Beetles, **Ed Lieser**, Tally Lake District Silviculturist; Areas infested by MPB in the 70's & 80's, what do they look like now? **Ken Gibson**, R-1 Forest Entomologist

2. *Whitebark Pine*, a Tree Species in Trouble? Big Mountain Ski Area, **Bob Keane,** RMRS Missoula; **Bryan Donner**, District Silviculturist; **Kate Kendall,** Glacier National Park; **Diana Six**, University of Montana.

6:30 Western BBQ/Entertainment—*Pavilion*
Founders Award Address—**Les Safranyik,** Canadian Forestry Service, Retired
Entertainment by **The Alan Lane Band**

Thursday, April 25

8:00-9:30 Panel—*Continental Divide*
Managing Forest Insects in the Current Political Arena: Is there Hope for the Future? **Jane Kollmeyer**, Tally Lake District Ranger, Moderator

This panel, comprised of land managers who consider insect and disease effects from state, federal, and private perspectives will address management implications of insect outbreaks on lands of differing ownerships. Of interest will be opportunities available to each as they analyze insect-caused impacts on forest resources and evaluate alternatives to reduce them to tolerable levels. We will be afforded considerations of insect infestations from their viewpoint; knowledge of which should enable us to better appreciate the constraints under which most land managers labor in the twenty-first century.

9:30-10:00 WFIWC Memorial Scholarship Winner Presentation—*Continental Divide*
"*Host selection in tree-killing bark beetles—Unraveling the intricacies of a complex communication system*"
by **Deepa Pureswaran,** Simon Fraser University

10:00-10:30 Break—*Continental Divide*

10:30-11:30 Final Business Meeting—*Continental Divide*

11:30-12:30 Lunch—*Pavilion*

12:30-2:00 Concurrent Workshop Session 4

4A. High Elevation Insects & Management

Tom Eager, FHP, R-2

This session will focus on the current state of information regarding two vegetative cover types found in western North America. Information will be presented on work currently being done on subalpine fir and associated insects and diseases. Impacts of these agents throughout the range of subalpine fir will be examined. The other major topic will be the status of mountain pine beetle in whitebark pine stands. Graphic information will be presented via slides and PowerPoint, but discussion will focus upon management response and the potential for impact mitigation.

4B. International Activities

Jose Negron, Rocky Mtn. Research Sta.

This will be an informal workshop where anyone who would like to share his or her involvement in projects in the international arena is welcome. Any types of projects such as research, extension, survey work, operational activities and so forth are welcome. Feel free to bring slides from projects or professional trips. Summaries from recent IUFRO meetings may also be of relevance.

4C. Roles of Fungi and Mites in Insect-Tree Interactions

Kier Klepzig, Southern Research Station

In a combination of informal presentations and group discussion, we will present our latest findings in fungal/mite/tree/insect interactions within the context of the most important unanswered questions in this field, the best manner in which to address these questions, and the practical applications of the work Speakers include: Rich Hofstetter, Dartmouth College; Kier Klepzig, USDA Forest Service; Susanne Kuhnholz, Simon Fraser University; Diana Six, University of Montana; Brian Sullivan, USDA Forest Service.

4D. Special Aerial Surveys that Support Forest Entomology

Tim McConnell, Forest Health Enterprise Team

Three special surveys that go beyond the regular annual overview aerial surveys will be discussed during this workshop: 1. Special aerial sketch map survey to delineate Douglas-fir tussock moth in northern Idaho for a suppression project; 2. Special digital airborne video project to precisely document southern pine beetle caused mortality locations on the Wayah Ranger District of the Nantahala National Forest; and 3. Special aerial sketch map surveys over four years in support of a large-scale Douglas-fir beetle mating disruption project on the Nez Perce National Forest.

2:00-2:30 Break—*Glacier Foyer*

2:30-4:00 Concurrent Workshop Session 5

5A. Status and Impacts of Balsam Woolly Adelgid in the West

Karen Ripley, Washington DNR

This workshop will feature 3 presentations on the history, status, and impacts of BWA in Oregon and Washington (Russ Mitchell), British Columbia (Dave Trotter or Peter Hall), and Idaho (Ladd Livingston). Approximately 25 minutes will be reserved for discussion and conclusions regarding the status and impacts of BWA, appropriate management recommendations for *Abies* species, and future work that is needed.

5B. Remote Sensing Applications in Forest Insect Management

Jim Ellenwood, Forest Health Enterprise Team

The following topics will be presented and discussed: **Monitoring bark beetle activities in recently burned areas: satellite remote sensing combined with field sampling** by Ken Brewer, Doug Berglund, Ed Lieser, Ken Gibson, USDA Forest Service; **Testing the value of using TM and ETM+ imagery for detection of mountain pine beetle caused mortality in lodgepole pine** by Barbara J. Bentz - Entomologist, USDA Forest Service, RM Station; **Spectral features associated with subalpine fir decline due to balsam woolly adelgid infestation,** by
Ryan Hruska, Karen Humes, Stephen Cook, University of Idaho, Moscow

5C. Recent Pheromone Developments

Darrell Ross, Oregon State University

Results of recent semiochemical research will be presented and discussed. The following speakers and topics will be presented: Nadir Erbilgin, UC Berkeley, **Dose-dependent synergism and inhibition of bark beetle responses to host monoterpenes**; Jennifer Burliegh, Phero Tech and Ken Gibson, USDA Forest Service, Missoula, **Protecting lodgepole pine from attack by the mountain pine beetle using high-dose verbenone and nonhost volatiles**; Nancy Rappaport, USDA Forest Service, **Sprayable pheromone formulations**; Darek Czokajlo, IPM Technologies Inc., **Attract and kill technology for western pine shoot borer**. If time allows, we will also have a discussion of the following topic: "Overcoming obstacles to the development and implementation of semiochemical-based technologies"

5D. Exciting New Directions for Forest Entomologists

Nancy Sturdevant, FHP R-1

This workshop will include formal presentations on a variety of non-traditional projects that forest entomologists are currently participating in such as: biological control of weeds, pollinator studies on sensitive plants, and conservation education. Presentations will be followed by an informal discussion on this topic. The goal of the informal discussion is to exchange ideas and promote activities in these and other non-traditional areas for forest entomologists.

EXECUTIVE COMMITTEE MEETING

WESTERN FOREST INSECT WORK CONFERENCE
53rd ANNUAL MEETING
Whitefish, MT

Executive Committee Meeting
22 April, 2002

Present: Barbara Bentz, Chair
Ladd Livingston, Treasurer
Mark Schultz, Secretary
Roger Burnside, Councilor (2000-2)
Sandy Kegley, Local Arrangements, Councilor
Ken Gibson, Local Arrangements, Founder's Award Chair
Boyd Wickman, Chair of the History Committee

Barbara called the meeting to order at 5:15 pm.

Ken Gibson read the notes he took of for the business meeting at the 2001 meeting:

OLD BUSINESS 2001

There were 26 members. Les Safranyik was voted to receive the Founders Award in 2002. Sandy Kegley reported on forest entomology history part II, published in the American Entomologist by Buck Warden. Boyd Wickman reported on the historical photos that Mal Furniss has been able to archive at the University of Idaho, from the 20s and 30s, mostly negatives. No one from the Common Names Committee was present. No one was interested in serving. The silent auction for fund raising idea was suggested by Steve Burke, raffle up to $500 for scholarship account.

Treasurer's report: Submitted by Ladd Livingston

Highlights of the 2001 year:

- Tax Exempt Status was received from the IRS

  Now we can expect great donations to start rolling in from all of you that have been waiting for this to be finalized. I now have to submit a report to the IRS on an annual basis. The donations need to start rolling in to make this worth the time.
- We received a donation of over $10,000 to our Memorial Scholarship Fund. The donor prefers to remain anonymous. This will be added to our base principal.

Current Status of Accounts:

Checking	$2,594.67	
Regular Savings	$3,472.84	These are the funds used for scholarships.
McGregor Fund	$3,100.00	Interest is deposited to savings account on a quarterly basis
Memorial Scholarship Fund	$6,700.00	Interest is deposited to savings account on a quarterly basis
Special Donation Savings Account	$10,388.55	Interest will be deposited to savings account on a quarterly basis
TOTAL	$26,256.06	

Scholarship Award Committee: Lorraine reported for the Scholarship Committee. The committee received 10 applicants. A Simon Fraser student, Deepa Pureswaran, was awarded a $1,500. There was a question about who could apply. They had to be to a meeting in the last 5 years but it was recognized that some Mexican students would not be able to qualify with this standard.

The 1995 proceeding has not been printed yet. There was a question of a need for money to do the printing.

There was a question about whether the proceedings be sent to the whole membership list. Don Dahlston motioned to only send it to those on the active list, or only to those in attendance. The motion passed.

History Committee: There was a discussion that not all of the forest entomology historical information should go to the University of Idaho because it had not been determined whether there was library staff dedicated to archive, or properly index those documents. Mike Wagner made a motion to delay that decision until the Whitefish meeting. The motion passed.

Future meetings: 2003 Guadalajara, Mexico, and a combined meeting with the pathologists in 2004, site to be determined.

Web site: Kathy Sheehan is still willing to maintain the site.

New Councilors: Whitefish will be the last year for Roger Burnside as councilor. Sandy Kegley replaces Bob Hodgkinson. Jaime Villa-Castillo was chosen and approved as a new councilor.

Sandy Kegley announced that there will be a Rocky Mountains Scolytids publication coming out. New addition of Western Forest Insects is needed. At 10:22 Les Safraynik asked for the meeting to adjourn and that motion was seconded.

NEW BUSINESS 2002

Scholarship committee: Time to reorganize the committee. Boyd Wickman is not going to be able to serve but wants to participate.

History Committee: Mal Furniss published a manuscript on early forest insect outbreaks in Yellowstone National Park. Ladd wanted to know if the manuscript should be published in the proceedings. Boyd said that it was funded by WFIWC but might get lost in the proceedings so that is why it needs a separate outlet. Boyd would like to find an outlet for a H.G. Burke manuscript. Mal could do desktop publishing and a graphic design company would add the artwork. Barbara thought that Boyd and Mal could put a proposal together for WFIWC funds and get one published every year. There was a discussion on how to raise those monies.

H.G. Burke's daughter was still alive and had valuable documents about Burke's life. John Miller is another historical figure. His daughter and niece have a diary and photos of his life. Boyd might get materials from other families. Boyd recommends that Steve Seybold should serve on the history committee because of Steve's interests.

Common Names Committee: The chair will ask Mary Ellen Dix who has a taxonomy interest and experience and would be a good candidate for this committee. Insects with multiple common names would be good candidates for this committee. Many wood borers do not have an agreed upon common name.

Founders Award: Report presented by Ken. (inserted in Initial Business Meeting Notes)

Treasurer's report: Report presented by Ladd (see below for detailed report). Steve Burke found that scholarship money might be contributed by the Bullitt Foundation. Its objectives fit well with our organization. John Schmid, in memory of Mark McGregor, will match up to $500. Whoever wins a scholarship will also have the meeting registration fee waived. WFIWC has only paid for rooms for recipients of the Founder's Award. There are a few items for sell: Lewis and Clark belt buckles, hat pins, and commemorative coins, and Swiss army knives.

Other business: There is still a need for a conference "How to" pamphlet. They received many good suggestions from the membership for the Whitefish meeting.

WFIWC Scholarship Fund Committee Report
Current members: Steve Burke – Chair; Ladd Livingston; Karen Ripley

1. Summary of Funds
The current principle of all scholarship dedicated funds is $21,372 (US)

McGregor Fund - $4,120
Memorial Scholarship Fund - $17,252
Savings Account - $2,718.57 (available for scholarships)

2. Summary of Disbursements

2001 - $1,500 Scholarship award – congratulations Deepa!!
2002. – no decision made yet

Note: annual expenditures also include engraving on the main plaque ($10-30US/yr) and any smaller plaques for scholarship recipients (expect roughly $40/yr). These expenditures are currently being covered by Phero Tech.

3. Annual Earnings (award) Potential

The amount available to be awarded each year is based on interest earned in fully secured banking and investment accounts. Within this arrangement, the following are the anticipated award potentials assuming no change in principle
Low est.- @ 3.5% effective annual interest - $707/yr
High est.- @ 5.0% effective annual interest - $1010/yr

4. Additional Fund Raising

- Funds raised in Edmonton from the sale of photos, proceedings of previous work shops and donations totaled roughly $ 1012 (US). John Schmid's challenge was matched for a total of $1,000. There was an additional $10 donation and a monumental sale totaling $2. A photo was sold recently for $25.
- a reminder, US WFIWC member contributions are tax deductible.
- A small number of grant-giving foundations, such as the Bullitt Foundation are being contacted in an effort to increase the operating principle. It would be helpful if WFIWC had an official one-page summary describing the organization, its goals, history, etc.

5. John Schmid's challenge

- John Schimd, a well-remembered forest entomologist and a close friend of Mark McGregor is again renewing his challenge, the "McGregor fund $500 challenge." He is willing to match any donations up to the amount of $500 (US).

6. Items from the 2001 Executive Meeting

This is reminder re: items that impact incomes or disbursements
a) Current annual award amount is $1,500 (US), but both frequency of disbursements and the amount will determine future availability.
b) The geographical coverage for potential recipients is western US and Canada and all of Mexico.
c) Potential scholarship recipients must be WFIWC members (which means they must have attended the last workshop, or at least one workshop? – this needs clarification). Some concern was expressed especially for Mexican students who would not necessarily be in a position to be members.
d) For scholarship recipients, the registration fee for the conference would be waived. There was a discussion re: $500 to help the recipient attend but I don't believe this was resolved. At issue was the desire to have the recipient available to give an acceptance speech. It was mentioned that, if assistance was to be forthcoming, $500 might not be enough.

7. Silent Auction

An auction of items of interest to conference attendees will be held at this year's WFIWC. For details and arrangements at the conference see Karen Ripley or Ladd Livingston.

8. Volunteers for Scholarship Fund Committee.

We could still use a few volunteers.

INITIAL BUSINESS MEETING

WESTERN FOREST INSECT WORK CONFERENCE
53rd ANNUAL MEETING
Whitefish, MT

Initial Business Meeting
23 April, 2002

Barbara Bentz, Chair, called the meeting to order at 8:00 AM.

Mark Schultz read the minutes of the 2001 Business Meeting. Ladd Livingston added that there should be a final decision made that conference proceedings go only to those members attending. Since the proceedings are available on the WFIWC website in PDF format, it can be obtained there. Also, there are no current plans to reprint Western Forest Insects, but that will be discussed at the final business meeting.

Treasurer's Report: Ladd gave the treasurer's report (attached).

History Committee: Mal Furniss gave the report (attached).

Scholarship Committee: There will be a match of up to $500, by John Schmid, to the scholarship fund for all those who would like to donate. Interest rates are not the best so we need to build up the Mark McGregor fund. The Bullet foundation may be willing to participate in donating to our scholarships. Silent auction will be tonight. Barb mentioned that all donations are tax free.

Founders Award Committee : Ken Gibson presented the report (attached). John Schmid is the 2002 winner and will deliver an acceptance address at next year's conference**.**

Common Names Committee: Since Torgy Torgerson retired, the common names committee has conducted little business.

New Business:
A portion of the minutes were read that spoke to a proposal to charge a commercial vendor $200 for a display table and poster board $200. Darrell Ross reported that no final decision about that had been reached at the 2000 meeting in Portland.

John Schmid asked about the 1995 proceedings. The executive committee thought that it could be published with the 2002 proceedings.

Comments on the qualifications for recipient of a scholarship:

Lorraine thought that the qualification should be relaxed. The issue is whether the recipient has to be a WFIWC member or not. It will be put up for a vote at the final business meeting.

Discussion Items:

Proceedings mailing: Propose that proceedings only be mailed to those at each year's meeting; but that proceedings would also be available as a downloadable PDF file on WFIWC website.

Terms for Officers: Ken Gibson suggested there may be an interest in, and need to, change the constitution for the term of the chair and secretary. Should they serve for two or three meetings? The constitution currently stipulates terms run for two meetings.

Location for North American Insect Work Conference: Ron Billings reported that there have been three successful North American Forest Insect Work Conferences. To date, no one has volunteered to host the 2006 conference. A location somewhere in the Lake States is a possibility.

Reprinting of Western Forest Insects: Beth Willhite discussed the need to reprint or revise Western Forest Insects, which was published in 1977. Few new copies can be found. That subject was discussed at a recent FHP Directors' meeting. Would it suffice to have it scanned and made available on a CD instead of reprinting? Reprinting does not seem to be a high priority for the Director of FHP (Rob Mangold). We (WFIWC) might need to write a letter in support of reprinting or revising. Barb suggested the formation of a 3-5 person committee to consider the issue. Ladd thought the National Organization of State Foresters might be interested, and might support its reprinting. Bruce Hostetler thought that since it was published in 1977, we might be better off to scan the current version, put it on the WFIWC website, and put more money into a revision. Nancy Rappaport noted that we really need good, hard copies for field use. Jan Volney thought the Canadian Forest Service could be approached for some funding. Tom Hofacker suggested the Director of FHP may only be willing to spend money on scanning and putting it on the web.

There was discussion about who would be in charge of a revision, can it be feasibly put on a CD, and will research make a monetary commitment for the revision? There was talk of coming up with a cost sharing arrangement between several groups or agencies. Nancy thought that if the issue were raised at next North American Forest Insect Work Conference it would get more attention and might get done. Barb reiterated the options: 1. Reprint; 2. Put on a CD (now); or 3. Revise.

Nancy Rappaport was asked to chair a committee consisting of Carroll Williams, Jack Stein, Mal Furniss, Beth Willhite, and Skeeter Werner. They will come up with a resolution to be voted on at the final business meeting. Jan Volney questioned who has proprietary ownership of the book, plates, etc. Tom responded that it is property of US Government (USDA Forest Service Miscellaneous Publication printed by Government Printing Office). Jan thought that we could get published at a publishing house and then charge for it.

Paying for Conference: Ladd pointed that WFIWC has no means for accepting payment by credit card nor registering over the internet.

Obituaries: Bob Dolph, Al Rivas, Hank Tompson, and Ron Stark have passed away within the past year. Ladd will read an obituary for Bob Dolph and Don Dahlston will read one for Ron Stark at the final business meeting.

2003 Meeting: Mike Wagner noted that if the 2003 WFIWC cannot be held in Mexico he has agreed to host it in Flagstaff.

Skeeter Werner motioned to adjourn the meeting at 9:00 a.m. Tom Hofacker seconded the motion, and the meeting was adjourned.

HISTORY COMMITTEE REPORT, 2001 – 2002

A manuscript by Wickman, Torgersen and Furniss on the historical photo file that originated at the Portland Forest Insect Laboratory was accepted by the American Entomologist. The article is entitled: Photographic Images and History of Forest Insect Investigations on the Pacific Slope, 1903-1953. Part 2. Oregon and Washington. These photos are now located at La Grande, OR and were put in good order by Torgy Torgersen before his retirement last fall. Part 1 dealt with the file that originated at the Berkeley Forest Insect Laboratory and was published in the American Entomologist in 1998.

A manuscript was prepared by Furniss and Roy Renkin, Management Biologist, Yellowstone N.P., entitled: "Forest Entomology in Yellowstone National Park, 1923 – 1957. A Time of Discovery and Learning to Let Live." It is based on unpublished reports and photos of the former Coeur d' Alene Forest Insect Lab and material in the YNP branch of the National Archives at Mammoth. It has been submitted for consideration by Natural History magazine and aspects of it will be presented during this morning's panel.

Boyd Wickman is corresponding with descendents of Harry E. Burke, John M. Miller, and Kenneth A. Salmon to obtain photos, biographical material, etc, for articles and for deposition in various archives. Burke was employed by Andrew D. Hopkins in 1902 and was only the second forest entomologist trained in the United States. Miller was another prominent California forest entomologist during the first half of the last century and was in charge of the laboratories at Stanford and later at U.C. Berkeley. Salmon developed the California Risk Rating System by which pines east of the Sierra Nevada Mtns. could be classified according to risk of killing by bark beetles. He had a short and turbulent career that ended after a conflict with F.C. Craighead, then Chief of Forest Insect Investigations in Washington, D.C.

Boyd has begun work on an extensive biography of Burke, aided and encouraged by two of Burke's surviving daughters and several grandchildren.

Submitted by M.M. Furniss and B.E. Wickman

TREASURER'S REPORT

Highlights of the past year:

- First Scholarship awarded for $1,500
- We received a donation of over $1,020 to our Memorial Scholarship Fund from a donation challenge issued to the members. The same challenge has once again been issued this year.

Current Status of Accounts:

Checking:	$16,359.91	Most of this is from 2002 registration approximately $3,500 regular checking.
Regular Savings:	2,718.57	These are the funds used for scholarships.
McGregor Fund:	4,120.00	Interest is deposited to savings account on a quarterly basis.
Memorial Scholarship Fund:	17,252.00	Interest is deposited to savings account on a quarterly basis.
TOTAL	$40,450.48	

Respectfully submitted, Ladd Livingston, Treasurer

FOUNDER'S AWARD COMMITTEE REPORT

Dr. Les Safranyik, the 2001 Award recipient will deliver the Founder's Award address at the conference banquet on Wednesday evening, April 24. His plaque will be presented at that time.

During 2001, the committee received two nominations for the award for 2002. Dr. Gary Daterman was nominated by Dr. Darrell Ross; and Dr. John Schmid was nominated by Dr. Jose Negron. The results of a difficult decision were that John was selected as the 2002 recipient. Results will be announced at the final business meeting of this conference. John will address the conference in 2003. Gary's nomination will be held and added to others which may be received in 2002.

I extend sincere thanks committee members Staffan Lindgren, Terry Shore, Boyd Wickman, and Jill Wilson for their assistance during the past year. This may be Boyd's last year to serve on the committee. I will confirm, and if so, suggest a replacement at this meeting.

Respectfully submitted, Ken Gibson, Chair

PANEL

Historic Forest Insect Outbreaks in Western National Parks: The Rocky Course Toward More Enlightened Management Policy

Moderator: Boyd Wickman, Pacific Northwest Research Station (retired)

History of Forest Entomology in Yosemite National Park: The First Fifty Years, 1903-1953.

Boyd E. Wickman

Pioneer forest entomologist, John Patterson begins the story of forest insect problems in Yosemite in his 1921 publication. “In 1903 it was reported to the Bureau of Entomology through the Secretary of the Interior that large area of lodgepole pine in the Yosemite Park were affected by a leaf-mining moth. In May 1904, Dr. A.D. Hopkins visited the Yosemite Park, planning to investigate the conditions reported, but was unable to reach the lodgepole pine areas, as all trails leading into the region were still closed by heavy snows.”

Thus begins the history of forest entomology in Yosemite National Park. A.D. Hopkins notched another first in his bug seeking endeavors in Western forests, but this time he was not the first to collect or study the reported needle miner outbreak. However, he did discover mountain pine beetle killing giant sugar pine in the Wawona area and encouraged park personnel to begin the first bark beetle control operations in any national park.

Next on the scene was H.E. Burke, the first entomologist hired in 1902 to study forest insects on the Pacific Slope by the Bureau of Entomology. In July 10, 1906, he started his stagecoach ride to Yosemite probably not knowing that a gunman on the same route had held up two stages just three days before. It must have been exciting time to be a forest entomologist. Eventually, Burke made it to the High Sierra country in the Tenya Basin and Tuolumne Meadows and could not find the needle miner, but did find many lodgepole pine being killed by the mountain pine beetle.

During the next four years, there were reports of the needle miner in Yosemite made by Professor Comstock in 1907 and by forest pathologist E.P. Meincke in 1911 that noted a heavy flight of moths in the Tenya Basin. Forest entomologists were unable to visit Yosemite at that time because of large bark beetle control operations in Northeast Oregon and Northern California. Finally, in October 1912, pioneer forest entomologist J.M. Miller, in his first year on the job, visited Yosemite’s high elevation country. Miller found that the bark beetle problems in Tenya Basin and Tuolumne Meadows had intensified and he found defoliation caused by the needle miner, but no adult moths.

The lodgepole needle miner has a two-year life cycle and adult’s fly and lay eggs in odd numbered years. So the collections of flying moths was hit and miss until more definitive studies of the insects’ life history could be made. Miller, however, could easily see that this was a large and important forest insect outbreak and might also be related to the expanding mortality of lodgepole pine by mountain pine beetle.

For the next two summers of 1913 and 1914, Miller made a point of visiting the Tenya Basin and Tuolumne Meadows areas to study the outbreak, even though he was also involved in a bark beetle control project near Yreka, California. In 1913 the moths were finally collected by Miller and sent to taxonomic specialist August Busck. He described them as a new species, *Recurvaria milleri* in 1914.

According to Miller's diaries he spent much of the summer of 1913 and 1914 in Yosemite Park. Not only did he map the extent of the needle miner outbreak (30,000 acres), but the established a cooperative relationship with Major Littlebrandt of the 4th U.S. Cavalry who was the Acting Superintendent of the park until late 1914 when civilian rangers took over management duties. (Until this time U.S. Army Cavalry units rotated to the park from the San Francisco Presidio to protect and manage national park resources.)

Miller encouraged, instructed, and supervised bark beetle control projects throughout the park in sugar pine, ponderosa pine, and lodgepole pine. He especially promoted control operations against the mountain pine beetle in needle miner weakened lodgepole pine. Even though he worked for the Bureau of Entomology he, in reality, became the Yosemite Park forest entomologist during this period and set the bark beetle control policies that were carried out for the next several decades.

Next on the scene was John E. Patterson, who was quoted at the beginning of this account. Miller realized that he could not devote the time necessary to do an intensive life history and biology study of the needle miner so he assigned Patterson to the job. Patterson devoted most of the summers of 1917-1919 to studying the needle miner. This resulted in the first published account of the life history of the insect in the Journal of Agricultural Research, mapping the extent of the outbreak, some excellent photographs of the insect and infested stands, and solid evidence that the heavy mortality of lodgepole pine in the high country was related to defoliation by the needle miner from the 1890's outbreak. Consequently, Patterson expanded his studies to include the biology of mountain pine beetle and made important contributions to the knowledge of this bark beetle in high elevation lodgepole pine stands. The needle miner outbreak subsided in 1921.

For the next fourteen years, Patterson, Miller, and Burke made intermittent forays to the park to give advice on forest insects, mostly bark beetle control operations at various localities. Then, in 1933, the needle miner returned to Yosemite in many of the same stands mapped by Patterson earlier. The country was in the depths of a depression and many young men were enrolled in the Civilian Conservation Corps. Many of the Civilian Conservation Corps units provided labor for bark beetle control projects. Yosemite was no exception and Patterson provided technical advice to these bark beetle control camps. The needle miner outbreak received little attention at first, but in the 1940's a young entomologist, Stu Yuill, was hired by the bureau to study the possible use of new chemical insecticides to control the needle miner. Under Patterson's supervision, a field laboratory was established at the east end of Tenya Lake to screen various insecticides for effectiveness to kill the needle miner. The Second World War put an end to this research as

Yuill went off to serve in the Navy Medical Corps and Patterson was one of the overworked few holding down the home front. Various forest insects showed no patriotism at all and continued their depredations at an even heightened level.

In 1947, with the war over and entomologists again available for research, Yosemite Park officials noted the rise of needle miner populations once again. They called for the Bureau of Entomology to help them carryout some action to protect the thousands of acres of brown, defoliated lodgepole pine forests in the high country. Park officials were worried that this latest outbreak, which was the largest on record, would result in severe mortality of the remaining old growth lodgepole pine in the high country if the needle miner were not controlled.

The needle miner became a candidate target insect for the new insecticide DDT. In 1949 and the early1950's, entomologist George Stubble carried out small-scale tests of DDT, with varying success.

Never the less, faith in DDT prompted a plan to test 11,000 acres of the high tourist use areas of Tenya Basin and Tuolumne Meadows with one pound of DDT per gallon of diesel oil per acre sprayed from an Army surplus B-18 bomber. The contractor was Ace Flying Service of Missoula, Montana. This operation was under the direction of entomologist, Ralph C. Hall with the author as his assistant.

The project was carried out as planned, but there were some serious operational and biological problems. First, because of the rugged terrain and high elevations (8,000-9,000 feet), the spray plane pilot flew over 1,000 above the ground. Consequently, as measured by spray droplet cards, only 17 percent of the insecticide reached the foliage. Second, the developmental stages of the needle miner included late instar larval, pupae, and adults, and the first two stages were sheltered from the spray in the needles.

The treatment failed. We found practically no reductions in the needle miner populations in the Fall, 1953 sample. The good news, in retrospect, was that so little DDT reached the ground that deleterious side effect's on non-target organisms was greatly reduced.
The first fifty years of forest entomology in Yosemite National Park ends with the failed control attempt of lodgepole needle miner in 1953. But it is better to end the story with a more enlightened view of controlling forest insects in national parks as quoted by the entomologist who was the first to visit the needle miner outbreak in Yosemite in 1906. In 1924, H.E. Burke wrote an essay for the Bureau of Entomology, Newsletter of the Western Division, Forest Insect Investigations. Basing his comments on his experiences over a period of twenty plus years in Yosemite and Yellowstone National Parks he wrote: "Insect killed timber is as natural to the primeval forest as are the trees themselves. The first law of nature is ceaseless movement. All is change. Nothing stands still. Trees grow and die from many causes, destructive insects, being one of them. All of this is as nature intended and mere man should be careful how he interferes if he is going to carry out to the fullest extent the purpose for which the parks are created. *Is there any real necessity for controlling insect infestations in the parks*?"

This question was heresy to many forest entomologists and park managers at the time. But Burke loved the national parks, spent a great deal of his professional career studying and controlling insects in them. His enlightened vision of the role of forest insects in forest ecosystems is generally accepted now, fifty years later. And, at least in my view and experience, "there is no real necessity for controlling insect infestations in parks." Roy Renkin, the last speaker on our panel today will expand on this viewpoint.

In the Past, How Did the "Bug Busters" Respond to the Park "Dicky-Birders" Alarm Calls?

Roy F. Shepherd, Canadian Forestry Service (retired)

First, let me set the scene in Western Canada during the early years:
Forest management didn't exist in the late 1800's. Trees were cut to supply lumber for local markets, or removed to make room for farms, ranches, and railways. Tress seemed endless and their removal represented a large cost in the establishment of the basic industries of agriculture, mining, and railroading. Fire was a tool in removing the unwanted forests and often, extensive areas were burned. This lead to large areas being regenerated naturally by the fire succession species, lodgepole pine. As a result of those early fires, a century later we now are battling huge mountain pine beetle outbreaks both in and outside the parks. The development of the forest industry started to become significant in the early 1900's. After the First World War, an important export market was developed and it was realized that governments required a strong management function. As a result, the B.C. and Alberta Forest Services became major players. Throughout this same period, forest reserves and parks were set aside, paralleling the development of industrial forests. When the first trans-Canada railway passed up the Bow Valley in the early 1880's, hot mineral springs were found near Banff. Small reserves were set up around these springs to preserve them for future generations. These reserves became Canada's first national park, Banff. In subsequent years the parks were expanded greatly, leading to the present collection of Rocky Mountain National and Provincial Parks, which, collectively, is one of the largest areas in Canada, which has been set aside for park purposes.

In the early 1900's there were massive outbreaks of spruce budworm in Eastern Canada and extensive outbreaks of bark beetles in B.C. and Rocky Mountain Parks. The government became alarmed and hired Dr. J.M. Swaine in 1912 as the first forest entomologist in Canada. He published the first paper on Canadian Bark Beetles in 1918. Although essentially a taxonomist like other entomologists of that time, he did arrange for extensive surveys of bark beetle outbreaks in 1913. This was followed in the subsequent year by joint control projects between the Feral Government and the Province of B.C. Unfortunately, concerns about these insect problems had to be set aside during the First World was, as all available manpower was sent to Europe, including my father and both grandfathers. Five years later the beetles were still winning the war at home and expertise was needed.

Ralph Hopping was enticed to move North from California to set up an insect laboratory in Vernon, B.C. in 1921-1922 to investigate forest insect problems in British Columbia, Alberta, and the Rocky Mountain Parks. Beside himself, he had three other staff members with training in entomology: his son, George Hopping, Hector Richmond, and Bill Mathers. Between them they carried out extensive surveys of damage, identified species, worked out life histories, and supervised control projects over the next eight years, until war, again, intervened. By the end of the "Great Depression of the Dirty Thirties", there were large outbreaks of mountain pine beetle at the South end of Kootenay National Park with scattered patches up to and throughout Banff National Park. During this period, a young ten-year-old boy was camped with his family in Kootenay Park, intent on hooking a few trout. He looked all around the valley at the sea of red trees and said to himself, "There must be something wrong with these trees, but they sure are pretty!" I was that young boy.

