58th Annual Western Forest Insect Work Conference Proceedings

Boise, Idaho
March 5 – 8, 2007

WFIWC 2007

Proceedings of the 58th Annual Meeting of the Western Forest Insect Work Conference

Boise, Idaho, March 5 – 8, 2007

Compiled by: Joy Roberts, Kathleen Matthews & Teresa Johnson

Western Forest Insect Work Conference
58th Annual Meeting
Boise, ID

Executive Committee
Peter Hall, Chair
Connie Mehmel, Secretary
Karen Ripley, Treasurer
Jennifer Burleigh, Councilor
Danny Click, Councilor
Joel McMillin, Councilor

Organizational Standing Committees
Common Names Committee: Brytten Steed, Chair
Founders Award Committee: Ken Gibson, Chair
History Committee: Mal Furniss and Boyd Wickman, Co-chairs
Memorial Scholarship Committee: Darrell Ross, Chair
Memorial Scholarship Fundraising Committee: Kimberly Wallin, Chair

2007 Meeting Organizing Committee

Program Coordination
Dwight Scarbrough

Local Arrangements
Carl Jorgensen
Laura Moffitt

Registration
Laura Dunning
Valerie DeBlander
Kathleen Matthews

Technical Assistance
Phil Mocettini
Doug Wulff
Dick Halsey
Darren Blackford

Photographs
Ron Billings

Auction
Kimberly Wallin

Poster Session
Joy Roberts
Terri Johnson
Lee Pederson

Proceedings
Joy Roberts
Kathleen Matthews
Terri Johnson

Conference Advisor
Dayle Bennett

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2007Western Forest Insect Work Conference Program
March 5-8, 2007

Date	Time	Activity / Title	Moderator / Speaker
March 5	**15:00 - 20:00**	**Registration**	**Bill Ciesla**
	17:30 - 19:00	**Executive Committee Meeting**	**Peter Hall**
	19:00 - 21:00	**Reception, Boise on the Grove Conference Center**	
March 6	**08:00 - 09:00**	**Initial Business Meeting**	**Peter Hall**
	09:00 - 09:10	**Welcome to Boise**	**Robbie Patterson**
	09:10 - 10:00	**Keynote Address, Birds of Prey**	**Peter Jenny**
	10:30 - 12:00	**2006 Memorial Scholarship Winner Presentation**	**Kjerstin Skov**
		2005 Memorial Scholarship Winner Presentation	**Andrew Graves**
	13:30 - 15:00	**Concurrent Workshops:**	
		-Cone & Seed Insects	*Ward Strong*
		-Regional Reports	*Brytten Steed*
		-High Elevation Ecosystems	*Barbara Bentz*
		-Invasive Forest Pests	*Carl Jorgensen*
	15:30 - 17:30	**Graduate Student Presentations**	**Mike Wagner Darrell Ross**
	18:00 - 21:00	**Banquet, Basque Dancers & Founders Award**	**Pat Shea**
March 7	**08:30 - 10:00**	**Concurrent Workshops:**	
		-Efficacy of Verbenone for Control of Mountain Pine Beetle	*Nancy Gillette*
		-International Activities	*Iral Ragenovich*
		-Invasive Adelgids - Eastern and Western Experiences	*Steve Cook*
		-Development of Policy & Procedures for the NAFIWC	*Robert Coulson*
	10:30 - 12:00	**Concurrent Workshops:**	
		-Efficacy of Verbenone for Control of Other Bark Beetle Spp.	*Nancy Gillette*
		-Landscape Ecology: Large Area Insect Disturbances	*Brian Aukema*
		-Digital SLR Photography for Entomologists	*Bill Ciesla*
		-Insects & Disease Web-based Data Clearinghouse	*Joel McMillin Beth Willhite*

2007Western Forest Insect Work Conference Program
March 5-8, 2007

Date	Time	Activity / Title	Moderator / Speaker
March 7	**13:30 - 15:00**	**Plenary Panel Session:**	
		Silviculture, Entomology, and the Current State of the Western North American Timber Industry	**Ralph Thier**
	15:30 - 17:30	**Poster session, Ice Cream Social & Silent Auction**	
March 8	**08:30 - 10:00**	**Concurrent Workshops:**	
		-Forest Silviculture & Bark Beetles	*Steve Munson*
		-Roles of Tree Terpenes in Modifying Insect-Plant-Environment Interactions Implications to Insect Attraction & Plant Defenses—Part A	*Nadir Erbilgin David Wood*
		-Defoliating Insects	*Laura Moffitt*
		-Current status of chemicals being used to manage forest insects	*Tom Eager*
	10:00 - 12:00	**Final Business Meeting**	**Peter Hall**
	13:30 - 15:00	**Concurrent Workshops:**	
		-Fire & Beetles: Restoration, Tree Survival & Biodiversity	*Andy Eglitis*
		-Roles of Tree Terpenes in Modifying Insect-Plant-Environment Interactions Implications to Insect Attraction & Plant Defenses—Part B	*Nadir Erbilgin*
		-Technology Applications & Future Needs	*Joy Roberts*
		-Comparison of State Programs	*Robbie Flowers*
	15:30 - 17:00	**Concurrent Workshops:**	
		-Bark Beetles and Fire - Fuel Model Interactions	*Liz Hebertson*
		-Latest Developments in Aerial Remote Sensing	*Jim Ellenwood*
		-Systemic Insecticides: Use, Efficacy, & Options	*Sheri Smith*
	17:00	**Conference Adjourns**	

Western Forest Insect Work Conference
Meeting Notes

Minutes of the Executive Committee Meeting
5 March 2007

The Committee Chair, Peter hall, called the Executive Committee meeting to order at 5:30 pm.

Attendees: Peter Hall, Chair,
Connie Mehmel, Secretary
Karen Ripley, Treasurer
Joel McMillin, Councilor
Danny Cluck, Councilor
Brytten Steed, Chair, Common Names Committee
Ken Gibson, Chair, Founders Award Committee
Darrell Ross, Past Chair & Chair, Memorial Scholarship Committee
Kimberly Wallin, Chair, Memorial Scholarship Fundraising Committee
Dwight Scarbrough, 2007 WFIWC Program Coordinator
Sheryl Costello, R2, FHP, 2008 WFIWC meeting planning committee
Ingrid Iguayo, R2, FHP, 2008 WFIWC meeting planning committee
Bob Coulson, Dept. of Ent., Texas A&M University

Dwight Scarbrough, Program Coordinator for the 2007 WFIWC gave a brief update on the status of the 2007 conference:

- We have 161 regular members, 16 students (13 are giving presentations), 6 retirees and 4 guests registered to attend the conference as of 3/5/2007.
- Estimated meeting expenses as of 3/5/2007 are $29,000.
- Estimated meeting revenues as of 3/5/2007 are $31,700.
- If WFIWC shows 400 roomnights, we will get a rebate of $2,250 from the Conference Center. (Encourage members to fill out the conference center roomnight form at the registration table to track this.)
- The Banquet, Basque Dancers, and Pat Shea's Founders Award Presentation will be in the Falcon's Eyrie room of the conference center which is down the main hallway from our breakout session rooms.

Peter Hall aknowledged that there are three WFIWC members who have passed away since the last WFIWC meeting that will be recognized during the Initial Business Meeting: Dave Schultz, Bill McCambridge, Bill Klein.

Sheryl Costello and Ingrid Iguayo, from R2, FHP office, Lakewood Service Center proposed to host the 59th Annual WFIWC Meeting in Boulder, Colorado, April 7-11, 2008. Sheryl indicated that there is a poster for viewing. The membership can "accept" this offer to host the meeting at the final business meeting.

The group reviewed and discussed the agenda for 2007 WFIWC.

Bob Coulson from the Department of Entomology, Texas A&M University requested a few minutes to discuss the development of "Guidelines and Procedures" for future North American Forest Insect Work Conferences. Bob also announced that the "Cone and

Seed Steering Committee" is starting up again. Contact Alex Mangini if you are interested.

The group reviewed the Executive Committee composition and the status and replacement needs of various positions. Part of the discussion focused on when the councilors on this committee started and when their terms would be completed. It was determined that one of the three councilors needs to be replaced. Danny Cluck will serve one more year, Joel McMillin will serve 2 more years. Danny and Joel will request nominations to find a replacement for Jennifer Burleigh during the Boise meeting.

indicated that the Common Names Committee was looking for a new Chairperson

WFIWC Committee Reports:

- Common Names Committee, Brytten Steed. Brytten indicated that the Common Names Committee was looking for a new chairperson. (Report read but not submitted for meeting notes).
- Founders Award Committee, Ken Gibson, Pat Shea will give the 2007 Founders Award Presentation at the banquet. The 2008 recipient will be Boyd Wickman. (Report read but not submitted for meeting notes).
- History Committee, Mal Furniss (Report was submitted previously to the secretary, see full report under Initial Business Meeting minutes).
- Memorial Scholarship Committee, Darrell Ross (Report was read and submitted, see the full report under Initial Business Meeting minutes).
- Memorial Scholarship Fundraising Committee, Kimberly Wallin (No Report read or submitted for meeting notes)

The group discussed the WFIWC mailing list, currently available on the website with a downloadable spreadsheet. There is a concern that this mailing list could be used to generate spam. We will retain the mailing list as it is, but members can have their addresses removed if they wish by contacting webmaster Kathy Sheehan.

The group discussed the 2009 WFIWC meeting that could potentially be a joint meeting with Western Plant Pathologist. Peter Hall will lead a discussion on this topic with the general membership.

Karen Ripley, Treasurer, gave the Financial Report. She discussed the scholarship account status and recommending to the membership that the annual award be raised from $500 to $750. The time for the accounts to be reviewed and approved by at least 2 other members of the Executive committee (per conference by laws) was scheduled. Some bills for scholarship award, plaques, and digitizing prior proceedings were delivered to Ripley. (See full report under Initial Business Meeting minutes).

The meeting was adjourned at 7:00 pm.

Note: There were no official minutes taken during this meeting. All of the above information was collected and compiled into minutes after the meeting by Dwight Scarbrough, 2007 WFIWC Program Coordinator. This information was provided by various attendees who had taken their own notes during the meeting.

Minutes of the Initial Business Meeting
6 March 2007

WFIWC Chair Peter Hall called the meeting to order at 08:00.

Dwight Scarbrough opened with a **welcome to the 58th annual WFIWC**, or possibly the annual Fruit Fly Conference for the Elimination of Humans. We have 161 registered attendees, 16 students, 6 retirees and 4 guests.

Sheryl Costello announced the **2008 WFIWC** will be held on April 7-11 in Boulder, Colorado.

Memorials were read for Dave Schultz, Bill Cambridge, and Bill Klein (see memorials on pages 14-15.)

Committee Reports were read: Founders Award, Scholarship, History, Common Names and Nominations. Karen Ripley read the Treasurer's report. (Reports from the History Committee, the Scholarship Committee, and the Treasurer are attached.)

Nancy Gillette gave a report on the **Bark Beetle Research Working Group**, a virtual research group which had its first organizational meeting in January.

Alex Mangini reported on a **Seed and Cone Insects Group** being formed for communication and coordination. He is collecting email addresses of interested people.

There was a discussion of the **WFIWC mailing list**, currently available on the website with a downloadable spreadsheet. There is a concern that this mailing list could be used to generate spam. We will retain the mailing list as it is, but members can have their addresses removed if they wish by contacting webmaster Kathy Sheehan.

Darrell Ross announced that all **WFIWC proceedings** are currently available on the website.

There will be a **retirement party for Bob Gara**, who is leaving the University of Washington, College of Forestry where he has been Professor of Entomology for 42 years. The party will be on March 17. Contact Andy Eglitis for information.

Iral Ragenovich reported on the ongoing revision of the **Western Forest Insects book**. The book has been scanned. Members are encouraged to offer updates and revisions.

The meeting was adjourned at 09:00.

Respectfully submitted, Connie Mehmel, Secretary

WFIWC Memorial Scholarship Committee Report 2006-2007

Darrell Ross, Chair
Sandy Kegley
Steve Seybold
Terry Shore

Six applications were received for the 2007 Memorial Scholarship. Four of the applications were from students pursuing M.S. degrees and two were from students pursuing Ph.D. degrees. The committee selected Monica Gaylord, a Ph.D. student at Northern Arizona University working with Dr. Michael Wagner, as the recipient of the 2007 Memorial Scholarship. Monica's dissertation research is focused on assessing the response of bark beetles and their natural enemies to thinning treatments in ponderosa pine forests in Arizona. Monica will be invited to give a presentation on her dissertation research at the 2008 WFIWC meeting.

The committee encourages all qualified graduate students to apply for the 2008 Memorial Scholarship. The deadline to submit applications is January 15, 2008.

WFIWC History Committee Report 2006-2007

In 2005, Boyd Wickman published an extensive biography of pioneer West Coast forest entomologists, Harry E. Burke and John M. Miller, based largely on recollections of their surviving children and grandchildren. He reports that he deposited the Burke-Miller material in the University of California Bancroft Library Archives, which has shown an interest in receiving material relating to forest entomology in the Pacific Coast states. Boyd, who worked throughout his career in California and Oregon, plans to deposit his personal file material there in April. (Note by M. Furniss: However, the Special Collections and Archives, University of Idaho, continues to be the official repository of the WFIWC).

Boyd is pursuing the possibility of archiving the former Portland Forest Insect Lab photo file that is presently at La Grande, OR. He suggests that the PSW Station should consider doing so with the former Berkeley Forest Insect Lab photo file that is now located in Redding, CA. These historical photo files were described in articles in the American Entomologist in 1998 by Mal Furniss & Boyd and in 2002 authored by Boyd, Torgy Torgersen & Mal. These files have been moved uncounted times since the Division of Forest Insect Investigations was dissolved in 1953 when its personnel and files were transferred to the Forest Service Experiment Stations. We support their integration into a <u>permanent</u> archive in the <u>West</u> that is acceptable to the Forest Service.

The manuscript by Mal Furniss entitled: <u>Reorganization of Forest Pest Control in Japan. An Account of Robert Livingston Furniss' Socio-Entomological Experiences During Assignments in 1949 and 1950</u> was published in the American Entomologist, Summer 2006. Editing took out some anecdotes such as the military no longer permitted scrubbing of backs by hotel maids, a practice put at end by the wives of the occupation personnel. Others did survive such as teaching the Geishas the California Schottische and Road to the Isles and even some entomological aspects.

A manuscript by Mal was submitted in October to the Heritage section of the American Entomologist, entitled: Forest Entomology in Yosemite National Park: Creation of the Tenaya Ghost Forest and glimpses of forest renewal, 1903-1984. The account involves an old-growth stand of lodgepole pine killed by the mountain pine beetle early in the last century and includes sequential photos of scenes initially photographed by John Miller and John Patterson during 1912-1925, and re-photographed by Mal in 1953 and 1984.

The manuscript, A History of Forest Insect Investigations in the Intermountain and Rocky Mountain Areas, 1901-1982, by Mal was accepted by the RM Research Station and is undergoing final editing. Jose Negron provided historical photos from the Fort Collins files. Retirees John Schmid, Mel McKnight, Daniel Jennings, Steve Mata, and others provided recollections of their experiences at the Rocky Mountain and the Southwestern Stations. Some of their recollections involved Bill McCambridge who, when given a subscription to Playboy magazine by a not-too-anonymous co-worker, got even by way of a cow-pie sandwich on a field trip.

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

WFIWC, Treasurer's Report, February 2007

Highlights of 2006:

- No expenditure related to 2006 Asheville meeting
- Total Interest Income from CD's and savings account $1292.89
- Award of scholarship to Kjerstin Skov $500.00

There has not been much financial activity within the Western Forest Insect Work Conference in 2006 because we were not financially involved in the Asheville, NC meeting. $85 was contributed to the Memorial Scholarship Fund by Ladd Livingston's sale of belt buckles. $268.85 paid for plaque inscriptions. A $500 scholarship was awarded to Kjerstin Skov of the University of Montana.

The Scholarship CD's are earning better interest than they have in the past (4.81% and 4.39%). The lower interest rate for the Memorial Scholarship Fund allows early withdrawal (without penalty) of part of the funds for more active investment. A discussion will occur with the Executive Committee.

A 2007 Memorial Scholarship will be awarded and fund-raising activities will occur at the 2007 Boise meeting.

Dec 31, 2006 Summary

Checking Balance	$2,504.80	Funds available for expenses.
Regular Savings	$1,017.90	Funds available for scholarships.
McGregor Fund	$5,120.00 (no change)	$4.81% interest will be deposited to regular savings account on a monthly basis
Memorial Scholarship Fund	$43,332.07	4.39% interest will be deposited to regular savings account in November 2007
TOTAL	$51,974.77	

Current Status of Accounts (Jan 31, 2007)

Checking Balance	$2504.80	
Regular Savings	$1030.61	
McGregor Fund	$5,120.00	Approximately 2 months of interest will be awarded when new signature cards are received.
Memorial Scholarship Fund	$43,332.07 (no change)	Interest is deposited to regular savings account when CD expires (11/07)
TOTAL	$51,987.48	+$12.71 change from 12/31/06

Recent highlights:

- CD's are earning 4.81% (McGregor) and 4.39% (Memorial).
- Tax exempt 501(c)(3) status continues.
- Seek permission to invest $20,000 more aggressively than Certificate of Deposit.

Respectfully, Karen Ripley, Treasurer, February 22, 2007

Minutes of the Final Business Meeting
8 March 2007

Chairman Peter Hall called the meeting to order at 10:30.

Dwight Scarbrough gave a final address to the group. He reminded us that hockey tickets are still available, and informed us of a change in the afternoon agenda. He gave special thanks to the many people who helped with the conference, both planning and assisting during the week. This included Carl Jorgensen, Laura Moffitt, Dayle Bennett and other members of the Boise Field Office, Doug Wulff and Lee Pederson of the Coeur d'Alene Field Office, Dave Beckmann of Idaho Department of Lands, Pat Ciesla for her assistance during the conference, (Laura Dunning for the registration) as well as many others.

Kimberly Wallin reported on the silent auction, which earned a total of $708 for the scholarship fund. Awards were given for the two highest earning items, which each had a bid of $35. These were a quilted table runner made and donated by Pat Ciesla, purchased by Ken Gibson, and a bottle of ice wine donated by Stephen Nicholson and purchased by Peter Hall. An award for the most aesthetic item(s) was given to the raku trivets made and donated by Leo Rankin. An award for the highest quality item was given to the book Manual of Dangerous Insects published in 1918, donated by Bill Schaupp and purchased by Andy Eglitis.

Bruce Hostetler has $80 to donate to the scholarship fund in the name of Dave Schultz. He encourages others to donate to get Dave's name on the scholarship plaque. Anyone interested in doing this can contact Bruce.

Ken Gibson encouraged members to submit nominations for the Founders' Award. Nominations will be accepted until the end of the year. Requirements are on the

website. It is somewhat time consuming to prepare a nomination, but it is worth the effort. A member does not need to be retired to be eligible for the award, but members of the Award Committee are not eligible. Peter Hall suggested there should be a time limit for membership on the Award Committee, since some committee members are deserving of the Founders' Award.

Brytten Steed gave an update on the search for a new chair of the Common Names Committee. Bill Ciesla has agreed to co-chair this committee with Brytten.

Brytten also suggested that the update of the Western Forest Insects book coordinate with new common names. The website for new common names can provide an electronic link to the Western Forest Insects R6FHP website: http://www.fs.fed.us/r6/nr/fid/wfi/

Iral Ragenovich said that the Western Forest Insects update can use all the help it can get. Both the Western and Eastern versions are being updated at the same time. Any new information or photos would be appreciated, and can be added on the website.

Sheri Smith expressed doubt that soliciting volunteers to update the website will result in a final product in 18 months. She asked about the feasibility of contracting this work. Iral will investigate.