George Hopping took charge of a control operation in Kootenay Park from 1941 to 1943, when 2,700 trees were felled and burned, successfully eliminating the problem. This time the Second World War provided manpower, instead of removing it. Conscientious objectors were assigned the job of controlling the outbreak and this they did.

Hec Richmond returned to this same outbreak at the Southern end of Kootenay Park with a student, Ken Graham. Many years later Ken became the forest entomologist at U.B.C. Ken, Hec, and Hec's wife, Vi, set up camp with the objective of studying the effect of the outbreak on the stand structure. They brought considerable food with them, including a side of bacon, as the nearest store was many miles away. Soon an unwelcome visitor appeared, entered their tent, and started to help its self. They drove the intruder off, but knew that this bear would be back. They decided to put all the food inside the car and leave a window down a crack to entice the bear away from their sleeping tent, yet still keep the food safe in the car. The car, by the way, belonged to Hec, as, at the time, field employees were expected to provide their own transportation, although mileage was provided to cover immediate expenses. At dawn, Vi woke Hec; the bear was back. They peeked out and the bear was circling the car, looking for a way in. He jumped onto the hood, and then onto the roof, sniffed all around, jumped down from the rear of the car to the ground. He repeated this several times, while the humans became more and more apprehensive. Hec didn't want the inside of the car demolished. The bear had detected the softness of the car's top, so decided to go through the roof. At this crucial moment, Hec also went "through the roof", springing into action. They threw cans of milk and poles at the bear, which it just ignored. He sat on his haunches and dug with both front claws until the cloth and supporting mesh had been ripped apart. The bear lowered his head into the car and put his paws on the back of the front seat. Only his rump stuck up above the roof. Hec was both frustrated and desperate. He opened the door and shouted into the bear's ear. Surprised, the bear pulled back on top of the car. Taking advantage of the bear's withdrawal, Hec jumped into the car to start the engine, hoping to roll the bear off the roof. Because of the groceries piled on the seat, Hec had to assume a partial standing position. The bear saw Hec through the hole and reached in to give him a swat. Just as the bear swung his claw at Hec, Vi screamed and Hec let out the clutch and floored the accelerator. The bear was thrown backward, just missing Hec's head. Hec was so intent at watching the bear, he forgot to steer and ran into a tree, causing considerably more damage. The bear rolled off the car and ran away, safe, but still hungry. Hec claimed the damage to his car with the insurance company under the theft clause, since the bear was definitely a thief. The company responded by saying they had never received a more interesting letter; in fact, everyone in the office had read the letter, but, regretfully, they couldn't agree that bear damages qualified under the theft clause. Hec appealed to his Department, which, in the end, accepted the costs and the Minister of the Day read the letter out in Parliament for all to enjoy! Thus, this bear story was preserved in the parliamentary record (Hansard) for all time. Hec survived this and many other adventures until he was well into his eighties.

The plots Hec Richmond and George Hopping laid out in the 1940's in Kootenay Park were still there forty years later and Les Safranyik and Terry Shore were able to document the changes and add the information to their studies of stand dynamics following beetle attacks.

When World War II ended, the Canadian Government was able to complete its plan for a sting of research laboratories across Canada to undertake research and surveys into forest insects and diseases. One of these was set up in Calgary in 1947, with George Hopping as Head. This time and location were selected partially in response to those bark beetle outbreaks in Kootenay and Banff Parks and also in response to inquiries by park officials of damage by another unknown insect pest in the bow Valley, which was turning the needled yellow on the lodgepole pine.

George Hopping hired a new forestry graduate from the University of Toronto to undertake research on this unknown insect pest. This recruit didn't know much about insects, having taken only one short course from Carl Atwood on tree pests, but he decided to take the job because he came from Calgary and wanted to return, had couldn't stand the black flies in Northern Ontario; so the tall, scrawny, fresh graduate with a new bride arrived in 1947. The insect was the lodgepole pine needle miner, the scientist-to-be was Ron Stark, and the new bride, of course, was Laurie. The next Summer Ron hired his first student, another scrawny kid, myself, and put him into a freezing tent in the Bow Valley to study this problem.

This was the beginning of the Castle Mountain Field Station. In 1954 we all took off a summer from research and with shovels and sledge hammers built a pan-abode research station. Over time many other scientists joined us and we carried out considerable research on both the lodgepole pine needle miner and the mountain pine beetle from that field station. An interesting side point concerns the last cabin of the three cabins built as summer residences for the scientists on site. Between 1955 and 1971 three men spent their formative scientific summers in that cabin: Ron Stark, Roy Shepherd and Les Safranyik. At the time of their retirements each, in time, received the Founder's Award for outstanding research and teaching in forest entomology. Roy and Les are two of the three Canadians to have been so honored; Ron was a Canadian at the time of residency in that cabin. I ask you what was so inspirational about that cabin, or was it related to the trout that came from the creek right behind the cabin?

Now Banff and Kootenay Parks are again under attack by the mountain pine beetle and, interestingly, the attacked stands are in the same geographical positions as those attacked 58 years ago. Hopefully, the information generated by research in both the parks and other areas has clarified the park manager's options to enable them to manage their insect problems in a more satisfactory manner.

History of Forest Entomology in Yellowstone N.P., 1922-1957

Malcolm M. Fumiss and Roy Renkin

Yellowstone, our oldest national park, extends over 2-1/4 million acres. It ranges in elevation from about 5,000 to 11,000 ft. Eighty three percent of the park is forested. Species in order of abundance are lodgepole pine, Engelmann spruce, subalpine fir, whitebark pine and Douglas-fir. These stands vary perpetually in their structure and stage of succession due to forces such as fire and insects. Admired by millions of people through the years, Yellowstone's forests are the product of natural factors that have operated here for millenniums.

Yellowstone's geysers and other thermal features, and its vertebrate wildlife, need no elaboration here. Less well known, however, is the turbulent history involving forest-inhabiting insects of the Park that began in 1922 with discovery of defoliated Douglas-fir in Blacktail Deer Creek drainage This presentation, is extracted from a manuscript by Roy Renkin and me that describes that occurrence and subsequent outbreaks, particularly of defoliators and bark beetles, and the circumstances responsible for what seem now to have been inappropriate and futile actions in attempts to control them, and the lessons learned.

Much of the substance of what we sought to record involving the early history of forest entomology in YNP occurred in the years between 1922 and 1934, a time when the insects involved were first reported within and adjacent to the park and vigorous efforts made to control them. Infestations and control actions were generally less intense or extensive during the next 20 years. We included the aerial spraying between 1953 and 1957 of the now-banned insecticide, DDT, because it came at the end of an era. Entomologist James C. Evenden, who was a central figure throughout this period, retired during that time. Furthermore, soon thereafter, park management and policy took a friendlier course and a more enlightened stance regarding the natural roles of this miniature, native, park fauna. Roy will address the latter subject.

Throughout this spading of history past, let us remember that we, ourselves, have learned mainly through experience and that at the beginning of this account the NPS (created in 1916) was hardly old enough to have left kindergarten. Thus, no finger pointing is done here

The Entomologists

Forest entomology in the northern Rocky Mountains began unwittingly in January 1909 when Josef Brunner, a native of Bavaria with some forestry training, observed bark beetle-infested trees in the Little Snowy Mountains, Montana. He wrote to Gifford Pinchot, Chief of the Forest Service, Washington, D.C., asking: "...the name of the little bug which makes the inner bark of freshly fallen trees its primary breeding place then attacks en masse nearby standing green trees?" Pinchot referred the letter to Andrew D. Hopkins, Chief of Forest Insect Investigations, USDA, Bureau of Entomology. Brunner's continued interest resulted in his being recruited during the following summer by Hopkins to investigate the virtually unknown forest insects of that region. However, he had a falling-out with Hopkins and left the service in 1917.

The next person on the scene was James C. Evenden (1889 - 1980), a recent forestry graduate of Oregon State Agricultural College, who was hired by Hopkins in October 1914 as an Entomological Ranger, stationed in Montana under Brunner. In June 1919, Evenden established the Coeur d' Alene Forest Insect Field Station, later renamed Coeur d' Alene Forest Insect Laboratory. Evenden remained there as Leader until his retirement in early 1955 after which it was closed and its personnel were transferred to a Forest Service facility in Missoula. A majority of our manuscript on YNP is derived from Evenden's many unpublished reports. Only one publication on forest entomology in the park appeared during this historical period. That was by H.E. Burke (1932) on a needletier and sawfly that he studied on lodgepole pine near West Yellowstone.

1923 -Yellowstone Forest Entomology begins

Evenden visited Yellowstone N. P. June 9-10, 1923 in response to the Park Superintendent's 1922 report of defoliated trees. He observed defoliated Douglas-fir at the head of Blacktail Deer Creek and along the south side of the Yellowstone River opposite Hell Roaring Creek. Examination disclosed only empty pupal cases still clinging to trees from the previous year. The suspected identity of the insect was confirmed in August on his third visit when moths were in flight around the afflicted trees. However, it was thought at the time to be the eastern spruce budworm, classified then as *Cacoecia fumiferana* Clemens (now described as *Choristoneura occidentalis* Freeman, the western spruce budworm), and was the first record of this native insect in the western United States.

Budworms mar scenery in Cody Canyon; get dosed with lead arsenate -- 1929-1932

While the Blacktail Deer Creek infestation was running its course in north central YNP, a separate spruce budworm infestation was attracting attention in Cody Canyon, the popular eastern approach to the park. By 1929, alarm was being voiced to officials by the summer home and resort owners. The scenic values at stake were evident in the preface of Evenden's 1930 report: "The Cody Canyon provides one of the most popular and beautiful entrances to the Yellowstone Park. The beauty of the rugged mountainsides, which rise from the Shoshone River for thousands of feet, depends upon the dense forests of Douglas-fir for a proper setting."

Responding to the insistent call for action by residents of the area, Evenden made the first effort to control the budworm in the west in June 1929 when a total of 300 acres of infested trees were experimentally sprayed with mixtures of lead arsenate and water. He used Evinrude forest fire pumps to apply the spray through 150 ft of hose. Spray solution was mixed by hand in two 55-gal barrels. Evenden concluded: "The outfit could be called "hay wire" as it was cumbersome, difficult to move, slow of operation, and not at all adapted to the spraying of tall trees.

Fortuitously, better spray equipment lay close at hand in Yellowstone Park, itself, evidently acquired for spraying lodgepole pines infested with other defoliators (needle tiers and sawflies) near West Yellowstone. So, from June 13 to July 7, 1930, the Park's sprayer was used to apply 136,000 gals of spray containing 3,864 lbs. of lead arsenate Crews worked two 8-hr shifts. Evenden was on the scene until June 24 when he left his field assistant, Vernon Lopp, in charge.

During the second shift on June 25 the tank "stopped up". Lopp "made a check-up on the crews to learn who was missing, as we found someone's underwear in the spray tank."

On July 1, he reported that a heifer at Holm Lodge had grazed in a sprayed area following rain a few days ago, became ill Saturday afternoon and died Monday … "Nothing was said about it. I talked with Mrs. Shawfer and I think they intend to keep their stock away from arsenate from now on."

Similar spraying continued through 1932 at which time the outbreak subsided from natural causes. By then, however, more than 260,000 gallons of spray containing thousands of pounds of lead arsenate had been applied and re-applied to inhabited areas of the canyon and along its roadsides

Mt. Washburn mountain pine beetle in white bark pine control project, 1933 -1934

In 1925, an infestation of the mountain pine beetle was reported in white bark pine near Dunraven Pass. Beginning about 1930, increasing numbers of mature trees were infested and killed in this area. The intensity of white bark pine mortality within YNP resulted in control projects in the depression years of 1933 and 1934 at Mt. Washburn.

The 1933 project met with dismal success. Inexperienced CCC crews, fresh out of New York City, were pressed into work in the spring with little time available between gaining access to the snow-bound 8,000 ft elevation area and when warming air temperatures caused beetles to emerge from infested trees. During 1934, more capable crews from ranches and towns surrounding the park were located in remote camps leaving the CCC crews, who commuted from Canyon Village, to deal with trees accessible by road. That year 2,643 white bark pine were felled, dragged by horse to decks, and burned.

In his report after the 1934 project, Assistant Chief Ranger Maynard Barrows concluded: " The mountain pine beetle epidemic is threatening all of the white bark and lodgepole pine stands in Yellowstone Park. Practically every stand of white bark pine is heavily infested …and will be swept clean in a few years. If the insects spread from the white bark pine to the lodgepole stands it seems inevitable that much of the park will be denuded."

The infestation continued for several years and a great majority of susceptible, older, large trees succumbed but white bark pine was not "swept clean." Instead, as noted by Elliott (1938): "Numerous cases were observed where (beetle) attacks had been made on sub-mature trees but such trees had sufficient vitality to repel attacks by pitching them out." Also of interest is that Evenden stated in a 1933 report that, as of then, practically no associated lodgepole pine had been killed although the outbreak in white bark pine was in its third year.

Mountain pine beetle infestations still persist in the Washburn Range but white bark pine communities there appear to be secure in their ecological realm in spite of agents like the beetle and fires. Concern has shifted to possible long-term effects of infection by white pine blister rust (*Cronartium ribicola* Fisch.), an exotic fungus causing widespread and increasing mortality elsewhere in the distribution of this pine. Though present at Mount Washburn, the fungus has been restricted so far to occasional branches rather than infecting tree trunks, which is required to kill trees.

The curtain closes: Spraying DDT to control the spruce budworm, 1953 -1957.

Resurgence of infestation by the spruce budworm in the northern portion of YNP led to spraying 2,000 ac of Douglas-fir in the Lava Creek drainage during 1953. However, the infestation enlarged in 1954 requiring the spraying in 1955 of 55,000 ac within the park and 77,000 ac on the adjacent Gallatin N.F. An additional 72,000 ac were sprayed in 1957 including 68,000 ac within the park. Put in other terms, those projects resulted in spreading 62 tons of DDT and 125,000 gals of fuel oil over this portion of the park.

Thereafter, use of DDT was discontinued in the park, and eventually elsewhere, due to mounting evidence of its persistence in the ecosystem and adverse affects on many life forms. The issue was brought forcibly to public attention by the publication of Silent Spring in 1962 and the pesticide was banned in the United States in 1972. Thus, by strange circumstance, Yellowstone N .P., -- where the budworm was discovered in 1922 -- is also where this life-altering, un-natural, substance was used for nearly the last time in our nation's forests.

In summary, much of what transpired in this period in the development of forest entomology and park management was by trial and error, motivated by the pressure to be a good neighbor and with the desire to preserve pristine forests, believing that their existence was threatened by infestations of insects, many of which were as yet un-described, unstudied, and their ecological roles not understood. In retrospect, the lessons learned have augmented similar advances in scientific knowledge about agents such as fire and resources such as wildlife, contributing to a more passive present-day management philosophy that will be described further by Roy.

CONCURRENT WORKSHOP SESSION 1

Status of Forest Insects in the West

Moderator: Lorraine Maclauchlan, B.C. Ministry of Forests

Presenters from seven regions throughout the west and west-central States and Provinces gave updates on the occurrence and damage of various forest insects. A common theme of these regional reports was the building populations of mountain pine beetle and various defoliators. Just a few highlights from the reports are summarized in the following paragraphs and tables. In Alberta, the major forest insects of note in 2001 were the spruce budworm covering 115,572 ha, various aspen defoliators including the large aspen tortrix that was mapped defoliating over 3.5 mill ha in 2001. The mountain beetle has been building within Banff National Park and 1,427 green attack trees were located in 2001/02. Other forest health problems mentioned were ink spot disease, lodgepole pine dwarf mistletoe, *Armillaria* root disease and white pine weevil. In British Columbia, the most significant problem is mountain pine beetle, attacking over 839,400 ha of forest in 2001. The table below highlights other notable forest pests in British Columbia.

Bark beetles	Ha
Mountain pine beetle	839,421
Western balsam bark beetle	1,072,700
Spruce beetle	99,564
Douglas-fir beetle	14,494
Total	2,026,179 ha
Defoliators	Ha
Budworms	
2-year cycle budworm	121,260
Western spruce budworm	123,638
Eastern spruce budworm	1,612,314
Western blackheaded budworm	1,986
Other	
Forest tent caterpillar	60,415
Satin moth	8,695
Western hemlock looper	5,174
Birch leaf miner	4,466
Douglas-fir tussock moth	*building*
Unspecified defoliator	851
Total	1,938,799

The mountain pine beetle and Douglas-fir beetle both saw increases again in the Pacific Northwest in 2001, increasing to cover over 358,000 acres. The Citrus long-horned beetle was introduced into Tukwila, Washington, last year. Other highlights from the Pacific Northwest are detailed below.

Insect pest	Acres
Mountain pine beetle	211,129
Douglas-fir beetle	147,123
Fir engraver	20,290
Pine engraver	1,700
Western pine beetle	18,000
Spruce beetle	24,900
Douglas-fir tussock moth	52,840
Western spruce budworm	272,110
Balsam woolly adelgid	50,820
Larch casebearer	4,500
Gypsy moth – catching moths in traps in Washington & Oregon	

Bark beetles are currently the insects causing the most mortality in the Northern Region. Approximately 236,600 acres of mountain pine beetle caused mortality was reported during aerial detection survey during 2001. This is a significant increase over levels of mortality for this insect in recent years. Hundreds of thousands of acres of lodgepole pine are becoming increasingly susceptible and weather conditions are proving to be more and more conducive to beetle survival. The majority of the affected acres, 207,400, were in lodgepole pine on the Nez Perce, Lolo, and St. Joe National Forests. The insect continues to be a cause of great concern impacting high elevation whitebark pine forests in conjunction with white pine blister rust, currently affecting 10,300 acres. In the Selkirk Mountains these two agents in combination are decimating highly valued whitebark pine stands. Beetle-caused mortality attributed to mountain pine beetle in ponderosa pine was reported to be 18,900 acres affected a number of areas in Montana. The table below highlights other insects noted in the Northern Region in 2001.

Insect pest	Acres
Mountain pine beetle	236,600
Douglas-fir beetle	200,500
Fir engraver	14,806
Subalpine fir decline (primarily due to western balsam bark beetle)	90,700
Douglas-fir tussock moth	141,885
Western hemlock looper	28,400
Western false hemlock looper	1,000
Western spruce budworm	low @1,300
Balsam woolly adelgid	51,551

Fire and Forest Floor Ecology

Workshop Moderator: Nancy Rappaport, PSW Research Station

(Summary Not Available)

How to be a Better Shutterbug

Moderators: Ron Billings, Texas Forest Service, and Bill Ciesla, USDA Forest Service (retired)

Using examples from his personal collection of color slides taken over the past 35 years, Ron Billings discussed how to capture better images with a 35 mm camera. Topics discussed included camera equipment, film, filters, flash, shutter speed and aperture relationships, elements of composition, the quality of light, hyperfocal distance, and how to photograph landscapes, travel photography, close-ups and people. Ron currently uses a Nikon N-6006 camera with lenses that include a 28-105 mm zoom, a 20 mm Nikkor wide angle, and a 70-300 mm zoom, plus a filter or two on occasion (circular polarizer, starlight or uv filter). A sturdy tripod is recommended for obtaining crisp images of landscapes with maximum depth of field (area in focus). Bill Ciesla described a relatively simple approach for taking close-up photographs of insects, fungi, wildflowers, and other small objects. He uses a Nikon F2S camera body (with 1/250 second synchronization speed), a 55 mm Micro-Nikkor f2.8 lens and a Vivitar 283 flash unit. The flash is connected to the camera via a cable, rather than a hot shoe. With the flash held close to the subject, a 1/250 shutter speed and f-stop of f-16 or f-22 will provide maximum depth of field for small subjects. Bill recommends shooting a range of f-stops and a minimum of 3-4 photos/subject. For light-colored subjects, f-stops of f-22 to f-32 may be required to get correct exposure. Finally, Art Stock (Canadian Forestry Service) described his use of a sturdy tripod with a small level to assure improved landscape photos. Questions from the audience also were addressed.

Trapping techniques for Longhorned beetles

Moderators: Dan Miller, USDA Forest Service, Southern Research Station, Athens, GA and Peter de Groot, Canadian Forest Service, Great Lakes Forest Research Centre, Sault Ste Marie, ON

Fifteen participants attended the workshop that started with a slide presentation of trap designs used by various researchers (Rory McIntosh, Dean Morewood, John Borden, Peter de Groot, Kathy Hein, Mark Dalusky and Dan Miller) and those sold by industrial companies (Phero Tech Inc. and IPM Technologies Inc.). Factors considered by attendees included: (1) trap shape; (2) height & width; (3) color & patterns; (4) placement & orientation; (5) preservation agent; (6) collection containers; and (7) attractants. Practical considerations in the development of new traps include: (1) manufacturing ease & cost; (2) efficacy vs ease of use; (3) durability; (4) non-target effects; (5) continued registration of preservatives such as dichlorvos; (6) deployment limitations; and (7) specific needs of managers and users. Shape of trap is probably not a significant factor in capturing cerambycids if an effective attractant is used and the trap is dark and shape is consistent with that of a tree trunk. Height of trap significantly affects the capture of beetles but limitations arise from ease of use. At present, collection cups with preservation outperform dry cups with dichlorvos. There is a strong need for a dry cup system that does not require liquids.

CONCURRENT WORKSHOP SESSION 2

Fire/Insect Interactions and Marking Guidelines

Moderators: Joel McMillin, FHP R3 and Sheri Smith, FHP R5

The session was organized around 2 main themes: 1) wildland fire – insect interactions and marking guidelines and 2) prescribed fire – insect interactions. Joel McMillin (FHP, Region 3) was the first speaker and presented the results of a west-wide survey on current marking guidelines used by the National Forest System following wildland fires. Sharon Hood (Fire Sciences Lab, Missoula) presented the current status of their lab's work on assessing tree survival following fire, followed by Daniel Cluck (FHP, Region 5) presenting the work that has been ongoing in northeastern CA towards the development of marking guidelines. Dave Ganz (UC Berkeley) completed the formal presentations by presenting his research on prescribed fires/bark beetles/mortality guidelines from Blacks Mountain Research Forest in northeastern CA. Abstracts from each presenter follow.

West-Wide Survey of Marking Guidelines Following Wildfires

Joel McMillin,[1] Sheri Smith.[2] USDA Forest Service, [1]Region 3 Forest Health Protection, [2]Region 5 Forest Health Protection.

Following the fire seasons of 2000 and 2001, there have been many questions from Forests, States, and the public concerning marking guidelines for salvaging fire-killed trees. Specifically, how much fire damage can a tree sustain and still live, or conversely, what trees are going to die from fire-caused injuries and/or subsequent bark beetles attacks. In addition, there has been concern that bark beetle populations could increase in fire-damaged trees and then move to neighboring stands of undamaged trees.

Based on discussions with Forest Health Protection personnel across the western US, there appears to be a wide-range of protocol used to determine what trees will live or die following wildland fires. However, to our knowledge, there has not been an attempt to summarize guidelines by forest type, region, season in which the fire occurred, etc. Therefore, we sent a questionnaire to Forests throughout the western United States to obtain information regarding what guidelines are currently being used. The goal was to determine if current marking guidelines are adequate or could be improved upon with additional information based on recent and ongoing research examining wildland fire-insect interactions.

We received responses from Forest Service Regions 1, 2, 3, 4, 5, 6 and 10. Although no region has region-wide guidelines, most regions have guidelines for at least some forests or districts. Seventy-eight percent of the responses had either formal (published) or informal (unpublished) guidelines, while 22 percent had none. Regions 1, 3, 4, 5 and 6 were using guidelines based on data collected from the region, while Regions 2 and 10 were using guidelines developed elsewhere or did not have guidelines. Most responders believed that current guidelines were adequate, but could be improved upon; 54 percent considered the guidelines defendable in court. Additional needs identified include: more information on wood deterioration rates by tree species, size and geographic location; more local data; longer-term data sets to validate models used to predict mortality; more data on effects by season of fire; data on hardwoods; and easier guidelines for marking crews to use in the field.

Most marking guidelines are based on fire-caused crown scorch and damage to the cambium at the base of the tree. In general, trees are marked for salvage if there is more than 70 percent of the live crown has been scorched or consumed. An example of salvage criteria using cambium measurements include that if more than 50 percent of the cambium is killed on trees less than 20 inches dbh or more than 75 percent on trees greater than 20 inches dbh, then the tree has a high probability of not surviving. Several responders commented that appeals of planned salvage operations or the nearly 2-year time frame for completing NEPA prevents forests from carrying out treatments in a timely manner (prior to loss of value due to wood deterioration), if at all.

Most of the concern about fire/insect interactions was focused on bark beetles (67%) and woodborers (33%). However, several forests commented that although there is concern that insects will kill additional trees, they only mark trees already dead and do not mark trees that are currently infested with bark beetles. In fact, few forests have ever implemented sanitation/salvage operations to minimize bark beetle impacts. Most of the responders concerns regarding bark beetles was in mixed conifer forest types; principally the build up of Douglas-fir beetle populations. The anti-aggregant pheromone for Douglas-fir beetle, MCH, has been used to minimize beetle population increase following fires in mixed conifer forests.

In summary, most regions and forests in the western United States have some type of marking guidelines for salvaging trees following fires. However, frequently the current social-political environment or time requirements for the NEPA process may preclude sanitation/salvage operations from being implemented in a timely fashion. In addition field personnel indicated knowlegde and data gaps regarding wood deterioration rates by tree species, size and geographic location; availability of local data; data sets to validate models used to predict mortality; effects by season of fire; data on hardwoods; and the need to develop guidelines that are accurate, quick to implement, and easy to interpret and apply in the field.

Assessing Tree Survival After Fire

Sharon Hood and Kevin C. Ryan, Fire Sciences Lab in Missoula, MT

Surveys conducted after the 1988 fires in Yellowstone suggest that bark beetle population levels can increase in fire-injured trees and then spread to uninjured trees (Amman and Ryan 1991, Rasmussen et al. 1996, Ryan and Amman 1996). The level of insect activity following fire will depend on several factors including: 1) the surrounding insect population available to take advantage of the new resource (e.g. stressed trees), 2) the severity of tree stress due to fire injury to foliage, stem, and root tissues, 3) the proximity of green, non-stressed trees, and 4) post-fire weather. More information is needed to adequately assess the probability of delayed mortality due to bark beetles following fire. For example, the level of fire injury that is most optimal for beetle success and growth appears to differ by bark beetle/host species (Ryan and Amman 1996, Northern Region-FHP 2000). There is also little to no available published information on the association of tree burn severity and beetle production. Also, factors contributing to the movement of beetles from fire-injured trees to surrounding green trees have not been investigated for any species.

The Fire Sciences Lab in Missoula, MT is currently involved in several studies to assess fire injury to trees following fire in order to improve predictive models of tree mortality following fire. Methods developed over the past 25 years (Ryan 1982, 1998) are being used to document fire injury in stands across a gradient representative of the full range of fire severity and a robust range of species composition. Scientists at the Fire Lab and the Forestry Sciences Lab in Moscow, ID have developed the Fire and Fuels Extension to the Forest Vegetation Simulator (FFE-FVS) (Beukema 2000) to assist managers in developing treatment prescriptions for managing fuels and vegetation in post-fire management decisions such as salvage. Likewise, Fire Lab scientists have developed the First Order Fire Effects Model (FOFEM) (Reinhardt et al. 1997), a national fire effects prediction system which is used in conjunction with the BehavePlus (Andrews and Bevins 1998) and FARSITE (Finney 1998) fire behavior models to develop prescribed burning windows and treatment objectives. These models are available for download at http://www.fire.org. Tree mortality relationships in these models rely heavily on data from prescribed fires. These models need to be improved to better support post-fire management decisions. In particular, data collected following the 1988 wildfires indicate that these models underpredict mortality for some species and ranges of fire injury. Data collected from wildfires in 2000 and 2001 will be used to increase the accuracy of the models and test the models' performance for new species.

Work by Ryan and Amman (1996) and Ryan (1999) developed a conceptual model for predicting which species of bark beetles and wood borers are attracted to trees with varying injury, but their data were insufficient to develop a predictive model. Further, while their work showed that some species of bark beetles successfully spread to adjacent green trees, it did not answer critical questions about beetle population dynamics, the factors contributing to the spread, nor the aerial extent of the beetle spread. Studies implemented in 2001 and 2002 are designed to examine the factors leading to bark beetle population build-up and spread to develop a predictive model of beetle spread following fire.

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Evaluating Fire Injured Conifers – Development of Marking Guidelines

Sheri Smith and Danny Cluck
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Historically, fire-salvage marking guidelines used throughout California were based on Willis Wagener's "Guidelines for estimating the survival of fire-damaged trees in California" (1961). These guidelines provided evaluation criteria for fire-injured trees, based on the amount of crown and cambium damage, which were used to predict tree survivability and/or mortality. Until recently, this document represented the only information available (based on data from California) to land managers for evaluating fire-injured trees in California.

In the late 1980's, following the Stanislaus Complex fires in the southern Sierra Nevada, Wagener's guidelines were questioned as to their accuracy in predicting tree survival and/or mortality. Many resource specialists and publics involved felt that the guidelines allowed many trees to be harvested that would most likely have survived their fire injuries. One of the major concerns with Wagener's guidelines is the inability to locate the data associated with his study. The number of each species studied, the average diameter of sampled trees and the methods he used to evaluate the extent fire-damage, especially cambium damage, are unknown.

Land managers in California need to be able to accurately evaluate fire-damage and predict survivability of trees for planning rehabilitation, salvage, and fuel reduction operations. In addition, guidelines developed to meet this need must use variables that are easy to interpret and quickly applied in the field. Information used to develop such guidelines should be obtained from studying the same tree species in the similar geographic regions for which they are to be applied.

In response to this need FHP, R5, Susanville, CA established six different administrative studies, some completed and some in progress, monitoring several different tree species suffering various levels of fire injury. To date 913 trees (439 ponderosa/Jeffrey pine, 235 white fir, 212 red fir, 17 sugar pine and 10 incense cedar) from six sites in the Sierra Nevada have been sampled. These sites are comprised of four wildfires and two prescribed burn areas.

The three most important criteria FHP staff used for field evaluation of fire-injured trees were crown damage, cambium damage and insect attack. Crown damage was measured on a linear scale by taking the height (or length) of remaining green foliage or live crown and dividing by the original (pre-fire) crown height (or length) to calculate the percent remaining green foliage or percent remaining live crown. Cambium damage was determined by physically removing one-inch samples of the cambium/phloem layer from four equidistant locations around the base of the tree near ground line. Insect attacks were evaluated based on the type and number found on the bole of the tree.

Based on the information obtained from our monitoring studies and a comprehensive review of the available literature we have developed the following guidelines for evaluating fire-injured conifers in California (Table 1). Survival criteria outlined in the guidelines are partially based on Wagener with some modification by Weatherspoon (1987).

Table 1. Survival criteria.

Species	% Remaining Green Foliage (% of original crown height or length)	% Remaining Live Crown (% of original crown height or length)	Pitch Tubes	Bole Circum. with frass/ boring dust	Cambium Kill (# of DEAD samples allowed) Trees < 20" DBH	Cambium Kill (# of DEAD samples allowed) Trees > 20" DBH
	+	=				
Ponderosa/ Jeffrey pine	>10	>35	<10 or >10*	<1/3	<2	<3
Sugar pine	>35	>35	<10 or >10*	<1/3	<3	<3
Df, Wf, Rf, Ic,	>35	>35	N/A	<1/3	<2	<3

+ Use this criterion if marking right after the fire and up until the next years growth (needle flush) is apparent.)
= Use this criterion if marking after the following growing season.
* If found on less than 50% of the bole circumference at or above 5 ft.
excluding red turpentine beetle pitch tubes.

These guidelines will continue to evolve as new information becomes available. We still have much to learn in regards to differences in tree survivability among various species and size classes. We intend to modify the guidelines, as appropriate, based on publications of work from others and the results of our ongoing fire-injured tree monitoring studies.

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The Post Burning Response of Bark Beetles to Prescribed Burning Treatments

David J. Ganz, Donald L. Dahlsten, and Patrick J. Shea

Ecologists and fire scientists recommend reintroducing fire to achieve the twin goals of restoring pre-settlement forest conditions and reducing catastrophic fire risk (McKelvey et al. 1996; Parsons 1995). Early work by forest entomologists (Miller and Patterson 1927; Salman 1934;

Miller and Keen 1960, Rasmussen et al. 1996) established a direct relationship between fire injury and subsequent insect attack in burned-over areas. Today, bark beetles are recognized as a significant factor in California forest ecosystems (Mutch 1994, Bradley and Tueller 2001). Susceptibility of forest stands has increased through combined effects of climate change, past forest management, fire suppression, drought and other pests. The accelerated use of prescribed fire in California ecosystems may or may not alleviate these conditions. In response to concerns over these conditions, a study was initiated to study the extent of fire effects, and subsequent tree mortality, from different fall and spring prescribed fires in the East Side pine ecosystem of Northern California. These fall and spring prescribed burns in Northern California were evaluated from 1997-2001 in order to determine the severity of tree mortality associated with prescribed fires burned under a wide variety of environmental and fuel conditions. This study included 17 prescribed burns of approximately 100 acres each, performed at Blacks Mountain Experimental Forest, Lassen County, Lassen Volcanic National Park's Roadside Burn, Lake Tahoe Basin Management Unit's Spooner Summit and Harvey Mountain, Lassen County.