Darrell Ross, chair of the Scholarship Committee, reported that six applications were received for the 2007 Memorial Scholarship. Four of the applications were from students pursuing M.S. degrees and two were from students pursuing Ph.D. degrees. The committee selected Monica Gaylord, a Ph.D. student at Northern Arizona University working with Dr. Michael Wagner, as the recipient of the 2007 Memorial Scholarship. Monica's dissertation research is focused on assessing the response of bark beetles and their natural enemies to thinning treatments in ponderosa pine forests in Arizona. Monica will be invited to give a presentation on her dissertation research at the 2008 WFIWC meeting.

The committee encourages all qualified graduate students to apply for the 2008 Memorial Scholarship. The deadline to submit applications is January 15, 2008.

Scholarship Committee members are Darrell Ross, Sandy Kegley, Steve Seybold and Terry Shore.

Karen Ripley provided members with information about WFIWC financial status. We are a 501c(3) nonprofit organization. Our funds are used to hold conferences and to provide
scholarships. If we earn more than $25,000 in a single year we have to file a tax return. In order to avoid this chore, income and expenses associated with the annual meeting are managed by the local hosts. Any money left over after the conference bills are paid goes into our operating funds. Money from the silent auction goes entirely to the scholarship fund. Our goal is to get the scholarship fund up to $100,000. The scholarship is paid from interest on CDs.

Bill Riel has volunteered to fill the councilor position vacated by Jennifer Burleigh. A move to appoint him to this position passed unanimously.

Sheryl Costello reminded members of the 2008 Conference to be held in Boulder, Colorado. There will be a field trip to Estes and Rocky Mountain National Parks.

Bob Coulson gave an update on the North American Forest Insect Work Conference. No organization exists to produce this conference. He recommended that we form a committee with members from each of the four work conferences (South, East, North Central and Western), in order to mitigate liability. The conference is held every five years. The next year should be 2011. A motion to form a NAFIWC passed unanimously. Darrell Ross will chair.

Peter Hall has not received a 2009 Conference invitation. 2009 should be the next year that we hold a joint conference with the forest pathologists. Peter has received information that the pathologists have voted not to meet with us in 2009. Peter will track down the details.

Andy Graves told us that the pathologists do want to have the joint conference, but they would like to postpone it until 2010.

Sheri Smith was in charge of organizing the last joint conference. She noted that the pathologists do not like the concurrent sessions format, and that they like to have more organized meals. Beth Willhite suggested that we could try changing our format. Bob Coulson said that the Western and Southern Conferences want a variety of things. The Southern Conference has tried to use themes. Concurrent workshops accommodate the kind of diversity that helps make a conference successful.

Publication of Proceedings is costly. The Conference discussed publication options. Some paper copies need to be produced for the University of Idaho library, but electronic copies may be an acceptable option for members. All proceedings are now available on the web. Bill Ciesla pointed out that many organizations are publishing their proceedings as CDs. It is easy to insert color photographs in this format. Bruce Hostetler said that not everyone wants or needs a CD if the document is available on the web. The Executive Committee made the decision to provide the proceedings in electronic format.

Peter Hall invited all members to come to British Columbia to see what a mountain pine beetle Act of God looks like. He will send an invitation to all conference members.

Bill Ciesla would like a memorial for Bill Klein to be added to the scholarship fund. Members can contact Bill to contribute.

Bruce Hostetler said that if more than $50.00 is contributed in someone's name, that person's name will go on the plaque. Karen Ripley will track any donations for a named individual.

The meeting was adjourned at 11:30.

Respectfully submitted, Connie Mehmel, Secretary

COMMON NAMES COMMITTEE REPORT FOR CY2006/7
May 2006 through March 2007

Committee Members – As of this writing, March 1, 2007, the Common Names Committee (CNC) membership consists of Bill Ciesla, Bobbi Fitzgibbon, Lee Humble, Iral Ragenovich, Lee Pederson, John McLean, and Chairperson Brytten Steed. With the addition of Bill Ciesla and Bobbi Fitzgibbon after the May 2006 meeting we now have a full Committee membership of seven.

This year we thank many people for preparing the proposals submitted by the WFIWC CNC including Bill Ciesla, Iral Ragenovich, Mark Shultz, Leah Aquino, Danny Cluck, and Jana Lee (with Steve Seybold and others). John McLean was again instrumental in providing Commonwealth Agricultural Bureau International (CABI) search results (includes CAB abstracts, Tree CD, and Forest Science Abstracts) to authors of these proposals.

Most submissions to the Entomological Society of America's (ESA) and Entomological Society of Canada's (ESC) Common Names Committees relate to the 200+ insects listed in Western Forest Insects (WFI) with common names not officially recognized by ESA. Names for new introduced species of importance (*) have also been submitted. In addition, species not found on the WFI list of 200+ names have been occasionally included to minimize confusion among species within a genus or associated group. Since the last WFIWC meeting, the following has been accomplished by the CNC:

Completed proposals that will begin their 30-day review by the WFIWC membership on March 15th, 2007:

Disholcaspis quercusmamma oak rough bulletgall wasp
Eriophyes calaceris purple erineum maple mite
Hylurgus ligniperda redhaired pine bark beetle*
Ips emarginatus emarginated ips
Rhagium inquisitor ribbed pine borer
Phaenops (Melanophila) gentiles green flathead pine borer

Approved by the WFIWC membership and sent to the Entomological Society of America (ESA) Common Names Committee (CNC) for their review.

Dasychira grisefacta grizzled tussock moth (12/06)
Dendroctonus approximatus larger Mexican pine beetle (12/06)
Dendroctonus mexicanus smaller Mexican pine beetle (12/06)
Pseudohylesinus granulatus fir root bark beetle (12/06)
Pseudohylesinus sericeus silver fir beetle (12/06)

Approved by the Entomological Society of America CNC the membership (officially approved in 2006) (*some names listed as submissions in the 2006 meeting notes*):

Contarinia oregonensis Douglas-fir cone gall midge
Contarinia washingtonensis Douglas-fir cone scale midge
Choristoneura lambertiana western pine budworm
Choristoneura retiniana (viridis) Modoc budworm
Cydia (Laspeyresia) piperana ponderosa pine seedworm
Ips confusus pinyon ips
Ips lecontei Arizona fivespined ips
Matsucoccus acalyptus pinyon needle scale

Polygraphus rufipennis foureyed spruce bark beetle
Pseudphylesinus nebulosis Douglas-fir pole beetle
Scolytus tsugae hemlock engraver

The WFIWC CNC continues to pull together submissions for the 'spruce engraver' group. Many have similarities in their unapproved common names. These species, their proposed common names, and the authors of the proposal are listed. Several proposals remain to be completed and several still need a principle author.

Ips perturbatus northern spruce engraver (A. Ambourn - **completed**)
Ips pillifrons southern spruce engraver (L. Pederson and J. Negron)
Ips tridens lesser/diverse? spruce engraver (D. Huber)
Ips borealis narrow/boreal? spruce engraver (??????)
(Note that *Dendroctonus punctatus* = boreal spruce beetle)
Ips hunteri blue spruce engraver (W. Ciesla – **completed**)
Pseudips concinnus Sitka spruce engraver (Iral Ragenovich)
Scolytus picea spruce limb engraver (??????)
(Note that *Opsimis quadrilineatus* = spruce limb borer in WFI)

Any WFIWC member willing to help out with these or other common name proposals should contact the WFIWC CNC chair. An updated list of species, common name as listed in WFI, and person assigned to completing the submission can be found on the WFIWC web page under the CNC.

In 2002, Brytten Steed was elected to become the CNC Chair. During the past five years the CNC has grown to its full seven-members, has re-organized the submission processes and created a new set of Rules of Order, has developed a proposal form to facilitate submissions, had developed a website and a mailing list to facilitate communication with the WFIWC membership, has promoted common names proposal submissions in support of the proposed revision of the Western Forest Insect's publication, and has assisted in proposal submissions for several important introduced insect species. During this meeting, Brytten asked the WFIWC membership to find a new Chair of the CNC. No one stepped forward to take on the chairmanship, but Bill Ciesla agreed to co-Chair with Brytten and the remaining CNC committee agreed to take on additional tasks.

Respectfully submitted, /s/ Brytten E. Steed

Committee on Common Names of Insects[1]
Membership as of March 5, 2007

Brytten E. Steed, Chair (2002)[2]
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[1] Rules require that there be a minimum of three and a maximum of seven members.

[2] Year of appointment.

William H. Klein
1928 – 2006

William H. (Bill) Klein passed away November 14, 2006 in Ogden, Utah after a brief illness. Bill enjoyed a long carrier as a forest entomologist and remote sensing specialist with the U.S. Forest Service and was an active member of the Western Forest Insect Work Conference.

Bill Klein, ground checking bark beetle infestations in California using aerial photos

Bill was born in October 1928 in San Francisco, CA. At the end of World War II he worked in the U.S. Merchant Marines and later graduated from John Muir College in Pasadena, CA. He served as a Second Lieutenant in the U.S. Army in Germany. Later he received a Bachelor's Degree in Forestry from Oregon State University and a Master of Science Degree in Entomology from Yale University.

During his years with the U.S. Forest Service, he held assignments with the PNW Research Station, the former Amherst, MA Field Office of Forest Pest Management in R-7, R-4 and, finally, as a Remote Sensing Specialist with the FPM Methods Application Group on Davis, CA. He retired in 1982. After retirement, he taught Photogrammetry and Remote Sensing at Stephen F. Austin University in Nacogdoches, TX, undertook graduate studies at Albert Ludwig University in Freiburg, Germany and served in the Peace Corps. Throughout his professional carrier, Bill's strong work ethic and conscientious approach to any project he undertook was exemplary.

Bill was an avid skier, hiker, camper, photographer and motorcyclist. He made several motorcycle trips across Germany. During his years in Ogden, he was a strong advocate for mass transit, including light rail, and was active in several other civic projects.

More than anything, I remember Bill as a great friend and wonderful traveling companion. I still have fond memories of a winter camping trip with Bill into California's Desolation Wilderness. There was another time when we had two weeks of back-to-back meetings in Colorado. During the weekend we traveled from Fort Collins to Durango, skied Crested Butte and spoke to one another in German because both of us were planning trips to Germany later in the year. On another occasion, while working together in the Black Hills, we found ourselves serving as extras in the Spearfish Passion Play. Other than getting outfitted with costumes, no one told us what we were to do once we got on stage. The longer we waited backstage the greater became our level of stage fright. As it worked out, we were members of a crowd and were cued by professional actors as to what to do and say, so we had nothing to worry about. It was a hoot.

Bill Ciesla
Fort Collins, CO

David E. Schultz
1946-2007

Dave grew up and went to school in upstate New York, receiving a B.S. in 1968 from the State University of New York in Syracuse. Following a brief tour with the Agricultural Research Service, he enlisted in the Army in 1969 and served in Vietnam, earning a Bronze Star and several other medals. Returning to SUNY Syracuse after his military service, he was granted a Ph.D. in forest entomology in 1976.

Dave started his permanent Forest Service career as a staff entomologist in the Region 5 Regional Office in San Francisco. When Forest Health Program service areas were created, Dave came to the Shasta-Trinity National Forest in 1989, spending the rest of his career providing technical assistance to landowners and resource managers to promote the health, productivity and diversity of forests across all ownership boundaries in northern California.

Dave's friends and colleagues came to appreciate him as a master of dry wit, an encyclopedia of knowledge of the West, and an artist of frugality. He was one of a kind.

WILLIAM F. McCAMBRIDGE
1923-2007

William F. McCambridge died Monday, January 22, at McKee Medical Center, Hospice Unit in Loveland. A memorial mass will be held 11 a.m. Friday at St. Joseph Catholic Church. A private interment will be held at Roselawn Cemetary.

Mr. McCambridge was born March 8, 1923, in Springfield, Mass., to James H. McCambridge and Frances V. Bradley McCambridge.

He graduated from the New York State College of Forestry at Syracuse University in 1948 and continued graduate work in entomology at Colorado State University from 1949 to 1951. His professional life was a research entomologist for the U.S. Forest Service in Colorado, Alaska, and Asheville, N.C. He published many papers concerning bark beetle behavior and control.

He was a naval aviator during World War II.

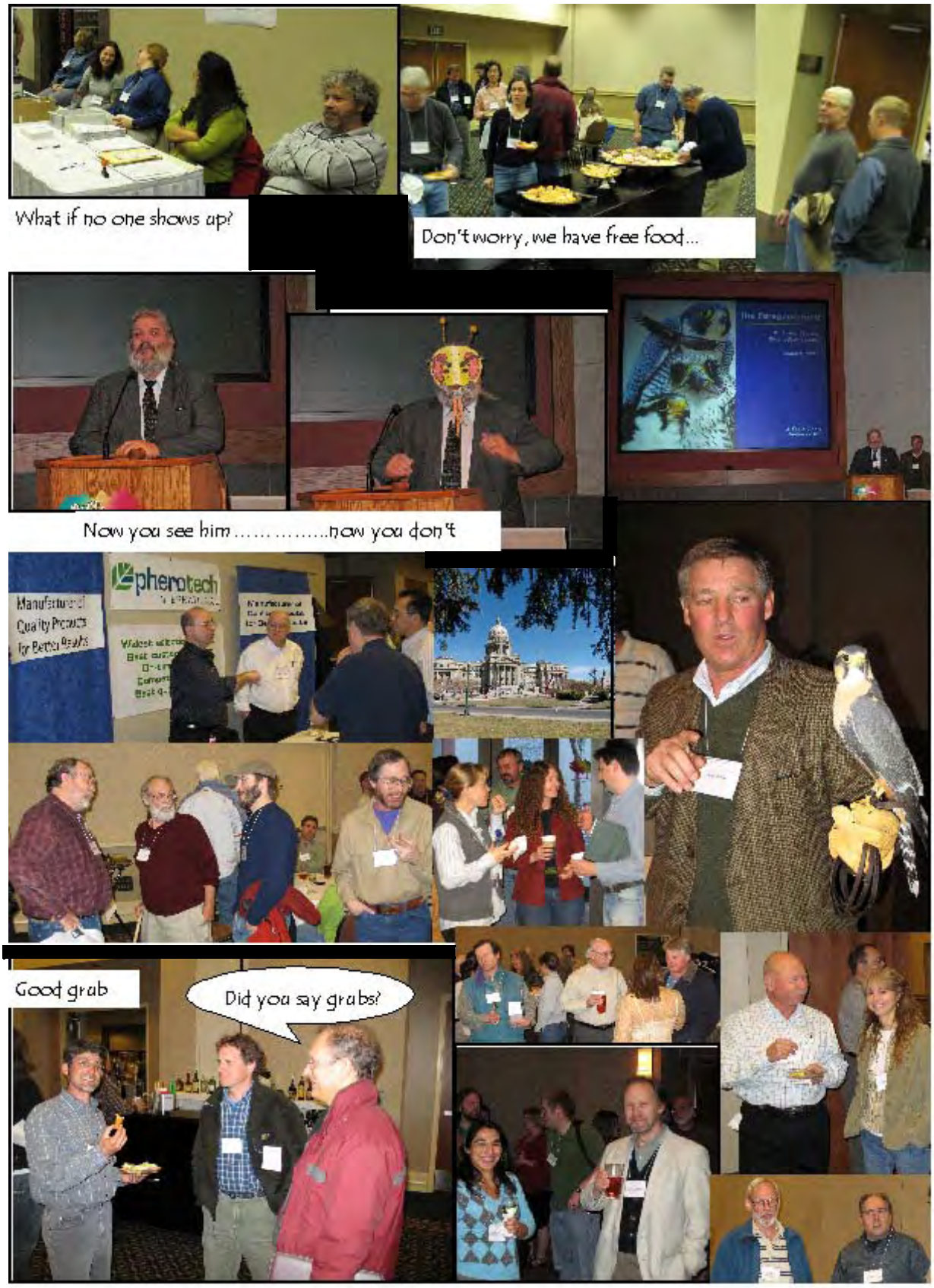
Survivors include his wife, Virginia, of Fort Collins and a brother, Robert H. McCambridge of Pittsford, N.Y.

He was preceded in death by his first wife, Ursula Marsolais McCambridge; a sister, Mary Mulcahey; and a brother, John McCambridge.

He was an avid skier since 6 years of age and generally a miserable golfer.

In lieu of flowers, contributions may be made to Hospice of Larimer County, in care of Bohlender Funeral Chapel.

(Fort Collins, CO newpaper; ca January 24, 2007)


What if no one shows up?
Don't worry, we have free food...
Now you see him.....now you don't
pherotech
Manufacturer of
Quality Products
for Better Results
Good grab
Did you say grabs?

2007 WFIWC Keynote Address
Peter Jenny, President & CEO, The Peregrine Fund
World Center for Birds of Prey

Background

Peter Jenny was officially named as The Peregrine Fund's new President and CEO on November 27, 2006. Peter has been associated with The Peregrine Fund since the organization's beginning. In1970 he accompanied one of the founding directors, Robert Berry, to the eastern Canadian Arctic to collect some of the first Peregrine Falcons to be used for captive breeding. Once captive breeding was successful, Peter worked at one of the early release sites on the Susquehanna River in Pennsylvania. After graduating from the University of Montana with a Bachelors degree in Zoology, Peter pioneered The Peregrine Fund's involvement in the Neotropics with his research on the rare Orange-breasted Falcon and subsequently co-founded the Maya Project with Bill Burnham. During his 18-year tenure as The Peregrine Fund's Vice President, Peter divided his time between managing the Northern Aplomado Falcon Restoration project and program development. Peter remains an active falconer and private pilot and enjoys a variety of field sports including bird hunting and fly-fishing. He and his family relocated to Boise from Sheridan, Wyoming.

The Peregrine Fund is an international conservation organization founded in 1970 by Tom Cade, who excelled in academic research and was very adroit in bringing people together for a focused cause. Currently, a staff of 100 people is working on 15 active projects around the world.

The World Center for Birds of Prey located in Boise, Idaho serves as the headquarters and primary site for breeding and food propagation. The Center works with small numbers of birds as breeding populations, but maximizes their productivity using artificial insemination techniques and double-clutching by removing eggs to incubators. The World Center is home for 200+ birds of prey including breeding pairs and education birds. Providing high quality food is vitally important … birds are only as good, strong, and healthy as what they eat! (70,000 Japanese Coturnix Quail and 12,000 cockerel chickens are produced annually to feed the birds at the Center).

Business/field offices and stations for The Peregrine Fund located within the United States: Arizona, California, New Mexico, Texas, and Wyoming; International locations: Greenland, Kenya, Madagascar, Panama, and South Africa.

KEYNOTE ADDRESS

The Peregrine Fund … Working to Conserve Birds of Prey in Nature

Peter Jenny was the Keynote Speaker for the 2007 WFIWC. His presentation was well-received and enjoyed by all those who attended. He began with some background on The Peregrine Fund and how the World Center for Birds of Prey facility here in Boise came to be. He spoke about the importance of conservation of bird habitats and in

general. Peter also provided some great thoughts and observations on the many important links between birds of prey and other life forms and ecosystems, including insects.

Peter Jenny displays an Aplomado Falcon during his Keynote Address.

Peter spent a good portion of his presentation talking about some of the various species of birds that his organization works with around the world and then he brought out a live Aplomado Falcon. The audience had a chance to interact with at the end of his talk during the question and answer period. This bird was a big hit with the audience and was a truly great ambassador for all of the other birds of prey that the Center works with. Below is a summary of some of the birds of prey that Peter spoke about.

PEREGRINE FALCON
Species we got our start with … extremely charismatic. Very cosmopolitan bird proven to be behaviorally adaptable to its environment. The densest population is midtown Manhattan … to the birds the skyscrapers are cliffs and there is an endless supply of prey available (pigeons).