Live crown still seems to be the most convenient measure for assessing tree vigor and therefore tree survivorship, especially with pines. Percent of live crown scorch continues to be a significant parameter in all mortality models developed with exception of western pine beetle and Jeffrey pine beetle. This impact of live crown scorch has been well documented by other studies (Wagener 1961, Ryan 1982, Peterson 1985, Ryan et al. 1988, Ryan and Reinhardt 1988, Cluck and Smith 2001). Bark char heights have also been used in conjunction with crown damage to predict tree mortality (Peterson and Arbaugh 1986).

In this study, the combination of percent live crown and bark char codes has greatly increased the ability to predict tree mortality, both from the fire itself and from subsequent insect attack. There were distinctions between trees killed by fire (KBF) and trees killed by insects (KBI). Linear models were used to determine which fire severity measure was most important for KBI and KBF. Live crown, as in previous studies, was still the best predictor but performs best in conjunction with other fire severity measures. In general, bark char Code 3[1] performed best for KBF and bark char Code 2[2] for KBI. This verified the biological rational for using the bar char codes as a measure of fire severity. Also intuitive in this modeling was the specificity of each insect in the order of parameters and their respective importance to the model. Some insect mortality models had DBH as the next best predictor while others had Code 2 measured on the backside as a significant model parameter for predicting mortality.

Initial concern has centered on the primary tree killers *Dendroctonus* sps. and *Scolytus ventralis* Leconte. This research is also finding that *Dendroctonus valens*, *Ips pini,* and secondary wood borers are major players in tree mortality with both fall and spring burns. The mere presence of *D. valens* and wood pecker foraging can essentially girdle an otherwise healthy small diameter tree. For ponderosa and Jeffrey pine trees, mortality in the smaller diameter classes (4-10 inches DBH) caused by *Ips pini* has usually been in combination with *D. valens*. *Phloesinus* spp. has also been found contributing to small diameter incense cedar mortality following fall burns. Fire and forest managers need to re-evaluate the ecological role of some of these insects following

[1] The entire bark is black including the fissures and a significant degree of bark consumption is evident.
[2] The entire bark including the bark fissures is black, but the bark has not been consumed by fire.

prescribed fire. Insects like *Phloesinus, Ips pini,* and *D. valens* are behaving differently following fire.

Many of the sites studied in northern California have experienced delayed mortality in their large tree, overstory components. Delayed post-burning bark beetle induced mortality can be quite significant and needs to be managed. This study speculates that the re-introduction of fire in these stressful environments has led to high rates of mortality due to extensive root injury. Other works have also speculated that root injury is probably of greater significance in growth losses and mortality of thick-barked trees than is stem injury (Ryan 1982, Harrington and Sackett 1989, Sweezy and Agee 1990). Frequent field observations of the seventeen prescribed burns in this study support these claims. Further attention to roots systems is necessary in future fire effects studies. To date, there has not been enough emphasis on the prediction of fire effects that are more strongly dependant on the duration of heating such as stem and root injury.

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Forest Insect Damage and Control Conflicts with T&E Species or Wildlife Habitat

Moderator: Elizabeth Willhite, USDA Forest Service, Westside FID Service Center, Sandy, OR

Threatened and Endangered Species (TES) protection requirements have generated challenging management situations for forest land managers in recent years. Complex biological, ecological, regulatory, and political issues surround management of TES habitat, and conflicts between TES wildlife species, their habitat management, and forest insect activity or prevention/suppression efforts have arisen throughout the West. Forest insects may threaten essential TES wildlife habitat conditions directly through their effects upon stand structure and composition, or indirectly through the creation of forest conditions predisposed to catastrophic wildfire. Management activities designed to prevent or suppress forest insect activities may impair TES habitat suitability or result in non-target effects upon TES wildlife or their prey base. Much is really unknown regarding the interactions of TES wildlife and "natural disturbance" caused by insects or "human disturbance" caused by insect prevention/suppression activities. Are our underlying assumptions about insect effects upon critical TES habitat elements correct? What are the short-term and long-term responses of TES individuals to insect-caused disturbances and attempts to prevent or suppress them? Is quantitative data available regarding how insect outbreaks affect fire hazard over time? This session was designed to highlight several examples of forest insect/TES wildlife conflicts and to share relevant work that is addressing important questions in this area.

Effectiveness Monitoring of Aerial Spraying to Reduce Defoliation in Riparian Zones of Value to Bull Trout

Thomas DeMeo, USDA Forest Service, Pacific Northwest Region, Portland, OR (speaker)
Mark Fedora, USDA Forest Service, Ottawa National Forest, Ironwood, MI
Katie Boula, USDA Forest Service, Umatilla National Forest, Pendleton, OR

Recent defoliation of grand fir and Douglas-fir in the Wallowa Mountains of eastern Oregon has generated concern about stream temperature levels affecting bull trout, a threatened species. Increased defoliation by Douglas-fir tussock moth (DFTM) presumably leads to less shade on streams, in turn leading to increased stream temperatures. To address this concern, forests along some streams were sprayed in July 2000 using a virus pathogenic to DFTM. To test the effectiveness of this action in decreasing light levels, we used an Ozalid paper technique that records solar radiation. Radiation is captured on sheets of blueprint paper; this exposure is then correlated to light levels using a previously-developed relationship derived using electronic instrumentation. We used this method on the Wallowa-Whitman National Forest as a surrogate to measuring stream temperatures on nine streams across the landscape, a prohibitively costly method. Streams fell in the grand fir vegetation zone between 3000 ft and 4000 ft elevation. We sampled three streams each in areas not sprayed with low numbers of DFTM, not sprayed with high numbers of DFTM, and sprayed with high numbers of DFTM. We found these streams were already receiving 83 to 88 percent of full light before spraying. Results showed no effect of spraying on decreasing light levels. Variation in light exposure was due to differences between individual streams. At least in this forest type in this elevation range, there appears to be little value in spraying to reduce DFTM numbers where the objective is protecting bull trout populations.

Conflicts and Relationships Between the Endangered Red-cockaded Woodpecker and the Southern Pine Beetle

Ron Billings, Texas Forest Service, College Station, TX

Ron Billings described the relationship between the endangered red-cockaded woodpecker (*Picoides borealis)* and the southern pine beetle (*Dendroctonus frontalis*) in the southern U.S., with emphasis on east Texas. The red-cockaded woodpecker prefers to nest in living longleaf pine, but has been forced to inhabit loblolly pine trees in recent decades due to the conversion of most native longleaf pines to other tree species. The woodpecker selects pines with high oleoresin production capabilities and maintains fresh resin exudation along the trunks of cavity (nest) trees to ward off rat snakes, a major predator. The red-cockaded woodpecker feeds on small insects, particularly southern pine beetle brood and/or other insects associated with bark beetle-infested trees. The southern pine beetle, in turn, favors loblolly pines as hosts. During outbreaks, red-cockaded woodpecker foraging habitat and cavity trees may be eliminated as established southern pine beetle infestations expand in the absence of control. More commonly in recent years, adult southern pine beetle dispersing out of multiple-tree infestations in October and November have selected active red-cockaded woodpecker cavity trees to infest prior to overwintering, further threatening this endangered species. Recent rulings by a federal judge to address declining red-cockaded woodpecker populations on the National Forests in Texas required reductions in the basal area of pines and elimination of mid-story hardwood trees in colony sites. Ironically these practices appear to have increased the incidence of southern pine beetle infestation of red-cockaded woodpecker cavity trees, possibly due to the lack of green-leaf volatiles from mid-story hardwoods. Thus, following these court-mandated habitat "improvements," the endangered red-cockaded woodpecker has become frequently threatened by its own food supply during years of high southern pine beetle populations. Fortunately, southern pine beetle activity in east Texas has been negligible since 1994, giving the red-cockaded woodpecker a break at least until the next periodic southern pine beetle outbreak.

Effects of spruce budworm defoliation on wildfire potential in spotted owl habitat

Susan Hummel, USDA Forest Service, PNW Research Station Portland, OR (speaker)
James K. Agee, University of Washington, College of Forest Resources Seattle, WA

Forest structure and composition on the eastern slope of the Cascade Mountains have been influenced by decades of fire exclusion. In turn, these changes affect the population dynamics of western spruce budworm (budworm) (*Choristoneura occidentalis*) and habitat for the federally listed northern spotted owl (owl) (*Strix occidentalis caurina*). We asked how an ongoing budworm outbreak in this area has affected elements of owl habitat, how the changes might affect potential fire behavior and effects, and what the implications could be for future owl habitat. To answer our questions we made use of permanent plots established in 1992 on Smith Butte in the Gifford Pinchot National Forest (T7N, R11E). The stands in which the plots are located are uncommon for the grand fir (*Abies grandis*) zone at this elevation (1200 m), as they have not been commercially logged and, therefore, contain large diameter (>10cm) ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*) trees. The plots are near an owl nest site where budworm defoliation has occurred annually since 1994 (Willhite 1999). We re-measured all the plots in 2000. We used the data from 1992 and 2000 (early and late in the budworm outbreak, respectively) to characterize changes in owl habitat elements and to estimate potential changes in fire behavior and effects.

Between the two measurements, we found that canopy closure had significantly decreased, to an average of 43% in 2000. In contrast, the amount of coarse woody debris (fuels) doubled in the same period to about 80 metric tons per hectare. These fuels contributed to significant increases in potential surface fire flame lengths, but changes in torching potential and independent crown fire behavior were not significant. Our results indicate that fire behavior within such remnant, old forest stands, might not result in as much stand replacement fire severity as the fuel load suggests (Hummel and Agee, in review). The large, early-seral, fire-resistant trees likely to survive a wildfire are an important element of future owl habitat, but they must also survive post-fire stressors. Treatments to control budworm defoliation in these remnant stands may, therefore, not be necessary if the treatment objective is to reduce stand replacement fire severity within owl habitat in the grand fir zone east of the Cascade Mountains. However, if the amount of woody debris remaining or recruited after a wildfire jeopardizes the survival of any remaining large ponderosa pine or Douglas-fir trees, then treatments to reduce the debris or to control associated insect activity might be considered.

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Potential Exotic Insect Threats in the West and Status of Recent Introductions

Moderator: Tom Hofacker, FHP, WO

(Summary Not Received)

Douglas-fir Beetle Management

Moderator: Art Stock, BC Forest Service, Nelson, BC

This session was well attended and many topics came up in discussion. As with most bark beetles, the key to success for management of DFB is early detection and rapid mop up.

Baited Funnel Traps (BFT's).

BFT's offer a significant advantage in that while trap trees may fill up, funnel traps can catch beetles throughout the entire beetle flight period without saturating. Some issues concerning the use of BFT's are:

1. Spill over attack on standing healthy trees – funnel traps should be kept al least 30-100m from susceptible Douglas-fir; 50 m is the recommended distance in central BC. Traps placed in the open are successful at catching beetles. Experience from Salmon Arm, BC indicates that placing traps too close to Ponderosa pine will induce attack by western pine beetle. Could BFT's could be used in combination with the anti-aggregant MCH to reduce spillover? Would a combination of traps trees and unbaited funnel traps reduce spillover?
2. Resources **-** BFT's traps require substantial time and $ to set up and monitor. In central BC funnel traps are used only if trap trees (and harvesting) can't be used, in situations such as ski hills, riparian reserves, and recreational properties.
3. Bears knock down traps – perhaps one way to deal with this is to put up at least 2 baited traps close together, which (hopefully)leaves one trap to keep working.
4. There is some indication from an unreplicated uncontrolled trial in Invermere, BC, that a baited trap surrounded by unbaited funnel traps can reduce spillover attack in small openings, although there is no advantage in terms of total numbers of beetles caught. What is the optimum trap placement pattern for catching maximum numbers of beetles while reducing spillover?

Trap Trees

How many trap trees to use? Bob Hodgkinson noted his "rule of thumb" of 1 trap tree for 2 green attack trees.

Root Disease

Beetle killed trees become a source of *Armillaria* inoculum, but so do the cut stumps if a beetle infested stand is selectively logged. Wet and dry belts in BC and USA vary in responses to harvesting. Southern Idaho has more problems with *P. schweinitzii* than with *Armillaria*. There seems to be no current consensus on the direct interactions between root diseases and DFB.

Fire and DFB

In Salmon Arm District in BC a large trapping effort (750 funnel traps and 300 trap trees)was put in place to preclude a post-fire outbreak of DFB. It was noted that DFB attacked fire stressed trees regardless of the bole scorch height. Both Salmon Arm District and Cariboo Region in BC have used MCH to disperse populations and help in keeping post-fire outbreaks from developing. Fire and therefore scorch timing must be in sync with beetle flight, so that attack occurs before the phloem dries out. Leo Rankin commented that he had noticed a correlation between degree of fire scorch and mountain pine beetle attack in the Cariboo. A good system is needed for classifying the hazard of fire stressed trees.

Attacks on Debris and Stumps

Terry Shore found that trap tree stumps < 30 cm diameter will get attacked and produce 30 beetles in south-eastern BC. Debris management and low stumps are important aspect of a DFB management program.

Variation in some traits seems to be a feature of Douglas-fir beetle across it's range in the north-west US and British Columbia. This variation has important implications for classifying attacked trees in the field, and for employing management strategies and tactics. Some of these traits are listed in the following table.

Characteristic	**Regional differences?**
High risk trees	30 cm dbh in the East Kootenays of BC (a dry area), 60 – 70 cm dbh in the "interior wet belt" around Nelson, BC
Attacks on freshly cut stumps	Do occur in south-east BC, where a 30 cm stump can produce 30 beetles? Not a problem in central Idaho.
Distance of new attack centres from previous years attack centres	Unpredictable, 50 – 200 m away in south-east BC, seldom farther than 50 m away in central BC
Duration of attack cycle	Possibly 10 years in south-east BC and Idaho. Five years in central BC, population collapse due to epizootics?
Appearance of "pouch fungus" Polyporus volvatus at entrance holes.	Commonly occurs in the March following attack in the interior wet belt of south-east BC. Commonly occurs 1 or 2 years following attack in the dry east Kootenays.
Behavior of root diseases as pre-disposing agents for DFB attack on trees	*Armillaria* is more virulent in moister eco-systems?
Man flight period	Main flight occurs in second flight peak at elevations above 1000 m in south east BC?

Thanks to Marnie Duthie-Holt for keeping track of these wide ranging discussions.

POSTER SESSION

Analysis:

Evaluating a Critical Assumption of Behavioral Preference Tests: Does the Number of Choices Affect Results?

Erik V Nordheim, Statistics Department, Univ. Wisconsin - Madison
Nathan P Havill and Kenneth F Raffa, Entomology Department, Univ. Wisconsin - Madison

Choice tests comprise one of the most commonly used designs for studying host plant preferences, pheromones, and kairomones. Statistical analyses are based on the assumption the outcome is independent of the number of choices. We tested this assumption, and developed an approach for incorporating this effect into experimental design. We chose a test model that reduced other sources of variation to the fullest extent possible: one age class of a lab-cultured folivore, feeding on one leaf age of a clonal plant, treated with defined concentrations of an antifeedant. Feeding trials were conducted with L3 gypsy moths on Populus, treated with varying doses of isopimaric acid. This diterpene occurs in a favored host, Larix, but is concentrated in less preferred foliage (current-yr. shoots). No-choice assays established a strong dose-response relationship. We then varied the numbers of choices from among these doses. In two-way choice tests, N= 30 generated significant separations among all concentrations. The same conditions generated significant but inconsistent results when four concentrations were offered and failed to provide complete separation among five concentrations. Some factors associated with the number of choices that affected feeding included differing pairwise variabilities among choices, physical arrangement of choices, and total consumption per larva. One approach for addressing this problem is to consider it a question of Power computations. We used our data to develop methods for estimating sample sizes needed to compare a specified number of choices at a particular level of significance, needs for data transformation, and inclusion of covariates.

Bark Beetles and Wood Boring Insects:

Stain Fungi Associated with *Ips perturbatus* and Eruptive *Dendroctonus rufipennis* in Alaskan Spruce Forests

Barbara Illman[1], Kirsten Haberkern[2], Ken Raffa[2], Richard Werner[3]
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[3]USDA Forest Service (Retired), Corvallis, OR

The spruce beetle, *Dendroctonus rufipennis,* has caused almost total mortality to several million hectares of pure spruce stands throughout Alaska and western Canada during recent years. This research reports the first of a two–phase study: Characterizing the fungal associates of *D. rufipennis* and another problem species on the Chugach National Forest in Alaska, *Ips* *perturbatus*. Ongoing studies are quantifying sources of variation in these fungi, with particular emphasis on potential differences between eruptive and endemic populations. Study sites were located near Fairbanks and on the Kenai Peninsula. Beetles were collected from host trees and pheromone traps during 1999 and 2000. Fungi were isolated by rolling the insects on selected culture media or by placing dilutions of water and crushed insects on selected media. The major fungi associated with *D. rufipennis* were *Leptographium abietinum*, *Ophiostoma* species A, and *Pesotum* species F. The major fungi associated with *Ips perturbatus* were *Ophiostoma bicolor,* and *L. abietinum*. Preliminary evidence suggests differences in the composition of fungal associates of *D. rufipennis* with insect population phase. Two major fungi were isolated with the greatest frequency, *L. abietinum* and *O. bicolor.* Preliminary evidence suggests differences in the composition of fungal associates of *D. rufipennis* with insect population phase.

Southern Pine Beetle and Mexican Pine Beetle in Arizona

J.C. Moser, Bobbie Fitzgibbon, K. Klepzig

In 2000, an infestation of southern pine beetle, *Dendroctonus frontalis,* (SPB) was identified in the Chiricahua Mountains of southeastern Arizona. The infestation covered almost 12,000 acres with extensive tree mortality. Since SPB has been known to occur in Arizona without causing widespread tree mortality, studies were initiated to determine the factors that precipitated the infestation. In the process of destructively sampling infested Chihuahua pine, *Pinus leiophylla*, a sibling species of SPB, Mexican Pine Beetle, *Dendroctonus mexicanus*, (XPB) was collected and identified by the USDA Forest Service Southern Research Station. This was the first record of the species in the United States and the third notation of the two species cohabiting the same tree. Continued monitoring of the populations with pheromone trapping and destructive sampling of infested Chihuahua pine and Apache pine, *Pinus engelmannii* along with temperature records has shown that the biology of SPB in Arizona is very different than that recorded in the southeastern United States. The infestation has continued, however, the populations of XPB have increased while those of SPB have declined.

Sampling Range of Douglas-fir beetle, *Dendroctonus pseudotsugae*, Pheromone-baited Traps

Kevin J. Dodds, Darrell W. Ross, and G.E. Daterman

Douglas-fir beetle, *Dendroctonus pseudotsugae* (DFB), is an economically important bark beetle species occurring throughout western North America. Pheromone-baited traps have potential as a tool for Douglas-fir beetle management. The objective of this study was to determine the sampling range of Douglas-fir beetle pheromone-baited traps in the interior West.

Two mark-recapture studies were conducted to determine the sampling range of the pheromone-baited traps. Captured beetles were released from logs containing brood or release platforms at distances from 50 to 400 m from a pheromone-baited trap. The results of the experiments indicate that most beetles were captured from distances ≤ 200 m.

Douglas-fir Beetle Response to Artificial Creation of Coarse Woody Debris In the Oregon Coast Range

Darrell W. Ross, Oregon State University, Department of Forest Science, Corvallis, OR
Bruce Hostetler, USDA Forest Service, Westside Forest Insect and Disease Technical Center, Sandy, OR
John Johansen, USDA Forest Service, Siuslaw National Forest, Hebo, OR

In an effort to accelerate the development of late successional forest stand conditions in plantations on federal lands in western Oregon, managers are trying new silvicultural treatments. One of those treatments is deliberate felling and leaving of trees to create downed woody debris during thinning operations. This downed woody debris is needed to provide wildlife habitat, maintain soil productivity, and for other ecological values. Previously, these trees would have been removed for their timber values. In this study, we monitored the response of endemic Douglas-fir beetle populations to the artificial creation of coarse woody debris through felling and leaving of large diameter Douglas-fir trees.

The local Douglas-fir beetle population increased in response to the residual felled trees as measured by pheromone-baited trap catches. Douglas-fir beetle-caused tree mortality was significantly higher on plots with residual felled trees compared with unthinned plots, but the mortality was less than expected. Tree mortality would have been higher in the absence of nearby logging that occurred in spring of 2000 when beetles were emerging from the felled trees. Trees harvested in this logging operation inadvertently served as trap trees and removed large numbers of beetles from the area.

Resource managers must be careful when using the fell and leave approach to creating woody debris. The risk of beetle-caused tree mortality will depend upon the scale of the operation and other variables such as weather, silvicultural activities in adjacent stands, and natural disturbances.

Impacts of Western Balsam Bark Beetle on Forest Conditions of the Bighorn National Forest

Kurt Allen, Joel McMillin, Daniel Long

The impact of subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.) decline was quantified in 2000 near areas of blowdown that occurred in 1993 on the Bighorn National Forest. Transects and pairs of infested and non-infested plots were installed to detect changes in forest stand and forest understory conditions. Data from these plots also were used to determine associations between stand conditions and western balsam bark beetle-caused fir mortality. Based on the paired plots, western balsam bark beetle (*Dryocoetes confusus* Swaine) impact was greater in areas comprised of large diameter fir trees growing in dense, fir-dominated stands. Beetle-caused mortality resulted in significant decreases in subalpine fir basal area, trees per acre, stand density index, average stand diameter, and the percentage of subalpine fir stems in the overstory. Small, but significant increases were detected in the understory; herbaceous plant abundance increased in the infested plots compared with the non-infested plots. Root disease (*Armillaria*, *Heterobasidion* species) was suspected, but not yet confirmed, to be present in less than 10 percent of the plots. This suggests that the western balsam bark beetle is acting as the primary mortality agent in the Bighorn National Forest. Significant relationships were determined between the amount of fir mortality and the percentage of subalpine fir trees in a stand, subalpine fir basal area, and subalpine fir stand density index. Tallies of beetle-killed fir in transects averaged more than 70 trees killed per acre over the last several years. A significant linear relationship was found between the percentage of fir logs in the blowdown and the amount of logs used by western balsam bark beetle. Western balsam bark beetle had utilized more than 30 percent of the subalpine fir logs in areas of blowdown. This provides evidence that beetles were using the blowdown and may have triggered increased beetle populations that, in turn, resulted in high levels of fir mortality in neighboring stands. Western balsam bark beetle is significantly impacting the overstory and understory of spruce-fir forests on the Bighorn National Forest. Blowdown events in the mid-1990's in combination with a high percentage of fir component has provided ideal conditions for continued beetle expansion. Forests in other regions with similar stand conditions found in this study can expect to experience comparable impacts.

Roundheaded Pine Beetle, *Dendroctonus adjunctus*, and fuel loads in the Sacramento Mountains, New Mexico

J. Negron and J. Popp

The roundheaded pine beetle (RPB), *Dendroctonus adjunctus*, is one of the most important bark beetles associated with ponderosa pine, *Pinus ponderosa*, in the Southwest. Outbreaks of this insect have caused extensive mortality in the Lincoln National Forest, NM in the 1970's and in the 1990's. During the mid-1990's a network of plots was established in infested and uninfested stands to develop models to estimate the probability of infestation by the RPB. During re-measurement of these plots during the summer of 2001, we quantified fuel loads associated with tree mortality caused by the RPB. We observed no differences in cwd in the 0 – ¼ in or the ¼ to 1.0 in size classes between the infested and the uninfested stands. We observed significantly higher cwd debris levels in the 1.0 to 3.0 in, the > 3.0 in sound and rotten size classes, and in total cwd in the infested stands. We used BehavePlus (USDA Forest Service) to simulate spread and flame length using default values for the timber with litter and understory fuel model but adjusting the 1-, 10-, and 100-hour fuels to the levels we observed. We obtained increases in flame length and rate of spread with corresponding increases in 100-hr fuels. The largest increases in fuel loads are associated with cwd > 3.0 in. These increases will likely result in increased fire severity. These findings suggest that bark beetle outbreaks can cause significant increases in fuel loads, influence fire behavior, and perhaps increase the severity of the fires.

Visual and Semiochemical Deterrence of Host Seeking Forest Coleoptera

Stuart A. Campbell and John H. Borden

Many coniferophagous beetles use volatile semiochemicals from bark and foliage to avoid non-host angiosperm trees. However non-host angiosperms often differ in visual appearance from host conifers. For example, trembling aspen, *Populus tremuloides*, has white bark, and is strikingly different from dark conifers. We hypothesised that beetles utilise both vision and olfaction in avoiding these non-hosts. Both the mountain pine beetle, *Dendroctonus ponderosae*, and the Douglas-fir beetle, *D. pseudotsugae* (Coleoptera: Scolytidae), avoided white, attractant baited multiple-funnel traps compared to black, baited traps, and there was an additive/redundant effect of combining chemical and visual non-host angiosperm stimuli. The ambrosia beetles, *Trypodendron lineatum*, *Gnathotrichus sulcatus*, and *G. retusus* (Coleoptera: Scolytidae) were not deterred from landing on white, baited traps, although non-host semiochemical deterrence was demonstrated. The woodboring beetles, *Monochamus scutellatus*, *M. clamator* and *Xylotrechus longitarsus* (Coleoptera: Cerambycidae) avoided white, attractant-baited traps. Tree-killing bark beetles would benefit from visual avoidance of angiosperms, as chemical cues are often spatially inconsistent. Conversely, ambrosia beetles almost always infest material on the forest floor, where the lack of reliable colour information and distinct silhouettes may have selected in part against in-flight visual host discrimination. Cerambycids also utilize downed host material, but respond to relatively few chemical cues and may therefore rely more on vision than ambrosia beetles.

Effect of Trap Design on Capture of Large Cerambycidae and Curculionidae in Florida

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Four experiments were conducted in the spring and fall of 2000 and 2001 in stands of mature longleaf and slash pine in the Osceola National Forest in northern Florida. In each experiment, traps were baited with devices releasing ethanol and (-)-α-pinene at high rates of 1-3 g/day. Traps were grouped into 8-10 replicates of 4 treatments per replicate. Trap catches were collected at 2-3 week intervals, with propylene glycol or dichlorvos strip replaced on each occasion. Tests of various designs (pipe, delta, vane) with both hard and soft plastics, against the PheroTech multiple-funnel trap demonstrated that design had little influence on catches of Cerambycidae (*Arhopalus rusticus*, *Monochamus titillator*, *Xylotrechus sagittatus* and *Acanthocinus nodosus*) and Curculionidae (*Pachylobius picivorus* and *Hylobius pales*). Similarly, trap and funnel width had little influence on catches of *A. rusticus*, *X. sagitattus* and *A. nodosus*. Traps with collection cups containing glycol (RV antifreeze) outperformed those with cups containing dichlorvos (VaporTape) for all species.

More Effects of Trap Design on Capture of Large Cerambycidae and Curculionidae in Florida

D. Miller, C. Crowe, D. Johnson, R. Brantley
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Three experiments were conducted in the fall of 2000 and spring of 2001 in stands of mature longleaf and slash pine in the Osceola National Forest in northern Florida. In each experiment, traps were baited with devices releasing ethanol and (-)-α-pinene at high rates of 1-3 g/day. Traps were grouped into 8-12 replicates of 4 treatments per replicate. Trap catches were collected at 2-3 week intervals, with propylene glycol replaced on each occasion. Tests of various designs (pipe, delta, vane) with both hard and soft plastics, against the PheroTech multiple-funnel trap and the IPM Technologies Intercept trap demonstrated that design shape had little effect on the capture of the cerambycids, *Arhopalus rusticus* and *Xylotrechus sagittatus*, and the reproduction weevil, *Hylobius pales*. However funnel traps and pipe traps that were twice the size of regular-sized traps caught significantly more *A. rusticus* and *X. sagittatus* but significantly fewer *H. pales*.

An Improved Trap for Large Wood Boring Insects (Cerambycidae, Buprestidae, Siricidae)

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Commercially available multiple funnel traps have three potential weaknesses for trapping large wood-boring insects: 1) escape by captured insects from the dry collecting cup, 2) low catches of insects that fall outside the trap, and 3) poor visual orientation to the narrow funnel column. To test the importance of these weaknesses, we compared conventional multiple funnel traps to multiple funnel traps with water-filled collecting cups or large bottom funnels, and crossvane traps with a prominent silhouette. The experiment was conducted in a mill yard in the southern interior of British Columbia between July 5-October 2, 2000. Differences in catch among different trap types indicated that two of the three potential weaknesses were important limitations for the capture of most target species. Crossvane traps captured significantly greater numbers of most Cerambycidae and Siricidae, and similar numbers of most Buprestidae, compared to the other traps. Of the two most abundant species, *Xylotrechus longitarsus* Casey was captured in consistently greater numbers in crossvane than in other traps., but *Monochamus scutellatus* (Say) showed little discrimination early in the flight season and much higher captures in crossvane traps late in the season. The change in behavior of *M. scutellatus* may be related to a transition from maturation feeding to searching for oviposition sites.

InterceptJ Panel Trap, a Novel Trap for Monitoring Forest Coleoptera and Hymenoptera

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A novel trap, the InterceptJ Panel Trap (InterceptJ PTBB), was developed and field tested for monitoring forest Coleoptera. The trap is made from corrugated plastic. It is light-weight, water proof, and durable. Field experiments measured capture of several forest Coleoptera in comparison to the Phero-Tech 12-unit Multi-Funnel Trap. Target species: spruce beetle, *Dendroctonus rufipennis,* Douglas-fir beetle, *D. pseudotsugae,* western balsam bark beetle, *Dryocetes confusus,* pine bark beetles, larger pine shoot beetle, *Tomicus piniperda,* pine sawyers, *Monochamus spp.*, Asian longhorn beetle, *Anaplophora glabripennis,* buprestid beetles, wood wasps, and several other exotic forest pests. For most bark beetle species, the InterceptJ PTBB captured equivalent or higher numbers, except for spruce beetle and larger pine shoot beetle when compared to the multi-funnel trap. InterceptJ PTBB captured a substantial numbers of Cerambycid and Buprestid beetles, and Siricid wood wasps. In comparative tests in Oregon, the InterceptJ PTBB captured substantially more exotic forest pest species of greater diversity than the multi-funnel trap.

InterceptJ Panel Trap Modified For Monitoring Forest Cerambycidae

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The InterceptJ Panel Trap (InterceptJ PTBB), was modified and field tested for enhanced monitoring of forest Coleoptera, and especially for family Cerambycidae. The trap is made from corrugated plastic. It is light-weight, water proof, and durable. Field experiments measured capture of forest Cerambycidae in five different prototypes of InterceptJ PTBB and in Phero-Tech 12-unit Multi-Funnel Trap. Captures of longhorn beetles were significantly higher in two modifications of the new prototype of the InterceptJ PTBB than in the old version of the trap or the Funnel trap. The best performance of the InterceptJ PTBB for monitoring longhorn beetles was achieved by using: 1) trap with 5 cm hole in the collecting funnel, 2) “wet-cup” option of collection cup, and 3) increased slipperiness of the trap surfaces.

Biodiversity:

Habitat Availability Thresholds of Boreal Carabid Communities in Response to Six Intensities of Forest Harvest at the EMEND Experiment

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Anthropogenic disturbances such as harvesting are dominant features of present-day forest ecosystems. Understanding the relative impact of harvesting on native biodiversity is essential for sustainable management of forests. At the EMEND experiment site in Western Alberta, we have experimentally manipulated the amount of standing trees in four boreal forest stand-types to emulate differing intensities of forest harvesting and determine thresholds of habitat availability required by native arthropods. One-hundred forest compartments (approximately 10 ha or greater) were harvested in 1998 and 1999, leaving 100%, 75%, 50%, 20%, 10% and 2% (standard clearcut) standing residual in the stand. Carabid beetles were sampled pre-treatment in 1998, one-year post harvest in 1999 and again in 2000 following any pre-treatment recruitment effects. Overall 45,000 from 31 species were collected. Significant changes in carabid composition were apparent between all four cover classes in each year. Once spatial effects were removed, harvesting by cover interactions were apparent one and two-years post harvest. These interactions became more pronounced in 2000 after any potential pre-treatment recruitment. Effects of harvesting were most apparent in stands dominated by either deciduous or coniferous overstories and less apparent in stands of mixed compositions.
Retention levels of less than 50% had significant effects on overall carabid community composition in non-mixed stands. These effects are largely due to the response of species such as *Platynus decentis* and *Calathus advena* that show affinity for deciduous and coniferous dominated stands respectively.