1970 – 32 known pairs; Today – 2,000+ pairs
Restoration was successful because: 1) cause for decline removed; 2) captive bred birds released into the wild in significant numbers; 3) primary goal was clear and specific; and 4) cooperative and non-controversial approach.

MAURITIUS KESTREL
Great story … Very little press as it was an environmental success. Down to only 4 individuals partly because birds had become so specialized and had such a specific environmental niche – habitat destruction decimated their numbers because they could not adapt rapidly.

To restore, birds were bred in captivity and then introduced into highly modified habitat: sugar cane fields with new prey items. Birds didn't "know" any better (the young had no pre-programmed environment learned from parent birds) so they were able to survive. This illustrates the point that sometimes a species can be saved if we are able to "retrain" their behavior and assist them in adapting to new environment.

APLOMADO FALCON
The Southwestern United States is historical habitat. Found a remnant population in Mexico and collected breeders from this group. Noticed connection between cattle-ranching and birds … the falcons followed the cows. More than 1,200 captive-bred Aplomado Falcons have been released in South and West Texas, and New Mexico with an average 70% reaching independence over the past five years. Most likely reasons for decline: 1) widespread pesticide contamination, 2) habitat changes, and 3) human persecution. This project exemplifies the collaborative approach that is a hallmark of The Peregrine Fund: Developing and implementing a Safe Harbor Agreement that allows landowners to participate in the conservation effort without fear of reprisal/penalty from the Endangered Species Act.

Field science is work in progress and requires flexibility, adaptability, and creativity because you never know what the "real" conditions are going to present. Areas of

reintroduction for Aplomado Falcons had high numbers of predators … we had to create a structure that would maximize their survival chances and minimize threats. The challenge was keeping predators from getting nestlings … artificial nest structures were designed that allow the falcons to enter but not other species (including owls, raccoons, etc.). Biologists were pleasantly surprised when the falcons used the structures and other birds did not. Young birds spend ~3 weeks in the box being fed before the door is opened for them to explore and begin to hunt on their own.

CALIFORNIA CONDOR

In 1982 only 22 individuals remained; In 1987, the last wild condors were captured and brought into captivity to enhance breeding productivity with goal of releasing enough birds to re-establish wild population. Northern Arizona is our project site … remote Grand Canyon and vast landscapes enhance survival chances for these gigantic, very curious birds. In February 2007, total population was 289; of these, 61 are in northern Arizona. The Peregrine Fund maintains on average one-third to one-half of the entire world's population of California Condors.

Captive breeding is an equipment and labor intensive process and is necessary to adequately increase productivity; Condors reproduce SLOWLY producing only one chick every other year at most. Releasing is similar concept to the hack box for Aplomado Falcons … just different size/scope based on species. It is necessary to maximize survivability rates, especially as birds get older … don't breed until 6-8 years of age, and live up to 50-60 years. Older birds are instrumental in teaching younger ones how to "behave like a condor" and they are critical for increasing the population size.

We currently have GPS transmitters on 12 condors. By the end of 2007 we should have them on 21. Birds are tracked 24/7 … this data helps for monitoring and also provides significant data regarding flight range, foraging patterns, and other details. It is necessary to use GPS units as the birds cover HUGE distances rather quickly. They can easily travel 100+ miles a day in remote and highly rugged terrain that makes it impossible for ground crews to move as quickly. Important to keep track of as scavengers, they are the bellwether for environmental quality and health.

A high number of carcasses and/or gut piles are available during hunting season and condors have been observed regularly feeding on them on the Kaibab Plateau. Condors consume lead fragments from these carcasses/gut piles. They do not regurgitate food as often as other bird species; therefore the lead stays in their systems longer and they become poisoned. Hunters in Arizona are offered an opportunity to participate in a voluntary non-lead ammunition program co-sponsored by the Arizona Game & Fish Department. The lead issue is significant enough to the long-term survival chances of condors that The Peregrine Fund is going to convene a conference on the topic: *Spent Lead Ammunition in Wildlife and Humans*.

HARPY EAGLE

The Harpy Eagle qualifies as mega fauna and is the national symbol for Panama … people now hold in high regard and protect them with pride. Studies have shown species declines well before habitat alteration indicating the primary cause for decline to be human persecution. Birds are unafraid and would investigate human activity; seen as aggressive, humans would shoot. Our efforts in breeding have been successful and we are now finishing the project by releasing and studying the last of our captive-bred Harpy Eagles. The goal is to apply learning to other large forest eagle projects

(Philippine Eagle, New Guinea Eagle). Education is vital for success, especially to decrease/eliminate human persecution. Since education is much more accessible and faster today, the exposure of these programs increases chances for success - cause for hope and celebration.

ASIAN VULTURES

Birds of prey are excellent bellwethers to indicate the condition of the environment. Three species of Gyps vultures on the Indian subcontinent are rapidly going extinct. Dramatic population declines starting about 5+ years ago. In 2003, Peregrine Fund scientists discovered that diclofenac is *the* cause of the Asian Vulture decline. Results were published in the February issue of *Nature*. These findings represent the first time a pharmaceutical drug has been found to have such widespread and devastating consequences on wildlife. Program for breeding in India and Pakistan has been initiated by another organization; diclofenac has recently been banned, however the supplies in the field are still numerous and lethal. There has been a concerted effort to educate the local populations and veterinarians in the affected areas to stop using diclofenac and why.

Extinction would represent an important loss of a critical element in the ecosystem of Earth's most densely populated landmass and may initiate significant spread of deadly diseases by opportunistic scavengers such as rats and feral dogs.

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Judging from the wonderful response by the audience and the great interest that was shown in Peter Jenny's overall presentation and the Aplomado Falcon that he shared, we thought some of you may be interested in contacting or visiting the World Center for Birds of Prey facility here in Boise, Idaho. Their contact information is provide below.

For photographs and more information about this facility, the birds they work with, and current projects and programs, visit their website at: www.peregrinefund.org

The Peregrine Fund – World Center for Birds of Prey
5668 West Flying Hawk Lane
Boise, Idaho 83709

208-362-3716 Phone
208-362-2376 Fax
208-362-8687 Interpretive Center

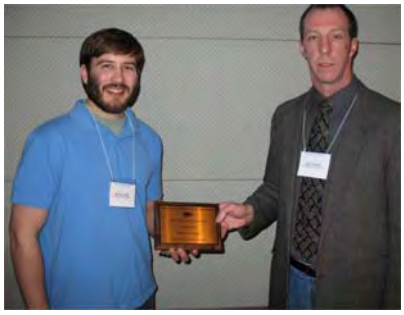
tpf@peregrinefund.org
www.peregrinefund.org

2005 Scholarship Presentation

Lutz Spruce on Alaska's Kenai Peninsula: Experiments with Semiochemicals and Methyl Jasmonate to Prevent Colonization and Mortality Caused by *Ips perturbatus* (Coleoptera: Scolytidae)

Andrew D.Graves, University of Minnesota, Department of Entomology

The northern spruce engraver, *Ips perturbatus* (Eichhoff) (Coleoptera: Scolytidae), is a major pest of Lutz spruce *Picea ´lutzii* Little, the naturally occurring hybrid of white spruce, *Picea glauca* (Moench) Voss, and Sitka spruce, *Picea sitchensis* (Bong.) Carr., which occurs primarily on the Kenai Peninsula of Alaska and other areas where these two tree species co-occur. *Ips perturbatus* is distributed transcontinentally in the boreal region of North America, generally following the distributions of its host trees, *Picea* spp. During warm and dry summers following mild winters, beetle populations can significantly increase and kill groups of standing trees. For example, in 1996 more than 47% of the residual spruce trees in a thinned area near Granite Creek, Kenai Peninsula became infested with *I. perturbatus* and an associated bark beetle, *I. tridens* (Mannerheim). Logging activity, spring drought conditions, and changes in the stand dynamics following large-scale spruce beetle, *Dendroctonus rufipennis* (Kirby), outbreaks as well as the recent overall warming of the Kenai Peninsula apparently led to this rapid increase in *Ips* activity.



Andrew Graves accepting award from Darrell Ross.

The purpose of this presentation was to present methods and results from studies that included trapping with semiochemicals, application of semiochemicals to protect individual standing trees, and application of the combination of semiochemicals and methyl jasmonate (a plant hormone) to protect standing trees. In addition, results from anatomical analyses of xylem were presented from the first attempt to spray or inject methyl jasmonate on commercial-sized standing trees.

Field bioassays using verbenone and conophthorin, interruptive semiochemicals of *I. perturbatus* and methyl jasmonate, a hormonal stimulant of monoterpene synthase in conifers, were conducted in south-central Alaska in a stand of *P. ´lutzii*. The primary objective of this project was to determine whether behavioral chemicals and/or a defense-inducing plant hormone could be used to protect individual standing trees from bark beetle attack. During the two-year study (May 2004-May 2006), attacks by *I. perturbatus* were induced using a three-component aggregation pheromone (ipsenol, ipsdienol, and *cis*-verbenol) and the aggregation was initiated prior to 3 or 7 June and attack density monitored through 3 or 16 August. Also during both years, tree mortality caused by *I. perturbatus* was recorded at two time points (initially in August and finally during May of the following year). In 2004, attack density was greatest on trees baited with the three-component attractive pheromone. Attack density was significantly reduced by the addition of the semiochemical interruptant to trees baited with the attractant. There was no significant difference in attack density between the attractant + interruptant-baited trees and those that were left unbaited. Likewise, mortality was

highest in the attractant-baited trees, whereas the addition of the interruptant significantly reduced the level of initial (2 mos. post treatment) and overall (12 mos. post treatment) mortality. In 2005, treatments from 2004 were repeated and additional treatments were assayed using methyl jasmonate spray or injection with and without the combination of verbenone and conophthorin. As in 2004, the highest attack density was observed on trees baited with the attractant. Again, there was a significant reduction in attack density on trees baited with the attractant and the combination of verbenone and conophthorin. There was no significant reduction in attack density on trees baited with the attractant when methyl jasmonate was sprayed or injected. The highest initial (2.5 mos. post treatment) and overall (11.5 mos. post-treatment) mortality was observed in trees that had been injected with methyl jasmonate and baited with the attractant. Mortality was significantly lower in all other treatments including any of those that included the attractant and combination of verbenone and conophthorin.

Although treatment with methyl jasmonate did not reduce attack density or tree mortality, methyl jasmonate-treated trees (sprayed or injected) exuded copious amounts of resin on the bark surface. Trees from four treatment groups (Tween-sprayed, MJ-sprayed, Tween-injected, and MJ-injected + attractant baited) were felled, limbed, and sectioned (1 m). Disks (5-10 cm wide) were removed every meter along the length of the tree and frozen for further analysis under laboratory conditions. Analyses of these trees revealed the presence of a continuous ring of traumatic resin ducts in the newly formed xylem tissue, supporting increased monoterpene synthesis and secretion. Based on these analyses, application with MJ (sprayed or injected) 1) significantly increased the density of resin ducts produced by spruce trees, 2) significantly increased the size of resin ducts produced by spruce trees, and 3) significantly reduced growth in spruce trees. These physiological observations lend themselves to evidence that MJ may play a role in reducing attack density and subsequent bark beetle caused mortality. Based on these experiments, though, we were not able to show that MJ treatment (sprayed or injected) reduced attack density or bark beetle cause mortality. Future studies with MJ will include determining the optimal dose and timing of application. Our primary results from these studies show that treatment with a simple, two-component interruptant system of verbenone and conophthorin significantly reduced *I. perturbatus* attack density and mortality on attractant-baited trees and can provide a full year of protection from bark beetle attack.

2006 Scholarship Presentation

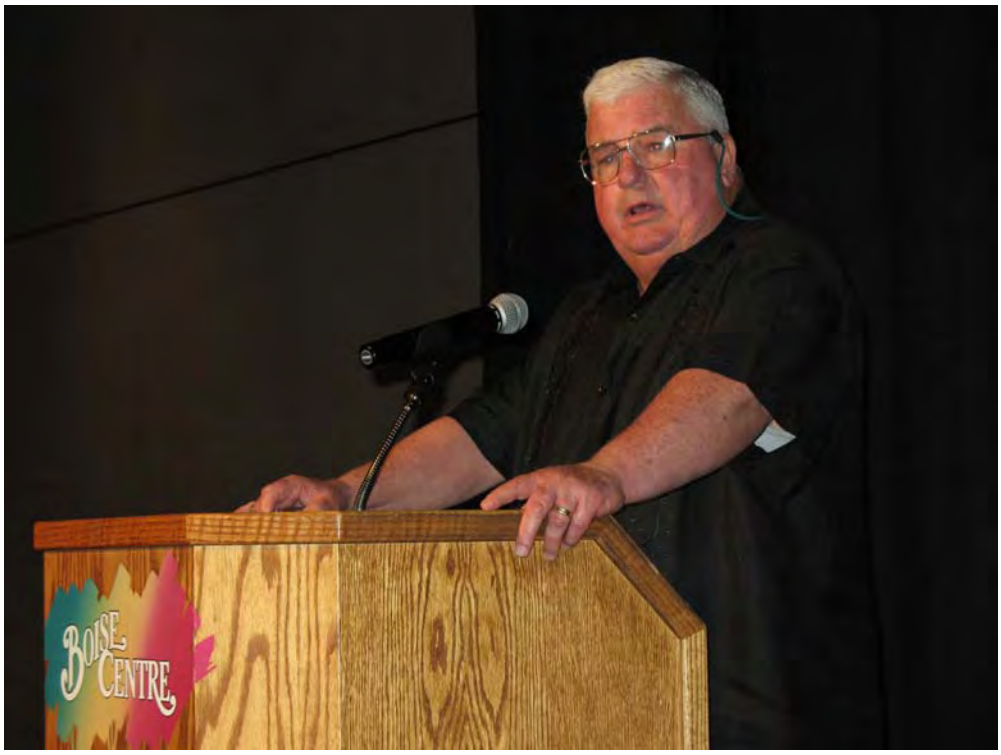
Douglas-fir Beetle Population Dynamics and Associated Mortality of Douglas-fir in Fire-affected Stands

Kjerstin R. Skov and Diana L. Six
University of Montana, College of Forestry and Conservation

Both fire and bark beetles are important agents of disturbance in the western United States. A major area of concern after fire is the potential for increased tree mortality due to bark beetles. In particular, Douglas-fir beetle (DFB) populations have been observed to increase after fire. DFB may kill fire-weakened trees and emerging brood may move into green trees. Little research has investigated this interaction or identified trees that contribute to this population growth. We established 115 fixed area, tenth acre plots at three fires in western Montana (40 plots per fire at two fires and 35 plots at the third fire). Plots were inside and outside of these 2003 fires. We measured crown scorch, bole scorch, and ground scorch in burned trees and the number of trees attacked and killed by DFB in all trees in three post-fire years (2004, 2005, 2006). We randomly located trees attacked by DFB at each fire in two post-fire years (2004, 2005) and collected bark samples and fire damage information (crown, bole, and ground scorch) and assigned each tree to a damage group (Unburned, Low, Medium, High). In each bark sample we counted new progeny and assessed factors that limited or contributed to reproductive success (crowding, resin defense, woodborer competition, evidence of natural enemies). Mortality due to fire and DFB differed between fires and fires with the most fire damage and mortality had the most mortality from DFB. Fires with higher pre-fire DFB populations had higher DFB-caused mortality after fire. DFB killed most trees in first year after fire and few trees in subsequent years. In the first year after fire, crown and bole scorch were related to mortality from fire and DFB, but not in subsequent years. Probability of mortality is positively related to tree diameter, percent crown scorch, and percent bole scorch. The probability of mortality by DFB in the first year after fire is higher than the probability of mortality from fire alone. Burned trees are a transient resource—may be due to degradation as a food source or because host trees are consumed in first year after fire or a combination. In first year after fire, DFB primarily attacked trees with High fire damage and more eggs were laid and survived to produce more new adults. In the second year after fire, DFB attacked mostly trees with little or no fire damage, laid more eggs and produced more new adults in these trees. More eggs were laid per area in the second year than the first. DFB may be crowding into fewer available hosts in the second year after fire. Management immediately after fire will be most effective but logistically difficult. Nevertheless, DFB kill few green trees in second and third year after fire so the threat may be short-lived.

Kjerstin Skov accepting award from Darrell Ross.

2007 Founders' Award
Pat Shea



2007 Founders' Award Presentation
Patrick J. Shea, Retired Research Entomologist
Pacific Southwest Research Station
Davis, CA

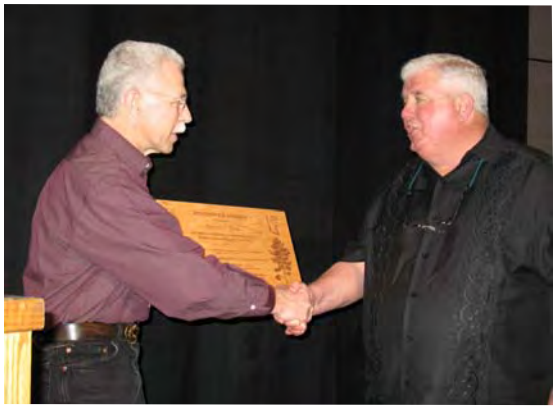
I began my Forest Service career in 1969 beginning as a GS-5 Biological Technician (Insects) with the Insecticide Evaluation Project located at the Pacific Southwest Research Station, Berkeley CA. One of my first assignments was to participate in a western spruce budworm efficacy field test of the insecticide Zectran that was being conducted in Darby, Montana. It was during this field season that I first met Mark McGregor, the first recipient of the Founders Award. He was accompanied by Jed Dewey, another R-1 entomologist. They were making a site visit as representatives of R-1, Forest Insect and Disease Management Unit. For whatever reason, Mark and I quickly became close friend and over the years worked on a number of budworm and bark beetle projects. Mark was an excellent field entomologist and during those first few years of my career he taught me a great deal about forest entomology in the inland empire and western spruce budworm specifically. Later we would embark on several years of developing strategies to deal with mountain pine beetle both on an individual tree basis and on the stand level.

Mark was not one to worry about things like experimental design, randomization, significance level, replication and the other niceties associated with conducting valid and efficient field experiments but concepts that were incredible important to me. To his thinking, his primary responsibility was to solve regional forest insect problems and

Introduction of Pat by Tom Eager.

provide forest land managers with management solutions to their insect problems and the quicker the better. This difference in approach to problem solving was the cause of many late night discussions/ heated arguments. Foremost in his mind was the question, "Was a particular effort going to assist the forest land manager?". If it wasn't, then he wanted to move on. The reason I mention Mark's devotion and single-mindedness about solving forest land managers problems is because throughout my career I tried to pursue a similar path. He was a dear friend and valued colleague and is still sorely missed.

One of the most rewarding and enjoyable research efforts I participated in was developing the experimental approach to determining the efficacy of various compounds for protecting individual high value conifers from bark beetle attack. This line of research started in the late 1970's due to a request from the Forest Insect and Disease Management group in Region 5. This was a time when the registration and use of lindane, like many other chlorinated hydrocarbons, were being questioned. Lindane was the sole material registered for protecting individual trees from attacked by a number bark beetles. There were several experimental approaches being used to test new insecticides for protecting trees from attacked by bark beetles but they all had drawbacks that limited there usefulness. Through the use of consultation with a number of disciplines including statisticians and entomologists with experience in western pine beetle biology, behavior, and pheromone chemistry, an experimental approached has evolved over time that is commonly used today. From a personal perspective this area of research was one of the most enjoyable of my 35-year career. I took personal enjoyment from these efforts for several reasons, three of which are the most important: (1) The results of these experiments are known in a relatively short time; (2) The results are put into practice within a reasonable amount of time; (3) Most importantly this line of research afforded me the opportunity to work with numerous very talented and quality colleagues that I was able to learn a great deal from.



Award presentation by Ken Gibson to Pat .

Finally, I want to sincerely thank those colleagues that took the time and effort to put together my nomination for this prestigious award. I will forever be grateful. I also wish to thank the Founder's Award Committee for approving my nomination. I am truly humbled and grateful for their kind consideration.

Plenary Panel Discussion: Silviculture, Entomology, & the Current State of the Western North American Timber Industry

Silviculturists and Entomologists (or Entomologists and Silviculturists): Working Together to Develop Desired Forest Conditions

Tom Martin
Regional Silviculturist, Intermountain Region, USDA Forest Service, Ogden, UT

Federal land managers, including Silviculturists, have a long history of collaborating with Forest Entomologists to address sustainable forest conditions at several spatial scales. Involvement at the national, regional, forest and stand levels occurs throughout the USDA Forest Service for the purpose of addressing a variety of issues. Products include national risk/hazard mapping (for coarse scale priority setting and potential budget allocations at the national scale), inventories (Forest Health Monitoring), regional mapping/inventories to develop more focused strategies and priorities, forest planning, watershed assessments, and desired vegetation conditions at both the landscape and stand scale.

The most tangible benefit of this cooperation is the end result that occurs on national forest landscapes. When treatments are planned (including cultural, timber harvest, or other suppression/prevention techniques), the informed silvicultural prescription will include information relating to insect hazard and risk, combined with other management information, that develops integrated desired conditions and alternative treatments that address these issues to varying degrees. At the landscape level, entomologists and silviculturists should address the broader perspective of forest health, or sustainable ecological conditions based upon our current understanding of ecosystem composition, structure and processes.

Well documented silvicultural prescriptions provide concise guidance that includes clear objectives and implementation steps. Objectives should include statements on the affect of the proposed treatments to forest insects, including both temporal and spatial effects. Entomologists can provide the latest research information that assist in developing context and correct application for objectives and implementation sequence.

Monitoring is crucial if we are to learn from the results of our past treatments so they can be adjusted, where needed, in an adaptive management framework. Entomologists provide valuable information when their monitoring results are incorporated in land management planning.

The relationship between these two disciplines should not be taken for granted. The training and technology transfer that includes forest insect relationships and forest vegetation most be continually provided as the agency undergoes workforce and other organizational changes, and to ensure that we maintain the proper knowledge base required for effective management.

North American Timber Industry

Dave New
Growing Excellence Inc.

No abstract submitted

The Effectiveness of Vegetation Management Practices for Prevention and Control of Bark Beetle Outbreaks in Western Coniferous Forests

Christopher J. Fettig
Pacific Southwest Research Station, USDA Forest Service, Davis, CA

Insects are major components of forest ecosystems, representing most of the biological diversity and affecting virtually all processes and uses. In the USA, bark beetles (Coleoptera: Curculionidae, Scolytinae) heavily influence the structure and function of these ecosystems by regulating certain aspects of primary production, nutrient cycling, ecological succession and the size, distribution and abundance of forest trees. The purpose of this presentation was to review tree, stand and landscape-level factors associated with bark beetle infestations and analyze the effectiveness of thinning for mitigating the negative impacts of bark beetles on forest ecosystems.

Changes in forest structure and composition have led to increased competition among trees for water, nutrients and growing space thereby increasing susceptibility to bark beetles. As trees become stressed, their insect resistance mechanisms are compromised. Trees of low vigor are more susceptible to bark beetle attack. Factors such as stand density, basal area or stand density index, tree diameter and host density are consistently identified as primary attributes associated with bark beetle infestations. However, it is important to note that despite the existence of conducive stand conditions certain abiotic factors must also be met before large-scale infestations occur.

Efforts to prevent undesirable levels of bark beetle-caused tree mortality must change stand susceptibility through reductions in tree competition, disruption of pheromone plumes thus negatively affecting host-finding, and reductions in the fecundity, fitness and survivorship of target bark beetle species. Thinning has long been advocated as a preventative measure to reduce the amount of bark beetle-caused tree mortality and its effectiveness for this purpose is supported by the scientific literature (Fettig et al. 2007). Some studies of the efficacy of thinning have failed to detect significant differences among treatments, and others are limited to anecdotal evidence. However, to date there are no reports of significant increases in the amount of *Dendroctonus* spp.-caused tree mortality in response to traditional thinning treatments (Fettig et al. 2007).

Forested landscapes that contain little heterogeneity promote the creation of large contiguous areas susceptible to similar insect outbreaks. Efforts to prevent undesirable levels of bark beetle-caused tree mortality at the landscape level must also account for the spatial distribution of both cover types and stand ages. In many areas, treatments should be implemented to increase heterogeneity.

The effectiveness of direct control techniques, which varies among bark beetle species, was briefly discussed. Direct control (i.e., cut-and-remove, cut-and-leave) is especially

effective for controlling the spread of southern pine beetle infestations because of its unique life cycle and attack behavior. Fettig et al. (2007) provided an extensive review of much of the information discussed in this presentation.

Fettig, C.J., K.D. Klepzig, R.F. Billings, A.S. Munson, T.E. Nebeker, J.F. Negrón, and J.T. Nowak. 2007. The effectiveness of vegetation management practices for prevention and control of bark beetle outbreaks in coniferous forests of the western and southern United States. For. Ecol. Mgmt. 238: 24-53.

Workshop 1: Cone and Seed Insects

Moderator: Ward Strong, BC Ministry of Forests, Vernon, B. C., Canada

An Efficacy Test of Novaluron on Loblolly Pine to Control Coneworms and Seed Bugs.

Alex Mangini
USDA Forest Service, Pineville, LA

Pine seed orchards in the South produce 120,000 pounds of genetically improved seed per year. Insects that cause serious damage to this seed crop are coneworms (*Dioryctria* spp.) (Lepidoptera: Pyralidae) and the seed bugs *Leptoglossus corculus* (Say) (Hemiptera: Coreidae) and *Tetyra bipunctata* (Herrich-Schaffer) (Hemiptera: Scutelleridae). A pilot test of the insect growth regulator novaluron (Pedestal™) was conducted on loblolly pine trees at the Hebron Seed Orchard (Plum Creek Company) in Louisiana in 2005 and 2006. Novaluron is a chitin-synthesis inhibitor effective against Hemiptera as well as Lepidoptera. Cone and conelet survival, whole-tree counts cones, and conelet ovule health indicated that novaluron had some efficacy against seed bugs but not apparently against coneworms. As a discussion point, Alex asked the Workshop audience about the experimental design; particularly, the value of a multiple-clone test versus a one- or two- clone test with more replication. Points were raised in favor of each approach.

Examining Host Monoterpenes and Azadirachtin Against the Conifer Seed Bug, *Leptoglossus Occidentalis*

Steve Cook
University of Idaho , Moscow, ID

During 2004, I conducted a survey of the major insect pests present in eight seed orchards operated by members of Inland Empire Tree Improvement Cooperative. The orchards were under a variety of management regimes that included federal, state and industry partners and there were a variety of tree species within the orchards (western white pine, ponderosa pine, lodgepole pine, Douglas-fir and western larch). Fir coneworm (*Dioryctriaabietivorella*) and western conifer seed bug (*Leptoglossus occidentalis*) were the two pests that were present in all of the orchards. We had been examining the use of host monoterpenes to disrupt attack of pine cones by *Conophtorus ponderosae* and expanded the work during 2005 and 2006 to examine the impacts of two host monoterpenes (α-pinene and myrcene) on adult *L. occidentalis*. Exposure to either of the monoterpenes at 50 ppm for 48 hours resulted in complete

mortality of the exposed seed bugs. At an exposure to 25 ppm of myrcene, 56 % of the exposed seed bugs were dead at 48 hours and 72 % were dead at 72 hours. At an exposure to 25 ppm of a-pinene, 44 % of the seed bugs were dead after 48 hours and 84 % were dead after 72 hours. None of the control insects had died within this same 72 hour period. In the future, we would like to test the toxicity of additional host monoterpenes and include immature seed bugs in the trials and determine if the use of host terpenes can be included in management tactics for *Leptoglossus occidentalis*. During the upcoming field season, we also plan to test the use of the triterpene azadirachtin against immature and adult seed bugs in field and laboratory trials. Azadirachtin has demonstrated activity as an insect growth regulator and as an anti-feedant against other insects.

Systemic Insecticide Injections: New Effective Option for Several Conifer Seed Orchard Pests.

Don Grosman
Texas Forest Service, Lufkin, TX

The efficacies of systemic insecticides emamectin benzoate, fipronil, and imidacloprid have been evaluated in conifer seed orchards during the past 3 to 9 years for preventing damage and mortality to cones by cone and seed insects. Emamectin benzoate and fipronil have been found to be consistently effective in reducing cone damage and mortality (80 – 95%) by coneworms in both slash pine and loblolly pine orchards for two years. Both chemicals are only moderately effective against seed bugs. In contrast, imidacloprid is effective against seed bug, but less effective against coneworms. A recent trial also showed that emamectin benzoate has some activity against slash pine flower thrips. Plans to test imidacloprid and dinotefuran alone or combined with emamectin benzoate and fipronil in 2007 for protection of seed crops against seed bugs was described.

Pityophthorus spp. Response to Mixtures of Pheromones and Host/Green Leaf Volatiles

Nadir Erbilgin (Division of Organisms and Environment, College of Natural Resources, University of California, Berkeley, CA); Nancy Gillette (USDA-FS, PSW Station, Berkeley, CA); Carline Rudolph (USDA-FS, Inst. For Gen. Placerville, CA); Kristina Bischel (USDA-FS, PSW Station, Berkeley, CA); Sylvia Mori (USDA-FS, PSW Station, Berkeley, CA); John Stein (USDA-FS, Morgantown, WV); Donald R. Owen (CDF, Redding, CA); David L. Wood (College of Natural Resources, University of California, Berkeley, CA)

Twig beetles in the genus of *Pityophthorus* are well represented in central, coastal California. The most abundant species are *P. setosus*, *P. carmeli*, *P. nitidulus*, *P. tuberculatus*, *P. californicus*, *P. murrayanae aurulentus*, and *P. sculptor*. Some of these species have been reported to be associated with the exotic Pitch canker fungus, *Fusarium circinatum*, in Monterey and Santa Cruz Counties. Some of these species are able to colonize both twigs and cones of several conifer species, including Monterey (*Pinus radiate*) and Bishop (*P. muricata*) pines. We conducted field experiments to develop effective semiochemical lures to trap twig beetles occurring in central, coastal California. We tested a variety of compounds representing a broad range of chemicals, including pityol (a pheromone component of *Pityophthorus* spp.), (-)-α-pinene,

limonene, (-)-3-carene (common monoterpenes of conifers), conophthorin (a pheromone component of several *Pityophthorus* and *Conophthorus* spp.), 2-hexenol (a green-leaf volatile), verbenone (anti-aggregation pheromone of several species of bark beetles), and 4-allylanisol (a green-leaf volatile). Each of these compounds was released with pityol together in binary combinations. These chemicals were tested in Big Basin National Park (Santa Cruz Co.) in 2005. Treatments were repeated 5 times in a randomized complete block design. Baits were attached to Japanese beetle traps which were suspended from canopies (ca. 5 meters above ground). Traps were collected weekly from April 28 to May 25 and biweekly after that until September 28. Lures were replaced once every two months.

Our results indicated that 3 species of *Pityophthorus* were attracted to our traps: *P. setosus*, *P. scalptor*, *P. nitidulus*. The most attractive compound for *P. setosus* was its aggregation pheromone, pityol. Attraction of *P. setosus* to pityol was significantly reduced by conophthorin, verbenone, 3-carene, or 4-allylanisol.

Pityophthorus scalptor, the second most abundant species caught, showed significant attraction only to the combination of pityol and conophthorin, suggesting that conophthorin is a part of its aggregation pheromone. Other compounds, including pityol, had no effect on attraction of this species.

Although the numbers of *P. nitidulus* were very low, our study suggests that 2-hexanol seemed to be attractive to this species.

Dioryctria Abietivorella-- Advances in Research

Ward Strong
BC Ministry of Forests, Vernon, BC, Canada

The pheromone blend for *D. abietivorella* was found in 2005 to be a mixture of (Z9, E11)-tetradecadienyl acetate (Z9, E11-14:Ac) and a polyunsaturated, long-chain hydrocarbon, (3*Z*,6*Z*,9*Z*,12*Z*,15*Z*)-pentacosapentaene (C25 pentaene). In 2006, we optimized the blend to 200 µg Z9, E11-14:Ac and 2000 µg C25 Pentaene. We found no evidence for activity of other potential components, and the stabilizers Sumisorb 300 and BHT did not reduce trap catches. The best trap types were the Pherotech Diamond and Delta traps. Synthetic lures were as attractive as well as caged virgin female moths. More moths were captured in the upper portions of trees than in lower portions. Life history studies indicated five instars. In 24-hour trap checking, catches started at 2300 hours and ended at 0500 hours, with a peak at 0100 hours. Area-wide flight phenology studies using pheromone traps in coastal BC, the interior of BC, and the PNW, showed that flights started in early May, peaked in late July to August, and ended in mid-October. This extended flight period, with no distinct generational peaks, is unusual among pyralids, and creates problems for seed orchard managers. Future research will female phenology, overwintering behaviour, reproductive behaviour, and the potential for pheromone control techniques such as mating disruption or attracticide methods.

Workshop 2: Regional Conditions Reports

Moderator: Brytten Steed, USDA Forest Service, Forest Health Protection, Missoula, MT

Reports on regional insect activity are largely based on aerial detection surveys (ADS) conducted the summer prior to this report (e.g. June-August, 2006). These ADS surveys report acres or trees detected by fading or discoloration. In the case of bark beetle caused mortality, this fading generally occurs the year after attack. Thus, 2006 ADS numbers indicate levels of 2005 attacks. In the case of defoliation, 2006 ADS numbers may be more indicative of 2006 insect activity.

USDA Forest Service Northern Region (Region 1)

Leah Aquino
USDA Forest Service, Northern Region, Missoula, MT

- In 2006, mountain pine beetle-killed lodgepole pine decreased on portions of the Lolo and Flathead NF's, but increased on the Deerlodge and Gallatin NF's. In northern ID, populations declined on the Nez Perce NF. Much of north Idaho was not flown, but ground surveys showed increasing new attacks in many areas. Populations are still high in whitebark pine and in ponderosa pine stands throughout the Region.
- Douglas-fir beetle populations are generally declining in north Idaho and Montana. In some surveyed stands, many old, large-diameter Douglas-fir have been killed, but most areas are not experiencing building populations.
- Infested acres, on which mortality is attributed to western balsam bark beetle, declined in 2006. Populations remained high in north Idaho and west Montana, despite improved weather conditions.
- Acres of grand fir killed by fir engraver decreased in 2006. Most of the mortality was recorded in north Idaho, but a few faders were noted on the Flathead and Lolo NF's. Most mortality is drought related.
- Mortality in ponderosa pine attributed to white pine blister rust declined from 2004 to 2006. It is now affecting as little as 1000 acres. Most is in north Idaho, and virtually all is weather related.
- Except for a rapidly declining SB outbreak in YNP, populations were at generally endemic levels throughout the Region. The outbreak in the park declined from 2003 to 2005. The area was not flown in 2006. Fewer than 200 infested acres were reported elsewhere in the region.
- Pine engraver-infested acres decreased significantly in 2006. Most were recorded in west Montana. Ponderosa pine stands and most beetle-caused mortality is drought related.
- No Douglas-fir tussock moth-defoliated acres were recorded in the Region in 2006. In 2005, fewer than 400 defoliated acres were reported-down dramatically from more than 142,000 acres recorded as recently as 2001 (most in North Idaho).
- Acres infested by western spruce budworm more than doubled in 2006, region-wide. Nearly 1,159,000 defoliated acres were reported in 2006; up from 502,000 acres recorded in 2005.
- Balsam wooly adelgid has caused mortality in sub-alpine fir stands and growth deformities in grand fir on more than 42,400 acres in central Idaho, up from 28,200 acres in 2005.

USDA Forest Service Rocky Mountain Region (Region 2)

Bill Schaupp
USDA Forest Service, Golden, CO

Tree killing bark beetles continued to dominate the forest insect news in the Rocky Mountain Region; a decade-long story that keeps getting worse and more diverse. Large, expanding, and intensifying beetle populations were noted in almost all conifer cover types, with stand depletion increasingly evident in some areas.

Mountain pine beetle was the 2006 headliner of this "forest renewal" event produced by bark beetles that stretches from sagebrush up to timberline. Ponderosa, lodgepole, limber, white bark, and bristlecone pines were killed across the mountains of Colorado and Wyoming within areas ranging from small to immense in too many places to list. In the Black Hills of South Dakota and Wyoming, beetle-caused ponderosa pine mortality increased and spread across a large affected area. Of special note is the episode in the lodgepole pine of central and northern Colorado and southern Wyoming that has caused considerable anxiety and threatens to move east over the Continental Divide. Biological notes of interest include univoltine populations occurring in lodgepole pine above 9,500 feet of elevation in Colorado and late larvae found developing within Engelmann spruce in mixed stands depleted of susceptible pine.

Landscape level spruce beetle epidemics were ongoing in northwestern Wyoming and north-central and southern Colorado. As well, areas of rising populations and blowdown among susceptible forests portend future increases and new problem areas in both states.

Douglas-fir beetle continued to cause high levels of mortality in northern Wyoming. It seemed as if most locations with susceptible Douglas-fir stands in Wyoming now have or have recently had epidemic populations causing significant mortality. Activity by this beetle species declined in Colorado, however, and was associated mostly with previous budworm defoliation and fire-affected areas. The deployment of MCH has proven effective at protecting high-value stands to date. Some mortality was noted in a protected campground subjected to severe beetle pressure and the added influence of mountain pine beetle currently infesting lodgepole pine.

Subalpine fire mortality due to western balsam bark beetle, root disease, and other factors continued. In the mid 1990s, this widespread and occasionally intense mortality phenomenon was the major conifer problem in R-2 --- now a distant memory of simpler times, yet apparently undiminished in extent and occurrence in Colorado and Wyoming.

Ips activity in pinyon pine has subsided along with the drought in southern Colorado. While piñon *Ips* and pinyon twig beetle activity were much reduced from the large mortality event which occurred in 2003 and 2005, there were still some areas of notable mortality.

Ips activity in ponderosa pine appeared to be down this past year in much of Wyoming and the Black Hills. Drought conditions and recent fires will be continuing concerns. *Ips* activity in jack and ponderosa pine continued to occur at elevated levels on the Nebraska National Forest in central Nebraska.

Two-lined chestnut borer (*A. bilineatus*) was associated with dying bur oaks located in native stands in western South Dakota. This is likely drought-related.

Several thousand acres of bur oak stands in south central South Dakota were again turned orange by larval leaf mining and adult leaf skeletonizing by the basswood leaf miner, *Balliosus nervosus* (Chrysomelidae).

Defoliation by western spruce budworm is appearing in more places in Wyoming and Colorado each year, with some localized heavy impacts and chronic situations but no immense impacted areas so far. Of note was defoliation on Engelmann spruce and subalpine fir at high elevation in southern Colorado.

Western tent caterpillar again defoliated aspen in western and southern Colorado and was associated with some tree mortality in areas affected for about four consecutive years.

European gypsy moths were trapped at one location in Kansas, three locations in Nebraska, and two locations in South Dakota.

Moisture conditions improved somewhat in 2006, but parts of the Region are still under severe drought. All tree species have become vulnerable to secondary stressors such as bark beetles and foliar and root diseases.

USDA Forest Service Southwestern Region (Region 3)

Terry Rogers
USDA Forest Service, Albuquerque, NM

Defoliator activity in New Mexico decreased from 225,730 acres in 2005 to 172,720 acres in 2006. Defoliation in New Mexico was caused by the western spruce budworm (142,510 acres), piñon needle scale (2,850 acres), Douglas-fir tussock moth (1,230 acres), and *Nepytia janetae,* a geometrid moth, (7,130 acres). Aspen defoliation, caused by western tent caterpillars totaled 19,010 acres in 2006 compared to 35,800 acres in 2005.