Diversity of Saproxylic Beetles along a Succesional Gradient

Joshua Jacobs & John Spence
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Following disturbance the boreal forest undergoes a predictable change in tree composition. This succession typically begins with fast growing deciduous trees and gradually becomes a conifer-dominated forest. Natural disturbance is an integral part of the boreal forest; it is responsible for allowing the forest to revert to an earlier successional stage, creating a mosaic of forest types on the landscape. Saproxylic beetles, are dependant on dead and dying trees, and play important roles in forest food webs, decomposition and nutrient cycling. Studies in Europe have demonstrated that forest harvest has resulted in a biologically significant drop in saproxylic insects. Few studies have been done on saproxylic insects in North America, and in order to fully understand the effect of harvest and wildfire on saproxylic beetles we must first investigate assemblages in undisturbed stands. Using flight intercept traps, I collected saproxylic insects in four forest types, representing four stages along this post disturbance successional gradient;

deciduous dominated, deciduous dominated with a conifer under story, mixedwood, conifer dominated. It is expected that the deciduous dominated and the conifer dominated forests will have unique assemblages of saproxylic beetles, due to the close association the beetles have to the trees, and the mixedwood forest will have the greatest amount of diversity, as it represents the greatest diversity of habitats.

Coneworms and Cone Beetles:

The Taxonomy and Identification of Coneworms (Pyralidae: Dioryctria) in Western North America, Preliminary results from a seed orchard in Northern California.

A. Roe, N. Rappaport, J. Stein, G. Grant, and F. Sperling

Roughly thirty species of coneworm (Pyralidae: Diorcytria) are found throughout North America and the majority of these species are important pests of conifer trees. Dioryctria attack all species of conifer trees and the damage they cause ranges from irregular growth and loss of branches to significant losses in seeds. These species also display a wide range of morphological variation making identification, and ultimately control, difficult. A preliminary study is being conducted at a seed orchard in Chico, California where heavy infestation levels have resulted in significant reductions in seed cone production. This study aims to elucidate the taxonomy of Dioryctria species in the region and develop accurate identification methods. Adult specimens have been collected since 1995 from pheromone traps, rearings, and light traps. A 475 bp fragment of mitochondrial DNA in the COI gene is compared across 110 specimens and from this sample 26 haplotypes from four different genetic lineages are identified. Molecular differences are compared to morphological, host and pheromone differences and are used to tentatively link each lineage to one of four species groups previously recorded in the region (Abietella, Zimmermani, Aurenticella or Bamhoferi species group). Further examination of individuals reared from cones suggests that only haplotypes linked with the Abietella species group are responsible for causing the majority of damage in the orchard. By using molecular methods to clarify the taxonomy of Dioryctria, it is hoped that this can help to increase the accuracy of pheromones used in monitoring and to possibly implement mating disruptions to control this forest pest.

Enantiomeric Composition of Pinenes Affect Response of White Pine Cone Beetle

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Five experiments were conducted in the springs of 1999 and 2000 in three eastern white pine seed orchards at the USDA Forest Service Beech Creek Seed Orchard near Murphy NC. In each experiment, Japanese beetle traps were baited with (±)-pityol and appropriate monoterpene lures, and placed in the crowns of seed trees, adjacent to cones. Traps were grouped into seven or ten replicates with six or four treatments per replicate. Lures consisted of (±)-pityol (40 mg) in a polyethylene bubblecap (PheroTech Inc) and pinenes in closed low-density polyethylene centrifuge tubes (250 & 400 µL) or bottles (8 and 15 mL). The release rate of pityol was about 0.2 mg/d @ 24° whereas the rates for the pinenes ranged from 5 to 579 mg/d @ 24°. All chemical purities were > 98%. Optical purities of (-)- and (+)-α -pinene, and (-)-β-pinene were > 98%. (+)-β-Pinene was not tested due to lack of availability. Beetles were collected in 500-mL plastic Mason jars, filled with 200 mL of plumber's antifreeze (pink propylene glycol solution) as a killing and preservation agent. Trap catches were collected at 2- to 3- week. We found that (-)-α-pinene significantly increased catches of male cone beetles to pityol-baited traps in a dose dependent fashion. Attraction of cone beetles to the combination of pityol and (-)-α-pinene was interrupted by the antipode, (+)-α-pinene, as well as (-)-β-pinene.

Defoliators:

Douglas-fir Tussock Moth Early Warning System Database

Kathy Sheehan

A network of Douglas-fir tussock moth pheromone traps is in place throughout the western US. These traps are monitored annually with the expectation that the number of moths caught in the traps will increase for several years prior to the onset of visible defoliation, thus giving land managers an early warning.

Download a copy of the **DFTM Early Warning System database** (a 803 KB WinZip file) -- a 3.4 MB Access2000 file that was last updated on April 10, 2002. A summary table of data for Oregon and Washington from 1993-2001 is now available as a 16page, 187K PDF file. This summary includes all 2001 data -- but high catch traps have not yet been verified -- and was last updated on **December 12, 2001**. Contact Kathy Sheehan (503-808-2674) for additional information.

Graphic displays of 1979-2001 data are available for the following National Forests and Reservations in Oregon and Washington. Data for 2001 does not include state of Washington plots, and federal plots with high trap catches have not yet been verified. The display for a given Forest or Reservation includes data collected both on and nearby that Forest or Reservation.

Colville Indian Reservation	**Malheur National Forest**	**Umatilla National Forest**
Colville National Forest	**Mount Hood National Forest**	**Wallowa-Whitman National Forest**
Deschutes National Forest	**Ochoco National Forest**	**Winema National Forest**
Fremont National Forest	**Okanogan & Wenatchee National Forests**	**Yakama Indian Reservation**

Contact Kathy Sheehan (503-808-2674; email: ksheehan@fs.fed.us) or Iral Ragenovich (503-808-2915; email: iragenovich@fs.fed.us) for more information.

http://www.fs.fed.us/r6/nr/fid/data.shtml#dftm,

Exposure and Spruce Aphid Defoliation of Sitka Spruce

Nellie Olsen and Mark Shultz

Spruce aphid (*Elatobium abietinum* Walker) is an introduced defoliator of Sitka spruce in southeast Alaska, Kodiak Is. Alaska, as well as British Columbia, Canada, Washington state, Oregon, and Arizona. Historical accounts from Alaska have reported that spruce aphid outbreaks are intermittent, of short duration, and mainly occur on spruce growing on beach fringe areas. Since 1998, the intensity and possibly the duration of outbreaks have changed. Recent outbreaks are occurring well inland from the beach fringe and many trees are being killed by successive years of defoliation. The latest outbreak in the Juneau area was the most intense outbreak ever recorded. In 2000, 482 trees on 11 sites were rated for defoliation. It was determined that trees on southeast, south, and southwest aspects had significantly more defoliation than trees on north, northeast, and east aspects. Average defoliation for all sites did not exceed 40 percent. These results will provide property owners some information about what trees to treat. Acephate treatment of severly defoliated trees is being recommended by Cooperative Extension in combination with fertilization. Sitka spruce can form epicormic branches on tree limbs that are completely defoliated so treatment of even severely defoliated trees is a good option. As long as there is uptake of the chemical, trees can be protected from further defoliation. Feeding on sap, needles or seeds of treated trees has not shown any effect to wildlife. Two dead sapsuckers collected by the U.S. Fish and Wildlife Service did not have detectable levels of acephate or its more toxic byproduct. Further work will be done to assess levels of pesticide within various plant tissues.

Exotics:

Impact of Introduced Basswood Thrips on Forest Health in the Great Lakes Region: Relationships with Predators and Host Plants

Shalah M. Werner and Kenneth F. Raffa

Introduced basswood thrips, *Thrips calcaratus*, is associated with damage to American basswood, *Tilia americana*, an important component of northern hardwood forests. This insect does not damage linden (*Tilia cordata*) in its native European habitat. Objectives are: 1) Assess relative populations of thrips and other herbivorous insects associated with basswood, 2) Evaluate basswood health; 3) Determine the basis for differential damage by *T. calcaratus* in its native vs. introduced range. Crown condition, insect populations and site factors were monitored in 22 sites in Michigan, Wisconsin, and Minnesota. Branch dieback increased from 7-17% and foliage transparency (a defoliation index) increased from 22-33% during 1998-2000. *Thrips calcaratus* accounted for over 99% of foliar insect abundance. *Thrips calcaratus* feeds on opening buds, whereas the native basswood thrips, *Neohydatothrips tilae* , occurs later and feeds on leaves. In conjunction with collaborators, we monitored *Thrips* and *Tilia* phenology throughout Europe and North America. Differential damage by *T. calcaratus* could not be related to either phenological differences, or differences in host preference between European and North American *Tilia*. Differential damage may relate to differences in synchrony of native vs. introduced thrips with predators. Occurrence of the native basswood thrips coincides with the native predator, *Leptothrips mali*. In contrast, both introduced thrips species, *T. calcaratus* and the pear thrips, *Taeniothrips inconsequens*, emerge, feed as adults, and oviposit before native predators are present in high abundance. Understanding these relationships may contribute to general principles of invasion ecology and provide suggestions for management.

Red Gum Lerp Psyllid Biological Control in California

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The red gum lerp psyllid, *Glycaspis brimblecombei* (Homoptera: Psylloidea) has recently been discovered on *Eucalyptus camaldulensis* (red gum) in California in 1998. Since that time it has spread throughout many counties in the state. These psyllids form a lerp, which is a secretionary structure produced by the nymphs from honeydew as a protective cover. Some of the *Eucalyptus* species have been heavily attacked, which has resulted in considerable leaf drop. This may stress the trees and make them susceptible to other problems, and in some cases result in tree mortality. We have monitored 30 sites throughout the state to implement a biological control program against *G. brimblecombei* via natural enemies to reduce its damage. After intensive searching and host specificity testing, *Psyllaephagus bliteus* (Hymenoptera: *Encyrtidae*) is currently being reared against *G. brimblecombei* at the U.C insectary as well as at the CDFA insectary in Sacramento. 15,300 parasitoids were reared and released at 36 locations from spring 2000 to fall 2001. The first recovered parasitoids were 15 km from the nearest release point in one site (Redwood City) in late August 2000. By summer/fall 2001 recoveries had become common in 9 California coastal counties at a total of 21 sites. However no recoveries have yet been made in California's central valley, which has high psyllid infestations. We are currently conducting further studies to determine if temperature or other factors (e.g., endemic natural enemies) are affecting establishment of the parasitoid in the central valley or other inland areas.

Fire:

The Role of Wildland Fire and Subsequent Insect Attack on Ponderosa Pine Mortality

Joel McMillin,[1] Linda Wadleigh,[2] Carolyn Hull Sieg,[3] Jose Negrón,[3] Ken Gibson,[4] Kurt Allen,[5] and John Anhold.[1]

USDA Forest Service, [1]Region 3 Forest Health Protection, [2]Region 3 Fire Management, [3]Rocky Mountain Research Station, [4]Region 1 Forest Health Protection, [5]Region 2 Forest Health Management.

The unprecedented fire year of 2000 provided an opportunity to quantify cumulative impacts of wildland fires and subsequent insect attack on ponderosa pine mortality over a large region. In 2001 we established plots in 4 National Forests: Black Hills in South Dakota, Custer in Montana, Arapaho-Roosevelt in Colorado and Coconino in Arizona. In each area, we sampled 1500+ trees in burned areas and 500 trees in unburned areas. For each tree, we measured height, dbh, pre-fire live crown ratio, percent crown scorch, percent crown consumption, percent scorched basal circumference, scorch height on the bole, and insect presence. In addition, we collected 4 phloem samples from each of 200+ additional trees in each area to quantify the relationship between exterior signs of fire-caused damage and cambium damage. Tree mortality will be monitored for at least 3 years post burn. Our goal is to provide land managers with quantitatively based guidelines for assessing potential tree mortality following wildland burns.

Entomological Research on the Fire and Fire Surrogate Treatments in Arizona and New Mexico, Preliminary Results and Perspective

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Because of the increasing concern for unhealthy forests and catastrophic wildfire in western forests, substantial mechanical thinning and prescribed burn have been implemented to enhance forest health and reduce fuels. However, potential impacts of such practices on forest ecosystems have not been fully evaluated. Fire /Fire Surrogate (FFS) project (http://www.ffs.psw.fs.fed.us) is a multiple institution and interdisciplinary long-term study with the purpose of developing a standard experimental design and protocol for a national study of the consequences of fire and fire surrogate treatments. As part of the national network on FFS project, our research is primarily focused on bark beetles (Coleoptera: Scolytidae) and ground beetles (Coleoptera: Carabidae) in ponderosa pine forests of Arizona and New Mexico. We hypothesize that fuel treatments will reduce the risk of bark beetle attacks, and that the assemblage of ground beetles will be an effective ecological indicator of treatments. Pretreatment survey in Arizona and New Mexico (three sites each) showed that all sites were characterized by high stand density composed of large number of small trees and few large trees but a low population of bark beetles (< 5% of trees were attacked). Most attacks occurred in trees less than 25 cm in diameter at breast height (DBH). *Dendroctonus valens* was responsible to approximately 75% of all infested trees, whereas the other 4 major bark beetles (*D. frontalis, D. brevicomis, D. adjunctus, and D. approximatus*) and their complexes attacked 25% of trees. Sampling for ground beetles will begin in summer 2002.

Key Words: Fire and Fire Surrogate, Bark Beetles, Ground Beetles, Ponderosa pine, Ecological Indicators

Effects of fire behavior on insect-plant dynamics: Carabidae (Coleoptera) in jack pine lichen woodland.

Colin Bergeron, University of Alberta, Edmonton, AB, Canada

Heterogeneous forest conditions induced by wildfire influence vegetation and insects for an extensive time period after burns. Complex wildfire-atmospheric interactions during the spread of a 1941 stand-replacing wildfire created a pattern of stem density by differentially damaging the canopy seed bank between areas of contrasting crown fire severity on the study site. This study examines the fire effects on ground-beetles (Carabidae) and vegetation communities in 60 year-old jack pine lichen woodland in northern Québec. This mid post-fire successional stage is characterized by jack pine lichen woodland with a dominance of *Cladina mitis* in the lichen mat and five main species of ground-beetles (*Carabus taedatus agassii* (Lec.), *Calathus ingratus* (Dej.), *Notiophilus semistriatus* (Say.), *Pterosticus brevicornis* (Kby.), *Miscodera arctica* (Payk)). This association is typical of northern boreal forest upland sites. Catches of *N.semistriatus* are significantly highest ($p=0.042$) in low severity crown fire areas but the opposite is true for *C.taedatus* ($p=0.035$) and *P.brevicornis* ($p=0.023$). Similarly, density of jack pine is highest ($p<0.001$) and percent cover of *C.mitis* is greatest ($p<0.001$) in the high severity crown fire area. In the high severity crown fire area, many seeds are burnt in the canopy seed bank and the regeneration is sparser than in the low severity crown fire area. Therefore, microclimatic conditions are variable between areas of different crown fire intensities and the influence of this variation on plant and insect communities is apparent for at least 60 years after fire.

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Resources, Web Based Tools, Remote Sensing, and Models:

Field Guide to the Bark Beetles of Idaho and Adjacent Regions

Malcom M. Furniss and James B. Johnson

A practical guide for forest owners and managers, entomologists, and anyone curious about the natural world. The first field guide to the bark beetles of Idaho includes many recent records of species found there by the authors. Simplified keys to beetle identification make primary use of host trees and gallery patterns to identify beetles to genus and species. Detailed information on each species includes distribution by county, host trees, gallery pattern, and a description of the adult beetle.

To order contact Ag Publications, University of Idaho P.O. Box 442240, Moscow, ID 83844-2240 USA Phone (208) 885-7982, Fax (208) 885-4648

The Bugwood Network (www.bugwood.org)

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Bugwood is a network of closely related web sites focused in the areas of agriculture, forestry, entomology, integrated pest management, invasive species and promoting the use of information technologies in these areas. It is a joint project between the University of Georgia College of Agricultural and Environmental Sciences and Warnell School of Forest Resources with support from the USDA Forest Service and USDA Animal and Plant Health Inspection Service. The Bugwood web site began in 1996 to help promote the Photo CD image products and to host Work Group publications. Over the next few years, the Work Group began to develop custom content for the site and repurpose existing materials. Bugwood also hosts the Southern Forest Insect Work Conference site for its yearly conference and has since expanded to host web sites for the Southeast Exotic Pest Plant Council, the Georgia Exotic Pest Plant Council and the Georgia Entomological Society. Specific sites have been developed to host individual subject areas as well as work in East Africa and the South Pacific. The philosophy of the Network is the integration of various disciplines and technologies toward a common goal.

Bark Beetles of North America: Forest Insects and their Damage CD-ROM Set Volumes III and IV (www.barkbeetles.org)

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Introduction: Bark beetles are important insects in the forests and forested environments across the US and North America. Identification of bark beetles and their damage are important prerequisites for proper implementation of Forest Health and Integrated Pest Management (IPM) in forested systems. There has been much effort to develop bark beetle information and materials by federal, regional, state and private foresters, forest entomologists and forest health practitioners. However, it is often difficult to locate a comprehensive set of information about bark beetles, particularly with appropriate and correctly identified quality photographs. Access to quality photographs of many of these organisms contained in individual or organizational slide collections would be a valuable teaching resource to educators as they develop IPM materials.

Objectives: The objectives of this project are to provide an accessible and easily used archive of: selected literature and publications produced by The USDA Forest Service on bark beetles of North America, and high quality digital-format images that can be used by educators, practitioners and the general public for educational applications.

The two CD set can be ordered from www.barkbeetles.org and is priced at $25.

Forestry Images: The Source for Forest Health and Silviculture Images
www.forestryimages.org

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National Forests in North Carolina, Nantahala National Forest- Wayah Ranger District Southern Pine Beetle Detection Flight, Airborne Video Mosaic, December 3-5, 2001

R. Spriggs and E. Coffman

Integrating Modeling and GIS Tools for Landscape Analysis, Applications in an Analysis of Mountain Pine Beetle Conditions in the Red River Watershed, Idaho

E. Smith, C. Randall, D. McMahan

Recent advances in computing technology has given rise to a multitude of modeling and geographic information system (GIS) tools. We demonstrate how different tools can be synthesized and applied to a watershed (landscape-scale) analysis. For a working example, we performed various analyses on one compartment from the Red River watershed, Red River Ranger District, Nez Perce National Forest, Idaho. Two computing tools are used. The first is the Forest Vegetation Simulator (FVS), a distance-independent individual tree growth model. The second tool is ArcView GIS. Within FVS, we used: (1) base model growth and mortality routines; (2) the Event Monitor, to calculate various published bark beetle hazard rating systems; and (3) the Westwide Pine Beetle (WWPB) Model extension (in conjunction with the Parallel Processing Extension) to simulate the landscape-level effects of the mountain pine beetle. With ArcView®, we used three customized ArcView® projects—FVS-EMAP, and two WWPB Model Mapping Tools—all of which help users spatially portray FVS output. Complex, landscape-scale questions can be meaningfully addressed by conducting analyses at this scale. The synthesis of the presented tools demonstrates how advanced technologies can help forest managers address their ecosystem management objectives.

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Shoot Borers:

Attract and Kill Technology for Management of Western Pine Shoot Borer, *Eucosma sonomana*.

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An attract and kill bait, Last Call EucosmAK, was deployed for management of western pine shoot borer (WPSB), *Eucosma sonomana* in ponderosa pine plantations and seed orchards. WPSB causes substantial economic losses in ponderosa, lodgepole, and Jeffrey pine in the Western United States. A&K technology selectively removes male WPSB moths from the ecosystem with negligible impact on non-target organisms. Baits combine the selectivity of pheromone (only 0.21 g/ha, compared to 3.5-20 g/ha for mating disruption) with an insecticide (only 7.92 g/ha, compared to 500-800 g/ha for conventional sprays). The EucosmAK contains the insecticide and pheromone within a hydrophobic matrix that precludes ecosystem contamination.

Commercial Displays:

IPM Technologies

The business of IPM Tech is environmentally responsible and secure management of insects for a safer, healthier, better fed, more economically productive world. IPM Tech has evolved into a manufacturing, sales and marketing company by leveraging seven years of innovative research and development. We are a leader in development and innovation of new pheromone products.

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888-IPM-TRAP (476-8727)
Portland, Oregon
www.ipmtech.com

Positive Systems, Aerial Photography and GIS Imagery Applications

We are an aerial photography company located in Whitefish, Mt. providing aerial photography services and software to help prepare imagery for GIS. We have completed a sample project to demonstrate how imagery can be used for forest fire management and harvest decisions. We took aerial photography taken after last year's Moose Fire on the Flathead National Forest, ran it through our DIME Software to prepare it for GIS (mosaic, georeference and color balance the images). Our clients are using our product as a backdrop for their GIS and as s a source of tree health information.

We are interested in assisting other clients with similar projects or with any of their aerial photography/ GIS needs. Feel free to contact us at:

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CONCURRENT WORKSHOP SESSION 3

Spruce Beetle Ecology and Management

Moderators: Barbara Bentz and Matt Hansen

Spruce Beetle Suppression in Utah

A. Steve Munson, USFS-FHP, Ogden

Various strategies have been used throughout Utah to suppress building populations of spruce beetle, *Dendroctonus rufipennis*. There are a variety of factors that influence treatment success including susceptibility of the landscape, size of the infestation, distribution of susceptible hosts on the landscape, patterns of ownership, resource management objectives, treatment alternatives available and timing associated with treatment application. Successful treatments are generally related to early intervention tactics that address all or most of the infested area. The most successful of these tactics include sanitation/salvage harvests in combination with trap tree treatments. Although there are other treatment tactics available that will reduce bark beetle populations (baited funnel traps, lethal trap trees, burning and peeling infested trees) they are usually used in conjunction with the treatment tactics listed above to successfully suppress populations. However, developing a long-term strategy to address spruce beetle effects is the most practical approach to reduce catastrophic losses and maintain a variety of site or landscape resource objectives. Vegetation treatments that address susceptible stands or landscapes which reduce site susceptibility to spruce beetle, are really the most effective means to sustain most short- and long-term resource objectives.

History and Future of MCH Use Against Spruce Beetle

Richard Werner, USFS-PNW

MCH (3-methyl-2-cyclohexen-1-one), an antiaggregation pheromone produced by bark beetles of the genus *Dendroctonus,* has been field-tested since the early 1970's for its ability to prevent the build-up of Douglas-fir beetle and spruce beetle populations when their host breeding material becomes available naturally or by human-caused stand disturbance. MCH has recently been registered by EPA for use in reducing populations of Douglas-fir beetle. Results of studies with MCH and spruce beetles have been inconsistent and inconclusive. Suggested factors contributing to these mixed results include micro-environmental influences and problems with release devices that dispensed the MCH. Questions remain as to the significance of MCH as a preventative for spruce beetle population growth. A possible new approach would be the use of micro encapsulated MCH applied in a liquid formulation using some type of spraying equipment.

Understanding and Forecasting Increased Risk from Univoltine Broods

Matt Hansen and Barbara Bentz, USFS-RMRS, Logan

In a laboratory experiment, no fecundity differences were detected among field-collected univoltine, semivoltine, and re-emerged parent spruce beetles, although re-emerged parents were less successful in establishing brood galleries. Because population growth is a function of net replacement rate and time, this result suggests that univoltine broods will result in exponential population growth relative to the semivoltine cycle. In turn, rapidly expanding populations can increase the probability of an outbreak or, in an existing outbreak, increase the rate of spruce mortality. Temperature-based models have been developed to predict the univoltine proportion of local brood and the timing of peak emergence flight. These models can be driven with remotely sensed climate data and the output can be linked with digital elevation models to produce landscape scale predictions of univoltine brood proportions. Preliminary validation data suggest that model predictions are accurate within 10-20% of corresponding field samples. Model output can be used to map outbreak risk and to indicate priority areas for suppression, especially if coupled with aerial detection surveys and stand hazard ratings in GIS. On the Dixie National Forest, Utah, retrospective model predictions compared with aerially detected spruce mortality suggests a link between the proportion of univoltine beetles and the number of stems killed per year.

Linking individual host selection behavior and population dynamics

Kimberly Wallin, USFS-RMRS, Logan and Ken Raffa, Univ. of Wisconsin

We examined the role of population density on host selection behavior of *Dendroctonus rufipennis*. We conducted field and laboratory experiments using bark beetles collected from 29 non-outbreak and outbreak populations in Alaska and Utah, USA, and Yukon, Canada. Beetles from both of these population phases colonized trees that were felled to remove host defenses; only beetles from the outbreak population phase colonized standing vigorous trees. A series of laboratory assays in which phloem-based media were amended with three concentrations of alpha-pinene identified several factors that may cause density-dependent responses to hosts. First, beetles were repelled by concentrations of alpha-pinene that were similar to induced tissue. But intermediate concentrations, simulating vigorous trees, increased entry and gallery construction behaviors. Second, heritability of host entry behavior was high, suggesting high genetic variance within each population phase. Third, beetles from outbreak populations were less likely to enter medium amended with alpha-pinene, and constructed shorter galleries than beetles from non-outbreak populations, regardless of geographic location. This disagreed with our prediction and seemingly contradicts field observations that beetles in outbreak phase were less discriminating and would construct longer galleries than those in non-outbreak populations. However, discrimination was modified by the presence of other beetles, and this effect was more pronounced among beetles from outbreak population. Ultimately this broadens the range of hosts that outbreak beetles colonize. We propose that the above modifications of behaviors may contribute to positive feedback in population dynamics and discussed linkage between host breadth increased population densities in outbreak species.

Spruce beetle catches in pheromone traps: do they mean anything?

José F. Negrón and John Popp, USFS-RMRS, Ft. Collins

During the summer of 2001, we initiated a study at the Routt National Forest in Colorado. The objective was to relate season long pheromone trap catches using the 3-component lure to the basal area of spruce attacked the previous year (the source of the beetles) and the basal area attacked in 2001 (new attacks). Typical plots were square with 400 meters to each side. A total of ten plots were established. Five traps were deployed in a number five-domino pattern with the outside traps separated by 200 meters and the fifth trap in the center. Preliminary results indicate a significant relationship between season-long catches and the number of previously infested and currently infested trees. The study will be replicated in 2002.

Estimation of Spruce Beetle-Caused Mortality From Pheromone Trap Catches

Barbara Bentz, Matt Hansen and Steve Munson

Multiple funnel traps are routinely used to monitor flight patterns and trends in bark beetle populations. However, there has been no attempt to associate trap catch information with associated tree mortality in the general area where traps are deployed. Our objectives for a 3 year project are 1) to quantify the relationship between pheromone baited funnel trap catches and spruce beetle (*Dendroctonus rufipennis*) caused tree (*Picea engelmannii*) mortality; and 2) to quantify the relationship between year to year trends in spruce beetle caused tree mortality and year to year trends in pheromone trap catch. We will present data from the first year of trapping.

Traps were deployed similar to that routinely used by Forest Service Regions for monitoring spruce beetle populations. The study was conducted on the Manti-La Sal and Fishlake National Forests in Utah, with three treatments at 2 sites. The treatments represent three spruce beetle population phases: endemic, building and epidemic populations. A single treatment consisted of four Lindgren funnel traps (16 funnel) baited with the two component spruce beetle lure (Pherotech, Inc.), spaced at least .25 mile from another trap. The three treatments within a site were at least 2 miles apart. Traps were checked once per week during spruce beetle flight. Following beetle flight, a 100% survey was conducted in a square 4 ha block surrounding each trap. All spruce beetle-attacked trees were identified. To estimate stand conditions, 9 variable radius plots were established at each trap location. Data from the 2001 spruce beetle flight indicated a significant relationship ($r^2 = 0.53$) between trap catch and surrounding tree mortality in the 4 ha blocks. The study will be repeated in 2002 and 2003.

National Fire/Fire Surrogate Program: Opportunities for Research

Moderator: Michael R. Wagner
School of Forestry, Northern Arizona University

The National Fire and Fire Surrogate Study is a long-term study to understand effects of alternative methods for fuel reduction and forest restoration. The study is a 5-year national study funded by the Joint Fire Science Program (US Department of the Interior and USDA Forest Service). There are thirteen sites nationwide, 8 of which are in the West. The experimental treatments consist of mechanical thinning, prescribed fire, thinning plus fire, untreated control. Standard sampling protocols for bark beetles are used on all Western sites.

Presenters at the workshop included: Michael R. Wagner School of Forestry, Northern Arizona University, Diana Six, University of Montana, Don Dahlsten, University of California, Berkeley, Chris Fettig, USDA Forest Service Davis, California.

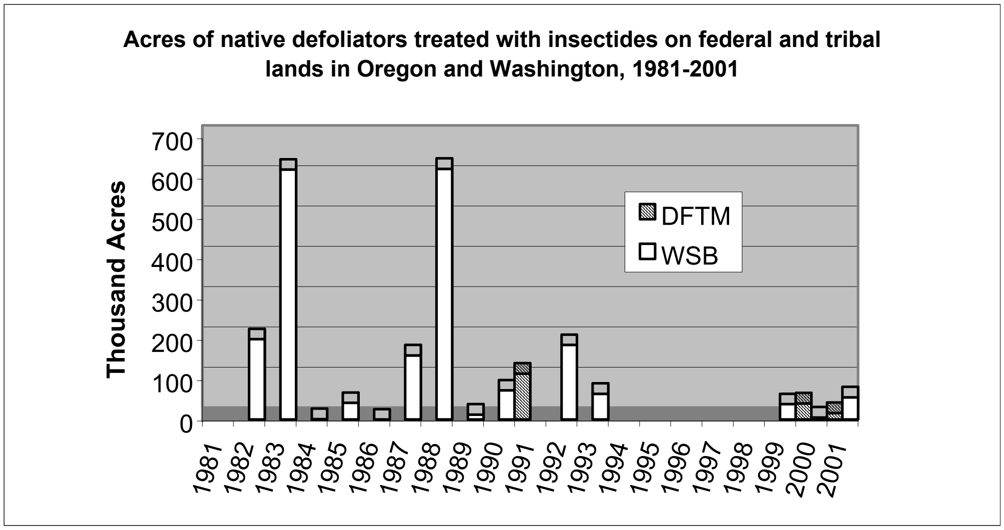
Presenters provided an overview of the basic experimental design and project objectives as described above. Progress reports from California, Montana, Arizona and New Mexico were given. In every case there is strong preliminary evidence that these treatments, particularly fire, will have significant effects on the bark beetle community. There is a strong interest in examining the relationship between bark beetles and other components of the study such as wildlife, coarse woody debris, etc. Presenters described a plan and invited participation by members in attendance to develop a proposal to the Joint Fire Science Program to expand entomological sampling to include ground beetles.

Direct Suppression of Native Defoliators: Does It Make Sense?

Moderator: Paul Flanagan

Bruce B. Hostetler
USDA Forest Service
Westside Forest Insect & Disease Service Center

During my tenure with the USDA Forest Service I have been directly involved in several suppression projects ranging from relatively small (2,400 acres, jack pine budworm, Nebraska National Forest, 1980) to quite large (444,000 acres, western spruce budworm (WSB), Mt. Hood National Forest/Warm Springs Indian Reservation, 1988). Since moving to the Pacific Northwest Region in 1981, we have applied insecticides to over 2 million acres of western spruce budworm and 170 thousand acres of Douglas-fir tussock moth (DFTM). The total cost of these suppression efforts was over 35 million dollars. For the earlier projects, this does not include the costs of Forest Service entomologists' salaries or of conducting environmental analyses.



The first question that comes to mind is: Were they worth it?

Powell (1994) found evidence that the large scale western spruce budworm projects of the early 1980s had little effect on reducing topkill and mortality. Other studies showed reductions in budworm populations last for only 2 years to, at best, 3 years (Torgersen et al. 1995, Mason and Paul 1996, Sheehan 1996). I have observed units which exhibited significant defoliation (based on the color signature of current defoliation) the year after insecticide treatment.

Torgersen et al. (1995) found little difference in budworm population behavior in treated and untreated plots, and found no evidence of increased radial growth in treated plots. Mason and Paul (1996) showed that populations reduced by 90% using *Bacillus thuringiensis* were back to outbreak densities the third year after treatment. Sheehan (1996) found that insecticide treatment coincided with reduction in percent area defoliated the year following treatment, but returned to pre-treatment levels in the second year. Also, she found that during the period of 1985 to 1992, the extent and severity of defoliation was similar in treated and untreated areas of the outbreak.