In Arizona, defoliator activity remained relatively unchanged decreasing only slightly from 77,100 acres in 2005 to 74,710 acres in 2006. Aspen defoliation, from a combination of causes increased from 47,430 acres in 2005 to 66,870 acres in 2006. Western spruce budworm-caused defoliation decreased dramatically from 11,200 acres in 2005 to 2,530 acres in 2006. Approximately 5,310 acres of drought-caused defoliation was also recorded.

Bark beetle-caused tree mortality in New Mexico increased to 180,030 acres in 2006 compared to 165,380 acres in 2005. This mortality was caused by the western pine beetle (79,250 acres), Fir engraver beetle (56,050 acres), western balsam bark beetle (15,270 acres), Douglas-fir beetle (12,040 acres), spruce beetle (6,960 acres), Ips engraver beetles in ponderosa pine (6,290 acres), piñon ips beetle (2,550 acres), and cedar bark beetle (1,610 acres).

In contrast, bark beetle activity in Arizona decreased from 40,870 acres in 2005 to 30,920 acres in 2006. This mortality was caused by ips engraver beetles in ponderosa

pine (12,170 acres), cedar bark beetles (9,510 acres), Douglas-fir beetles (3,320 acres), piñon ips beetles (3,250 acres), western pine beetles (1,020 acres), roundheaded pine beetles (380 acres), spruce beetles (70 acres), and a true fir pest complex (1,200 acres).

USDA Forest Service Intermountain Region (Region 4)

Darren Blackford
USDA Forest Service, Ogden, UT

Douglas-fir beetle, *Dendroctonus pseudotsugae*, on Douglas-fir of ID, UT, and WY: Douglas-fir beetle-caused tree mortality decreased significantly across Region 4. In 2006, nearly 19,200 acres were affected compared to 140,800 acres in 2005. Most of the Douglas-fir mortality for 2006 was scattered across southern ID with the majority mapped on the Salmon-Challis National Forest. Both the Ashley National Forest in UT and the Bridger-Teton National Forest in WY saw significant reductions in affected acres, from 33,100 and 19,100 acres in 2005 to 1,400 and 1,300 acres mapped in 2006. Increased precipitation in 2005 may have contributed to the decline in tree mortality as residual trees recovered from the effects of the previous drought.

Douglas-fir tussock moth (DFTM), *Orgyia pseudotsugata*, on Douglas-fir and true firs of ID, NV, and UT: Defoliation of Douglas- and subalpine fir attributed to DFTM continued to decrease in 2006. Approximately 2,700 acres of defoliation were reported in 2006 compared to 10,500 acres mapped in 2005.

Fir engraver beetle (FEB), *Scolytus ventralis*, on grand fir, red fir, subalpine fir, white fir of CA, ID, NV, and UT: Fir engraver beetle-caused tree mortality continued to decrease region-wide in 2006. Aerial surveyors recorded over 21,100 acres with fir mortality in 2006, compared to 65,800 acres reported in 2005. On the Humboldt-Toiyabe National Forest in NV, fir mortality increased slightly from 12,400 acres in 2005 to 16,200 acres in 2006. Additionally, Great Basin National Park in NV had 2,200 acres with mapped fir mortality. In UT, 1000 acres on the Fishlake National Forest were recorded as being affected by FEB.

Tent caterpillars, *Malacosoma spp.*, on aspen and cottonwood of CA, ID, NV, UT, and WY: In 2006, tent caterpillar defoliation was not detected during aerial surveys. However, isolated pockets of tent caterpillars and fall webworm defoliation were noted throughout the region based on ground observations.

Jeffrey pine beetle, *Dendroctonus jeffreyi*, on Jeffrey pine of CA and NV: Jeffrey pine beetle-caused mortality nearly doubled in 2006. Approximately 900 trees were killed over 460 acres. Most of the mortality occurred on the Carson Ranger District of the Humboldt-Toiyabe National Forest affecting nearly 700 trees over 300 acres.

Mountain pine beetle (MPB), *Dendroctonus ponderosae*, on bristlecone, limber, lodgepole, Jeffrey, ponderosa, western white, and whitebark pines of CA, ID, NV, UT, and WY: Mountain pine beetle caused tree mortality decreased from 2.4 million trees killed over 615,700 acres in 2005 to 1.7 million trees killed over 510,500 acres in 2006. Most of the mortality occurred in three distinct areas: 1) Central ID on the Salmon-Challis National Forest and Sawtooth National Recreation Area (827,200 lodgepole, whitebark and limber pine trees killed over 205,500 acres); 2) western WY on the

Bridger-Teton National Forest (369,700 lodgepole and whitebark pine trees killed over 163,000 acres); and 3) northern UT on the Wasatch-Cache and Ashley National Forests (169,700 lodgepole and ponderosa pine trees killed over 74,200 acres).

Pine engraver beetle, *Ips pini*, in lodgepole and ponderosa pine of ID and UT: Approximately 150 trees on Bureau of Land Management and National Forest lands in ID were killed in 2006. Tree mortality caused by pine engraver beetle remained at endemic levels throughout the Region. An increase in top-killed ponderosa pine was noted on the Boise National Forest, ID Bureau of Land Management, and the State of ID and private lands in 2006.

Spruce beetle, *Dendroctonus rufipennis*, in Engelmann spruce of ID, UT, and WY: In 2006, spruce beetle mortality decreased to 20,700 trees killed over 12,800 acres compared to 83,200 trees killed over 35,400 acres in 2005. Nearly all of the mortality occurred in UT on the Fishlake, Manti-La Sal, and Uinta National Forests. (1,100, 2700, 1200 acres, respectively). Spruce mortality was also mapped on private lands from central to southern UT affecting 1,200 acres.

Western pine beetle, *Dendroctonus brevicomis*, in ponderosa pine of ID: In 2006, the number of ponderosa pine trees killed by western pine beetle attacks remained at endemic levels. Most of the mortality occurred on National Forests and private lands in ID. Approximately 1,000 trees were killed affecting 500 acres in 2006, compared to 1,500 trees killed over 600 acres in 2005.

Western spruce budworm, *Choristoneura occidentalis*, in Douglas-fir and true firs of ID, UT, and WY: Western spruce budworm-caused tree defoliation tripled in the Region in 2006 affecting 342,900 acres compared to 103,600 acres of defoliation mapped in 2005. Defoliation was reported on nearly all ownerships in south-central ID and the southern part of UT. In ID, for the second consecutive year, most of the defoliation occurred on the Boise National Forest (102,600 acres). Moderate to heavy defoliation were also reported on the Salmon-Challis (81,500 acres) and Sawtooth (34,500 acres) National Forests; Bureau of Land Management lands (11,900 acres), State of ID lands (8,500 acres) and private lands (3,300 acres). In UT, the Fishlake and Dixie National Forests had moderate to heavy budworm defoliation with 51,200 and 33,200 acres affected, respectively. Private land in UT had 3,300 acres of moderate to heavy defoliation.

Pinyon ips, *Ips confusus*, in pinyon pine of CA, NV, and UT: Historically, in the Intermountain Region, pinyon-juniper forests have not been aerially surveyed. However, the dramatic increase in pinyon mortality during 2001 and 2002, which resulted from an extended drought and increased pinyon ips populations, necessitated documenting this widespread mortality. By 2005, the pinyon ips outbreak had collapsed. Therefore, much of the pinyon/juniper forest type was not surveyed in 2005 or 2006. Of the pinyon forest type surveyed in 2006, approximately 12,800 pinyon pines were mapped across 9,200 acres. Most of the tree mortality was reported in UT. In UT, most of the mortality occurred on the Dixie National Forest. In NV, most of the mortality occurred on private and Bureau of Land Management lands.

European gypsy moth, *Lymantria dispar*, in various deciduous species of ID, NV, and UT: Gypsy moth was first detected in UT in 1988. Since then, male moths have been captured in various locations throughout the region nearly every year. In 2006, no

male moths were captured in any delimitation-trapping grids. In 2005, one male moth was captured in UT and two separate single male moths were captured in WY.

Balsam woolly adelgid (BWA), *Adelges piceae*, in subalpine and grand firs of ID: While this introduced forest insect has been present in northern ID (Region 1) since 1983, its presence in southern ID (Region 4) was not verified until 2001, when it was found killing subalpine fir trees in residential areas of Cascade and McCall. In 2006, delimitation surveys were conducted by personnel from Idaho Department of Lands and Region 4 Forest Health Protection to determine the distribution of BWA south of the Salmon River. From these surveys, we have identified the presence of BWA on state, private and Forest Service lands as far south as Smith's Ferry, as far west as Sturgill Peak, and as far east as Johnson Creek. Continuing delimitation surveys and the establishment of long-term evaluation plots are planned for 2007.

Subalpine fir mortality complex in subalpine fir of ID, NV, WY, and UT: In 2006, approximately 125,300 subalpine fir trees died over 61,700 acres. This is nearly half of the mortality reported in 2005. The Bridger-Teton National Forest in WY accounted for the majority of subalpine fir mortality for the third consecutive year with 57,200 trees killed over 27,900 acres down from 90,200 trees killed over 47,900 acres in 2005. An additional 24,800 trees were killed across 5,500 acres of Bureau of Land Management and private lands in WY. Both ID and UT experienced high levels of subalpine fir mortality. Most of the mortality in both states was scattered across national forest land. In ID, the Salmon-Challis National Forest had the highest amount of mortality (15,650 trees over 8,100 acres). In UT, most of the mortality occurred on private lands (4,850 trees over 3,200 acres).

USDA Forest Service Pacific Southwest Region (Region 5)

Mike Bohne
USDA Forest Service, McClellan, CA

JPB activity increased on the east side of the Sierra Nevada range and is expected to continue to increase in 2007. MPB and WPB remained low, with the exception of the Modoc NF where mortality was observed on ponderosa, lodgepole and whitebark pine on the Warner Mountain RD. FE populations remained low throughout California, but elevated fir mortality continued on the Warner Mountain, Big Valley and Doublehead RDs, Modoc NF and throughout the entire red fir belt on the TNF. Fir mortality was also noted at higher elevations throughout the Sierra Nevada range. Defoliation from DFTM increased in Sierra and Stanislaus NF's and Yosemite NP. DFTM was detected in several new locations on the Eldorado NF and Shasta-Trinity NF. An unknown leaf miner was observed causing injury in black oak at a few locations on the Plumas and Tahoe NF's. LPNM defoliation continued in Yosemite NP but at reduced levels from previous years.

Aulacaspis cycad scale continues to infest and kill introduced and indigenous cycads throughout Guam. The erythrina gall wasp caused extensive mortality of coral trees in Hawaii and continues to spread.

USDA Forest Service, Pacific Northwest Region (Region 6)

Iral Ragenovich
USDA Forest Service, Portland, OR

Aerial detection surveys were extended into October due to the large number of forest fires that prevented ability to survey. Many of the fires were in areas where previous bark beetle mortality had occurred. Mountain pine beetle populations decreased from 2005, with over 580,000 acres affected. Most activity occurred in central and north central WA and south central OR. Acres affected by western pine beetle increased slightly. All other bark beetles - pine engraver beetles, spruce beetle, fir engraver, and Douglas-fir beetle - decreased from 2005 levels. Douglas-fir tussock moth Early Warning System traps indicate slight trap catch increases particularly in the Blue Mountains of northeast OR. A defoliation survey for Pandora moth was conducted in 2006 with about 11,000 acres defoliated. Acres defoliated by western spruce budworm almost doubled from 352,000 acres in 2005 to 593,000 acres in 2006; most of this defoliation was in central and north central WA but defoliation also increased from 250 acres to 33,780 acres on the Malheur NF in northeast OR. Gypsy moth eradication projects will be conducted in Bend, OR (aerial application on 550 acres) and Kent, WA (25 acres of ground application) and an Asian Gypsy Moth eradication project will be conducted in St. Helens, OR (640 acres of aerial application).

USDA Forest Service, Alaska Region (Region 10)

Jim Kruse
USDA Forest Service, Fairbanks, AK

Bark beetles:

- Spruce beetle up, 120,000 acres expanding into the Lake Clark area west of the Kenai Peninsula.
- *Ips* beetles up, 9,000 acres, expanding from 2004/2005 burn fringes and into new construction areas around Fairbanks.

Defoliators:

- Aspen leaf miner, 460,000 acres, down, outbreak showing signs of collapse imminent.
- Spruce budworm, 53,000 acres, up.
- Amber-marked birch leaf miner, about 150,000 acres, up, but intensity down due to cool summer.
- Large aspen tortrix, up, 35,000 acres.
- Spear-marked black moth, up, 7,000 acres.

EDRR/CAPS efforts have produced a single male gypsy moth in Fairbanks, documented spread of European yellow underwing into south-central AK, and discovery of two new North American records of Tortricidae, one in Fairbanks and one on Kenai Peninsula.

Canadian Forest Service, British Columbia Region

Peter M. Hall, Tim Ebata, and Joan Westfall
BC, Canada

The current mountain pine beetle outbreak continued to be the leading cause of tree mortality in British Columbia, with a record of over 9.2 million hectares of attack

recorded in 2006. Over the past two years, expansion rates of area affected has declined substantially. More than half the infested stands were located in the Southern Interior Forest Region.

The area affected by western balsam bark beetle was down slightly to 1.2 million hectares provincially compared to 1.4 million hectares in 2005. The majority of this mortality was trace to light in severity and chronic in nature. Spruce beetle attack was up 50% over last year, with 83,660 hectares delineated. The southern areas of the province also experienced an increase in Douglas-fir beetle activity for the fourth consecutive year to 60,709 hectares affected.

Western spruce budworm continued to be the primary defoliator in the province in 2006. Recorded infestations rose to a seven year high of 776,723 hectares affected, primarily in the southern interior of the province. The biological control agent *Bacillus thuringiensis* var. *kurstaki* (Btk) was applied aerially to control infestations over 43,982 hectares of high value Douglas-fir stands. This was the largest program of its kind ever undertaken in British Columbia.

Large aspen tortrix defoliation declined for the 3rd consecutive year to 123,312 hectares; two-year cycle budworm lightly defoliated 67,654 hectares; and, aspen leaf miner defoliated stands in the south to cover 12,878 hectares.

In response to 135 gypsy moths trapped in 2005, a ground spray with Btk was conducted this year in Saanich, Nanaimo and Saltspring Island. High density mass trapping was also utilized at five locations. Monitoring traps caught 153 moths in the past summer. Eradication plans are underway to treat 6 sites in the coming year.

Mexico

Javier Víctor
(Escuela Nacional de Ciencias Biológicas, IPN with input from the
Comisión Nacional Forestal and other sources)

The main forest insect pests in Mexico are bark beetle species (responsible for almost half of the damage in affected forest areas), distantly followed by defoliators, bud and shoot borers, and cone- and seed-feeding insects. Among bark beetles, the most damaging species belong to the genus *Dendroctonus*. During the first half of 2006, climate was dryer than usual (particularly in states such as Baja California, Coahuila and Oaxaca), and was correlated with bark beetle outbreaks occurring in several regions. Some of the most remarkable cases have included continuous *D. adjunctus* epidemic outbreaks in the states of Chihuahua, Coahuila (both in northern Mexico), and Oaxaca (in southern Mexico) attacking, in particular, *Pinus hartwegii* and *P. arizonica* stands, as well as *D. frontalis* and *D. mexicanus* outbreaks in a number of locations in central and southern Mexico. In addition, *D. rhizophagus* has caused significant damage to pine plantations, particularly those of *P. engelmannii*, *P. arizonica*, and *P. durangensis*, in Chihuahua and Durango, while *D. pseudotsugae* continues to attack Douglas-fir (*Pseudotsugae menziesii* var. *glauca*) stands in the southwest of Coahuila state. Although not so important, some *Ips* species have also caused tree mortality in selected areas of the country, particularly *I. pini* in Baja California (mainly as a consequence of a extended drought and fire damage in Sierra de Juarez), and *I. lecontei* in Jalisco.

With respect to defoliating insects, *Malacosoma incurvum* remains as an issue of concern due to damage caused to willow trees (*Salix bomplandiana*) in central Mexico. Tropical forest areas in Mexico have also been significantly affected by some insect pests, such as *Hypsipyla grandella* larvae boring in shoots of mahogany (*Swietenia macrophylla*) and cedar (*Cedrela odorata*) in southeastern states (from Chiapas and Tabasco to Yucatan peninsula), and *Rhynchophorus palmarum* causing coconut palm mortality in various coastal zones in states like Jalisco, Guerrero and Tabasco.

Finally, regarding exotic insect pests, the Asian termite *Coptotermes gestroi* (introduced in 2005) is now established in the states of Colima and Aguascalientes, where monitoring and eradication programs for this species are currently underway. The Opuntia moth, *Cactoblastis cactorum*, has just been detected in continental Mexico (near Cancun, Quintana Roo, in the Yucatan peninsula).

Workshop 3: High Elevation Ecosystems

Moderator Barbara J. Bentz, USDA Forest Service, Logan, UT

Lake Sediment Records of Past Mountain Pine Beetle Infestations.

Andrea Brunelle
Department of Geography, University of Utah, Salt Lake City, UT

Paleoecological reconstructions from two lakes in the U.S. northern Rocky Mountain region of Idaho and Montana revealed the presence of bark beetle elytra and head capsules (cf.

Dendroctonus spp, most likely *D. ponderosae*, mountain pine beetle). Occurrence of these macrofossils during the period of time associated with the 1920/1930 A.D. mountain pine beetle outbreak at Baker Lake, Montana suggest that when beetle populations reach epidemic levels, beetle remains may be found in the lake sediments. In addition to the beetle remains found at Baker Lake during the 20th century (1920-1930s outbreak), remains were also identified from ca. 8331, 8410, and 8529 cal yr BP. At Hoodoo Lake, Idaho remains were found at ca. 7954 and 8163 cal yr BP. These Holocene records temporally coincide with the 8200 year cold event and suggest the infestations occurred during periods that were cooler and effectively wetter than present. In addition, the early Holocene infestations occurred in forests dominated by whitebark pine. These two lake records provide the first preliminary data for understanding the long-term history of climatic influences on *Dendroctonus* bark beetle activity, and also provide information on the antiquity of the relationship of Dendroctonus in whitebark pine which suggests scenarios for infestation different from what we see today.

Mountain Pine Beetle Conditions in Whitebark Pine Stands in the Northern Region.

Ken Gibson, USDA Forest Service, Missoula, MT
Sandy Kegley, Coeur d'Alene, ID

Mountain pine beetle, at outbreak conditions throughout western North America, along with white pine blister rust, is threatening the existence whitebark pine (WBP). Hazard-rating systems, developed for LPP and PP stands, led to effective means of silviculturally reducing beetle-caused mortality in those hosts. Such efforts may not be as effective in WBP stands; but should be explored. We are currently testing prescribed fire as a means of decreasing competition and enhancing regeneration. We have tested anti-aggregation compounds (verbenone and non-host volatiles) as a means of protecting high-value trees. Protection of "plus" trees, with pheromones or chemical treatments, will be crucial to enhancing blister rust resistance and the maintenance of WBP in these fragile, high-elevation ecosystems.

Landscape Patterns of a Mountain Pine Beetle Outbreak in a Whitebark Pine Forest in Central Idaho.