Thus, there is indication that these large-scale treatments were not very effective. Whether this ineffectiveness was due to resurgence, inflight, or poor insecticide application, we do not know. But the evidence shows that we were not particularly successful in our endeavors.

Project analyses

Some aspects of the past economic analyses are cause for concern. The benefit/cost ratios of all projects conducted during the 1980s were based on cost of treatment versus benefits in wood fiber protection. These B/C ratios carried much weight in making treatment decisions, even though they were highly sensitive to variables such as discount rate and projected real stumpage price increases. Assuming a different value for either of these two variables -- and there is no lack of dispute among economists on which values should be chosen -- can easily change the B/C ratio from greater than one to less than one.

In addition, for past projects we made a number of assumptions which, in hindsight, were not the best. These included the following which tended to slant decisions in favor of treatment.:

- Only one treatment is needed to lower budworm populations for the duration of the outbreak period.
- Areas in need of treatment are accurately delineated.
- All insecticide applications are of high quality.
- Timing of harvest of host trees would occur on schedules included in the economic analysis.
- Populations, if left untreated, will persist at outbreak levels for at least three years following the treatment year.

My belief is that during the 1980s and 1990s we treated collapsing populations of budworm in 1992 and 1993, and resurging populations in 1982, 1983, 1987, and 1988. In 1991 we treated a collapsing population of Douglas-fir tussock moth. In other words, some of our assumptions did not serve us well.

Another factor inherent in the large-scale treatment efforts is that there can be significant amounts of public pressure to treat because of the appearance of a forest with heavy defoliation. This can sometimes lead to decisions which are based less on biology and more on politics.

Funding

The way in which federal projects are funded by the USDA Forest Service is another concern of mine. Each year there is a large pot of money set aside for prevention and suppression projects. This money is available for the highest priority projects across the country until it runs out. Thus, decision makers can meet their political/public concerns without taking money out of their base budget. In other words, they do not have to prioritize the suppression project along with the other resource management projects which they have scheduled. If, in fact, they had to do this, I suspect decisions would be different. With rare exception, when I asked Forest Service silviculturists how they would spend the suppression project money if they could have it to spend on their highest priority efforts, they would not have spent it on large-scale budworm suppression.

Changes in justification for treatment

Starting with the 1991 Douglas-fir tussock moth project, the Pacific Northwest Region began a shift away from justifying suppression projects on saving wood fiber to justifying them on benefits to other resources. Two primary issues driving the 1991 project were stream temperatures (i.e., fisheries habitat) and thermal cover in elk calving areas. Even though this was done, there was no effort to collect before and after treatment data to determine if we had derived any benefits.

For the Douglas-fir tussock moth projects of 2000 and 2001, the objectives did not include wood fiber production. They did include protection of: riparian habitat, old growth habitat, residential/administrative sites, high use recreation areas, municipal watersheds, scenic quality, and nesting, roosting, and foraging habitat for northern spotted owl.

Changes in assumptions

Through time, assumptions used in suppression project analyses have changed. We no longer assume that budworm populations will not resurge. We have lowered our expectations that every acre will be treated adequately. We are looking at treating smaller, high value areas (as determined by National Forest specialists). We are trying to get specialists for all affected resources more fully involved at the environmental analysis stage of the process, and to develop plans for effectiveness monitoring.

Effectiveness monitoring

During the early projects starting in 1982, we did little effectiveness monitoring beyond looking at short-term (i.e., same year) effects on budworm populations, and a small amount of water monitoring for insecticide levels and insect drift in a stream or two within the project area. We now are making small strides towards looking at the effects on the resources upon which we have justified treatment. For example, following the 2000 Douglas-fir tussock moth project, monitoring of stream-shading along bull trout inhabited streams has been done for two years. The preliminary results indicate that in the areas sampled: 1) streams receive 80 to 85 percent full sunlight even with completely foliated trees; 2) there was no apparent difference in amount of shade between treated and untreated areas; and 3) even with complete defoliation, not sure that influence on stream temperature would be significant. This type of monitoring is excellent, and needs to be done for all resources upon which treatments are justified. We must ensure that effectiveness monitoring is done, or we may fall into the old trap of using these resource concerns as justifications for a decision made for unrelated reasons.

Bottom line

I don’t believe that large-scale suppression of native defoliators makes sense. I can, however, support smaller, targeted areas in which pre-treatment data are adequate, specialists for resources of interest are involved and have a well-thought-out plan for effectiveness monitoring, and we adapt to the information gathered.

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Peter M. Hall
B. C. Ministry of Forests

An obvious answer?

- B. C. Forest Service annually treats areas for WSBW
- B. C. Forest Service maintains a stock of npv for treatment of DFTM
- B. C. Forest Service treats DFTM with npv as necessary

Obvious answer?

Of course we think it makes sense……… SOMETIMES

Issues to consider

- management objectives
- resource at risk
- expected type and severity of damage
- benefit/cost
- technical feasibility
- resources available
- alternatives

A quote

"The decision to protect a stand from budworm attack, framed in economic terms, is essentially an investment decision. It involves the commitment of scarce resources today to obtain increased returns in the future……..No investment is a "sure thing", the poorer the information and the more distant the pay-off, generally the more risky the investment becomes."

- Eastern Spruce Budworm Economic Analysis: Fort Nelson Forest District. Nov. 2001

Damage considerations

Defoliation of trees may result in the following types of damage:

- loss of increment
- reduced crown ratios
- reduction in frequency and viability of cone and seed production
- increased frequency of tree deformities
- reduced height due to top-killing
- increased wood decay
- reduced tree vigor
- tree and stand volume loss; and ultimately
- tree mortality.

How much and when?

How much damage?

- Conflict with TS Analysis?
- Conflict with mngmnt objectives?

When will we get the benefit?

- Immediate?….protecting standing mature timber?
- Intermediate?….preserving a

From the quote...

- immediacy of the resource at risk (timber? Aesthetics?)
- shrinking resource base with desire to maintain productive land base
- cost and other options for allocation of management resources…..balance.

Evaluation Process

- previous model showed consideration of management objectives near end of process
- just as valid is a consideration of objectives upfront……ie, zoning a landbase into areas where:

– no treatment would ever be employed
– areas where treatment may be employed infrequently
– areas where treatment may be routinely recommended

Some criteria used

Priority areas for B.t.k. treatment

The following criteria are considered when planning a control program for western spruce budworm and other defoliating insects. Areas considered for treatment must have one or more of the following criteria:

Stand Related

- are located within the working forest;
- are located in a woodlot;
- silviculture investment, such as spacing, pruning, thinning;
- approaching free-growing assessment;
- recent partial cutting;

Insect Related

- moderate to high density in L3 and L4 layers (understory layers);
- Located in an area of chronic budworm activity (>8 years total defoliation as determined from historic overlay analysis);
- 1st priority IDFxh, 2nd priority IDFdk, ICH stand endure very short lived outbreak cycles and trees rebound quickly, so do not warrant direct control efforts;
- stand has suffered a minimum of 1 year defoliation and defoliation predictions are moderate to high for the coming season; and,
- population are building in area.

It is not always a GOOD thing

Direct Suppression of Native Defoliators: Does it make sense?

In summary... It depends.

Top Ten Reasons….

1. Because we can
2. We like air shows
3. We enjoy early morning sunrises
4. We wish to support the pesticide industry
5. We enjoy the stress of public meetings
6. We are primarily entomophobes
7. Our eyesight wasn't good enough to get us into F18's
8. Continued employment
9. Just Because…..

…………and…………

10. Because sometimes it makes sense to do so.

Karen Ripley
Washington Department of Natural Resources

Washington has had a history of using direct suppression against native defoliators such as hemlock looper, western spruce budworm, and Douglas-fir tussock moth. Suppression projects in the 1960's through 1980's were generally large scale (tens of thousands of acres), but generally did not alter the course of outbreaks. In the late 1990's and early 2000's biological pesticides have been used for direct suppression of western spruce budworm on scales of 4,000-10,000 acre projects. Landowners have been very satisfied that the resulting 3-5 years of foliage protection provided time and management options at reasonable cost.

Does direct suppression make sense? Yes.
Issues:

- Thanks to GPS tools and product improvements, reliable insecticides can be applied more predictably and precisely than ever before.
- Land management objectives must be well thought out, articulated, and genuinely threatened by the predicted level of insect activity.
- Suppression project objectives must be reasonable. The protective effects will be temporary, until the outbreak subsides or the landowner can manipulate stand conditions to capture value and/or alter stand susceptibility.
- Monitoring insect population trends is important.
- Washington's Forest Practices regulations and constraints have been reasonable.
- Familiarity with pesticide products and spray project logistics, sufficient to generate confidence in the public and reviewers, is thin.
- Expertise in running spray projects (operations, logistics, timing) is thin.

Does direct suppression make sense? No.
Issues:

- Suppression without silvicultural follow up to alter susceptible stand conditions and improve resilience is a bad idea.
- Suppression with the goal of protecting views and preventing fuel build-up, but no silvicultural changes is a bad idea.
- Out-of-date laws which declare native forest insects which threaten timber to be a nuisance that must be "controlled, destroyed, and eradicated" are bad policy.
- Small landowners who love their overstocked stands of susceptible, low vigor trees and want to spray to kill bugs are a bad recipe.

Conclusions:

The skills of entomologists are needed, more than ever, to aid forest managers in developing and achieving realistic, ecologically appropriate objectives. These objectives will primarily be achieved through the management of vegetation. When insect activity temporarily threatens management objectives, direct suppression makes sense. Entomologists have an important role in monitoring insect activity and implementing effective suppression projects.

How Can We Lead the Public in the Direction We Want Them to Go?

Moderator: Ralph Thier

Participants in the workshop came ready for active discussion and, as expected, first took on the title of the workshop. Someone summed things up by saying, “Leading the public is like herding kitties.” - everyone agreed.

Time was devoted to a discussion regarding just who is the public – a national public? a local public? an influential few? Although nothing was resolved, we noted that some groups are influential and affect policy where others may seem interested in land management activities but remain passive and unengaged.

Discussion then focused on the social, political and economic aspects of natural resource management and the role of the pest manager in the debate. Everyone had something to contribute to the topic of whether the proper position for the pest manager was one of complete objectivity, professing only the scientific truths, or was one of opinion, professing not only the science but also a position. Unsurprisingly, discussion moved on to another topic without resolution.

We talked about marketing – that is providing the service desired by the customer – and who had the responsibility to market a pest management program. Some felt the job belonged to public affairs specialists while others argued marketing is everyone’s responsibility. Harry Beckwith said, “Every act is a marketing act.” in his 1997 book Selling the Invisible. If Mr. Beckwith was correct, then every action, every communication, every presentation and every study has the potential to enhance the pest manager’s position with respect to his customer.

We adjourned, on time, where discussions on the topic continued in the halls among workshop participants.

PANEL

Graduate Student Papers

Moderator: Diana Six

Predator and Competitor Effects on Pheromone Use by *Ips pini* Bark Beetles from Northern Arizona and Western Montana, USA

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We studied variations in the population dynamics of pine engraver beetles (*Ips pini* Say) and their associates in two distant regions, Flagstaff, Arizona and Missoula, Montana, USA. Seasonal differences in pheromone preference of pine engraver, and their related predators and competitors were tested using the attractant pheromone ipsdienol and the synergist lanierone. Five isomeric blends of ipsdienol (+03/-97, +25/-75, +50/-50, +75/-25, +97/-03) were tested with and without the synergist lanierone. Insect catches from the Lindgren-funnel traps were collected weekly for no less than four weeks during peak flight periods. Traps were re-randomized after each collection. Regression analyses of *Ips pini* spring and summer flights indicate a seasonal shift in pheromone preference with increased attraction by (-)-ipsdienol in summer. In summer at both sites, the treatment combination of +03/-97 ipsdienol with lanierone resulted in higher catch numbers of pine engraver than did other treatments. This seasonal shift in pheromone preference was compared to seasonal abundance and pheromone preference profiles of predators and competitors caught during the same trapping experiment. Data indicates that the seasonal shift exhibited by *Ips pini* in Missoula may be a reaction to selection pressures by predators. However, in Flagstaff, the seasonal shift may assist in avoidance of competition and maintenance of reproductive isolation with *Ips latidens* (LeConte).

Semiochemical Control of Mountain Pine Beetle in Whitebark Pine Using Green Leaf Volatiles and Verbenone.

Beverly M. Bulaon-Fowler
Humboldt State University

Mountain pine beetle, *Dendroctonus ponderosae* Hopkins, is a native bark beetle in coniferous forests of the northwestern United States. Decreasing precipitation and increased warming trends during the past several years have subjected host trees, particularly Boise National Forest in central Idaho, to severe water stress and high risk for wildfire, both of which conditions are optimal for mountain pine beetle populations to build to epidemic levels.

The purpose of this project was to determine the efficacy and effects of two semiochemical deterrents on mountain pine beetle attack dynamics in whitebark pine *Pinus albicaulis* Engelm., forests, including the density of host-seeking beetles, the intensity of attacks against host trees, and the rate of host mortality. The semiochemicals tested were verbenone, a mountain pine beetle anti-aggregation pheromone, and green leaf volatiles, a synthetic mixture of non-host tree derived plant volatiles. Both semiochemical treatments were tested against naturally occurring mountain pine beetle populations in mixed whitebark pine-subalpine fir forest on Snowbank Mountain near Cascade, Idaho. Mountain pine beetle flight density and attack frequency were monitored throughout the mountain pine beetle flight period during late summer 2001.

Mountain pine beetle dispersal was positively correlated with ambient temperature, peaking whenever daily maximum temperature exceeded 16 °C. Mountain pine beetles preferentially attacked and colonized larger, presumably more mature whitebark pines. Stand basal area, whitebark pine stems acre^{-1}, and stem cluster density were not accurate predictors of mountain pine beetle attack frequency, but this might have been the result of site selection to minimize variance in stand characteristics. Secondary mountain pine beetle attacks typically targeted closely adjacent trees, a pattern that was facilitated by the naturally clumpy distribution of whitebark pines.

Verbenone was an effective deterrent of mountain pine beetle immigration through protected stands and of attacks against whitebark pine trees. Significantly fewer mountain pine beetles were captured in flight monitoring traps within verbenone treated plots and no successful host colonizations occurred. On the other hand, green leaf volatiles were not effective semiochemical deterrents. Neither the number of host-seeking mountain pine beetles nor the number of successful attacks was reduced by GLV treatment. Several management implications of successful semiochemical control of mountain pine beetle populations were reviewed.

Preliminary Findings on Bark Beetle Flight and Ponderosa Pine Physiology in Northern Arizona

Monica Gaylord
Michael R. Wagner

(Summary Not Received)

Competition Among Yeasts and Filamentous Fungi Associated with the Mountain Pine Beetle.

Adams, A.S., and D.L. Six
School of Forestry, University of Montana, Missoula, Montana

Performance of bark beetle brood varies according to which filamentous fungus is present within the tree phloem. Competition among fungi within the phloem may therefore impact brood performance. We present data suggesting that the presence of yeast may restrict growth of both filamentous mycangial fungi of the mountain pine beetle. Four unidentified yeasts and the two mycangial filamentous fungi of the mountain pine beetle, *Ophiostoma clavigerum* and *O. montium*, were paired to quantify competition between these two fungal groups. The objectives were 1) to determine if *O. clavigerum* and *O. montium*'s ability to compete is different among yeasts and 2) to determine if *O. clavigerum* and *O. montium*'s ability to compete differs versus any yeast. Three of the yeasts had no impact on the growth of either filamentous fungus. However, one yeast significantly reduced growth of both *O. clavigerum* and *O. montium* after 7 days of growth. Growth measurements indicate that *O. clavigerum* and *O. montium* respond in a similar manner to each yeast; however, visual observations suggest that the two filamentous fungi grow differently in the presence of two of the four yeasts. These data suggest that the presence of some yeasts may restrict growth of the filamentous fungi, and therefore impact development of mountain pine beetle brood.

Changes in Insect Herbivore Communities Along an Ozone and Nitrogen Deposition Gradient in the San Bernardino Mountains

Michele Eatough Jones and Timothy D. Paine
Department of Entomology, University of California, Riverside CA

The mixed conifer forest of the San Bernardino Mountains has been impacted by air pollution arising from the Los Angeles basin. Ozone has decreased in recent years, but nitrogen deposition in the forests of Southern California is expected to increase as urban centers continue to grow. Both these pollutants alter patterns of plant growth and allocation, and affect nutritional quality of foliage for insects which may subsequently affect the diversity and abundance of insect herbivore communities. The impact of LA Basin emissions on surrounding forest ecosystems may therefore be mediated by changes in foliar chemistry that are optimally examined by assessing the herbivore populations of affected plant species. If atmospheric inputs of ozone and nitrogen deposition lead to ecologically significant changes plant growth and chemistry, then the composition of the herbivore insect community of those plants will also be altered. The goal of my research is to examine the impact of ozone and nitrate deposition on three cornerstone plant species (ponderosa pine, California black oak and bracken fern) in the San Bernardino National Forest and the impact on the associated arthropod herbivore communities of these plants. We sampled the insect communities at 6 sites along the naturally occurring air pollution gradient. 3 western sites were associated with high ozone and nitrogen input, while 3 eastern sites were expected to have lower atmospheric input. Herbivore groups on all 3 plant species show patterns of change that followed the air pollution gradient. It is expected that the effects seen in the herbivore community are associated with changes in carbon and nitrogen allocation of the plants. For bracken fern and oak chewing insects were more abundant at high pollution sites. Chewing herbivores could have responded positively to increased nitrogen content, or ozone may have stressed plants making them more vulnerable to herbivores. On pine, some groups of sucking insects had increased abundance on high pollution sites. High densities of sucking insects on conifers has been associated with ozone exposure and ambient pollution.

Resistance of Elms (*Ulmus* sp.) and Elm Hybrids to the Elm Leaf Beetle (*Pyrrhalta luteola*) Under Field Conditions in East Central Arizona

Paul Bosu, Michael R. Wagner, Fredric Miller and Steve Campbell

(Summary Not Received)

Using Ant Community Structure as Indicators of Forest Health

Stephanie Sky Stephens and Michael R. Wagner

(Summary Not Received)

FOUNDER'S AWARD ADDRESS

Founder's Award Address

Dr. Les Safranyik
Canadian Forestry Service, Retired

My Beginning:

My talk is comprised of three parts. 1) I will begin with a few words about my upbringing, and major events in my early life, 2) next, I will relate some of the events that shaped my career, and 3) conclude with a few comments about mountain pine beetle biology and management.

(1) My parents had a small farm in the middle of the plains region of central Hungary. By the time I was old enough to go to school, I was expected to pitch in to help tending the livestock and the crops. From grade 1 to grade 8 I went to a 1-room country school with 25-30 students counting all grades. I was the only student in grades 6 to 8. In my senior years I was expected to supervise the younger students and check their homework. One end of the school building housed the living quarters of the schoolteacher, Mrs. Sebestyen. School started at 8AM but the students were expected to be seated at their desks by 7:40AM and sing out the multiplication table from 1x1 to 12x12 and loud enough to be heard from the teacher's living quarters. Doing this day after day, year after year was mind numbing but on the positive side none of us graduating from that school had troubles with multiplying small numbers.

Mrs. Sebestyen was an excellent teacher, kind, knowledgeable, and inspired interest and enthusiasm about learning. To this day she remains my idol. I am convinced that without her guidance and enthusiasm I would have dropped out of school and become a farmer. She was instrumental in making up my mind to further my education. Among the many things I have learned from her was that "ignoring the facts does not change the facts". This advice came in handy throughout my research career. After finishing grade school, I wanted to enroll in teachers college to become an elementary school teacher. However, since I have no ear for music and being able to carry a tune was one of the prerequisites, I failed my entrance exam. Hence, I fell back on my second choice of a high school education.

In high school I especially liked the natural sciences and set my heart on studying astronomy after graduation. However, in the communist system of higher education the number of graduates in a field was limited by closing the first year of the faculty in that field for various lengths of time to control the number of practicing professionals. It just so happened that when I graduated from high school they closed the first year of the only faculty of astronomy in the country. So how did I end up studying forestry? After completion of the high school exams, I was playing ping-pong with my best friend. During the game I asked him which field is he trying to enroll at university. He said forestry. So, by the time the game ended I warmed up to the idea that I too would like to be a forester. A corollary to this story is that my friend failed the entrance exam and I succeeded. To this day, I feel some guilt about the possible role my success may have played in denying his aspirations.

Sopron and the Uprising:

In October 1956, 6 weeks after starting my classes in the Forestry Faculty at the university in Sopron, the Hungarian uprising broke out against the Communist regime and the Russian occupation. The university participated in the armed resistance. As a consequence, when the uprising was put down, a large part of the students and academic staff moved to Austria, I was among them.

Stay in Austria:

Austria, being a neutral country, was compelled to intern us, fearing that if they did otherwise the Russians would use it as an excuse to re-occupy their country. The Austrians treated us very well. We were put up in a vacated 2nd World War American Army base and spent the next two months playing soccer and trying to learn some German. In the evenings small groups of us were allowed to go with the guards to the local beer halls. Even though we were not solders, the Austrians felt necessary to designate us such since some of us had small arms when we crossed the border. Not only that, since we were university students they felt compelled to give us ranks. So I became a sergeant and drew a salary of 80 Schillings per month. One funny episode stands out in my mind from my stay at the camp. After about a month of repeated assurances by the authorities that we will be allowed to leave the camp shortly, we grew weary of the delays and started a hunger strike. Naturally, the Austrians were quite troubled by this , especially when on the third day into the strike one of my classmates became seriously ill. He was taken to the hospital for tests where it was discovered that he was suffering from chocolate poisoning! Since we were paid and the only thing we could spend it on was chocolates from the vending machines in camp, in preparation for the strike most students stashed away a supply in anticipation of a long hunger strike.

Fortunately, shortly after this episode we were allowed to leave the internment camp and received the exciting news that the Canadian Government has invited us, 150 students and about 30 faculty, to come to Canada, join the Forestry Faculty at UBC, and to continue our education, in Hungarian, using our own professors. So, at the end of December 1956 we set out on our journey, traveling from Austria by train through to Belgium and then to England. We sailed on New Year's Day, 1957, from Liverpool and arrived to St. John, New Brunswick one week later.

In Canada:

We traveled by train to Vancouver, and on to Powell River where we spent 4 months learning English. In the fall, 1957, the first year of instructions begun at the Sopron Faculty at UBC. The Sopron Faculty was a sister faculty of the Forestry Faculty of UBC, the difference being that in the Sopron Faculty initially the language of instruction was mostly Hungarian and changed to mostly English as the students gained facility in that language. The curriculum was based on the curriculum of the parent Alma Mater in Hungary. The diploma from the Sopron Faculty was recognized both in Canada and the USA. The Sopron Faculty ceased existence in 1961 following graduation of the last class of which I and Imre Otvos were members. The graduates of this faculty spread across Canada and the USA but most remained in BC. A large proportion of the students obtained graduate degrees and held important positions in academia, government and industry. In forestry circles in BC the group is affectionately known as the "Hungarian Mafia!"

Graduate Studies:

I entered graduate school at UBC during a period when the main means of combating insect problems was through the use of pesticides. When I solicited the advice of a practicing forester what he thought about a career in forest entomology his remarks were not very encouraging. He thought that the practice of entomology in the near future will pretty much get reduced to the following two basic activities: 1) applying the insecticide, and 2) counting the dead. On the research side, how ever, it was an exciting period for forest entomology. The Green River project in New Brunswick on the Spruce budworm was in full swing. This was the first major project on the dynamics of a forest insect in North America. There were several other on- going, in-depth population studies on other forest insects including the larch sawfly, the lodgepole needle miner, and at least three destructive species of bark beetles. Other projects included host resistance to bark beetles and some of the pioneering investigations on chemical communication in forest insects.

My interest in insect population studies was kindled by the publications from the Green River Project, especially the work of Dr Frank Morris. I had met Frank Morris only once, shortly after I joined the Canadian Forest Service. Over lunch, he related the following story that had a deep impression on me. Shortly after the Green River Project was organized it was decided to invite Sam Graham, the famous forest entomology prof from the University of Michigan, for a week to review and critique all aspects of the project: the objectives, the field and lab work, and data analysis. Sam was to accompany the research team to the field to witness the methods of sampling, data acquisition, and handling of the various lab-rearing programs. On the last day he was to give a critique of the work. When the time came for Sam to make his comments, he said the following: " All aspects of the work are well thought out and the various measurements are made with great care. The only criticism that I have is that everything is being measured and nothing is being observed. Obviously, these remarks left a deep impression on Frank because his subsequent work on the fall webworm was a classic in integrating field observations and measurements in interpreting the ecology of this species.

Starting My Research Career:

(2) Half way through my PhD work in the mid-1960s, Roy Shepherd hired me to do research on mountain pine beetle populations at the Calgary Lab of the Canadian Department of Forestry. At the time Roy was section head of forest entomology research. He was a brave man to take a chance on a fellow who at the time only had textbook knowledge of bark beetles. Incidentally, I filled the vacancy created by the retirement of George Hopping, one of the pioneers in bark beetle research in Western Canada and an authority on the bark beetle genus Ips. I joined a team comprised of Rob Reid, Malcolm Shrimpton and Stu Whitney. The three of them worked on various aspects of host tree-beetle-blue stain interactions, and my project involved description of the sampling characteristics of populations within and among trees, and the spatial distribution of attacks and brood within trees. This work was the subject of my PhD thesis. In the late 1960s, the team was joined by the late Jerry Lanier who continued Hopping's work in revising the genus Ips, and John McGhehey who worked on individual variation in egg production and egg viability, and differential survival of the sexes in the mountain pine beetle.

The diversity of interests and expertise within the group made for many stimulating discussions. The following particular incident comes to my mind. For several weeks at coffee breaks during a winter in the late 1960's, Malcolm, Stu and I discussed whether or not it would be useful to develop an experiment to test the resistance of lodgepole pine of different ages against the main blue stain fungi carried by mountain pine beetle. The main argument against doing the experiment was that we would just prove the obvious, that resistance is inversely related to tree age. However, the argument persisted and it seemed that the easiest way out of the uncertainty was to do the experiment. So we did, and to our surprise, resistance increased with age up to the point near the maximum yearly wood volume growth and then declined sharply. This result was a clear demonstration that deductions based on so-called logical arguments can be misleading and there is no substitute for data based on a well designed experiment.

The first workshop I moderated at the Western Forest Insect Work Conference was on the subject of' "What is wrong with forest entomology education today?" I invited 5 of the western forest entomology profs to participate. Naively, I thought that being professors I should have an easy time moderating the sessions. Boy, was I wrong! A few minutes after the session started, the invited participants started a vigorous debate on the merits of the current curricula and teaching methods, mostly ignoring my pathetic pleas for order. Near the end of the workshop, one of the profs directed the following remark at his fellow participant seated across the table from him." I will tell you what is wrong with forest entomology education! . Old chicken pluckers like you and I should have been put out to pasture a long time ago". Somehow I survived the event and through the years I have learned to appreciate the true value of the candid discussions that characterized most of the numerous workshops I have attended at this work conference.

The work on mountain pine beetle out of the Calgary lab of CFS culminated in two major publications: One was the synthesis of our understanding of the interaction between the beetle with its associated microorganisms and lodgepole pine. It described the nature and effects of these interactions on the onset, intensity and collapse of outbreaks and contained a map of outbreak hazard based on climatic factors. The second publication interpreted information on beetle population biology in terms of management. It emphasized that the long-term focus of management should be on lodgepole pine rather than the mountain pine beetle.

Malcolm Shrimpton, Stu Whitney and I were transferred to the Victoria Lab in 1972, principally to undertake studies of spruce beetle populations. So for the next 10 years my work involved population dynamics on that insect at two locations in central BC. This work has led to a conceptual model of spruce beetle dynamics, analysis of survival in stumps and windfall, measurement of absolute populations and associated mortality factors for seven generations. Currently, analysis of the data on factors affecting generation survival, and development of a hazard rating system occupy much of my time.

Later work on mountain pine beetle included studies of dispersal, rates of development at constant temperatures, effects of winter temperatures on survival, the bark beetle guild associated with lodgepole pine, and the effects of spacing and fertilization of mature lodgepole pine on mountain pine beetle attack. This body of work and other published information on mountain pine beetle biology, was used in the development of a detailed population dynamics model for the mountain pine beetle. Also, in collaboration with Terry Shore, we developed a stand level hazard rating system for mountain pine beetle and the spruce beetle. Currently, the rating system for mountain pine beetle and the population dynamics model are being used in an exciting new project to model infestation spread and intensification at the landscape level, and to assess the relative merits of various management strategies and tactics.

What Have We Learned About Bark Beetles and Management?

(3) In closing, I will say a few words about what I think we have learned about mountain pine beetle biology and management over the past 4 decades and refer to some misconceptions. Necessarily, what follows will be just brief statements on various aspects of biology and management without elaboration. For those of you who may want to discuss any or all of the following statements I am willing, especially over a glass of Guinness.

First, I will say a few words about mountain pine beetle generation mortality.

- At an average sex ratio of two females per male, and an average of 60 eggs produced per female beetle, mountain pine beetle populations remain stable at 97.5% mortality.
- Given a one-year life cycle, at about 95% generation mortality population and damage levels will double each year.
- Thus, contrary to popular belief, during epidemics generation survival is only a few % higher than during the endemic state.
- This modest increase in generation survival, however, will remain steady for a number of generations.
- So the challenge to research is to identify the factor or factors responsible for this small increase in generation survival during the beginning stages of outbreaks.
- As we can attribute only about 60-70% of generation mortality to known factors, there is a lot of room for improvement in our understanding of population dynamics.

The following statements relate to epidemiology.

- Secondary bark beetles are important factors of mortality in unmanaged, mature lodgepole stands, especially in the smaller DBH classes. At low endemic levels, mountain pine beetle often infests trees that are colonized by these secondary species. Therefore, it appears that stand hygiene is an important factor affecting mountain pine beetle survival at endemic levels.
- Mountain pine beetle outbreaks are loosely synchronized over much of the beetle's range where the one-year cycle dominates, indicating that population change may be governed by the so called Moran effect.

- Although we can describe the changes in host conditions and weather factors that should occur as a precursor for a change from the endemic state to the beginning stages of epidemics, we still cannot predict the timing of such event.
- The main factors mostly responsible for the development of outbreaks are host susceptibility and suitability of the climate for beetle establishment and survival.
- Of the host factors, the presence of mature /over mature stands at the landscape level appears to be the most important.
- Of the climatic factors, unseasonably low temperatures, and temperature conditions during the growing season that affect mass attack and univoltine cycling of populations appear to be most important.
- Once outbreaks develop at the landscape level, the population's very size becomes a major factor in maintaining its momentum.
- In areas where mountain pine beetle outbreaks are most damaging, the beetle generally has a univoltine life cycle.
- Therefore, it does not necessarily follow that sustained increased temperatures such as those associated with climate warming would invariably result in greater average level of damage.
- The adverse effects of the very factors that are responsible for the development of the outbreak will eventually cause it to decline. Namely, reduction in susceptible host and or increasing adverse climatic conditions.

So what implications beetle population dynamics have for operational management?

- In the long term, the focus of management should be lodgepole pine and not the mountain pine beetle.
- Once scattered infested trees appear in some stands, it is usually a forerunner of the development of an outbreak in 5-10 years.
- The lack of knowing where the infested trees are, especially at low population levels, is rarely a major impediment to management: the lack of early and thorough management action on infestations is.
- There is generally a degree of pessimism, or at least uncertainty, even among forest entomologists as to our ability to control mountain pine beetle outbreaks and on the size of effort required for successful control.
- It can be shown that infestations can be suppressed but the work generally requires a large effort in terms of the proportion of trees that need to be treated annually. As a rule of thumb, the proportion of infested trees treated annually needs to be greater than (1-the average ratio of brood trees to currently infested trees). As an example, if the average ratio of brood trees to currently infested trees was 25%, one would need to treat more than 75% of the infested trees each year to be able to suppress the infestation.
- The commonly held argument that most epidemics are the results of populations building up in susceptible hosts within parks and other protected areas rest on the following assumptions. If such places did not exist outbreaks would not occur, or at least would occur less frequently, in forests managed for timber production. Based on current knowledge, it is unlikely that that the frequency of outbreaks is materially affected by susceptible hosts in protected areas. However, the intensity and rates of spread of infestations are likely affected.