Jeffrey Hicke
Department of Geography, University of Idaho, Moscow, ID

High-elevation whitebark pine forests are important ecosystems in the Rocky Mountains, providing habitat and resources and affecting the hydrologic cycle. These ecosystems are under a number of threats, including white pine blister rust (an invasive pathogen) and fire suppression. A third threat has appeared in recent years: attacks by mountain pine beetle. We know from historical studies that this beetle has killed whitebark pine stands in the past, most likely due to a temporary increase in temperature that facilitated the epidemic. Today, many whitebark stands across western North America are being attacked by mountain pine beetle. As previously, the outbreaks appear to be driven by higher temperatures. Unlikely previously, however, analysis of recent and future climate behavior suggests that conditions will be continuously suitable for mountain pine beetle outbreaks, implying a shift in this disturbance type with potentially serious consequences for whitebark pine. At Railroad Ridge, a remote, high-elevation site in central Idaho, substantial whitebark pine mortality is occurring due to an outbreak of mountain pine beetle. We have obtained a time series of very high resolution satellite imagery during 2004 to 2006 at Railroad Ridge for studying the landscape patterns of the epidemic. A classification tree analysis produced maps of mortality that we related to topographic effects. We found a substantial increase in mortality from 2004 to 2006.

Mountain Pine Beetle Phenology in High Elevation Whitebark Pine Ecosystems: Observations and Predictions.

Barbara J. Bentz & Greta Schen-Langenheim,
USDA Forest Service, Rocky Mountain Research Station, Logan, UT

Mountain pine beetle (MPB) has existed at detectable levels in high elevation whitebark pine stands for some time. Paleoecological records suggest that *Dendroctonus spp*. were present in ecosystems dominated by whitebark pine during the Holocene

(Brunelle, this workshop). Dendroecological and written records also indicate that MPB population outbreaks occurred in high elevation stands during the 1930 to 1940 time. Within the past 5-10 years, wide-scale MPB caused mortality has occurred in high elevation pine stands throughout western North America and ongoing climate shifts are blamed. We describe MPB phenology in high elevation, seral whitebark pine forests in the Greater Yellowstone Ecosystem during 2004 and 2005. Using field observations and predictions from a MPB phenology model, we explore how temperature changes may be influencing the ecological relationship between MPB and high elevation pines. Our field results suggest that temperature-driven MPB population development in high elevation whitebark pine results in a variety of cohorts emerging to attack trees at any given time. Cohorts comprising parent beetles, brood adults developing on a 1 year lifecycle and brood adults developing on a 2 year lifecycle are emerging to attack new host trees at any given time. Given the large amount of whitebark pine mortality observed at our sites, these results suggest that strict univoltinism, as is often observed in low elevation lodgepole pine sites, is not necessarily a requirement for MPB population outbreaks at high elevation sites. Using estimates of historical temperature data from the United States Historical Climatology Network and NRCS Snotel sites, phenology model predictions suggest that current MPB voltinism in high elevation pine sites is similar to developmental timing during the warm period of 1930 – 1940. Although the majority of populations were predicted to develop on a 2 year lifecycle, several years showed that at least 40% of the populations developed in a single year. Following the warm period of 1930-40's, temperatures cooled off and populations returned to lifecycles of 2 and 3 years. Currently, increasing temperatures due to climate change may result in a different trajectory for MPB populations infesting high elevation pine stands.

Workshop 4: Invasive Forest Pests

Moderators: Carl Jorgensen, USDA Forest Service, Boise, ID and
Ralph Their, USDA Forest Service, Washington, D. C.

About 30 individuals attended the workshop. After some opening comments, Trisha Johnson presented her findings of two studies. Her first study was to examine the possible movement of scolytids and other insects from metropolitan areas to rural areas in northeastern Oregon. Her second study showed how genetic testing could distinguish between the banded elm bark beetle, *Scolytus schevyrewi*, and the European elm bark beetle, *Scolytus multistriatus* at different life stages.

Mark Hitchcox presented his involvement in port security in Portland and some of the challenges, limitations, enforcement and processes in evaluating shipments coming into the U.S. A vibrant discussion regarding treatment and inspection of solid wood packing materials followed.

Characterization of Two Non-native Invasive Bark Beetles, *Scolytus schevyrewi* and *Scolytus multistriatus* (Coleoptera: Curculionidae: Scolytinae)

Patricia L. Johnson[1], Jane L. Hayes[1], John Rinehart[2], W. Steve Sheppard[3]
[1]USDA FS Pacific Northwest Forestry and Range Sciences Laboratory;
[2]Eastern Oregon University; [3]Washington State University

Introduction of woodboring insects, such as the bark and ambrosia beetles (Coleoptera: Curculionidae: Scolytinae) is a particular concern in forests and urban ecosystems. The number of non-native Scolytinae and their movement into and across North America continues to increase. The significant number of non-native species found in western Oregon and lack of knowledge of scolytids east of the Cascade Mountain Range indicated the need to survey the species occurring in eastern Oregon. The object of the first part of this study was to establish a baseline reference list and examine the possible movement of insects from metropolitan areas to the southeast or northwest into the Grande Ronde Valley (Union County) in northeastern Oregon. Using pheromone-baited traps in seven locations in 2003-2004, 14 genera and 39 species of Scolytinae were collected, including three non-native species. Species richness, evenness, and the Shannon-Weaver diversity index were used to compare community structure attributes among trap locations in this rural area mixture of agriculture, residential, commercial, and forest interface. The baseline reference list compiled from this study provides needed information to more easily detect and rapidly respond to new introductions of scolytids. In the second part of this study, two non-native scolytids *Scolytus schevyrewi* Semenov (Coleoptera: Curculionidae), the banded elm bark beetle, and *Scolytus multistriatus* Marsham, the smaller European elm bark beetle, which are morphologically similar, were characterized using two identification techniques, reproductive morphology (aedeagus) and molecular genetics [random amplified polymorphic DNA analysis (RAPD-PCR)]. The morphology of the aedeagi showed species-specific characteristics that can be used as an identification tool for these two species. Two oligonucleotides used in the RAPD-PCR analysis resulted in DNA banding patterns that were distinct between the two species. Species identification using RAPD-PCR analysis was validated by a blind test and used to make species identifications of larval specimens. These tools improve the ability to differentiate between *S. schevyrewi* and *S. multistriatus* at immature and adult stages, and could be developed and used for other scolytids as well.

Exotic Woodboring Insect Threats to Pacific Northwest Forests

Mark Hitchcox
USDA APHIS PPQ, Portland, OR

Repeated port and domestic interceptions of several woodboring insect species continue to define a risk pathway for the unintentional introduction of exotic woodboring insect pests into the Pacific Northwest. Foreign woodboring pests are frequently intercepted in international imported wood shipping materials, such as dunnage, wooden crates, pallets, spools. In addition, increased importation of wooden craft items poses an emerging risk pathway. These pathways harbor several live insect groups, including ambrosia and bark beetles, (Scolytidae; Coleoptera); longhorned beetle species in the *Monochamus*, *Tetropium*, *Arhopalus* and *Callidiellum* genera (Cerambycidae; Coleoptera), metallic wood-boring beetles (Buprestidae; Coleoptera), and other

woodboring species. New international regulations with the IPPC are attempting to address the risks posed by the movement of wood packing material.

As an added safeguard, state and federal agencies conduct targeted survey programs, aimed at the early detection of any newly introduced or established woodboring pests. Through review of importer and business practices, these programs focus surveys on or near sites that frequently receive high-risk commodities.

Workshop 5: Efficacy of Verbenone for Control of (mostly) Mountain Pine Beetle

Moderator: Nancy Gillette, USDA Forest Service, PSW Research Station, Berkeley, CA

Verbenone Tests to Protect Pine Trees From Mountain Pine Beetle Attack in the Northern Region

Sandy Kegley, Coeur d'Alene, ID
Ken Gibson, USDA Forest Service, Missoula, MT

For five years, we've tested the efficacy of verbenone, an anti-aggregation pheromone for mountain pine beetle, in protecting one acre plots and individual whitebark pine and lodgepole pine trees from beetle attack. EPA-registered 5-gram verbenone pouches, replaced at mid-season, were tested along with larger (7.5-gram) pouches. During some years, green leaf volatiles were tested along with verbenone. All treatments were compared to untreated controls. In addition, all treatment trees or one acre stands were baited with attractant mountain pine beetle baits.

Beetle attacks in one acre whitebark and lodgepole pine stands treated with forty 5-gram verbenone pouches were significantly less than untreated controls. Additional testing in one acre lodgepole pine stands using twenty 5-gram pouches replaced mid-season produced similar results. Eighty to 90% of individual whitebark pine trees treated with either two 5-gram pouches replaced mid-season, or two 7.5-gram pouches were consistently protected from mass attack. Seventy percent of individual lodgepole pine trees were protected from mass attack although some partial successful attacks occurred. One 7.5-gram verbenone pouch used with a hexanol pouch on each tree produced promising results on individual whitebark and lodgepole pine.
Verbenone has been used operationally in the Northern Region to protect blister rust resistant whitebark and western white pine trees, leave trees in burned areas, and leave strips between ski runs at Lookout Pass ski area.

Verbenone Flakes Protect Lodgepole Forests from Attack by Mountain Pine Beetle

Nadir Erbilgin (University of California, Berkeley, CA); Nancy Gillette (USDA FS, PSW Station, Berkeley, CA); John Stein (USDA FS, Morgantown, WV); Donald Owen (Calif. Dept. of Forestry and Fire Protection, Redding, CA); Sylvia Mori (USDA FS, PSW Station, Berkeley, CA); Jeff Webster (Total Forestry, Anderson, CA); David Schultz (deceased, USDA FS, Shasta-Trinity National Forest, Redding, CA); Lee Pederson (USDA-FS Region 1, Coeur d'Alene, ID); David L. Wood (University of California, Berkeley, CA)

Verbenone is an effective anti-attractant for many bark beetle species in the genus of *Dendroctonus*. We applied verbenone-releasing laminated flakes (4X4 mm^2 and 2 mm in thickness) (Hercon Disrupt Verbenone Micro-Flakes®) for area-wide tree protection against mountain pine beetle, *Dendroctonus ponderosae* in lodgepole pine forest in 2005. Aerial applications were made using pods attached to helicopters at 150 g/Active Ingredient/acre with five 50-acre treated plots and five 50-acre control plots in California and Idaho. *Dendroctonus ponderosae* is one of the most economically important insect species in North America and may kill virtually all susceptible host trees over extensive areas during outbreaks. Plots were selected from areas of predominantly lodgepole pines with significant levels of mountain pine beetle activity. Panel traps baited with mountain pine beetle lures were placed near two of the four corners of each plot to monitor beetle flight within the plots. Beetles were collected from traps at 28-day intervals following application in Idaho and 14-day intervals following application in California. We also established five fixed east-west transect lines for strip cruises/fixed plot cruises, all equidistant from one another and each spanning the 25-acre core plot, to measure stand characters and pre- and post-treatment beetle infestation levels. Along each transect, we marked two $1/10^{th}$-acre fixed-plot centers. We conducted a cruise of "large trees" at each fixed-plot center (total of 10 centers for each of five treated and five control plots). "Large trees" are defined by host tree(s) susceptibility to bark beetle attack, and thus the DBH cut-off varies by host species (PP: six inches, LPP: four inches; WBP: four inches; DF: eight inches). We recorded all species and DBH of all trees at or larger than size cut-off described above. Within each $1/10^{th}$-acre plot, we also conducted a $1/100^{th}$-acre cruise (species and DBH) of all trees greater than 1 inch. Using the same five transects, we conducted 50-foot strip cruises (25 ft each side of transect) along each transect. For each strip cruise, we counted and marked all trees asymptomatic, red, orange, yellow or green needles with beetle attack. We repeated this sampling protocol before the spray and at the end of the experiment. Efficacy was determined by estimating the proportion of attacked trees in 2005 as a function of the number of dead trees in sprayed and unsprayed plots in 2004.

Our results indicated that the number of beetles trapped in panel traps baited with aggregation pheromones were similar between treated and control plots both in California and Idaho. However, the proportion of attacked trees in treated plots was significantly lower than that in control plots. The proportion of attacked trees for control plots is 2.88 times the proportion of attacked trees for treated plots; meaning that the treatment reduced the rate of attack in a 65.2% in Idaho. Likewise, the proportion of attacked trees for control plots is 3.77 times the proportion of attacked trees for treated plots; meaning that the treatment reduced the rate of attack a 73.5% in California.

The current study demonstrated that verbenone flakes significantly reduced attacks on and tree mortality by *D. ponderosae* in both California and Idaho and could be used in aerial applications against mountain pine beetle.

Verbenone-releasing Flakes Reduce Mountain Pine Beetle Attacks in Whitebark Pine

Matt Hansen, USDA, Forest Service, Logan, UT
Nancy Gillette, USDA Forest Service, Berkley, CA

In 2005, verbenone-releasing flakes were tested for interruption of mountain pine beetle response to baited traps and protection of whitebark pines from attack. The study area, near Togwottee Pass, Wyoming, was chosen because it offered reasonable road access and had a significant mountain pine beetle population, but with most whitebark pines uninfested. Ten 4 ha plots were laid out and randomly assigned to either flake or check treatments. Verbenone flakes were applied with broadcast spreaders, simulating aerial application (150 g/acre AI). Baited panel traps in treated plots caught significantly fewer mountain pine beetles than traps in check plots. The attack rate of whitebark pines in treated blocks was reduced by 57% relative to the check blocks.

Tests of the New Verbenone Pouch

John H. Borden, Anna Birmingham, Ervin Kovacs, and J.-P. Lafontaine
Phero Tech International, Delta, BC, Canada

While verbenone has potential for use in forest stands, the trend is for increasing use in urban and semi-rural locations, where the value of the trees to people is high enough to justify the cost of treatment. For example, when bark beetles kill a mature ponderosa pine in an urban setting, the lost services provided by this tree combined with disposal and replacement costs may lead to a value in excess of $15,000. In 2006 in the rural community of Lac le Jeune, BC, residential properties treated at 15 m centres with Pherotech's 4.65 g polyurethane verbenone pouch sustained attack on 3.6% of 3,857 available lodgepole pines, a 93% reduction in attack compared to the loss of 49.1% of 4,670 trees in adjacent control areas. Despite this remarkable success, the polyurethane pouch is imperfect in its steadily declining release rate over time and its short 90 day longevity. Therefore, we have developed a new pouch with a 7 g load and a sponge matrix to replace the polyurethane. The new pouch releases verbenone at levels between 50 and 60 mg per day at a constant 20°C for 120 days, well within the desired limits. In contrast, the newly registered pouch produced by Chemtica and sold in the USA by Synergy Semiochemicals Inc. released verbenone at levels between 20 and 40 mg per day under identical conditions. This lower release rate may explain why the Chemtica pouch failed to fully protect pheromone-baited trees in Montana in a 2006 field trial (K. Gibson, USFS, pers. comm.). The new Pherotech pouch was evaluated from 25 July-29 September 2006 in a 25 replicate field experiment near Princeton BC. Of 24 pheromone-baited control trees (one tree was not located at the time of evaluation) 23 (96%) were mass-attacked and killed. Seven of 25 unbaited control trees (29.2%) were similarly mass-attacked. Two of 24 pheromone-baited trees (8.3%) (one tree had the bait fall off) that were also treated with the polyurethane pouch were attacked and killed, whereas none of 25 pheromone-

baited trees with the new verbenone pouch was mass-attacked. During the 67-day duration of the experiment the mean daily temperature was 16.7°C, and the pouches released on average 2.5 g of verbenone, bearing out the release rate determinations in the laboratory. The new verbenone pouch was registered with Canada's Pest Management Regulatory Agency in 2007, and should be available as an EPA-registered product in the USA in time for the 2008 field season.

Workshop 6: International Activities

Moderator: Iral Ragenovich, USDA Forest Service, Portland, OR

Five reports provide a representation of activities in the international arena ranging from protecting North American forests to cooperating on projects and providing technical assistance.

Risk Assessments of Forest Products and Associated High Risk Pests

Andris Eglitis
USDA Forest Service, Bend, OR

This presentation focuses on some of the activities of the Wood Import Pest Risk Assessment and Mitigation Team (WIPRAMET). The Team consists of entomologists, pathologists and mycologists from the USDA Forest Service, and has a broad geographical representation from across the U.S. WIPRAMET was assembled in the early 1990s to provide technical assistance to USDA-APHIS (Animal and Plant Health Inspection Service) on matters related to forestry and forest products. Thus far WIPRAMET has primarily been involved in conducting pest risk assessments of raw logs and chips from several countries. Seven pest risk assessments have been prepared thus far:

1. Siberia and Soviet Far East – larch and other conifers (1991)
2. New Zealand – *Pinus radiata* and Douglas-fir (1992)
3. Chile – *Pinus radiata*, *Nothofagus dombeyi* and *Laurelia philippiana* (1993)
4. Mexico – *Pinus* spp. and *Abies* spp. (1998)
5. South America – *Eucalyptus* spp. (2001)
6. Australia – 18 eucalypt species (2003)
7. Australia – *Pinus* spp. (2006)

All of the risk assessment documents are available for downloading or viewing at the web address below:

http://www.fs.fed.us/foresthealth/related_links/wood_import_pest_risk_assmts.shtml

The risk model used in the wood import assessments is the same as the model used by APHIS for agricultural pest risk assessments and adopted by over 90 countries in the International Plant Protection Convention (IPPC). Seven elements (four for the Likelihood of Introduction and three for the Consequences of Introduction) are evaluated for selected insects known to be associated with the wood commodities being assessed. When the overall rating of Pest Risk Potential is "Moderate" or "High" there is justification

for establishing rules of pest mitigation prior to importation of the commodity.

It is important to note that each of the seven assessments of raw logs has documented numerous insects with a Moderate or High Pest Risk Potential for resources in the U.S. In fact, three of the insects identified in raw log risk assessments have already arrived in the U.S. via other pathways (*Hylurgus ligniperda*, *Orthotomicus erosus*, *Sirex noctilio*).

Lymantriid Monitoring and Pest Exclusion Program in Selected Russian and Asian Ports.

Steve Munson
USDA Forest Service, Ogden, UT

An Asian gypsy moth, *Lymantria dispar* (AGM) pest exclusion program began in the Russian Far East in 1993 due to several 1992 introductions of the insect in Pacific Northwest ports. Ships arriving from the Russian Far East had viable egg masses on the ship superstructures which hatched while unloading cargo at several ports including Vancouver, Canada and Seattle-Tacoma, Washington. Because of AGM's wide host range and flight capability of the female moth, the North American Plant Protection Organization considers AGM a significant threat to North American forests and agriculture. The monitoring program developed an AGM flight periodicity graph for all monitored Russian ports which indicates a period of risk within each port for ships arriving to berth in these port areas. The program has expanded to include other forest Lymantriids including the nun moth, *Lymantria monacha* and the pink or rosy gypsy moth, *Lymantria mathura*. Attractant pheromones and various trap designs have been tested to determine the most effective methods for capturing male moths of each species within the port areas. Ship and cargo inspection protocols were also developed to ensure a ship is pest free when it departs a Russian Far East port with a North American destination. The phytosanitary certificate indicating a ship has been inspected before departing a Russian port is now required for ships departing for the United States, Canada, Australia and New Zealand. Because AGM is also native in several other Asian countries the monitoring and ship inspection program has expanded to include Japan (2004), South Korea (2007) and eventually China.

ATENQUIQUE: *Ips* spp. and Slash Management in a Mexican Pine Plantation

Brytten Steed, Beth Willhite USDA Forest Service, and Jaime Villa,
Entomologist, Comisión Nacional Forestal, México

In 1997, Atenquique established the first industrial plantations of native pine in the State of Jalisco. Large-scale, intensive even-age management of native pine forests is relatively new in Mexico. Since 1997, Atenquique has regenerated past harvest areas with *Pinus douglasiana*, and to a lesser extent, *P.pseudostrobi*s. Preference of *P.douglasiana* is based on its fast growth, high quality fiber and resistance to *Dendroctonus* bark beetle attack.