Looking Back:

I consider myself very fortunate to have been able to pursue a research career for 37 years, in an important and highly challenging field. In my entire career I have worked mainly on two problems: the population ecology of the mountain pine beetle and the spruce beetle. When I started work on mountain pine beetle in the east Kootenays of BC in the mid-1960s, lodgepole pine was not considered an important commercial species. Consequently, there was not much sympathy on the part of small wood operators for research projects with a main objective of saving a tree species they had great difficulty selling. About a decade later, however, lodgepole pine became one of the major commercial species in the BC Interior. Commensurate with its commercial importance, interest grew steadily in industry and government in reducing losses from mountain pine beetle. With the increased environmental awareness during the past two decades, there has been steadily increasing interest by these agencies as well as the general public in the nature and effects of beetle-host interactions and the ecological role of damaging species such as the mountain pine beetle. As a consequence, information on beetle population ecology and management are in high demand by the forest industry.

Over my carrier I had the pleasure and privilege of knowing and working with a number of dedicated and highly talented foresters and forest entomologists. As well, my involvement with graduate students was a constant reminder that the profession is not short on talent. What we must ensure is a continuing opportunity for this talent to bear fruit in improving forest insect management.

As for me, I will continue to work on bark beetle projects as long as I am able. Why, you might ask. Simply because in the end all of us will conserve only what we love, we will love what we understand and understand what we are taught.

My sincere thanks to the persons who nominated me, and the Award Committee who found me worthy of the recognition. It is indeed a great honor be the recipient of an Award that symbolizes the ideals of forest entomology practice.

I also want to thank my wife for her understanding and infinite patience that allowed me to work at home after hours, on weekends, and even on some holidays. My work certainly would have been lot more difficult without her support and that of my technician Doug Linton who keeps me on track and cheerfully performs even some tasks that are not only difficult but also of uncertain scientific value.

Thank you for your attention

PANEL

Managing Forest Insects in the Current Political Arena; is There Hope for the Future?

Moderator: Jane Kollmeyer; Ranger, Tally Lake RD

Participants: Vic Andersen; Forest Manager, Plum Creek Timber Company, Inc., Kalispell, MT. Steve Kamps; Timber Resource Specialist, Montana Department of Resources and Conservation, Hamilton, MT. Kim Smolt; USDA Forest Service, Planning Forester/Silviculturist, Hungry Horse RD, Hungry Horse, MT.

This panel was comprised of land managers who consider insect and disease effects from state, federal, and private perspectives; and who addressed management implications of insect outbreaks on lands of differing ownerships. Each described the various opportunities available to them as they analyze insect-caused impacts on forest resources and evaluate alternatives to reduce them to tolerable levels. Of interest were considerations of insect infestations from their "political" and economic viewpoints. Their presentations enable us to better appreciate the constraints under which land managers labor in the twenty-first century.

Vic Andersen: Approaches to dealing with insect outbreaks on land of industrial-private ownership are for the most part very straightforward, and implementation is usually enacted quickly. The current Douglas-fir beetle outbreak affecting many stands in western Montana—and specifically lands under Plum Creek ownership—offer a good example. Currently, they are using a variety of "tools," ranging from salvage of infested trees, to the use of MCH to protect high-value stands.

In short, because Plum Creek manages privately owned land, they have the flexibility of dealing with disturbances in what they consider to be the most economically prudent manner. Most of the time, that means quickly identifying the problem, assessing its extent, and salvaging beetle-killed timber, for example, before it loses its value.

Occasionally, they will treat stands to reduce hazard, but because of their ability to move quickly, their response time to a beetle outbreak results in removing beetle-infested trees—an effective means of reducing outbreak expansion. While all land managers must abide by state-imposed timber practices; Plum Creek is largely free of the political ramifications affecting lands under public ownership and administered by state or federal agencies.

Steve Kamps: The Department of Natural Resources and Conservation (DNRC) oversees management of Montana's state lands. DNRC is guided by a State Forest Land Management Plan and is charged with producing long-term income for Montana schools, managing forests intensively enough to maintain healthy and biologically diverse stands, emulate natural disturbance patterns, and managing for conditions that existed historically. Specifically related to insects and diseases, DNRC strives to minimize the risk of biotic or abiotic problems; maintain complex and stable ecosystems capable of "buffering" damage from insects, diseases, wildfire, and climatic disturbance; and salvage material that will contribute to the spread of insects or diseases.

In their management efforts, DNRC is required to adhere to the Montana Environmental Policy Act (MEPA)—Montana's equivalent to NEPA. MEPA requires DNRC to analyze the environmental impacts associated with its management actions, inform the public of those impacts, and give them an opportunity for comment. When MEPA requirements have been met, the State Land Board approves a particular timber sale. Once approval has been granted, the only way for appellants to stop the sale is through the courts.

So long as DNRC's goals remain the same, we will continue to cut a sustainable amount of timber, and manage against insect outbreaks. DNRC implements a system of preventive maintenance and early detection intended to reduce the risk of insect-caused mortality, or salvage infested material to lessen the likelihood of infestation spread. Environmental analyses are scaled to analyze impacts of management actions, but without becoming unduly burdensome or overly time consuming. Both preventive maintenance of stands and direct removal of infested trees have proven quite successful—despite increasingly difficult analyses in the current political climate.

Kim Smolt: USDA Forest Service, in 2002, attempts to manage forested lands under their jurisdiction in an increasingly difficult and somewhat contentious political arena. Often cumbersome and time-consuming are the difficulties inherent to navigating the complexities of the planning process for vegetation management in the Forest Service today.

The steps involved in applying the National Environmental Policy Act (NEPA) include the development of a "proposed action," a "scoping" process designed to identify public issues, and finally the development of "alternatives," which must adhere to Forest Plan standards, opinions and rulings from federal and state agencies such as Fish & Wildlife Service, Endangered Species Act, Clean Water Act, Clean Air Act, and a host of other state and federal legal mandates. Once that process has been completed, alternatives and anticipated impacts are documented in an Environmental Impact Statement (EIS), or an Environmental Assessment (EA). Having been issued, those are open for public comment—for a period of 45 days (EIS) or 30 days (EA)—before a decision is made. The entire process is typically 9 to 24 months, depending on individual complexity.

Following the issuance of a Record of Decision (EIS) or Decision Notice (EA), the public has 45 days to review and appeal. If appealed, it is first reviewed by a Regional panel, and under the best of circumstances, another few months will lapse before implementation. And of course, appellants may still, and often do, take appeals to court. Needless to say, if the original intent was to deal with a bark beetle outbreak, the outbreak may have either come and gone, or become so extensive the original plan is no longer appropriate. Either way, we are left to implement a plan that may be woefully out of date.

The federal process, contrasted with those of private industry and the State of Montana, appears to be significantly more complex and time consuming. As a result, both private land owners and the State have the advantage of being able to expedite implementation of vegetation treatments to manage forest insects considerably sooner than the Forest Service.

Hope for the future? It's difficult to say. We try to have faith in the process, but it becomes more complex and muddled all the time. FS Chief, Dale Bosworth, has been working with Congress to reduce burdensome regulatory requirements. Whether or not he'll be successful is anyone's guess. In the meantime, we work as fast as we can and hope for a return to an "age of reason!"

WFIWC MEMORIAL SCHOLARSHIP WINNER PRESENTATION

Memorial Scholarship Winner Presentation

Host Selection in Tree-Killing Bark Beetles - Unravelling the Intricacies of a Complex Communication System

Deepa Pureswaran
Simon Fraser University

Good morning ladies and gentlemen. I am honoured to be the first recipient of the Western Forest Insect Work Conference Memorial Scholarship, and it gives me great pleasure to be here today to talk about the work we do in our lab to decipher the complex host selection mechanisms of tree-killing bark beetles.

Bark beetles are notorious for the damage they cause to coniferous forests throughout North America. The mountain pine beetle that you see here has in particular earned for itself (quite deservingly so), the honour of being the most lethal natural agent of lodgepole pine in Western North America. When I first started studying the biology of these beetles, I was quite astounded to see the magnitude of damage that a creature so tiny could cause. Beetles of the genus *Dendroctonus* that contains the main tree-killers are about 5 mm in length. I am going to briefly describe the biology of these beetles before exploring the mechanisms of host selection.

In late spring and summer, beetles emerge from brood trees and embark on a dispersal flight. “Pioneer beetles” locate hosts and initiate attack. Aggregation pheromones are produced by the first attacking sex which in synergism with host volatiles recruit mass attack. The invading beetles also inoculate the tree with pathogenic fungi that aid in overcoming host resistance. The females tunnel into the phloem, excavate galleries, mate and lay eggs. The larvae that hatch feed on the phloem and tunnel perpendicular to the parental gallery. This prevents water and nutrients from reaching the crown of the tree, and the tree dies. Once an optimum attack density is reached, the beetles produce antiaggregation pheromones that switch the attack to adjacent trees in the vicinity.

So the infestation spreads in an area and the trees turn red in a year… then grey the following year. So, in a couple of years, verdant forests are replaced by barren mountain sides.

In addition, the wood in attacked trees is stained by fungi that the beetles inoculate during attack, thereby decreasing their value. Bark beetles therefore cause huge monetary losses to the forest industry.

Here you can see a lodgepole pine tree attacked by the mountain pine beetle. Owing largely to their economic impact, considerable study has been done on the biology and management of bark beetles since the beginning of the century both from an academic standpoint as well as to control their burgeoning populations. Bark beetles are highly specific to the host species they attack even when host and nonhost conifers occur in sympatry. The precise mechanism by which these beetles select the right hosts to attack and establish viable broods still remains unresolved. The beetles have to discriminate among the myriad of odours that emanate from the forest and make complex decisions that would be a difference between life and death.

In our lab, we are currently investigating the host selection mechanisms in four tree-killing bark beetles: the mountain pine beetle which in British Columbia attacks lodgepole pine, the Douglas-fir beetle which attacks Douglas-fir, the spruce beetle which attacks Englemann and white spruce and their hybrids and the western balsam bark beetle, which attacks subalpine fir.

Host selection in bark beetles could be mediated by any of the following cues, either singly or in combination. Beetles could potentially discriminate among conifers using

visual cues: they do respond to vertical silhouettes on a long range, there could be short range perception of reflectance spectra
olfactory cues: there could be qualitative and quantitative variation in volatiles among conifers
tactile cues: beetles could land on trees and perceive differences in bark characteristics
or **gustatory cues:** where they can actually bite into the bark and leave if they find it unsuitable.

I am primarily concerned with the olfactory mechanisms that mediate host selection.

There are two prevailing hypotheses on host selection:
The random landing hypothesis states that beetles land randomly on trees and test them for suitability.
The primary attraction hypothesis states that pioneer beetles orient to their hosts by attraction to host compounds called kairomones.

Before I go any further, I'd like to present my stand on the two hypotheses. Although it seems like a wasteful and inefficient way to select hosts, I would not entirely dismiss the first hypothesis. It is not inconceivable that a few pioneer beetles could land randomly on the right hosts. The rest of the population would then respond to the aggregation pheromones released by the pioneers and locate hosts by secondary attraction.

The second hypothesis would theoretically be more efficient and we do know that beetles respond behaviourally to host monoterpenes.

Previous studies have shown that bark beetles do avoid angiosperms by perception of nonhost volatiles. But whether sufficient differences exist among conifers to enable such discrimination is as yet to be ascertained.

Our hypotheses are:
1) Pioneer bark beetles must perceive qualitative or quantitative differences among conifers to avoid attacking the wrong tree.
2) Orientation to host specific kairomones coupled with conspecific aggregation pheromones will optimise successful mass attack.

There are four main objectives of our research:
1) To study the mechanisms by which the four species of bark beetles use volatile chemicals to find host trees.
2) To determine the mechanisms by which beetles would avoid nonhosts.
3) To evaluate potential new attractants from conifers and use them to enhance the attraction of operational tree baits
4) To evaluate potential repellents as additions to the existing nonhost blend for use in tree protection

Our study was conducted in four main parts:

1) First, we conducted a test of host specificity to determine if bark beetles could be induced to attack the wrong host. We had to resort to a bit of trickery there, by baiting the nonhost trees with the aggregation pheromone of our victim.
2) Then we performed electrophysiological studies of the bark and foliage volatiles of the four conifers against the antennae of each of our four species of beetles to determine the compounds emitted by the trees that the beetles can actually smell.
3) Then, we conducted a survey of compounds contained in the bark and foliage of the four species of conifers across British Columbia to determine the variation of these compounds among species and also among sites within a species.
4) Finally, we came up with monoterpene blends that would represent each conifer and conducted field tests to determine

a) if beetles could discriminate between host and nonhost blends in traps
b) and if beetles exhibited primary attraction to host volatiles.

Part I: Test of host specificity

When we started this study in the summer of 1999, we were interested in assessing the potency of avoidance of nonhost conifers. So, my supervisor and I tried to induce attack by bark beetles on nonhost trees by baiting them with aggregation pheromones, to determine if beetles avoid nonhosts in flight and whether they can be induced to attack nonhosts. We were interested in determining if nonhost volatiles would overpower the effect of pheromones and prevent orientation to the wrong hosts.

We conducted four experiments in two ecological associations. The mountain pine beetle and Douglas-fir beetle were forced to distinguish between lodgepole pine and Douglas-fir. The spruce beetle and western balsam bark beetle were made to discriminate between spruce and subalpine fir.

We attempted to induce attack on nonhost conifers by baiting them with the respective aggregation pheromones. Ten host trees were also baited with aggregation pheromones as controls. The ten host trees, represented by dark green in the figure and ten nonhost trees represented in light green, that were 50m apart were randomly selected for each species of beetle. Unbaited traps were placed 1m from each baited tree to monitor whether beetles oriented towards them. Unbaited control traps were placed equidistant from the host and nonhost to monitor background flight levels.

Sticky panels were affixed to the trees to determine landing rates. After the flight, the trees were assessed for signs of attack by looking for frass or boring dust, pitch tubes and resin bleeds.

The attacked trees were stripped of bark and assessed for attack success by recording the presence of adult beetles, eggs and larvae.

Beetles in the traps and sticky panels were counted and sexed. Data were log transformed and analysed by Analysis of variance and the Ryan Einot Gabriel Welsh multiple range test. In the next four figures, the graphs on top show the trap catch data indicating that the beetles were orienting to the trees. The graphs on the bottom show data from the sticky panels indicating landing rates. Bars on your left indicate the number of males captured, and bars on your right the number of females. Bars with the same letter are not significantly different.

So what we see here is that the mountain pine beetle oriented equally towards traps associated with hosts and nonhosts. There was no difference in the landing rates on either hosts or nonhosts.

Douglas-fir beetles oriented preferentially towards hosts compared to nonhosts. But there was no difference in their landing rates on either hosts or nonhosts.

Both male and female spruce beetles oriented equally towards host, nonhost and control traps. But male spruce beetles landed preferentially on host trees, although females exhibited no difference in landing rate.

Both male and female balsam beetles oriented preferentially towards host traps compared to nonhosts or controls. More beetles landed on host trees than on nonhosts.

So, did beetles initiate attack on nonhosts???

We found that

- Mountain pine beetles initiated attack on nonhost Douglas-firs 90% of the time. Attacks were not successful, as beetles could not penetrate the thick Douglas-fir bark.
- Douglas-fir beetles initiated attack on lodgepole pine 45% of the time, again, attacks were not successful as the beetles were pitched out by the resin.
- There was no evidence of spruce beetles or balsam beetles initiating attack on nonhosts. Those that were not captured on the sticky panels must have flown away after landing.

From this preliminary study, the following conclusions can be drawn:

1. Volatiles from nonhosts did not overpower the aggregation pheromone signal and inhibit orientation in any species. Therefore, pheromones of con- and possibly heterospecific beetles attacking trees are important cues in host selection.

2. It is possible that some mountain pine beetles and Douglas-fir beetles may detect nonhosts only after attempting to initiate attack. This supports the random attack hypothesis where it is proposed that pioneer beetles land randomly on trees and sample them to determine suitability.

Spruce beetles and balsam beetles did not initiate attack on nonhosts. Spruce beetles may detect nonhosts immediately after landing. The western balsam bark beetle was the only species of the four that oriented and landed preferentially on host trees and may detect them prior to landing. This supports the primary attraction hypothesis which states that beetles locate hosts in flight using volatile semiochemicals in flight.

Part II : Collection and identification of conifer volatiles

No olfactory conclusions can be drawn from my preliminary experiments so we decided to look at the volatile profiles of trees and investigate what chemicals the beetles perceive. Two trees from each species were felled and the bark and foliage were aerated in chambers using a water aspirator. Volatiles were captured on a Porapak-Q column and subjected to gas chromatographic electro-antennographic detection analyses against the antennae of males and females of all four species.

In this technique, volatiles were run simultaneously past the antenna of a beetle and through a flame ionisation detector of a gas chromatograph to locate compounds that elicit an antennal response. Such compounds are candidate semiochemicals that were field tested for behavioural activity.

Using gas chromatography mass spectroscopy, we identified 18 compounds to which the antennae responded, 17 monoterpenes and one acetate. We also found that the trees did not differ qualitatively in the monoterpenes they possessed.

So we figured that if beetles used olfaction to discriminate between their hosts, there could be a quantitative difference in the monoterpenes that the trees possessed. Beetles may cue in to differences in the relative ratios of terpenes that exist among species. There may also be geographic differences within a species.

Part III: Survey of bark and foliage

To answer these questions, we conducted a survey of conifer bark and foliage from three sites in the interior of British Columbia.

We collected samples from:
1) Princeton
2) 100 Mile House and
3) Prince George for all four species, except Douglas-fir where a fourth site from the coast at Maple Ridge was included.

Bark and foliage were collected from ten trees of each species in each geographic location. Trees of the same species were sampled at least 500 meters apart and samples were frozen until extracted.

The samples were homogenized in alcohol… filtered…centrifuged…and monoterpenes were quantified by gas chromatography using heptyl acetate as an internal standard.

Data were log transformed and analysed by Multivariate analysis of variance, the Ryan-Einot-Gabriel-Welsh multiple comparisons procedure and principal components analysis to determine differences in the monoterpene profiles of bark and foliage among the four species and between sites within a species.

I am going to show you data from the monoterpene profiles of bark volatiles for the four tree species and the site differences in Douglas-fir bark.

In this bar graph, the y-axis represents the amount of volatile material in micrograms, and the x-axis represents the species. The four species differed significantly in the amount of extractable volatiles in the bark, with subalpine fir containing the most, followed by lodgepole pine, spruce and Douglas-fir.

Multivariate analyses revealed that the four species varied significantly in the relative ratios of monoterpenes they possessed. In this figure, you can see the variation in the profiles of compounds that constitute more than 5 % of total volatiles (represented by the x-axis) and the amount in nanograms represented by the y-axis. Douglas-fir and spruce are more similar to each other, in their profiles, both containing high amounts of alpha- and beta-pinene than either of them is to lodgepole pine or subalpine fir. (-) b-phellandrene is a major constituent of lodgepole pine and subalpine fir.

Using principal components analysis which examines the relationships among several quantitative variables, we looked to see if the four species of conifers separated based on their chemical profiles. Here you see a plot of the first and second principal component. The principal components represent the perpendicular directions through the space of the original variables, which is this case is the amount of monoterpene. I'd like to bring to your attention the separation on the graph of the four species into four zones, with Douglas-fir and spruce occupying the left of the graph and lodgepole pine and subalpine fir occupying the right indicating that the species differ in the quantitative profiles of monoterpenes they possess.

The conclusions that can be drawn from this part of the study are that:

1) The four species differ significantly in their chemical profiles with respect to the relative ratios of compounds they possess.
2) Douglas-fir and spruce have similar profiles, as do lodgepole pine and subalpine fir.

Part IV: Tests for behavioural activity

So we figured out that the trees do indeed smell different, and to test if the Douglas-fir beetle and mountain pine beetle could discriminate against these differences, we conducted trapping experiments last summer, by reconstituting bark volatiles in the ratios in which they were found in the conifers and testing them for relative attraction in combination with an attractive bait. Only compounds that constituted 5 % or more of the volatile profile were included in the blends. Similar tests for the spruce beetle and balsam beetle will be conducted this summer.

We conducted two sets of trapping experiments. One to test if beetles discriminated between host and nonhost conifers and two, to test if primary attraction existed in the Douglas-fir beetle and the mountain pine beetle.

We had five treatment blends in addition to an unbaited trap and a pheromone bait. The treatments were the pheromone bait plus the volatiles of coastal Douglas-fir, interior Douglas-fir, spruce, lodgepole pine and subalpine fir. Each treatment had 15 replicates and traps were set up in randomised complete blocks.

This is the data from the host discrimination test for Douglas-fir beetle. In the next four graphs, the x-axis here represents the mean number of beetles caught, with males on the left and females on the right. The y-axis gives the treatments. In the interior, Douglas-fir beetle males did not discriminate among any of the treatments, while females responded significantly less to the bait in combination with volatiles of lodgepole pine and subalpine fir, compared to any of the other treatments. Female Douglas-fir beetles are the first attacking sex, so it makes sense that they are more discriminating than males when it comes to host selection.

In the primary attraction experiment, the bark volatiles were tested alone and in combination with the pheromone to determine if the host blend was attractive by itself (which would demonstrate primary attraction) and if it increased attraction to the pheromone bait, which would demonstrate synergism. You can see that in both males and females, the bark blend caught significantly more males and females that the unbaited trap, indicating that primary attraction does occur in the Douglas-fir beetle. When the bark volatiles were added to the aggregation pheromones, there was a significant increase in the number of females caught compared to the pheromones alone, but made no difference in the number of males, indicating that females were more sensitive to differences in attractive odours, being the first attacking sex.

This is the data from the host discrimination experiment in the mountain pine beetle. The commercial lure containing the monoterpene myrcene along with the aggregation pheromones *trans*-verbenol and *exo*-brevicomin is the most attractive of all treatments. There was no significant increase in the number of beetles caught in traps baited with the aggregation pheromones in combination with host and nonhost volatiles. The was no evidence of host discrimination in the mountain pine beetle, suggesting that the beetles may indeed land on the tree and test it for suitablity.

In the primary attraction experiment, the bark volatiles of lodgepole pine were not significantly more attractive than the unbaited trap indicating that there was no primary attraction to host volatiles in the mountain pine beetle. Again, myrcene, in combination with the aggregation pheromones was the most attractive and the lodgepole pine blend in combination with the pheromones did not significantly increase the response to the pheromones. This suggests that host volatiles are not vital in the host selection process of the mountain pine beetle. Also, mycene, the most effective synergist is not a major component of lodgepole pine and may be an ancestral response to another host. We are going to examine the volatiles of ponderosa pine in

BC to see if this is the case. So, landing randomly on trees may be the host selection mechanism of the mountain pine beetle.

The conclusions that can be drawn from the field tests are that

5) Douglas-fir beetles are capable of discriminating among certain nonhost conifers and can locate hosts by primary attraction, lending evidence for the primary attraction hypothesis.
6) Mountain pine beetles are unable to discriminate between hosts and nonhosts in flight and may have to land and sample them for suitability.

Experiments are in progress for the spruce beetle and the western balsam bark beetle to determine their mechanisms of host selection and I'm happy to say that this is yielding some interesting insight into the biology and behaviour of these beetles.

FINAL BUSINESS MEETING

WESTERN FOREST INSECT WORK CONFERENCE
53rd ANNUAL MEETING
Whitefish, MT

Final Business Meeting
25 April, 2002

Barbara Bentz, Chair, called the meeting to order at 10:30 a.m.

Mark Schultz read the minutes of the 2002 Initial Business Meeting.

New Business:

Item 1. Commercial exhibits: Commercial exhibits will be charged $200 and will not be put in the room with the posters session (2000 approved resolution below).

Item 2. New Chair and Councilor: A motion was made (by Ken Gibson) to change the constitution to extend the term of the chair and secretary for an additional year. There was a discussion that this would reduce the diversity in the executive committee and that there are only so many chances to get the honor of the chairmanship. Peter Hall made a motion to extend the term of the secretary for three years and keep the term of the chair at two years. There was discussion that this change would not benefit the membership and that the chair and the secretary should not have different terms. Other member thought that the current term is not enough time to get things done or issues the chair is interested in resolved and that there are other benefits in extending the term. It was also brought up that it takes both chair and secretary some time to get used to the job and that the first year is a learning experience. By the time one learns the responsibility of the job, the term is over. There would seem to be enhanced effectiveness in extending the term of office. There also was some discussion on the alleged benefits of an extended term that was not clear to some members. We need an examination of what you get compared to what you give up. Article 7 of the constitution says that a 2/3rds vote of those attending the conference is needed to change the constitution. There was a suggestion that two terms could be allowed. Vote on the motion to extend the term of chair and secretary to three years was: Yes - 16, No – About everyone else. Motion failed. Peter's motion also failed by a vote of 6 (Yes) to 50+ (No). **The term for chair and secretary will stand at 2 years**.

Item 3. Scholarship committee:
Ladd Livingston made a motion to drop the requirement of membership to receive a scholarship. No questions were asked. Vote results: Yes – 50, No – 10. The motion passed.

Item 4. Reprinting of Western Forest Insects: Nancy Rappaport, as chair of the committee, made a motion of how to proceed with the reprinting of Western Forest Insects (attached). The committee viewed it as a need for reprinting. Boyd Wickman seconded the motion. It was brought up that 'Forest Health Protection' (in the motion) should be modified to 'Forest Health Protection and Research'. It was discussed that the scanning part of the resolution would get in the way of what we need, but it was generally agreed that we need copies now. Also, copyright laws might be a problem if we outsource the printing. There was general discussion on reducing the motion to just reprinting of the book. Even though the original plates could not be found there are probably better pictures available for a reprint. A new edition could also be enhanced with more geographic distinctions. Recognition of the revision has to be worked out. A similar book, on Mexican Insects, has excellent color photos and section or chapter authors. A revision of Western Forest Insects could follow a similar format. Books are good because the software that reads CDs could change with time, making it difficult to find a reader. Nancy made a motion to put together a committee to look at options of reprinting Western Forest Insects. Nancy re-read the motion with the 'research' addition and with an addition to stage three of: 'as well as other North American forestry organizations'. Jan made a motion to ***amend Nancy's resolution and to keep only the third stage (revision) of the book***. Boyd seconded Jan's amendment of the resolution. Vote was Yes – 40, No - 0 for Jan's amendment of original motion. Amended motion passed (attached).

Item: 5. **Printing of the 1995 Conference proceedings**. Dave Wood made a motion that WFIWC Chair request the 1995 minutes be delivered within 30 days and to secure workshop summaries to reconstruct the proceedings. There was discussion on whether we could recreate the document without the notes and whether we could seek legal action to get the notes. Ken and Sandy are willing to publish both proceedings. The revised motion was made that: The new ***WFIWC Chair will appoint a committee to determine how to get the minutes and other 1995 proceeding documents***. Vote was: Yes - 55, No - 1. The motion passed.

Item 6. Mailing the proceedings: Ladd made a motion to ***mail the proceedings only to those who attend the meeting***. Other members can get a copy from the website, or a paper copy from Ladd, inasmuch as a few extra copies are always printed. If the website is not maintained, we can always have the proceedings scanned. Vote: Yes – 50, No – 0. The motion passed.

Item 7. Committee Appointments. Brytten Steed was appointed Chair for the Common Names Committee. Boyd Wickman is retiring from all committees but will help raise money. Darrell Ross has agreed to be Chair of the Scholarship Committee. A new committee has been formed to compile guidelines to help in hosting WFIWC. Barb Bentz, Ken Gibson, and Sandy Kegley have agreed to serve on this Conference Committee. Roger Burnside reported that the Selection Committee chose **Jose Negron for WFIWC Chair, Sheri Smith for Secretary, and Tim McConnell for Councilor starting in 2003**. There was a unanimous vote for all new Executive Committee members.

Item 8: 2003 Conference location: Mike Wagner reported that most members in 2001 agreed to go to Mexico for the 2003 conference, despite a concern for cost. We would meet in late September 2003 because of certain advantages to our prospective hosts: 1) better timing for their budgetary processes, and 2) that's a time they could coordinate our meeting with other meetings. We agreed to adjust our schedule to meet their needs. There may be a simultaneous meeting of an Urban Forestry group, but meetings should not conflict. As with all joint meetings, professionals from other disciplines will be in attendance, and that could benefit our meeting. We should know by late-September 2002 if the meeting will be held in Mexico. If not, it will be held in Flagstaff.

Item 9. 2004 Joint-Meeting with WIFDWC and 2005 WFIWC meeting location. We do not yet have a proposal for the 2004 meeting site. It will be in spring 2004. Lorraine made an invitation to hold the 2005 meeting in Kamloops, British Columbia.

Other Miscellaneous Items:

1. Copies of the Entomology Society of American Journals and Bulletins from the 30's are available. Anyone interested could contact Red McComb.

2. Karen Ripley suggested we could do more to increase memorial scholarship contributions. We will work with members who knew members that have passed away. Is there an appropriate place to hang both the Memorial Scholarship and Founder's Award plaques?

3. The Scholarship Committee is pleased to announce that Kevin Dodds, PhD candidate at OSU, is the 2002 Memorial Scholarship recipient. Kevin will address the conference in 2003.

4. Ladd read an obituary for Bob Dolph (attached).

5. Don Dahlston read an obituary for Ron Stark (attached).

Nancy Rappaport motioned to adjourn the meeting at 11:30 a.m. Boyd Wickman seconded the motion, and the meeting was adjourned.

RESOLUTION ON COMMERCIAL EXHIBITS

(Proposed in 2000, approved in 2002)

During previous meetings of the Western Forest Insect Work Conference (WFIWC), companies marketing products of interest to the forest entomology community have displayed their products and product literature. The WFIWC does not have a formal policy on commercial exhibitors. As a result, the types of exhibits or displays allowed at the WFIWC vary from year to year based on decisions of the Program Committee. An established policy on commercial exhibits would reduce the potential for controversy at future meetings of the WFIWC.

The WFIWC provides an ideal opportunity for companies to market their products to the forest entomology community. In addition, commercial displays allow members of the WFIWC to become familiar with companies and their products. Consequently, commercial displays have the potential to benefit the members of the WFIWC and companies alike. However, it is important that the presence of commercial exhibitors does not interfere with the open exchange of information among the forest entomology community.

Because the WFIWC provides a marketing opportunity to the private sector and the meeting facilities are paid for by member registration fees, it seems appropriate that the WFIWC benefit from commercial exhibits by charging a fee for the space provided to commercial exhibitors. Commercial exhibitors should pay a fee for display space to be determined by the WFIWC Program Committee. This fee should cover all costs associated with providing floor space, tables, display boards, electrical access, and any other needs of the commercial exhibitors plus $200 US. The profit generated from commercial exhibits will be deposited into the WFIWC Memorial Fund to provide scholarships to forest entomology students.

Commercial exhibits will be in space separate from any poster display areas that are part of the WFIWC. However, representatives of commercial enterprises that are members of the WFIWC and have paid their registration fees are entitled to present poster displays provided that the focus is not primarily to market company products. For example, they are welcome to present the results of research that they have conducted as part of the general poster session.

The WFIWC will not actively solicit the participation of companies, but will follow the above policy when companies inquire about commercial exhibits at the WFIWC.

WESTERN FOREST INSECTS

(Unapproved resolution)

Whereas there is an acute need for reprinting of Western Forest Insects and

Whereas there is also a need for a complete revision of Western Forest Insects including forest insects of western Canada and Mexico,

Therefore be it resolved that the Western Forest Insect Work Conference (WFIWC) address these needs in a three-stage effort:

1. Request the support of Forest Health Protection and Research in scanning the existing document which will be posted onto the FHP website and made available as a CD (target date 2003);

2. Request the support of Forest Health Protection and Research for reprinting of a limited number of hard copies of the existing version of Western Forest Insects, using the scanned version as a basis (target date 2003), in order to provide necessary copies until a revision is complete;

3. Using the scanned version of Western Forest Insects as a basis for a complete revision, request financial support through the North American Forestry Commission for such a revision, which will include forest insect pests of all of western North America (target date 2005). We will consider making available a Spanish language translation of the text on CD. Logistical support will be requested from organizations such as WFIWC, the Western Association of State Foresters, the

Mexican Entomological Society (Sociedad Mexicana de Entomologia), and the Entomological Society of Canada as well as other North American forestry organizations.

Furthermore be it resolved that a committee shall be formed to coordinate these activities, with Nancy Rappaport

(nrappaport@fs.fed.us) as interim chair until a permanent committee formed and the technical lead identified. Interested parties should contact Nancy Rappaport to participate in the committee.