In early August 2004, *Ips* outbreaks were detected in two 7- to 8-year-old *P.douglasiana* plantations. Outbreaks covered 7-20 hectares with approximately 130-

150 trees. Both areas had been thinned and pruned in March/April. Harvesting in the older forest matrix surrounding these sites was also being conducted. The company responded by promptly removing and burning any *Ips*-infested trees and on-site slash in the outbreak areas. Occasional spot infestations have continued to occur throughout the plantations with attacked trees removed and burned as quickly as they are located.

During 2005 – 2007, Brytten Steed and Beth Willhite provided assistance to the Mexican forest health program (Comisión Nacional Forestal-CONAFOR) in developing an *Ips* spp. management program for young pine plantations in the areas managed by Compañía Industrial Atenquique in Jalisco state. With little information available on *Ips* in Mexico, this project allowed FHP to provide needed data on slash and stand management and provided a unique opportunity to strengthen ties between the forest health programs of the two countries.

Project Objectives:

1. Identify the *Ips* spp. present
2. Determine seasonal abundance of the principle *Ips* spp.
3. Evaluate options to minimize the impact of *Ips* spp. on Atenquique plantations (slash mgmt)

We completed three trips between August, 2005 and January, 2007, working closely with CONAFOR forest health specialists and Atenquique personnel. Cooperating scientists at the Colegio do Postgraduado, namely Dr. Armando Equihua Martínez and graduate students Alejandro Rodríguez Ortega and Rubén Ángel Hernández Livera, provided assistance with species identification, data entry and collection, and complementary studies.

Using trap collections and collections directly from slash, six species of *Ips* were identified. For several species this was the first official record of finding in the state of Jalisco.

Foreign Wide: Bark Beetles in Central America and Mexico and *Tomicus yunnanensis* in China

Steve Clark
USDA Forest Service, Lufkin, TX

Mexico

Dendroctonus bark beetles have caused extensive mortality in Central America and Mexico in the past ten years. A majority of the mortality was attributed to the southern pine beetle (SPB), *Dendroctonus frontalis*. In the aftermath of widespread pine mortality in Belize, a putative new species of *Dendroctonus* was discovered. This beetle did not respond to frontalin, the primary aggregation pheromone of the southern pine beetle. The beetles appeared larger than typical SPB, and gallery patterns were somewhat different. Some scientists believed that the new species may have been responsible for the outbreaks in Central America, while others suspected it only functioned as a secondary bark beetle.

A cooperative project involving Brian Sullivan, Southern Research Station, Ron Billings,

Texas Forest Service, and Stephen Clarke, FHP, was developed in 2005 to investigate the role of the new species in bark beetle infestations in Central America. The project objectives are:

1. Determine the sequence of arrival and portions of trees attacked by *Dendroctonus* spp.
2. Determine the influence of host orientation on attack by *Dendroctonus* spp.
3. Document the geographical and elevational distribution, host range and host preferences of the putative new species.
4. Develop an attractive bait for the putative new species, and initiate tandem trapping surveys for both *D. frontalis* and the putative new species.

Due to low bark beetle populations in Central America, the project was initiated in Chiapas, Mexico in association with Jorge Macias-Semana and his graduate student Alicia Niño.

In 2006, Brian carried a portable GC to Jorge's lab, where it will be used to evaluate the pheromone composition of the new species and identify potential attractants. A field trial testing (+)-endo-brevicomin as a possible attractant was established in September, but the results were inconclusive due to the loss of some traps and infrequent trap collection. Trap height was found to be an important factor in collecting SPB in Mexico, and future studies will incorporate height as a variable. Plans for 2007 are to get the GC fully operational, test potential attractants for the new species, and study the effect of host orientation on attacks.

China

Tomicus yunnanensis is a pest of pines in the Sichuan and Yunnan Provinces in China. This species aggregates during the maturation feeding phase in the shoots. In the winter the beetles attack the boles of the trees during the reproductive phase. Trees weakened from the shoot-feeding are often killed during the trunk attacks. This species does not respond well to the typical lure used for *T. piniperda*. Verbenone has been shown to protect trap log bundles from attack.

A cooperative project between the U.S. and China was established to investigate *T. yunnanensis*. Cooperators are Jianghua Sun, Chinese Academy of Sciences, and Tom Eager and Stephen Clarke, FHP.

Project objectives are:

1. Identify attractive pheromones or host compounds
2. Test verbenone for protection of trees from trunk attacks, and
3. Test other population suppression strategies such as trap-out or trap logs.

Initial trials in Sichuan Province were not successful, as the field site was distant from the Provincial Forest Pest Control Department and as a result the traps were not monitored properly. In addition, the Province did not want to cut trees to test trap-out suppression. The project will be moved to Yunnan Province in 2007. Dr. Sun has a former graduate student that works at the Forest Pest Control Department, and there are infestations close to that office.

Assistance for Recuperation and Revitalization of Chile's Temperate Forests with Emphasis on Deciduous *Nothofagus*

William M. Ciesla
Forest Health Specialist, Forest Health Management International, Ft. Collins, CO

A short technical assistance visit to identify and evaluate the factors affecting the health of Chile's native forests in January 2007 was described. This project was funded by the Food and Agriculture Organization of the United Nations (FAO) and is being executed by Corporación Nacional Forestal, (CONAF) Chile's national forest department.

Chile has about 13 million ha of native forests. These forests occur in the central and southern portions of the country, principally in the Andean cordillera. They are composed of both broadleaf and coniferous species and have a wide range of economic, ecological and social values. Ten species of *Nothofagus*, known as southern beeches, are indigenous to Chile and five species are dominant components of the native forests. Some of these forests are included in national parks and reserves, managed by CONAF. Other native forests are in small non-industrial private ownership. These owners typically have poorly defined forest management objectives. Other native forests are set aside as communal reserves for indigenous people. The value of these forests as an important resource is being realized and CONAF is providing forest management assistance to private landowners.

A number of damaging insects, diseases and pest complexes (diebacks and declines) are present in these forests. Relatively little is known about many of these agents and their impacts and few, if any, methods are available to mitigate their effects on resource values.

A large cerambycid, *Holopterus chilensis*, attacks roble, *N. obliqua.* This insect is capable of boring into the lower boles of healthy, vigorous trees, causing significant loss of lumber quality. Affected trees are not killed.

Several agents damage the foliage of roble. These include a recently discovered nematode, *Subanguina chilensis*, which causes leaf discoloration and deformity, an unidentified leaf miner and the well-known Saturniid, *Ormiscodes cinnamomea.*

A sawfly, *Cerospastus volupis,* is a defoliator of rauli, *N. alpina*. This insect can be locally abundant and its life history and habits have been studied.

CONAF is especially concerned about a decline of *N. obliqua*. Symptoms include smaller than normal foliage and transparent crowns. This condition was found on occasional forest trees and more commonly on old trees occurring in pastures, which have probably suffered root damage from livestock. In addition, single trees or small groups of roble with exceptionally heavy seed crops were observed. The seeds give the tree crowns a brownish appearance that resembles insect defoliation. It is not clear if the heavy seed crops are a symptom of stress and part of the decline complex.

A dieback of lenga, *N. pumilo,* is common in high elevation forests. Old trees, often more than 300 years of age are affected. The understories of these forests contain abundant but suppressed lenga regeneration, which is released as the older trees die. This condition appears to be an integral part of the dynamics of high elevation lenga forests.

Several species of feather mistletoes, *Misodendrum* sp. infest species of *Nothofagus.* These can be locally abundant and severe infestations appear to be associated with decline.

A twig boring buprestid of unknown identity was detected in coigue, *N. dombeyi*, which was killing branches of this species.

This project will attempt to reduce the occurrence of wood borer attack and occurrence decline in roble and rauli through various silvicultural treatments. Other objectives of this project are to publish a guide on the recognition of signs and symptoms of damage in Chile's native forests and to train foresters and extension specialists in factors affecting the health of these forests. This information will be shared with neighboring Argentina, which has similar native forests.

Workshop 7: Invasive Adelgids: Eastern and Western Experiences

Moderator: Stephen Cook, University of Idaho, Moscow, ID

The balsam woolly adelgid, *Adelges picea*, and hemlock woolly adelgid, *Adelges tsugae* (Hemiptera: Adelgidae), are invasive pests of coniferous forests in both the eastern and western United States. Balsam woolly adelgid is capable of attacking and killing native North American firs, with Fraser fir in the east and subalpine fir in the west being particularly susceptible to infestation. Hemlock woolly adelgid is capable of infesting native hemlocks and is a serious pest in forests of the eastern United States where it is causing significant mortality to both eastern and Carolina hemlock. The objective of the workshop was to bring together scientists who are examining various topics with regard to these insects in both eastern and western forests.

Hemlock Woolly Adelgid: The Host Factor

Fred P. Hain, Robert M. Jetton, and Navdip Kaur
Department of Entomology, N.C. State University

Better understanding of what constitutes resistance or tolerance to hemlock woolly adelgid is needed in view of the current efforts to manage the pest through biological control. Our hypothesis is that a complex of predators, in conjunction with host resistance, is needed to regulate HWA populations. Knowledge of what constitutes resistant hemlock and hemlock stands will help us identify areas where biological control measures will have the greatest probability of success. Preliminary results indicate that it is possible to test seedlings of various hemlock species for susceptibility to the adelgid. These results suggest that eastern hemlock is significantly more susceptible than either Carolina or western hemlock. The fact that Carolina hemlock was not significantly different from western hemlock is encouraging. Further research is necessary to elucidate the mechanism of resistance and to confirm that seedlings can be used as a reliable bioassay for resistance in mature trees.

Community Structure of Predators Associated with the Hemlock Woolly Adelged (Hemiptera: Adelgidae) in the Pacific Northwest

Glenn R. Kohler, Vernon L. Stiefel, Kimberly F. Wallin, and Darrell W. Ross
Oregon State University, Forest Science, Corvallis, OR

The hemlock woolly adelgid, *Adelges tsugae*, is causing widespread mortality of eastern hemlock, *Tsuga canadensis*, in the eastern United States. In the West, *A. tsugae* causes negligible damage to western hemlock, *Tsuga heterophylla*. Host resistance and presence of endemic predators may be contributing to the relative tolerance of western hemlock. Field surveys of the predator community associated with *A. tsugae* infestations on 116 *T. heterophylla* at 16 locations in Oregon and Washington were conducted every four to six weeks from March 2005 through November 2006. Predators collected from *A. tsugae* infested *T. heterophylla* represent 55 species in 14 families, listed in order of abundance: Derodontidae, Chamaemyiidae, Hemerobiidae, Coccinellidae, Cantharidae, Reduviidae, Miridae, Syrphidae, Chrysopidae, Coniopterygidae, Staphylinidae, Anthocoridae, Nabidae, and Raphidiidae. *Laricobius nigrinus* (Derodontidae), *Leucopis argenticollis*, and *Leucopis atrifacies* (Chamaemyiidae) are the dominant predators; together comprising 59% of predator specimens recovered. The abundance of derodontid larvae, *L. nigrinus* adults, chamaemyiid larvae, and *L. argenticollis* adults was predicted to increase with *A. tsugae* density. The remaining 52 species represent a diverse complex of predators potentially attacking *A. tsugae*; however, many are known to feed on non-adelgid prey. Fifteen predator species were either reared from larvae to adult on a diet of *A. tsugae* in the laboratory or were observed feeding on *A. tsugae*.

Release and Establishment of *Laricobius nigrinus* (Coleoptera: Derodontidae),a Prey Specific Predator of *Adelges tsugae* (Hemiptera: Adelgidae)

D.L. Mausel, S.M. Salom, and L.T. Kok
Virginia Tech, Blacksburg, VA

A mixed release approach was used to introduce the Pacific Northwest native *Laricobius nigrinus* Fender, a predator of the invasive hemlock woolly adelgid, *Adelges tsugae* Annand (Hemiptera: Adelgidae), on eastern hemlock trees from Massachusetts to Georgia. The manipulated release factors included the: (1) number of beetles released; (2) number of release trees; (3) time of release; and (4) location. There were 10 open releases in 2003-2004 consisting of the replicated treatments: 300 adults in fall 2003, 300 in spring 2004, or 300 in fall 2003 plus spring 2004 (sum = 600). There were 12 releases the following year (2004-2005) that included the new release sizes: 75, 150, or 1,200 adults in fall or spring. Beetles were released onto 2, 5, 10, or 15 trees depending on the release size. To monitor *L. nigrinus* establishment, adults were collected with beatsheets in autumn on six occasions after 1, 2, and 3 years post-release. To sample *L. nigrinus* eggs and larvae, HWA infested branches were clipped with pole pruners up to 10 m height in spring on one occasion when HWA sistens oviposition had peaked. The eggs and larvae were then reared in modified Berlese funnels and aestivation containers in the laboratory. Beatsheet sampling has recovered 37 F_1 and 13 F_2 *L. nigrinus* adults at 5 of 22 sites. Branch clipping has recovered 1,412 F_2 and 1,179 F_3 *Laricobius* larvae from 19 of 22 sites. The F_2 adults and F_3 larvae at the 2004-2005 sites remain to be sampled. In the first year of branch clipping sampling (spring 2005), 76% of the adults that emerged

the following fall were *L. nigrinus* and 24 % were *L. rubidus*. In the second year of branch clipping sampling (spring 2006), 69% of the adults that emerged the following fall were *L. nigrinus* and 31% were *L. rubidus*, to date. The F_3 *L. nigrinus* recoveries and increasing amounts of recoveries at most sites indicate that this important predator has established populations in the eastern U.S. Recoveries have been made at all release sizes and times except in GA, MA, WV, Mt. Rogers VA, and western MD (the warmest and coldest release locations). Release tree health and HWA populations at the majority of sites are declining however some sites appear to be recovering. More time is required to monitor long-term *L. nigrinus* population establishment, changing tree health conditions, and HWA populations at these sites to determine if *L. nigrinus* will be a successful biological control agent.

Remotely Sensed Data for Early Detection of Balsam Woolly Adelgid on Subalpine Fir

Stephen Cook[1], Karen Humes[2], and Grant Fraley[2]
University of Idaho: 1/ Department of Forest Resources; 2/ Department of Geography

The balsam woolly adelgid is a pest of true firs in both eastern and western North America. In Idaho, the adelgid is primarily found attacking subalpine fir. The primary objective of our current work is to examine and compare the spectral features of subalpine fir infested with BWA to determine if changes occur in foliar spectral measurements following attack. We have been using a hand-held spectroradiometer for our field measurements but have been 'combining' narrow bands to create 'Band Equivalent Reflectance' values similar to those available from various multispectral sensors. There are distinct and significant changes that occur in spectral measurements following attack that occur in the visible, near infrared and short-wave infrared regions. Using stepwise discriminant analysis procedures, we were able to correctly classify trees as infested versus not infested with greater then 90% accuracy using a variable model with the hyperspectral data. The classification accuracy decreased to approximately 85% using a 3-variable model and the Band Equivalent Reflectance data. Therefore, multispectral data may eventually be useful for detection of balsam woolly adelgid infestations. However, the issues of spatial scale will need to be resolved and other stressors need to be examined to determine how unique the measured spectral changes are with regard to various stresses.

Workshop 8: Development of Policies and Procedures for the North American Forest Insect Work Conference

Moderator: Robert N. Coulson, Texas A&M University, College Station, TX

The NAFIWC is the conclave of the forest entomology community. The conference is scheduled on a five year cycle and is intended to provide a forum for discussion of contemporary issues in forest entomology. The agenda is broad-based and includes topics relating to research, development, application, and education. Although the forest entomology community at large has vigorously supported the NAFIWC, no single agency or organization has responsibility for the planning and organization of the conference. These ends are accomplished by volunteers. The objective of this

workshop was to consider formalizing the planning and organization of future NAFIWC's. The conclusions from the workshop included the following: (1) the NAFIWC is a worthwhile endeavor, (2) Planning and organization should be formalized, (3) a standing committee with representatives from the Regional Work Conferences, (4) a strategy for hosting the NAFIWC needs to be established, (5) where and when the conference is held matters, (6) interagency partnerships are essential, and (7) consider expanding the scope: International Forest Insect Work Conference: IFIWC. This discussion was also held at The North Central Forest Pest Workshop in the Fall and will also be presented at the SFIWC this Summer. A formal committee will be established to guide the planning and organization of future NAFIWC's.

Workshop 9: Efficacy of Verbenone for Control of Other Bark Beetle Species

Moderator: Nancy Gillette, USDA Forest Service, Berkley, CA

Efficacy of Verbenone for Control of Western Pine Beetle in Ponderosa Pine Stands

Chris Fettig, USDA Forest Service, Davis, CA;
Dezene P.W. Huber, University of Northern BC, Prince George, BC, Canada

The western pine beetle (WPB), *Dendroctonus brevicomis* LeConte (Curculionidae, Scolytinae), is a major cause of ponderosa pine, *Pinus ponderosa* Dougl. ex. Laws., mortality throughout much of the western USA and southern British Columbia, Canada. Currently, pest management techniques for managing WPB infestations are limited to tree removals (thinning) that reduce stand density and perhaps host susceptibility and the use of insecticide treatments. We began this presentation with a review of the literature on verbenone and its influence on WPB behavior. We then discussed our study on the efficacy of the five gram verbenone pouch for protection of *P. ponderosa* stands from WPB, and displayed results indicating this technique was ineffective. This lack of response may be due to rapid isomerization and dispersal of verbenone in *P. ponderosa* stands, inadequate elution rates, high concentrations of of our recent efforts examining nonhost angiosperm volatiles and verbenone for their ability aggregation pheromones, or very short range sensitivity. We concluded with discussion to protect individual *P. ponderosa* from attack by WPB. A combination of (−)-verbenone and eight nonhost angiosperm volatiles [benzyl alcohol, benzaldehyde, guaiacol, nonanal, salicylaldehyde, (*E*)-2-hexenal, (*E*)-2-hexen-1-ol, and (*Z*)-2-hexen-1-ol] (NAVV) significantly reduced the density of WPB attacks and WPB successful attacks on attractant-baited trees. A significantly higher percentage of pitchouts (unsuccessful WPB attacks) occurred on NAVV-treated trees during two of three sample dates. In addition, significantly fewer red turpentine beetle, *D. valens* LeConte, attacks were observed on NAVV-treated trees during all sampling dates. The application of NAVV to individual *P. ponderosa* significantly reduced tree mortality, with only four of 30 attractant-baited trees dying from bark beetle attack while 50% mortality (15/30) was observed in the untreated, baited control. To our knowledge, this is the first report demonstrating the effectiveness of nonhost angiosperm volatiles and verbenone for protecting individual *P. ponderosa* from WPB attack.

Evaluation of Verbenone Hercon Flakes as a Protection Against Attack by Engraver Beetles on Ponderosa Pine Slash

Tom De Gomez[1], C. Hayes[2], J. McMillin[3] , J. Anhold[3] , M. Wagner[2]
[1]University of Arizona, Flagstaff, AZ; [2]Northern Arizona University; Flagstaff, AZ; [3]USDA Forest Service, Flagstaff, AZ

In previous studies verbenone has been shown to repel *Ips pini* (Say) and *I. latidens* (LeConte). Our study tested the effect Hercon verbenone flakes have on attacks by *Ips* spp. bark beetles on ponderosa pine (*Pinus ponderosa* Dougl ex. Laws.) slash piles. Our six 2005 treatments consisted of: 1) control; 2) verbenone only; 3) shredded white fir; 4) shredded white fir plus verbenone; 5) shredded juniper; and 6) shredded juniper plus verbenone. Shredded boughs of fir and juniper were applied weekly at a rate of 3.5 kg per pile, in a ring around the base of the pile. Verbenone was applied at a rate of 100g/ pile, using Hercon flakes scattered onto the slash pile. Our 2006 treatments consisted of four treatments: 100, 200, 400 and 800 g of Hercon flakes verbenone per slash pile, plus a control that had no Hercon flakes. In 2005 we found that when the data was pooled there was a statistically significant difference in number of nuptial chambers and egg gallery length between the slash piles treated with verbenone versus those without verbenone. In 2006 we saw no difference between the treatments and the control.