WESTERN FOREST INSECTS

(Revised and approved resolution)

Whereas there is a need for a complete revision of Western Forest Insects including forest insects of western Canada and Mexico, therefore be it resolved that the Western Forest Insect Work Conference (WFIWC) address this need as follows:

Using a scanned version of Western Forest Insects as a basis for a complete revision, request financial support through the North American Forestry Commission for such a revision, which will include forest insect pests of all western North America (target date 2005). Logistical support will be requested from organizations such as WFIWC, the Western Association of State Foresters, the Mexican Entomological Society (Sociedad Mexicana de Entomologia), and the Entomological Society of Canada.

Furthermore be it resolved that a committee shall be formed to coordinate these activities, with Nancy Rappaport (nrappaport@fs.fed.us) as interim chair until a permanent committee is formed and the technical lead identified. Interested parties should contact Nancy Rappaport to participate in the committee.

Obituary for **ROBERT E. DOLPH JR**.

(Born 7 October 1930, Died 11 March 2002)
(Prepared by Iral Ragenovich, read by Ladd Livingston)

Robert E. Dolph Jr, retired Forest Service entomologist, passed away on March 11, 2002 in Indio, CA. Bob was born on October 7, 1930 in Springfield, Ohio.

He served in the U.S. Coast Guard for several years, just after graduating from high school. Following his stint with the Coast Guard, he enrolled in Utah State where he earned a B.S. degree in Forest Management. Since he had served in the Service prior to going to college, he was older and much more mature than the rest of the students, and often admonished them on the "need to grow up". His interests did not lie in the "theoretical" - he just wanted to "get out in the field and get to work. After graduating, Bob worked for a few years in the Intermountain Region of the US Forest Service before transferring to the Pacific Northwest Region in early 1963, where he worked as a forest entomologist. He married his wife, Peg, in 1966. He was the Supervisory Entomologist in the Regional Office when he retired in 1986.

Bob was the consummate field entomologist, and his ability to relate to the field forester was a trademark talent throughout his career. He was highly respected by foresters and fellow forest entomologists and pathologists, alike. Although knowledgeable about all forest insects, his special focus was bark beetles, specifically mountain pine beetle. "Pay me now, or pay me later," became his trademark statement for that insect. When insects didn't operate by the book, his response was a gruff, "God damn, Mother Nature"; and issues of inconsequence became a "mute" point. He was a history buff, and respected the value of history and the need to document for those who would come behind. His "Mountain Pine Beetle in the Pacific Northwest 1955-1966" and his "Budworm Activity in Oregon and Washington 1947- 1979" are still used, and referred to by entomologists today.

He also refined many aerial survey procedures and techniques. Bob and LeRoy Kline (entomologist with Oregon Department of Forestry) developed the insect intensity coding system in a moment of necessity, when they ran out of colored pens (the traditional method for recording intensity at the time) in the middle of an aerial survey. That coding system is still used in aerial survey today. His flexibility in adjusting to situations seemed minor at the time, but became very sufficient in the long run.

Being from Ohio, he was an ardent Cincinnati Reds fan, and a standing Saturday golf game was a part of his life long before he considered retiring. After retiring he and Peg sold their house and lived and traveled throughout the country in an RV with their dog, Casey.

Bob's journey through life touched many; and our lives are richer for having known him.

Obituary for **RONALD W. STARK**

(Born 4 December 1922, Died 9 April 2002)
(Prepared and read by Don Dahlston)

Ron Stark died at Sand Point, Idaho on April 9, 2002 of complications involving cancer. There were no formal services but there was a private family remembrance. I am sure that his wife, Laurie, and family would appreciate hearing from friends. The family suggested donations in Ron’s name be sent to the Panhandle Animal Shelter in Sand Point, Idaho.

Ron was an internationally known forest entomologist and ecologist and was an active participant in the WFIWC for many years. He was my major professor and the major professor of many of our colleagues in the western United States and Canada.

He received a BS in Forestry in 1948 and a MA in Zoology in 1951 from the Univ. of Toronto and his PhD in 1958 with a specialization in forest entomology from the Univ. of British Columbia. He was a Research Scientist with the Canadian Dept of Agriculture, Division of Forest Biology from 1948-1959 and during this time made major contributions to the population dynamics of the lodgepole needle miner.

In 1959 he accepted a position as Assistant Professor of forest entomology at the Univ. of California – Berkeley. He moved rapidly from Assistant to Full Professor, received the campus Distinguished Teacher Award, served as mentor to a number of graduate students and made important contributions to the population dynamics of the western pine beetle. He worked actively with forest pathologists to better understand the role of insects as a complex affecting forest resources. He left Berkeley in 1970 for a position as Professor, Graduate Dean and Research Coordinator at the Univ. of Idaho, Moscow.

While at Idaho he served as the Deputy Program Manager for the USDA Combined Forest Pest Program on Douglas-fir Tussock Moth in Portland, Oregon from 1977-78. From 1981-84 he was the Program Manager for the Canada-US International Spruce Budworm Program, CANUSA, western component also in Portland, Oregon.

Ron received a number of honors during his career and to name several: 1968 – NSF Senior Postdoctoral Fellowship; 1978 – Entomological Society of Canada Gold Medal for Outstanding Achievement in Entomology; 1983 – Chief of the US Forest Service, Certificate of Appreciation for the CANUSA program; and 1983 – Society of American Foresters Barrington Moore Award for Outstanding Achievements in Forest Biological Research.

Ron was a gifted writer and editor and published over 125 scientific papers on general forest entomology, ecology, population dynamics, forestry education, technology transfer and integrated pest management.

He was known affectionately as “King Kong” to many of us and as we say goodbye to him we thank him for his many contributions to forest entomology, ecology, and the Western Forest Insect Work Conference.

Don Dahlsten aka “Son of Kong”

CONCURRENT WORKSHOP SESSION 4

High Elevation Insects and Management

Moderator: John Anhold

Whitebark Pine Forest Health Concerns and Management in the Selkirk Mountains of Northern Idaho

Sandy Kegley

Whitebark pine is a high elevation tree species that grows in the mountains of western North America. It is important for watershed protection, recreation and aesthetic values, and as a food source for wildlife, particularly the endangered grizzly bear. Its cones remain closed at maturity and regeneration is accomplished by the Clark's nutcracker that caches seeds in openings, especially those created by fire. Whitebark pine stands in the Selkirk Mountains of northern Idaho are currently experiencing a large outbreak of mountain pine beetle, which, along with white pine blister rust, threatens the largest remaining whitebark pine stands on the Idaho Panhandle National Forests. Some stands have lost more than 70% of their whitebark pine component, most of which has been killed in the past 2 years by mountain pine beetles. Most of the affected area is inaccessible and located in recreation areas or in caribou or grizzly bear habitat where logging or preventive spraying is not an option.

We tested high release verbenone pouches and non-host green leaf volatiles (GLVs) to protect whitebark pine trees from mountain pine beetle attack in one acre plots. Forty plastic release devices were placed on trees on a grid in each treated plot. Only plots treated with verbenone pouches had significantly ($p < .054$) lower mountain pine beetle attacks than control plots. Further studies testing verbenone pouches to protect individual trees are planned. Protecting trees from mountain pine beetle attack, along with prescribed burning to create openings for natural regeneration, are management strategies showing the most promise in preventing the loss of whitebark pine in these high elevation ecosystems.

Spruce Aphid in High Elevation Habitats in the Southwestern U.S.

John Anhold

Spruce aphid, *Elatobium abietinum* (Homoptera:Aphididae), is an invasive pest in the interior Southwestern United States. This insect is causing extensive and severe damage on dormant Engelmann spruce and Colorado blue spruce in high elevation forests in late fall and winter. Engelmann spruce is more susceptible than is Colorado blue spruce. Average mortality on heavily defoliated plots is 28-42%, with 100% mortality on some plots. In other regions, where the insect develops high density populations in the spring, it's mostly parthenogenic population dynamics and damage are limited to areas where temperatures seldom fall below freezing. In the interior Southwestern U.S., populations increase in the fall, and a sexual life cycle and greater cold-hardiness are possible factors contributing to the insects success under more severe conditions. Outbreaks appear to be associated with dry winter and spring weather prior to the fall and winter in which feeding occurs.

A Report On Studies of Western Balsam Bark Beetle, *Dryocoetes confusus* Conducted at the Fraser Experimental Forest, CO,

John Popp and José F. Negrón

Pheromone traps were used from 1996 through 2000 to examine flight periodicity of the western balsam bark beetle in central Colorado. Traps were deployed at elevations of 9000, 9500, and 10,000 feet. Results indicate that peak flight occurs around the 2^{nd} week in July with occasional lags at the higher elevations.

Several mature subalpine fir trees were cut down at two sites at approximately 9,800 ft in elevation in the spring of 2000 and baited with pheromone. Location of subsequent attacks were noted. The insect preferentially attacks the underside of the downed trees. Periodic sampling of the trees showed that the insect has a two-year life cycle at this location.

International Activities Workshop

Moderator: José F. Negrón, Rocky Mountain Research Station

In this workshop we had a number of short presentations on different projects conducted or continuing relating international activities by some of our members. Summaries of participants' comments follow.

An Update on the Global Status of the European Wood Wasp, *Sirex noctilio*

William M. Ciesla
Forest Health Management International
Fort Collins, CO 80525

The European wood wasp, *Sirex noctilio*, is native to Europe and North Africa, where it confines its attacks to weakened and dying conifers and is not considered a pest of economic importance. *S. noctilio* has been accidentally introduced into exotic pine plantations in the southern hemisphere where it has become a major pest. This insect is the vector of a fungus, *Amylostereum areolatum*, to which many pines are highly sensitive. Moreover, some pines are sensitive to the toxic mucus that the females inject into trees during egg laying. Both the fungus and the toxic mucus can kill trees. Furthermore, the larvae of *S. noctilio* feed in the wood and construct large tunnels, which causes a loss of the structural integrity of the wood of infested trees. *S. noctilio* has been introduced and subsequently established in New Zealand, Australia, parts of South America and South Africa.

AUSTRALIA AND NEW ZEALAND – S. noctilio was discovered in *P. radiata* plantations in New Zealand in the early 1900s and is believed to have arrived via log imports from Europe. Toward the end of World War II, it was causing extensive mortality in New Zealand=s exotic conifer plantations, which were not thinned during the War. In Australia, infestations were first detected in *Pinus radiata* plantations in Tasmania in 1952 and on the Australian mainland in 1961.

SOUTH AMERICA - *Sirex noctilio* was first detected in South America in Uruguay in 1980. By the time it was discovered, the insect had spread throughout the country=s plantations of *Pinus elliottii, P. taeda* and *P. pinaster*. It appeared in Argentina in 1985 in Entre Rios Province, probably spreading from the initial introduction in Uruguay (Espinosa and others 1986). *S. noctilio* apparently is widespread in Argentina. Klasmer and others (1997), report it to be present in Entre Rios, Corrientes, Missiones, Buenos Aires, Cordoba and Jujuy Provinces. In 1993, an infestation was discovered near San Carlos Bariloche in Rio Negro Province at the northern edge of Patagonia. Several North American pines including ponderosa pine, *Pinus ponderosa,* Monterrey pine, *P. radiata,* lodgepole pine, *P.contorta* var.*latifolia*, Jeffrey pine, *P. jeffreyi* and jack pine, *P. banksiana* are infested in at least two plantations.

This insect was discovered in Brazil in Rio Grande do Sul State in 1988 following a report of pine mortality in the northern part of the state. Infestations have since spread to two additional states: Santa Catarina in 1992 and Parana in 1996. At the present time, some 200,000 ha of pine plantations are believed to be infested.

On 29 January 2001, the Chilean Servicio Agricola y Ganadero detected *Sirex noctilio* in Chile for the first time. The infestation was detected in a small planting of *Pinus radiata* along the international highway between Los Andes, Chile and Mendoza, Argentina, Commune of San Esteban, Los Andes Province, V Region. The detection was made as a result of a network of trap trees established and maintained by SAG since 1991. The infestation is located in an area where no commercial plantings of *Pinus radiata* exist and the probability of eradication is high.

Sirex noctilio was discovered in a 44 - year old plantation of *Pinus radiata* in the Cape Peninsula of South Africa in April 1994. The insect entered the country via pine packing crates, which were subsequently transported inland to be used as fuel wood. The insect has since dispersed in a 90 km arc from this site. Despite pest management actions taken against this insect, characteristic exit holes were identified in pine logs originating from a site near Clan William, 205 km to the north. Surveys have also confirmed its presence near Leipoldtville where local farmers and timber operators indicated that pines began dying two to three years previously.

A Tropical Sawfly, *Sericoceros mexicanus* (Kirby), (Hymenoptera:Argidae) on Roatan Island, Honduras

William M. Ciesla
Forest Health Management International
Fort Collins, CO 80525
USA

While visiting Roatan Island, a 50 km long by 2-4 km wide island in the Caribbean Sea, about 50 km off the coast of Honduras, the author detected defoliation on seagrape, *Coocoloba uvifera*, a common tree of coastal areas. Closer inspection of the trees revealed large numbers of adults, eggs and larvae of a sawfly. The sawfly was subsequently identified as *Sericoceros mexicanus* (Kirby) (Hymenoptera: Argidae). The occurrence of large numbers of this insect provided an opportunity to collect data on the life history and habits of a species of a little known group of sawflies.

The adults are colorful insects and relatively strong fliers. They swarm around host trees on warm, sunny days and during cool or overcast periods, rest on seagrape foliage and branches. In 2002, peak adult activity occurred between January 8 and10. Eggs are deposited in circular or slightly oval clusters on the undersides of seagrape leaves. Mean egg cluster size is 32.7, range 7-85. Female adults remain with the egg cluster until they die. Eggs hatch within 2-3 days of oviposition and the larvae feed gregariously on the edges of seagrape leaves, consuming all of the leaf tissue except the major veins. Larvae undergo six instars. However, the small number of instar VI larvae collected suggests that female larvae may undergo an extra instar as is the case with other species of sawflies. Pupation occurs in parchment like cocoons attached to leaves, leaf petioles and branches of seagrape. Occasionally cocoons are attached to wooden surfaces such as picnic benches. While heavily infested trees can suffer complete defoliation, the insect appears to cause little or no permanent damage. Local residents regard the insect as a curiosity rather than a pest and report at least two periods of defoliation a year – January and August.

Southern Pine Beetle Outbreak and Control Program in Nicaragua

Ron Billings
Texas Forest Service, College Station, TX

Ron Billings described a severe outbreak of southern pine beetle (*Dendroctonus frontalis*) in northern Nicaragua and direct control efforts. In 2001, native stands of *Pinus caribaea* and *P. oocarpa* were becoming infested by the southern pine beetle. With financial assistance provided by the US Department of Agriculture and U.S. Agency for International Development, and technical advise from Billings and Denny Ward (USDA Forest Service, Region 8), a suppression project was implemented in May 2001. Billings provided training on southern pine beetle detection, ground evaluation, and direct control to Nicaraguan foresters and technicians, using available handbooks published in Spanish. Fifty chainsaw crews were hired to install large buffer strips along the advancing fronts of several expanding infestations. The 200 meter-wide buffer strips consisted of two-thirds recently-infested trees and one third unattacked trees felled to disrupt pheromone production and reduce brood survival. The buffer strips extended for 15 kilometers in one case and 6-8 km in two other cases, representing one of the most extensive control projects for SPB in Central America. The first buffer ultimately failed to halt expanding populations, because certain private landowners did not allow control crews to treat known re-infestations. The other two buffer strips were successful. The outbreak in Nicaragua was eventually controlled, but not before 30,000 hectares were impacted. The beetle activity has now declined, as indicated by high populations of predators and competing insects (*Ips* spp.). The direct control strategy, developed to address southern pine beetle outbreaks in Texas and Honduras, will be extended to other Central American countries by means of a regional workshop for national forest pest coordinators, scheduled for July 2002 in Honduras.

The Red Turpentine Beetle, *Dendroctonus valens*, in Shanxi Province, P. R. China

Donald R. Owen

The red turpentine beetle (RTB) was introduced to China in the 1980s, reportedly on logs imported from the West Coast of the United States. It caused little damage until 1999 when an outbreak developed in Shanxi Province on Chinese pine, *Pinus tabuliformis.* The outbreak has continued to the present, is coincident with ongoing drought, and has resulted in mortality of more than 6 million *P. tabuliformis* in Shanxi and adjacent Provinces. Affected stands of 20-30 year-old *P. tabuliformis* were visited in July of 2001. As high as a third of the standing trees had RTB attacks, both old and new, and tree mortality approached 50% in some areas. Density of RTB attacks on *P. tabulaeformis* did not appear different from what is observed on pine hosts in the U.S. Dissections of attacked trees yielded a wide range of RTB life stages in a single tree – including parent adults and eggs to pupae and brood adults. This is consistent with the general observation that RTB attacks may extend over a long period of time on a given tree, and that RTB host colonization does not proceed with a rapid, mass attack that is typical of more aggressive bark beetles. There was no obvious injury or disease on trees under attack by RTB and mortality was generally scattered as opposed to grouped. This suggests the beetles are responding to an area-wide effect such as drought. The Chinese have documented extensive colonization of tree roots by RTB. Excavation of roots confirmed this as well as the presence of extensive bluestain. The bluestain fungus *Leptographium terebrantis* is commonly associated with RTB and may play a key role in beetle’s ability to kill *P. tabulaeformis*. Collaborative research is currently underway between Chinese scientists Sun Jianghua, Zhang Zhong-ning, and Miao Zhenwang and U.S. scientists Nancy Rappaport, Jack Stein, and Don Owen.

Exotic Forest Pest Information System for North America

Mary Ellen Dix
USDA Forest Service, Forest Health Protection, 1601 North Kent Street, RPC 7th Floor (FHP), Arlington, VA 22209

The Exotic Forest Pest Information System for North America (EXFOR=EFPISNA) is a web-based database that provides hard to obtain information on the identification, biology, management, establishment potential, potential environmental impact, and potential economic impacts of forest insects and diseases that currently are not in North America or if present have not reached their full potential impact. The database was initially established as a supplemental information source for the Pest Risk Assessment (PRA) processes used to identify potential exotic invasive organisms that threaten the health of North American forests. However, unlike the country specific Pest Risk Assessment information, EXFOR records are independent of the country of origin. The EXFOR database by concentrating this hard to find information in one globally accessible location, is a valuable resource for pest management specialists, research scientists and the general public.

The EXFOR project was proposed and established by the North American Forestry Commission's Insect and Disease Study Group, a regional organization formed under the authority of the Food and Agriculture Organization of the United Nations. Organizations supporting the project are: Canadian Forest Service, Canadian Food Inspection Agency, Sanidad Forestal, USDA Forest Service and the USDA Animal and Plant Health Inspection Service.

Currently, the database contains 98 records. Additional species of potential exotic pests will be added in the future. The EXFOR team is identifying additional pests that should be included in the database and requests that WFIWC participants send Mary Ellen Dix (mdix@fs.fed.us) or Joe O'Brien (jobrien@fs.fed.us) the name of exotic insects and diseases they feel should be included on the list and possible authors of those records.

Roles of Fungi and Mites in Insect-Tree Interactions

Moderator: Kier Klepzig, USDA Forest Service

Can Mites Impact the Fungal Communities of Bark Beetles?

Rich Hofstetter, John Moser, Kier Klepzig, Matt Ayres

Phoretic mites have the potential to transport and introduce fungi into the galleries of bark beetles and the surrounding area, potentially impacting the interactions and associations between fungi and beetles. Several species of mites associated with the southern pine beetle (*Dendroctonus frontalis*), are known to carry the bluestain fungus, *Ophiostoma minus*, that is at times an antagonist with the southern pine beetle. We hypothesized that the population dynamics of *D. frontalis* are influenced by negative feedback through community interactions involving other (mutualistic mycangial) fungi and *O. minus*, and mites that transport and feed upon the associated fungi. We found *O. minus* abundance within bark to be positively related to mite abundance but negatively related to *D. frontalis* survival. The abundance of *O. minus* gradually increased as *D. frontalis* infestations progressed through time. Changes in *O. minus* abundance were more correlated with mite abundance than with the prevalence of *O. minus* on attacking beetles. Experimental manipulations of phoretic mite abundances showed that mites increased the quantity of bluestain in the bark. Factors that affect the population dynamics and behavior of these mites, and the growth of *O. minus* in pines, likely play an important role in the population dynamics of the southern pine beetle. The use of mites and fungi as possible biological control agents for bark beetles will be discussed.

Southern Pine Beetle Dynamics: Fungi Mite be Important

Kier Klepzig, Rich Hofstetter, Matt Ayres, Jim Cronin

In seeking to better understand the role of fungi in the population dynamics of bark beetles, we have been studying the interactions of southern pine beetle (SPB) with their phoretic fungus (*Ophiostoma minus*). This bluestain fungus, vectored as well by mites phoretic on SPB, has previously been identified as an antagonist of SPB larval development, competing with the beneficial mycangial fungi (*Entomocorticium sp. A.*, *Ceratocystiopsis ranaculosus*) for phloem tissue. Our recent work strengthens the case for negative impacts of this fungus on the success of SPB.

In field studies, we noted an inverse linear relationship between the % of phloem stained blue and the number of offspring/adult. In addition, mite abundance on beetles was closely correlated with bluestain abundance both on beetles and in bark, furthering the case that mites are important influencers of the dynamics of these interactions. Manipulative laboratory and field studies with pine logs also revealed strong negative correlations between levels of bluestain and SPB reproductive success.

As we understand more about the impacts of these fungi on SPB, we are also seeking to learn more about the mechanisms of the impacts, and the abiotic factors that may influence these interactions. Laboratory studies of N levels within the SPB associated fungi, for example, revealed that *Entomocorticium sp. A.* contains the most N/unit weight. Both *O. minus* and *C. ranaculosus* were substantially lower in N content, making them less nutritious and less beneficial. Finally, we found that water potential affects the competitive interactions of these fungi. When SPB associated fungi are grown at water potentials similar to those found in the phloem of SPB attacked trees, *C. ranaculosus* is nearly an equal competitor to *O. minus*. This is in marked contrast to results seen earlier on moisture rich media, and may explain patterns observed in the field.

Roles of Beetle Associated Fungi in Ecology and Biology of Natural Enemies

Brian Sullivan, Eva Pettersson

Studies by a number of researchers have suggested that Hymenopterous parasitoids of bark beetles locate hosts by responding to cues from their hosts' fungal associates. For example, in Y-tube bioassays the parasitoid *Roptrocerus xylophagorum* is attracted in significantly greater numbers to loblolly pine tissue inoculated with the bluestain associate of its host, *Ips grandicollis*, than to either a clean air blank or mock-inoculated tissue. At the same time, a growing body of evidence points to a single class of compounds, oxygenated monoterpenes, as the probable semiochemicals mediating both (1) host location in bark beetle parasitoids and (2) the observed attraction of parasitoids to growth of the fungal associates of bark beetles.

A distinctive group of oxygenated monoterpenes appear in the odor blend associated with pines infested with bark beetle brood. These are alcohols, aldehydes, and ketones typically possessing carbon backbones identical to those of one or more of the hydrocarbon monoterpenes abundant in pine defensive resin. Examples include camphor, isopinocamphone, *trans*-pinocarveol, terpinen-4-ol, *alpha*-terpineol, myrtenal, borneol, and verbenone. Electroantennogram data collected from species of bark beetle parasitoids in Europe and North America has typically demonstrated a high degree of antennal sensitivity to these compounds. These species include the Braconids *Coeloides pissodis* and *C. bostrichorum* as well as the Pteromalids *Roptrocerus xyolophagorum*, *R. mirus*, *Rhopalicus tutela*, and *Dinotiscus dendroctoni.* In coupled gas chromatograph-electroantennogram tests which used aerations or extracts of host-infested tree tissues as stimuli, all species tested registered stronger antennal impulses to oxygenated monoterpenes than to other compounds in the crude mixtures. Blends of oxygenated monoterpenes also elicited upwind movement from several of the above species in either wind tunnel or Y-tube olfactometer bioassays.

Simultaneously, evidence indicates that bark beetle associated fungi can, under certain conditions, produce (or induce) these same compounds. When bark beetle-associated fungi are grown either in pine tissue or in culture media amended with pine tissue extracts, strongly elevated levels of several oxygenated monoterpenes--including those producing electrophysiological and behavioral activity in parasitoids--are detected. At least two species of bluestain-producing *Ophiostoma* fungi and a variety of bark beetle-associated yeasts have been found to possess this activity. When these fungi are grown in a media that is not amended with pine constituents (such as malt broth), these compounds are not produced. Since the oxygenated monoterpenes appeared to be closely related structurally to resin monoterpenes, and since detoxification mechanisms involving simple oxidations are common to a wide range of organisms, we hypothesized that oxygenated monoterpenes arose through the action of fungal enzymes on resin monoterpenes. In support of this hypothesis, we found that several bark beetle associated fungi could produce some oxygenated monoterpenes (e.g., borneol, verbenone) in culture when grown in malt broth amended with resin alone. However, the majority of oxygenated monoterpenes apparently associated with parasitoid attraction were not produced. This suggests that pine tissue may contain growth factors or stimulants necessary for the fungi to carry out the oxidations, or other mechanisms--perhaps involving interactions with the tree's secondary defensive response--may be necessary as well.

Bark Beetle-Fungal Associates: Directions for Future Research

Diana Six

Fungi are ubiquitous associates of bark beetles, and while not all form close associations with their hosts, many are dependent upon their hosts for dissemination. In turn, many beetles exhibit at least some degree of dependence upon the fungi. Recognition of these reciprocal effects led to a long-standing view by many entomologists that these associations are primarily mutualistic. However, closer investigation has revealed a diverse array of interactions including antagonism and commensalism. Indeed, considering the extensive variation in life histories of the host beetles and their associated fungi, and the range of taxonomic variation in fungal associates, the discovery of a wide range of complex interactions is not surprising. Unfortunately few of these associations have been investigated and most remain poorly understood.

Our current understanding of bark beetle-fungal associations has been limited by a tendency to disregard the vastly more numerous and ecologically diverse non-aggressive species of bark beetles in favor of the economically important tree-killing species. Further, ecological theory on the development and maintenance of symbiotic associations has only been spottily applied to the study of these systems. Past bark beetle-fungal research has resulted in the development of a comprehensive body of literature on host tree defense reactions to invasion by aggressive beetles and their associated fungi, as well as a more limited literature characterizing interactions between beetles and their associates. Ultimately, however, if we are to gain a fuller understanding of these systems, it will be necessary to develop a broader conceptual framework that considers the full range of diverse bark beetle hosts and their associated fungi.

Directions for future research should include increased attention to effects of association with beetles on fungal partners, as well as continued attention to effects of fungi on host beetles. The hypothesis that pathogenicity of symbiotic fungi drive many of these associations should be revisited. In most cases, the most closely associated fungi are not pathogenic, or are only weakly pathogenic, and are not likely to aid in tree death. In fact, the pathogenicity exhibited by some associated fungi may induce defensive responses by the host tree, thus increasing mortality of invading beetles. The vast majority of bark beetles are not aggressive, yet like the aggressive tree-killing species, are associated with fungi. Comparisons of aggressive and non-aggressive systems should provide a broader and more valid view of these associations.

To date most research has focused on the mycelial ophiostomatoid fungi and a few basidiomycetes associated with bark beetles; however, yeasts are also common associates of bark beetles. Because these fungi potentially may have strong effects on their hosts, as well as on mycelial associates, future research should address the taxonomy, distribution and effects of beetle-associated yeasts.

Special Aerial Surveys in Support of Forest Entomology

Moderator: Tim McConnell

Speakers: Richard Spriggs
David Beckman
Tim McConnell

The Use of Digital Airborne Video to Support Southern Pine Beetle Management Activities on the Nantahala National Forest

Richard Spriggs
USDA Forest Service
Forest Health Protection
Southern Region
Asheville, N.C.

The large land area to the east of Fontana Lake in western North Carolina is part of the Wayah Ranger District on the Nantahala National Forest. The overall area is comprised of several thousand acres, and contains private land interspersed with National Forest.

In a 3,900-acre portion of the National Forest east of the lake, a vegetation management project named the "Upper Fontana Project" had been planned which included some timber harvesting, wildlife habitat improvements, prescribed burning, forest road construction and reconstruction, and forest regeneration. The primary forest cover types in the area are southern pine, southern pine-hardwood, and hardwood-southern pine; with a predominance of forest stands being in older (age 60+) age classes.

In the summer of 2000, the southern pine beetle began to make its presence known in this and adjacent areas of western North Carolina, as well as eastern Tennessee and other southern states. The extent of the damage incurred by the beetles in western NC did not really become evident until somewhat later. By the summer of 2001, the evidence was rapidly accumulating. In June of 2001, Forest Service district staff conducted a field survey of the proposed timber sale regeneration and thinning units in the Upper Fontana project. Some beetle spots were located in proposed units and in adjacent stands. However, the District did not have the funding, personnel, or time to undertake a full-scale ground reconnaissance to locate and assess the pine beetle spots.

After this limited survey, a beetle aerial-detection reconnaissance flight was proposed. Forest Health Protection in Asheville, NC conducted an airborne video and aerial photography mission. The results are a georeferenced airborne video mosaic accompanied with several still photographic products. Polygons were drawn on the mosaic creating a vector coverage of known infested areas with associated acres. The Wayah Ranger District personnel will use this product to assess the amount and locations of affected stands This information will assist in determining what actions are needed to restore the project area to a healthy condition.

Special Aerial Sketch Map Surveys in Support of Douglas-fir Tussock Moth Suppression

David Beckman
Idaho Department of Lands
Coeur d'Alene, ID

In the spring and summer of 2001 the State of Idaho sprayed 76,000 acres for Douglas-fir Tussock Moth (DFTM). In the fall of 2000 David Beckman sketch mapped 55,000 acres of DFTM defoliation on 1:100,000 scale maps during the annual overview aerial survey. Because of the pending aerial suppression project the following spring and the need to better define the outbreak area; the need to better define the location and intensity of defoliation was vital. In additional to Clearwater National Forest and large private timber company lands within the defoliation area there were many small private landowners. David Beckman, using 1:24,000 ortho photo quads, to better delineate the outbreak area, flew a special aerial survey.

Special Aerial Sketch Map Surveys in Support of the Evaluation of Douglas-fir Beetle Mating Disruption Project

Tim McConnell
USDA Forest Service
Forest Health Protection
Fort Collins, CO

In support of research efforts to disrupt Douglas-fir beetle (DFB) mating on a large scale, aerial sketch map surveys were conducted on the Nez Perce National Forest during the summer seasons of 1997, 1998, 1999 and 2000. Although these disruption efforts were also done on a few other National Forests, this report only discusses the Nez Perce.

Since obtaining an exact count of new fading host trees the year after successful attack was critical to the evaluation, the annual overview aerial survey did not provide enough accuracy, so a special aerial survey was planned. The first special aerial sketch mapping survey was done using a helicopter in 1997. After this first aerial survey it was decided that an equally accurate survey could be done using a high wing airplane. All surveys were done using 1:24,000 scale USGS topography maps.

The sketch mapper was not familiar with the treatment areas within the two 20 square mile blocks so as to not bias the aerial survey.

The principle entomologists for the DFB mating disruption project are Darryl Ross, Oregon State University and Gary Daterman, USDA Forest Service, Pacific Northwest Research Station.

CONCURRENT WORKSHOP SESSION 5

Status and Impacts of Balsam Woolly Adelgid in the West

Moderator: Karen Ripley, Forest Entomologist,
Washington Department of Natural Resources

This workshop was developed due to input from the Western Defoliator Work Group meeting in Moscow, Idaho in November, 2001. Participants were interested in improving their general understanding of balsam woolly adelgid (BWA), monitoring activities, possible interactions between BWA and defoliators, and management recommendations. Following the four presentations, summarized below, brief discussion occurred. The main conclusions from this workshop include:

- BWA has had significant impact on various *Abies* species in Washington, Oregon, Idaho, and British Columbia. Significant impacts continue, even though direct mortality has subsided, sometimes due to host depletion. There is high likelihood of increased damage as BWA moves east into the Rocky Mountains, and, if regional climates warm, throughout previously infested areas.
- Some effort is being made to accurately survey the extent and presence of BWA in infested states.
- In British Columbia, efforts are being made to slow the spread from infested coastal areas to the important commercial *Abies*. No similar efforts are being made in the United States, partly related to the lack of commercial importance of *Abies* forests in the Rocky Mountains.
- Baseline information regarding the presence/absence of BWA and impact to *Abies* upon its arrival in not-currently-known-to-be-infested-areas would enhance our understanding of this insect and its effects.

Long Term Patterns of Balsam Woolly Aphid Infestations and Damage in Oregon and Washington

Dr. Russel G. Mitchell, Research Entomologist, USDA Forest Service, retired

The balsam woolly adelgid (BWA) is a tiny sucking insect that was introduced on the east coast of North America about 1900. The insect seems to infest all true firs, but it is the North American true firs that suffer most for infestations. BWA was first found in the Pacific Northwest about 1930 infesting grand fir near Salem, Oregon. Years later, in 1955, BWA was found infesting and killing Pacific silver fir and subalpine fir at several locations in the Coast and Cascade Ranges of both Oregon and Washington. Because of multiple generations and populations composed wholly of females, new outbreaks of BWA proved to develop rather quickly.

Research in the late 50's and throughout the 60's focused primarily on insect biology, predator introductions, and trend plot evaluations. In a recent evaluation, many of the old research and trend plots were revisited and assessed for insect population levels and tree damage, developing a history of 35 to 40 years of BWA evaluations in Oregon and Washington. A summary of those observations follows:

- BWA can kill a significant number of grand, Pacific silver, and subalpine fir on suitable sites.
- Stem infestations proved, as expected, to be the most lethal form of attack. Tree mortality in stands with heavy stem attacks often approached 100%.
- For grand fir, Pacific silver fir, and subalpine fir, the most stem infestations and the greatest mortality were associated with the wettest sites and the lowest elevations where the tree species would grow.
- The best sites for grand fir were just about anywhere within the Willamette Valley, the Puget Sound Trough, or along coastal streams.
- For Pacific silver fir, the best sites were the low elevations where silver fir developed climax stands in areas once dominated by Douglas-fir.
- The preferred sites for subalpine fir were where pioneering subalpine fir colonized low elevation, disturbed areas such as swampy meadows, stream bottoms, avalanche tracks, and old lava flows.
- On preferred sites, most trees were killed in the first 10 years of an outbreak. Populations then collapsed and usually became rather scarce. Some trees, however, always resisted attack only to be attacked years later--often 20 to 40 years later.
- Gouting attacks—the low level infestations in the crown that caused nodal swelling and inhibited new growth—also killed trees. The process of death, however, was a lingering one, often lasting 10 to 20 years.
- With all tree species, BWA infestations in the upper half of a tree's elevation range were rare. When infestation levels did increase, it was usually brief and associated with a pattern of 3 to 4 years of increased heat accumulation.
- None of the 60 Pacific silver firs on the several infested subalpine fir trend plots developed stem infestations or ever showed significant gouting.
- Shasta red fir and noble fir also proved resistant to the BWA at high elevations (that is, in their natural stands), even when adjacent to infested subalpine fir. Yet both noble and Shasta fir were observed infested and killed by the BWA in low elevation ornamental plantings.
- Similarly, grand fir is severely damaged in the lowlands, but not in the mountains

The varying degree of susceptibility of true fir with increased elevation is a mystery. Why, for example, is Pacific silver fir attacked and killed at 1500 feet elevation but resists attack when growing side by side with heavily infested subalpine fir at 4200 feet? The same question applies to noble fir, Shasta red fir, and grand fir. But what ever its reason, if global warming is real, this could mean a significant increase in the range of BWA both upwards and outwards.

Right now, in Oregon and Washington, BWA populations exist throughout old infested areas at rather low levels, causing some gouting and occasionally killing a few trees here and there. Its damage pattern looks a lot like the pattern of a rather passive native insect. For this reason, BWA has largely fallen off the research radar screen.

But problems remain. One of them is the persistent low-level of infestations by BWA that is gradually removing grand fir from low elevation valleys. Wherever you go the Willamette Valley, for example, you see old trees close to death, with damage crowns that have not produced seed in decades. Eventually, grand fir in a few scattered farm woodlots will be a place where they take forestry classes to see something rare.

Similarly, there are stands of subalpine fir at higher elevations with BWA populations too low to kill trees but large enough to damage crowns and prevent seed production. Because subalpine fir is a pioneer species throughout the Cascades of Oregon and Washington, BWA infestations will greatly slow the rate of recovery in many disturbed sites.

Lastly, true firs are very popular trees as ornamentals, mostly where people live at low elevations. This should attract our attention, since it appears this is the environment where every North American true fir species is susceptible to attack by the BWA. Particularly sensitive to attack, and at an early age, are trees in the Frasier, balsam, subalpine, and corkbark fir continuum.

The Current Status of the Balsam Woolly Adelgid in British Columbia

Peter M. Hall, BC Ministry of Forests, Forest Entomologist
David Trotter, BC Ministry of Forests, Nursery Pest Management Specialist
(Plant Protection Advisory Council Balsam Woolly Adelgid Subcommittee Chair)

The balsam woolly adelgid or BWA, *Adelges picea* (Ratz.) was introduced to North America from Europe in 1900 and has since dispersed through most of the habitat range of our native true firs. In British Columbia, BWA is unevenly distributed over 6000 km^2 of southern Vancouver Island and the southwestern region of the province. Following its initial discovery near Vancouver in 1958, extensive surveys in the early 60's established this general distribution. Concern for artificial spread and increased damage led to a voluntary restriction on the importation and movement of *Abies* stock, and then provincial quarantine regulations in 1966. The initial ban on growing *Abies* nursery stock or ornamentals was amended in 1977 to allow production of *Abies* but all material had to be grown under an annual permit. In essence, only permitted material could be moved and any material grown within the declared quarantine zone could not be moved outside of this zone. Permitted material grown outside the quarantine zone could be moved anywhere in the province. The only exemptions are seeds and cones; logs moved by water, and cut Christmas trees moved from November to January.

In BC, BWA populations are most commonly concentrated in the crown causing swelling (gout), distortion and death of twigs and ultimately crown dieback. Heavy stem attacks are less common. It infests all *Abies* species and although alpine fir is the most susceptible to damage, *amabilis* and grand fir are most frequently infested in coastal BC. Seedlings can be infested and seriously gouted. In 1987, surveys of long-term plots, the mortality of mature *amabilis* fir averaged 15% with individual plots ranging from 5% to 95%. With the discovery in 1983 of surviving populations and damage on alpine fir and grand fir at higher elevations in Idaho, the risk and concern for potential spread into interior BC was re-emphasized. True firs are widely distributed in BC, comprising 20% of the softwood volume and rank fourth at 13% of the annual harvest.

In 1995/96, surveys conducted by the Canadian Forest Service and BC Forest Service of *Abies* stands in the Vancouver Forest Service Region found new BWA finds outside of the current quarantine zone. At this point, all reforestation and landscape nurseries on the southern BC coast were technically within infested areas. In 1997, the BWA technical group recognized that the level of resources available now and in the future would never be sufficient to effectively monitor and quarantine the movement of BWA. Therefore, the group focused on the best methods of insuring that the movement of potentially BWA infested stock did not mix with the most susceptible true fir species, *Abies lasiocarpa*, which ranges throughout BC. The other true fir species that are primarily coastal in distribution, i.e. *A. amabilis*, and *A. grandis* , are less susceptible and infestations are often linked to off-site conditions. The technical group felt that as BWA is naturally dispersing up the BC coast that forest management strategies concerning outplant mix and viability would reduce the risk to existing stands.

Of greatest concern was the regulation of ornamental nursery stock and Christmas tree production. As there is no effective system to monitor production levels and transport, the technical group felt that the only effective method would be a comprehensive education program. Reforestation seedlings, the largest commodity group, represent less risk due to age, methods of production and closely monitored reforestation criteria.

At present the following initiatives are the focus of the BWA technical committee:

- The Canadian Food Inspection Agency would administer a proposed BWA regulated area under an agreement with the Province of BC. The regulated area would be based on the biogeoclimatic zone distribution of *Abies amabilis*.
- The BC Ministry of Agriculture, Fisheries & Food (AFF) would continue to administer the permit system for all *Abies* grown and or brought into the province.
- The BC Forest Service seedling request system would be updated to block any *Abies* seedlings designated for plating outside the regulated area from being grown within the regulated area.
- All BC Forest Service regional and district forest health staff and the BC Ministry of AFF regional specialists would be informed of the changes and requested to report any potential finds of BWA.
- An education package would be available for distribution to all commodity groups. There is currently a draft poster, pamphlet and leaflet.
- A distribution list would be created from ministry staff, forestry consultants, nursery and Christmas tree association lists. A list of potential buyers/retailers/wholesalers will be developed. The intent is to provide timely reminders and updates.
- Training sessions would be planned for Canadian Food Inspection Agency inspectors.
- Research trials to investigate BWA resistance in *Abies lasiocarpa*, effective control and management treatments to reduce BWA infestation in nursery stock and the criteria for a nursery certification program are ongoing.

Distribution of the Balsam Woolly Adelgid in Idaho

Ladd Livingston, Forest Entomologist, Idaho Department of Lands

The balsam woolly adelgid (*Adelges piceae*) was introduced from Europe to northeastern North America in about 1900. In 1983, it was discovered infesting fir trees in Idaho. Since then, aerial and ground surveys have documented its spread in Idaho over an area of approximately 14,000 mi^2 (8,960,000 ac). It now covers most of the central one-third of the state. Aerial surveys in 1997 and 1998 identified about 125,000 ac of host type with dead or damaged trees. Subalpine fir (*Abies lasiocarpa*) is a critical species in many high elevation areas. The effects of the balsam woolly adelgid on aesthetics, hydrology, and other ecological values can be very important. The adelgid is likely to continue its spread throughout subalpine fir forests of Idaho and neighboring states. West. J. Appl. For. 15(4); 227-231.

Survey for Balsam Woolly Adelgid in Washington and Oregon

Elizabeth Willhite, Forest Entomologist, USDA Forest Service

Since the late 1950's, the balsam woolly adelgid has been noted causing significant decline and mortality of grand fir (*Abies grandis*), Pacific silver fir (*A. amabilis*), and subalpine fir (*A. lasiocarpa*) in many areas of Oregon and Washington. Although annual aerial detection surveys for forest insects have been conducted in both states since 1947, the accuracy of the information collected for balsam woolly adelgid is limited because balsam woolly adelgid occurrence and damage often is not visible from the air or is misidentified. Additionally, sufficient understanding of the long-term ecological effects of chronic balsam woolly adelgid infestations is lacking.

In response to the inherent uncertainties of the aerial survey database on balsam woolly adelgid distribution, incidence, and severity, and to concerns about negative long-term ecological effects, a balsam woolly adelgid monitoring project funded by the USDA Forest Service Forest Health Monitoring Program was initiated in 1998. Project cooperators include Washington Department of Natural Resources, Oregon Department of Forestry, USDI National Park Service, and USDA Forest Service. Project objectives are to: 1) Conduct a ground survey of host type throughout Washington and Oregon to confirm occurrence and distribution of balsam woolly adelgid, 2) Determine effects of balsam woolly adelgid on host species and changes in the local ecosystem, 3) Determine whether existing parameters for occurrence and risk that were developed in the 1960's are still applicable, and 4) Explore opportunities for adapting the study methodology to surveys of other introduced species.

A mostly roadside, systematic ground-based survey for balsam woolly adelgid in host type throughout Oregon and Washington began in 1998. It was completed in Oregon in 2000, and is ongoing in Washington with the expectation of completion during 2002. To date, 1096 plots have been surveyed, with 490 (44.71%) displaying evidence of balsam woolly adelgid infestation. Plot data on balsam woolly adelgid incidence, host species, host symptoms, and site characteristics are being incorporated into a geospatially-linked database. This data will be used to characterize the current distribution of balsam woolly adelgid in Washington and Oregon, and to test parameters for occurrence and risk.

In addition, seven long-term trend plots were revisited in 1999. Russ Mitchell, USDA Forest Service Research Entomologist (now retired), established these plots in the early 1960's and conducted the 1999 plot remeasurement, data analysis, and manuscript preparation. The long-term plot information is being used to characterize balsam woolly infestations during a period of 35 to 40 years, describing the course of the outbreak, ecological effects, and the relationships among host, site, and infestation severity.

Remote Sensing Applications in Forest Insect Management

Moderator: Jim Ellenwood, USDA Forest Service – FHTET, Fort Collins, CO

Moderator comments: The purpose of this session was to highlight various applications of remote sensing to forest health concerns at differing scales from the larger landscape scale to smaller project level scales.

Monitoring Bark Beetle Activities in Recently Burned Areas: Satellite Remote Sensing Combined with Field Sampling

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The demand for consistent and continuous vegetation monitoring data will continue to increase to address the many resource management issues that cross ownership boundaries and change through time. This is particularly true in areas that are burned in wildfires and are subsequently affected by bark beetle outbreaks. Wildfires and bark beetles have a long and varied history and predicting effects from the combination of these change agents is increasingly important to support sustainable resource management decisions. This project uses a simple, operational digital change detection methodology for mapping fire severity and combines these data with estimates of host populations. The combination of these datasets can form an efficient basis for field sampling and subsequent inference regarding current tree mortality as well as the potential for future mortality.

Testing the Value of Using TM and ETM+ Imagery for Detection of Mountain Pine Beetle Caused Mortality in Lodgepole Pine

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We are currently evaluating TM, ETM+, and Ikonos satellite imagery for use in estimating mountain pine beetle (MPB)-caused mortality in lodgepole pine on the Lolo National Forest in Montana and the Sawtooth National Recreation Area in Idaho. With the development of this technology we hope to provide the capability to quantify MPB impact severity at the landscape scale, map spatial patterns of impacted areas, monitor insect-caused forest change through time, and quantify the interactive relationships between forest disturbance agents such as bark beetles and fire. To date, data has been collected from 251 plots at 27 sites on the Lolo NF. Change detection techniques using various image transformations (including Tasseled-Cap and NDVI) are being used to associate spectral values from the images with MPB-caused mortality data collected on the ground. Logistic regression, general linear models, and regression trees are being used for statistical associations. To date, NDVI transformed data is providing a better prediction of observed mortality. Several areas have been identified that will need improvement for this technology to be successful. These include, 1) the inclusion of older mortality in regression equations, 2) prediction of presence/absence mortality rather than quantification of trees per acre killed per pixel, and 3) the use of homogenous, rather than mixed tree species, stands for ground data collection. We are also evaluating the use of both ETM+ and Ikonos imagery for detection of MPB-caused mortality in homogenous lodgepole pine stands in Idaho using similar methodology.

Spectral Features Associated with Subalpine Fir Decline Due to Balsam Woolly Adelgid Infestation.

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Balsam woolly adelgid, *Adelges piceae*, is an introduced pest of true firs. It is widely established in North America, but has only recently expanded its range into the interior west. Currently, there is no efficient technique to detect the presence of balsam woolly adelgid during the early stages of infestation development. Using a hand-held spectroradiometer, we have evaluated the spectral response of subalpine fir in different stages of decline due to infestation. Preliminary results suggest that following infestation, non-visual changes in the spectral signature of foliage at the branch level do occur in several spectral ranges. We are currently collecting additional branch level data across a range of infestation sites and are exploring the application of these results at the canopy level using low altitude AVIRIS data.

Recent Pheromone Developments

Workshop Moderator: Darrell Ross

About 40 people attended this workshop. Five speakers shared the results of recently completed research on pheromones and host tree compounds. The following are summaries of their presentations.

Dose-Dependent Synergism and Inhibition of Bark Beetle Responses to Host Monoterpenes

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Predators that engage in group attack pose special problems to prey, because even strong defensive capabilities can be overwhelmed. Bark beetles (Coleoptera: Scolytidae) represent such predators, in that single individuals or small groups cannot colonize healthy trees, but mass attacks mediated by aggregation pheromones can exhaust host resistance. Their ability to exploit conifer defensive compounds as pheromone synergists or precursors places trees in a particularly vulnerable position. We considered whether high emissions of host volatiles might inhibit attraction of conspecifics. We tested varying ratios of α-pinene, the predominant monoterpene in local hosts, to *Ips pini*'s pheromone, to simulate various stages of attack. Attraction of *I. pini* showed a parabolic relationship with ratios of α-pinene to ipsdienol plus lanierone. At high ratios, similar to what is emitted from the entrance site of the first beetle to attack or from a tree exhibiting induced resinosis, attraction was lower than to pheromone alone. Conversely, moderate ratios, similar to what are emitted from a weakened tree or one accumulating additional beetles, synergized attraction. Low ratios of α-pinene to pheromone, as would occur at high beetle densities and the tree's resultant resin depletion, were less attractive and hence might reduce overcrowding. These results suggest that inhibition of attraction to aggregation pheromones may be an important component of integrated constitutive and inducible defenses against bark beetles. *Thanasimus dubius* (Coleoptera: Cleridae), the predominant predator of *I. pini*, was also attracted to its prey's pheromone. However attraction to mixtures of α-pinene and pheromone increased across all ratios. This provides an additional example where exploitation by natural enemies of herbivore kairomones may be rendered more difficult by complex mixtures of chemical signals arising from enantiomeric ratios, synergists, spatial and temporal variations, and plant volatiles.

Attract and Kill Technology for Management of Western Pine Shoot Borer, *Eucosma sonomana*

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An attract and kill bait, LastCall™ EucosmAK, was deployed for management of Western pine shoot borer, *Eucosma sonomana* (WPSB) in pine plantations and tree nurseries. WPSB causes substantial economic losses in ponderosa, lodgepole, and Jeffrey pine in the Western Unites States. LastCall™ EucosmAK very selectively removes male moths of the target species from the ecosystem with negligible impact on non-target organisms. Baits combine the selectivity of pheromone (only 0.12 g/ha, compared to 3.5-20 g/ha for mating disruption) with rapid toxicity of insecticides (only 4.5 g/ha, compared to 500-800 g/ha for conventional sprays). This bait retains the insecticide within a hydrophobic matrix that precludes run-off or drift, thus preventing ecosystem contamination and damage. LastCall™ EucosmAK is an effective, environmentally safe, and inexpensive method for management of WPSB.

Mountain Pine Beetle Repellency Study

John Borden[1] and Jennifer Burleigh[2]
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Jennifer Burleigh reported on a mountain pine beetle repellency study conducted by John Borden in 2001 near Williams Lake, BC. John evaluated the antiaggregation pheromone verbenone at low and high doses alone and with a seven-component repellent blend of nonhost angiosperm bark volatiles (NHVs). Release devices containing the antiaggregants were deployed at 16 points on a 10 m grid in 40 x 40 m plots. In 10- control plots with no antiaggregants, single pheromone-baited trees at the plot centre were all mass-attacked, as were 26.6% of the 432 lodgepole pines within the boundaries of the plots. In contrast, in plots treated with a high dose of verbenone plus NHVs, two of the central, pheromone-baited trees escaped any attack whatsoever, four of 10 plots had no surrounding trees attacked and only 2% of the total 523 surrounding trees were mass-attacked. Density of attacked and mass-attacked trees was highest within 5 m of the central baited tree in all treatments, indicating that those beetles that breached the antiaggregant grid were then drawn toward the baited tree. Operational efficacy should thus be improved in the absence of baited trees within a treated area. The principal use of this tactic would be in the short-term protection of small, high-value stands, or in stands of high ecological or social value.

Pheromone Studies with Mountain Pine Beetle and Douglas-fir Beetle

Ken Gibson
USDA Forest Service, Forest Health Protection, Missoula, MT

Ken described his participation in a 4-area study done in 2001. Testing the ability of verbenone alone, and as part of a "pheromone/green-leaf volatile (GLV) blend," to prevent MPB attacks in WBP and LPP. The WBP sites were in northern and central ID; one of the LPP sites in central ID, the other in western MT. In all areas three treatments were compared: (1) 40 verbenone pouches per acre (about a 30' x 30' grid), (2) 40 GLV /pheromone "blends" of verbenone, alcohol, aldehyde, and guaiacol bubble capsules per acre, and (3) no treatment. All plots were baited with MPB lures in a funnel trap at plot center. Plots were 1 acre each. In WBP stands there were 4 reps of the 3 treatments; in LPP stands, 6 reps. In all areas, verbenone pouches provided best protection. Blends were better than no treatments, but not as good as pouches alone. Most pronounced results were observed in LPP stands. Western MT results were: 24.8% of green LPP attacked in check blocks; 4.7% attacked in GLV-treated blocks; and 1.9% attacked in plots treated with verbenone pouches. Complete test results are in preparation.

He also described an "aerial" application of MCH-impregnated beads to prevent DFB attacks in DF stands in northwestern MT. Tested against standard application rate of 30 MCH bubble caps per acre. Beads (4% MCH loading) applied at rate of 4 pounds per acre. A third "treatment' of no MCH provided controls. Plots were 5 acres each. Each treatment was replicated 4 times on randomly selected plots. Bubble capsules were stapled to trees at about a 40' by 40' grid. Beads were applied with hand-operated fertilizer spreaders. All plots had a funnel trap at plot center baited with weak DFB lure. Results showed no new attacks in either MCH treatment, and an average 7 new attacks per acre in untreated plots.

Finally, he reported on an MCH individual-tree protection test done in northwestern MT. Selected 4 replicates of 12 pairs of susceptible DF in areas where DFB populations were high. Each of the 48 trees were baited with a "weak" DFB lure. A randomly selected tree in each pair was treated with 4 MCH bubble capsules, applied at about 10 feet (using Hundel hammer), one to each quadrant of the bole. Results following beetle flight showed all trees not treated with MCH were heavily attacked. Three MCH-treated trees had unsuccessful attacks. None were attacked successfully.

Recent Scolytid Pheromone Research: R&D of Microencapsulated Pheromones for *Dendroctonus* and *Eucosma* Control

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We demonstrated efficacy of microencapsulated verbenone in interrupting attraction of *Dendroctonus valens* to its host volatiles (a 1:1:1 blend of alpha-pinene, beta-pinene, and 3-

carene) and in protecting pine trees from attack by *D. valens*. These studies were conducted in a *Pinus ponderosa* plantation in northern California and in a *Pinus tabuliformis* stand in central China. In California field tests, the S-(-) enantiomer of verbenone was twice as repellent as the R-(+) enantiomer, demonstrating an enantioselective behavioral response by *D. valens* to verbenone as an interruptant or repellent. We also demonstrated a sex-ratio difference in beetles responding to the different enantiomers, but numbers were small and the work will be repeated in 2003.

Microencapsulated verbenone also shows promise for control of two species of cone beetle in Mexico (*Conophthorus teocotum* on *Pinus teocote* and *Conophthorus conicolens* of *Pinus pseudostrobus*). However, cone populations were very low, and these results must be confirmed in a year of better cone crops. Microencapsulated 4-allylansole showed promise for the control of *Conophthorus ponderosae* populations in a *Pinus ponderosa* seed orchard in northern California.

We also tested microencapsulated 9-dodecenyl acetate for mating disruption of *Eucosma sonomana*, the western pine shoot borer, in northern California. We treated five 50-acre plots in ponderosa pine plantations. Each treated plot was paired with a control plot, and several measures of efficacy are being assessed. These include spray deposit assessment (was the helicopter application successful?), “sentinel” traps baited with female moth pheromone and placed in the plots after treatment (did we disrupt mating?), infestation levels (are the plots large enough that immigrating gravid females are an insignificant factor?) and tree growth response (were the treatments an overall success?). The first two assessments suggest that the helicopter application provides very even coverage and that it was successful in disrupting mating. Other measurements will be done in the fall of 2002.

New and Exciting Directions for Forest Entomologists

Workshop Moderator: Nancy J. Sturdevant

During this workshop, we brought together a group of Entomologists, Pathologists and Botanists to discuss topics that are traditionally not highlighted during our work conferences. The main objectives of the workshop were to share information with each other on these topics and encourage and support our continued efforts in these areas. The areas highlighted were: conservation education, biological control of weeds, and sensitive plants and their pollinators.

Conservation and Education Activities

Blakey Lockman
Forest Health Protection
U.S.D.A. Forest Service, Region 1

Most individuals in Forest Health Protection in Region 1 participate in conservation education activities. We discussed the basic concepts and definitions of conservation education. We also discussed some of the current projects which include the Flathead Forestry Expo, Natural Resource Youth Camp, Master Gardener Program, Insect and Disease training for government agencies and private audiences and many other informal presentations to both adult and youth audiences. For these projects, we have contributed everything from ideas, props or learning tools as well as participated in demonstrations and classroom activities. We believe that we have played a vital role in conservation education in the past with such traditional activities such as insect and disease training sessions. We also believe that we will fill an emerging need and desire with new projects and ideas in the future for both school aged children and adults.

Combining Herbicides and Biological Control Agents for Spotted Knapweed Management

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Spotted knapweed (*Centaurea maculosa*) is a perennial invasive weed infesting millions of acres of rangeland in the western U.S. and Canada. Herbicides and biological control agents are commonly employed to control spotted knapweed. This study explored the use of low rates of picloram and clopyralid to alter knapweed density and the resulting effect on the density of two root-feeding biological control insects, *Agapeta zoegana* and *Cyphocleonus achates.* Treatments were 0.11, 0.075 and 0.03 lb. ai./acre of picloram, clopyralid, and a control, each treatment was replicated three times at two sites. Treatments were administered spring 2000 and larval biological control insect densities were determined in early summer of 2001. There was no significant difference ($p=0.982$) in survival of larvae between control and treatment plots two weeks after herbicides were applied. One year after herbicide applications, an increase in the number of insects per plant was observed in the picloram and clopyralid treatments of 0.075 lb. ai./acre.

Kidnaper Project

Phil Mocettini
Forest Health Protection
U.S.D.A. Forest Service, Region 4

In 1996, the Boise Field Office began a cooperative project with county schools, soil conservation districts, cooperative weed management areas and the Fairfield Ranger District of the Sawtooth National Forest to offer a education and employment opportunity for middle school aged students. The project entailed teaching students about biological control of noxious weeds, specifically spotted knapweed, and the implementation of a biological control study on private lands on the Camas prairie around Fairfield, Idaho.

Forest Health Protection provided instruction on basic entomology along with some more specific information about the life cycles of the different biocontrol insect that would be studied. Forest Health Protection also provided conservation education money (through USDA Forest Service, State & Private Forestry) to help fund project needs. Not only did the project succeed in establishing harvestable populations of nearly all of the insects released, it also showed success in reducing the number of spotted knapweed plants on the study plots.

The students shared their knowledge with other students at schools and the general public at such venues as county fairs and open housed. The success of the project was recognized by Senator Larry Craig (R-Idaho) and many media outlets. It is a great example of a little effort and a few committed individuals making a difference.

The Effect of Soil Temperature on the Developmental Rates and Establishment of Two Root-Feeding Biological Control Agents of Spotted Knapweed

Cynthia Snyder, School of Forestry, University of Montana, Missoula 59812
D. L. Six, School of Forestry, University of Montana, Missoula 59812

Two root-feeding biological control insects, the moth, *Agapeta zoegana* and the weevil, *Cyphocleonus achates*, have been released at many sites infested with spotted knapweed with varying levels of success. Both feed in the taproot of the knapweed plant and have the possibility of causing extensive damage. However, little is known regarding the effects of site characteristics on their ability to establish at various sites. Because insects are poikilothermic, and these insects develop entirely below the soil surface, any site characteristics affecting soil temperature are likely to have significant impacts on the developmental rates, survival, and establishment of these insects. The objective of this study was to test the effects of shading due to vegetation cover, and the partial removal of that cover by mowing, on soil temperature and the consequent developmental rates and establishment of *A. zoegana* and *C. achates*.

Treatments were mowing with not mowing used as control; each was replicated five times at two sites for a total of twenty plots. Plots were established, insects released, and treatments administered in 2000. Each plot was subdivided into four subplots for sampling purposes. One subplot contained thermocouples tracking soil temperature, at two depths, throughout the study period. Spotted knapweed roots were destructively sampled for insect larvae from two sets of subplots at two intervals in spring of 2001. Larval head capsule widths were used to determine developmental rate and total dry weight was used as a measure of growth within instars. Adult insects were collected from another subplot into fall of 2001. Although results were not statistically significant, trends showed faster larval development and growth in the control and treatment plots, however, no difference in peak emergence was seen.

Sensitive Plants and Their Pollinators

Sheri Lee Smith
Forest Health Protection
U.S.D.A. Forest Service, Region 5

Forest Health Protection (FHP), R5, Susanville, CA, staff became involved in monitoring a sensitive plant during 2001 following the Long Damon fire, which burned over 23,000 acres on the Modoc NF in northeastern California in 1996. In July 1997 an Environmental Impact Statement (EIS) was completed. Subsequent survival success of the tree seedlings was very low due to competition from non-native grasses and the site being relatively harsh. In September 2000 the District developed an Environmental Assessment (EA) to address the need for site preparation and seedling release using herbicides. The EA was appealed and upheld over direct and indirect effects to mule deer, bats and the sensitive plant, *Iliamna bakeri*.

FHP became involved when we were asked to provide responses concerning insects to public comments for the environmental documents. Concerns were expressed by the California Indian Basketweavers Association over the California silkworm and pandora moth, both used for traditional purposes, and they were also concerned about the effects of the herbicide treatment on butterflies, moths, and native pollinators. In addition, the California Native Plant Society was concerned about the effects of herbicides on pollinators and on *Iliamna bakeri*.

The activities that occurred during 2001 included the collection and identification of bees and other insects on a number of plants in the Long Damon project area; the tagging of 1000 plants in the Long Damon project area and 100 plants in the Willow fire for the purposes of monitoring a variety of things; flowers and leaves were collected from several occurrences to develop populations genetic techniques; seeds were collected for germination studies.

GROUP PHOTOGRAPHS

Mal Furniss, Sandy Kegley, Leo Rankin, Bill Cramer, Doug Wulff, Beverly Bulaon, Ken Gibson.

Row 1: Chris Asaro, Leo Rankin, Blakey Lockman, Jill Wilson, Steve Cook, Peter Hall.
Row 2: John Schwandt, Tim McConnell, Andy Eglitis, Bill Riel, Sheri Smith.

Row 1: Sunil Ranasinghe, Stephen Nicholson, Robert Coulson, Brian Sullivan, Dan Miller.
Row 2: Richard Hofsetter, Russ Mitchell, Kier Klepzig, Terry Shore, Steve Kohler.

Row 1: Art Stock, Ladd Livingston, Ron Billings, Dave Bridgwater, Mark Schultz.
Row 2: Darrell Ross, David Moorhead, Phil Mocettini, Michael Camann.

Row 1: Kathy Bleiker, Jan Volney, Tamaki Kano, Roy Shepherd, John McLean.
Row 2: Hideji Ono, Keith Douce, Jerry Carlson, Christine Kominek, Richard Spriggs.

Row 1: Red McComb, Dan Stark, Chris Hanlon, Julie Brooks, David Wood.
Row 2: Carroll Williams, Bruce Hostetler, Joel McMillin, David Ganz, Jim Hanula.

Row 1: Dan Long, John Spence, Skeeter Werner, Stephen Mata, Don Dahlsten.
Row 2: Kevin Dodds, Sharon Hood, Tim Work, John Popp, Bill Ciesla.

Row 1: Mike Wagner, Jesus Cota, Gregg DeNitto, Zhong Chen, Darek Czokajlo.
Row 2: Mary Ellen Dix, Lee Pederson, Leo Koch, Lorraine Maclauchlan, Roy Renkin.

Row 1: John Schmid, Eric Smith, Ken Raffa, Wayne Bousfield, Jim Ellenwood.
Row 2: Chris Fettig, Boyd Wickman, Larry Stipe, Robert Hodgkinson, Josh Jacobs.

Row 1: Sky Stephens, Brytten Steed, Steve McKelvey, Monica Gaylord, Paul Bosu.
Row 2: Kjerstin Skov, Kimberly Wallin, Barbara Bentz, Jeff Witcosky.


Row 1: Roger Burnside, Kimberly Smolt, Janice Hodge, Carl Jorgensen, Matt Hansen.
Row 2: Priscilla MacLean, Don Owen, Nancy Sturdevant, Les Safranyik.


Row 1: Kathy Hein, Marnie Duthie-Holt, Heidi Trechsel, Marcus Jackson, Don Goheen.
Row 2: Robert Borys, Michele Jones, Danny Cluck, Bob Cain.

Row 1: John Anhold, Ed Lieser, Karen Ripley, Jose Negron, Stuart Campbell.
Row 2: Jeff Battigelli, Ralph Their, Nadir Erbilgin.

Row 1: Liz Hebertson, Dave Schultz, Carol Randall, Amanda Roe, Nicole Jeans-Williams, Colin Bergeron. Row 2: Jennifer Burleigh, Lia Spiegel, Terry Rogers.

Row 1: David Beckman, Beth Willhite, Jerry Beatty, Dan Miller, Ken Gibson, Beverly Bulaon.
Row 2: Doug Wulff.

LIST OF REGISTERED ATTENDEES

The information on the following pages was taken from the registration form completed by the attendees at the conference with a few exceptions. In several cases, registration forms were not filled out completely, so information is missing or was obtained from websites. In some cases, attendees provided updated information after the conference. No attempt was made to verify all of the contact information prior to printing the proceedings. Undoubtedly, some of the information has changed. In most cases, current contact information for an attendee can be obtained by connecting to the website for the organization where that person is employed.

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