Evaluation of Verbenone Flakes for Protecting Ponderosa Pine from Attack by Western Pine Beetle

Nancy Gillette[1], Nadir Erbilgin[2], David L. Wood[2], Connie Mehmel[3], Donald R. Owen[4], Sylvia Mori[1,] Gary Fiddler[5] J. Webster[6], and John D. Stein[7]
[1]USDA FS, PSW Research Station, Berkeley, CA; [2]University of California, Berkeley, CA; [3]USDA FS, FHP, Wenatchee, WA;[4]Calif. Dept. Forestry and Fire Protection, Redding, CA; [5]USDA FS, PSW Research Station, Redding, CA; [6]Total Forestry, Anderson, CA; [7]USDA FS, FHTET, Morgantown, WV

Tests of aerially applied verbenone flakes for control of western pine beetles in a ponderosa pine stand were initially quite promising, with significant reductions in attack on baited trees in treated stands and significant reductions in numbers of beetles trapped in treated stands. That first study was conducted against the second beetle flight of the season, however, and subsequent tests targeting both beetle flights failed to control beetle attack on ponderosa pines. In addition, tests of flakes sprayed onto tree boles for individual tree protection were unsuccessful. In view of the successes shown in tests of the same product for control of mountain pine beetle and Douglas-fir beetle, we conclude that a different active ingredient, or a blend of active ingredients that includes verbenone, will be required for control of western pine beetle using this technique.

Multi-year Evaluation of Verbenone to Reduce Mountain Pine Beetle Attacks of Lodgepole Pine

Robert Progar, Carl Jorgensen, Phil Mocettini, Richard Halsey
USDA FS, FHP, Boise, ID

Mountain pine beetle (MPB), *Dendroctonus ponderosae*, is considered the primary cause of mortality of mature lodgepole pine (*Pinus contorta* var *latifolia)*. Tree losses

associated with outbreaks of MPB have been described as devastating, exceeding a million trees a year in some forests, and causing changes in density, stand age and species composition. The semiochemical verbenone is the principal anti-aggregant pheromone of MPB. Studies have shown it can reduce the incidence of successful MPB attacks on lodgepole pine in one-year trials, or at low beetle populations. Other studies have found no differences between verbenone and untreated plots, or yield ambiguous data.
The inconsistencies of verbenone for affecting MPB population behavior are well documented. Some hypotheses include:

1. Beetle caused changes in stand structure alter the microclimate to permit the verbenone pheromone plume to dissipate above the tree canopy rather than disperse among the tree boles.
2. Weather related factors such as higher temperatures that cause the verbenone to elute before the flight period ends may cause the tests to fail.
3. Beetle response to verbenone changes in the later stages of an outbreak, beetles begin to attack small diameter trees that have thin phloem. Brood adults produced from these trees are smaller and weaker than the adults that emerge from larger diameter trees with thick phloem. These beetles are attracted to, or ignore, the verbenone signal.
4. Large populations of beetles at the peak of an outbreak may overwhelm the verbenone treatments.

To evaluate the performance of verbenone over the duration of an MPB outbreak, we established twelve one-acre plots in central Idaho, and in northern Utah. Six plots at each locale were randomly chosen for verbenone treatment. Twenty, 7.5g verbenone pouches were evenly distributed within the 1-acre plots on the north facing side of the trees in 2005 and 2006. The remaining six plots at each location were used as untreated checks for comparison. For two years prior (2003 and 2004) to the placement of 7.5g verbenone pouches, cumulative, beetle-caused mortality was the same among the study plots within location. After treatment with verbenone in 2005 and 2006, beetle populations were increasing at a faster rate in untreated areas than areas treated with verbenone pouches. It is likely the populations of MPB in the untreated areas will increase until trees in the preferred size range are depleted. At this time there will be more host trees of preferred sizes on plots containing verbenone than in untreated areas. With insufficient numbers of preferred or suitable sized trees available to accommodate the population of host seeking beetles, MPB may select smaller trees and/or ignore the verbenone signal. This response would suggest that the need to colonize a suitable host supersedes intra-specific competition. We will continue to place the verbenone in the same plots in an operational trial until the beetles are gone, or the available host trees are depleted.

Workshop 10: Landscape Ecology: Large Area Insect Disturbances

Moderators: Brian Aukema, Canadian Forest Service, Prince George, BC, Canada and Allan Carroll, Canadian Forest Service, Victoria, BC, Canada

Epidemiology of the Southern Pine Beetle

Andrew Birt, Rich Feldman, Maria Tchakerian, Lei Wang, Jim Guldin, Fred Stephen, and Robert Coulson[1]
[1]Texas A&M University, College Station, TX

Population dynamics of the southern pine beetle (SPB) (*Dendroctonus frontalis*) in meso-scale forest landscapes was the subject of this presentation. The objective was to consider SPB epidemiology in the context of the model: risk = hazard + exposure. Risk is an anthropomorphic concept. It is defined in terms of a human-valued quantity, e.g., loss of revenue resulting from SPB herbivory. Hazard is the conditional state of the forest environment. Exposure is defined in the context of variable population size. The discussion centered on the approach being used to link population dynamics of the SPB occurring in individual infestations (spots) distributed over broad spatial and temporal scales. The TAMBEETLE model was used to simulation population dynamics of the individual infestations and these results were propagated over a mesoscale forest landscape throughout the year. The spatial and temporal context of infestations, the conditional state of the forest environment, and the local weather conditions (principally temperature) drive epidemiology at broad spatial and temporal scales. Emphasis was placed on the need for better understanding of dispersal mechanisms and strategies used by the SPB.

When Forest Management and Climate Change Collide: The Eruption and Spread of Mountain Pine Beetle Populations in Western North America

Allan L. Carroll
Canadian Forest Service, Pacific Forestry Centre, Victoria, BC, Canada

The mountain pine beetle is native to the pine forests of western North America where it normally exists at very low densities, infesting only weakened or damaged trees. Under conditions conducive to survival, populations may temporarily increase allowing beetles to infest healthy trees. On rare occasions, these increases are rapid and widespread, leading to landscape-level outbreaks and the mortality of large numbers of trees. Although there have been 4 outbreaks during the past century in western North America, the ongoing epidemic is unprecedented in its size and severity – causing the mortality of mature pine over »14 million hectares in British Columbia alone. In recent years, the mountain pine beetle has successfully breached the northern Rocky Mountains. Small populations are now scattered over the Alberta Plateau where lodgepole pine hybridizes with jack pine forming a corridor of susceptible hosts extending to the boreal forest. Given predictions of increasingly suitable climate for MPB across Canada, there is concern that invasion of the boreal forest is a plausible threat. This paper will examine the independent and interacting influences of forest management practices and climate change on the mountain pine beetle and its potential for invasion of the boreal forest.

Mountain Pine Beetle in British Columbia: Lessons From Twenty Years Past

Brian Aukema
Canadian Forest Service, Prince George, BC, Canada

The current outbreak of mountain pine beetle has spread over almost 10 million hectares through the Canadian provinces of British Columbia and Alberta. Some view the outbreak as a continuation of a large outbreak over a region known as the Chilcotin Plateau in the central interior of British Columbia. The Chilcotin Plateau outbreak, extending over slightly less than 1 million ha of mature lodgepole pine, grew through the late 1970s and early 1980s until extreme cold temperatures in successive Octobers reduced insect populations. I present initial results of a model of outbreak dynamics studying the effects of various climatic variables on the occurrence of outbreak populations, using aerial survey data that spans the duration of the Chilcotin outbreak.

Workshop 11: Digital SLR Photography for Entomologists

Moderator: William M. Ciesla, Forest Health Management International, Ft. Collins, CO

William M. Ciesla opened the session with a presentation on the general characteristics of digital-single lens reflex (SLR) cameras with a review of the desired features of both SLR cameras and digital cameras.

SLR Film Cameras

1. What you see is what you get (WYSIWYG)
2. Interchangeable lenses
3. Can use a variety of filters to enhance subject

Digital Cameras

1. Variable ISO settings
2. No expensive film and processing
3. Can capture images in a range of resolutions
4. Images are in digital format, suitable for computer editing and storage
5. Can view resultant image immediately – delete if not suitable

A large number of digital SLR cameras are currently available with several models now capable of producing images in the 8-10 megapixel range at prices that are within reach of many consumers.

Most digital SLR cameras provide two or more options for image quality. While using the highest resolution imaging capability available will provide for high quality, mural sized enlargements, selection of medium or lesser quality images may be desirable if the images will be displayed only on computer screens or used for production of small prints. A 3.3 megapixel image, for example can easily be enlarged to a 7.5 x 11 inch image and produce a 200 dpi print of acceptable resolution.

Most digital SLR cameras record data on a 15.1 x 22.7 mm sensor. This sensor is slightly smaller that the dimensions of a single frame of 35 mm film (24 x 36 mm). Therefore, an image captured on a 15.1 x 22.7 mm sensor by a lens of any given focal length will have a somewhat greater telephoto effect when compared to an image captured on 35 mm film. Digital SLR cameras with a data chip of a given size have a focal length multiplier (FLM). The FLM for a 15.1 x 22.7 mm sensor is 1.5.

Lens focal length	Effective focal length @ FLM = 1.5 (15.1 x 22.7 sensor)
18	27
24	36
35	52.5
50	75
70	105
150	225

Some basics of good image composition were presented. These included:

1. Divide the horizontal and vertical axis of the scene into thirds and place the subject of interest at one of the four points where the lines converge.
2. Have the subject of interest facing or moving into the scene.
3. Frame edges of landscapes with foliage and/or branches to create a 3-dimensional effect.
4. Place people in the scene to help create interest and give the image a sense of scale.

Subjects that should be captured by forest entomologists include:

1. Insects in their various life stages.
2. Damage (tree killing, defoliation, deformity, bark beetle galleries, wood boring, galls) and impacts.
3. Program activities (data collection, monitoring, pest management activities).
4. Healthy forests (The end result of our efforts).

Good macro (close-up) images can be obtained by maximizing the depth of field order to get as much of the subject of interest into focus as possible. In addition, management of the background by either getting it totally out of focus or creating a black background with a fill-in flash is important. Recommended camera settings for a fill-in flash are:

1. Manual
2. ISO = 200
3. Shutter speed = 1/250 or 1/500
4. Aperture = f 22 - f 32

Another special need is to capture aerial oblique images that show various types of insect damage. For this application, it is important to minimize image motion and blur. Recommended camera settings are:

1. Lens focal length: 70 – 85 mm.
2. ISO of at least 400
3. Shutter speed: 1/1000 second minimum

4. Try to avoid cloud shadows.
5. Hold lens as close to aircraft window as possible to minimize reflection or open window if you can.

Other special applications discussed are documenting change in forest condition over time and a technique for using a mosaic of oblique aerial photos to capture and transfer damage to a map base.

Ron Billings described a simple technique for converting 35 mm slides to a digital format using a small digital camera mounted on a photo stand and placing the 35 mm slides on a light box. This technique produces images of a quality equal or superior to commercial scanning of 35 mm slides.

Ron also discussed the DxO Optics Pro digital image editing software, which offers a range of features to automatically correct and enhance images. Some features of this software include:

1. Elimination of distortion, vignetting and lens softness through specifically developed camera/lens modules
2. Removal of camera noise (http://www.dxo.com/intl/photo/dxo_optics_pro/overview/powerful_denoising/camera_based_noise_removal)
3. Removal of purple fringing (http://www.dxo.com/intl/photo/dxo_optics_pro/overview/optics_geometry_corrections/aberration)
4. Optimization of exposure & dynamic range (http://www.dxo.com/intl/photo/dxo_optics_pro/overview/sophisticated_lighting/contrast_and_exposure_optimisation)
5. Color optimization
6. Perspective correction
7. RAW conversion and highlight recovery

An open discussion followed and a variety of topics were addressed including storage of images on databases such as the University of Georgia forestryimages.org web site, who owns the images if the photographer is employed by a government agency or private company, and some aspects of ethics of using photos taken by other photographers in one's work.

Workshop 12: Insect and Disease Web-based Data Clearinghouse

Moderators: Joel McMillin, USDA, Forest Service, Flagstaff, AZ and
Beth Willhite, USDA Forest Service, Sandy, OR

Workshop objectives

1. Review background and relevant work.
2. Discuss issues surrounding development and maintenance of the database.
3. Develop a blueprint for future direction, coordination, and activities ($$, standards, etc.)

Background

A grassroots impetus for a centralized, web-based forest insect and disease literature database has been building over the past 3-4 years from several different quarters. During this time, both the Western Bark Beetle Technical Working Group and the Western North American Defoliator Working Group independently fostered parallel efforts to develop respective central database repositories for literature citations and full-text pdf's of gray literature. In addition, western forest insect researchers have repeatedly expressed interest in gaining better access to FHP "gray" literature. This subject was recently discussed at the inaugural meeting of the Western Bark Beetle Research Group at Skamania Lodge (Washington) in January 2007.

Several years ago, Marla Downing, FHTET, developed the web-based *Western Bark Beetle Information System* (WBBIS) to provide a web-based location for bark beetle literature citations and pdfs. The WBBIS provided a good start towards a centralized web-based bibliographic database, and this system was recently investigated for expansion to include defoliators as well as other forest insect and disease agents. Commercial software options were also investigated for this purpose, and one application in particular, Thomson ResearchSoft's "Reference Manager," was found to be superior to other alternatives in terms of capability, versatility, capacity, ease of use, maintenance, and support.

Presenters

Danny Cluck, USFS-FHP R5 and Mike Bohne, USFS-FHP R5, "Historical Literature Database efforts in Region 5"
Lia Spiegel, USFS-FHP R6, "Legacy Database efforts in Region 6"
Darren Blackford, USFS-FHP R4 and Jonathan Marston, USFS-FHTET, Ft. Collins, CO, "Reference Manager Demonstration and the role of FHTET"

Review of relevant work

USFS-FHP Region 5 (California and Pacific Islands)
Region 5 (Danny Cluck, Sheri Smith, and others) recently used a seasonal employee to go through their files and enter all their literature (published and gray) into an EndNote bibliographic database. In 2006, they catalogued their gray literature (site visit reports and biological evaluations; files date back to the 1930's and 1940's). This required having a seasonal employee read each report and then enter relevant information into an Excel spreadsheet with the following headings:

|Report |Date |SA/RO |Forest |Authors |Title |Subject |Have Report? |
Format | Insect |Disease |Other Key Words |.

They opted not to scan their reports, but instead are making a hardcopy of each one so there are 2 hardcopies of each document. One copy will be kept in the Regional Office and the other at the Service Area office where it originated. When someone wants to obtain a copy of a report, they will be directed to contact the Regional Office, which will then make a copy and send it to them.

Mike Bohne received 2007 funding from the Forest Health Monitoring (FHM) program to create a California Historic Insect and Disease Geodatabase that will be available to web users. A legal location (Township, Range, and Section) will be identified for each report so they can be searched spatially. ArcIMS (a web version of ArcView) will be used to develop a "clickable" map showing a listing of all insects and diseases reported for a particular legal location and will link electronic copies of the reports. For each legal location having reported incidence data, a list of insects, diseases and invasive plants will be displayed. In addition to extracting incidence data from site visit reports and biological evaluations, the following sources will also be utilized:

- Conditions Reports
- National Agriculture Pest Information System (NAPIS) Database (for reports on non-native forest invasives)
- California Coop Pest Survey Records

Region 5 has developed a form for online reporting that will allow users to enter information into an Access database (they are willing to share this form).

USFS-FHP Region 6 (Oregon and Washington)

Kathy Sheehan and one representative from each Service Center have been working to develop a web-based legacy database for Region 6 FHP forest insect and disease information. These are trip reports, biological evaluations, and other reports authored by FHP personnel. Users will be able to search the database by geographic area, agent, etc., view clickable maps with links to pdfs of reports and database tables, and add or edit new records. Aerial Detection Survey information also will eventually be linked to this database.

Currently the team is in the process of gathering copies of all the reports in the Region. They plan to create a scanned copy of each report, which will be linked to the website, and will also keep a hardcopy of each report in the RO. Each Service Center representative is responsible for entering their reports into the database.

USFS-FHP Region 4 (Southern Idaho and Utah)

Ogden Field Office

The Ogden Field Office has been entering all of their literature (journal and gray) into an EndNote database as time allows.

Boise Field Office

Joy Roberts has 4-5 years of R4 data (gray literature citations) in an EndNote database and is using EndNote to reference old slides that will be scanned and put on CDs.

USFS-FHP Region 3 (Arizona and New Mexico)

Flagstaff Field Office

Joel McMillin reports that recent Region 3 reports are sent and filed through the Forest Service Correspondence Database – this keeps a formal, retrievable record of the report. Region 3 is also hoping to create a searchable literature database and a digital archive of historical insect and disease documents. Regional Office has a color copier

that also scans documents and saves them as pdf's. Joel and Dan Ryerson have begun creating a digital archive.

States
Some State attendees have Access literature citation databases.

Reference Manager software

Darren Blackford, USFS-FHP R4 and Jonathan Marston, FHTET, have been exploring "Reference Manager," as a potential platform for the centralized literature database. EndNote and Reference Manager are commercially available bibliographic software owned by Thomson ResearchSoft. EndNote tends to be a relatively isolated desktop application for individual or networked users, while Reference Manager has web-publishing capabilities. A copy of Reference Manager costs $300.00; for our purposes we would only need to purchase one copy. Reference Manager can publish 15 databases, each containing 100,000 references or more (i.e., essentially no limit to database size). The databases associated with a copy of Reference Manager software must be published from a single server. Reference Manager exports into the RIS/XML format, which is accepted by EndNote, enabling easy data transfer between these applications. In addition to standard bibliographic fields, Reference Manager also provides user-defined fields. Reference Manager allows links to pdf's and images (e.g. attached map).

Issues/Concerns/Questions

- Compliance with the Disabilities Act (Jonathan will check)
- Need a way to import existing Access literature citation databases into Reference Manager (Jonathan checked before end of conference – yes it can be done)
- Security of Reference Manager on the FHTET server
- Ability to weed out duplicate citations
- Ability to have a live .html link in Reference Manager

Role of FHTET
Frank Sapio, FHTET Director, has agreed to house the Reference Manager application software and bibliographic database on the FHTET server. FHTET will provide technical assistance for developing this custom application of Reference Manager to the point where it is installed and fully functioning. After it is up and running, routine input and maintenance of the database will be provided by FHP personnel, and with the help of cooperators.

Discussion

A poll taken of the meeting participants regarding what they currently use for electronic storage of their citation databases showed that most people are using either EndNote or Access software (fairly evenly divided).

The group identified the user-base of the proposed data clearinghouse as being USFS-FHP, USFS-Research, and the States.

Database structure
Number of datasets: After some discussion, the group consensus was that one large dataset was preferable to having several smaller and potentially overlapping functionally defined datasets (e.g. defoliator, bark beetle, etc.). In addition, it was discussed but unresolved whether it would be useful to develop separate datasets for published literature and gray literature.

Hierarchy: Citations should form the top tier, followed by linked documents (full text pdfs), then geocoding of the linked documents (linked clickable maps).

How to proceed from here

Step 1: Compile existing literature citations by Region, especially the gray literature (can use EndNote or Reference Manager to search online sources for published articles).

Step 2: Enter citations into the data clearinghouse (i.e. Reference Manager database housed on the FHTET server).

Issues

- Gathering of current/relevant bibliographic data – how to accomplish ($$, standards, coordination)
- Standardize what and how we enter into the database clearinghouse by developing criteria for what we include and standards for how we report (e.g. standard file names).
- Need to develop a standard list of keywords. It was suggested that we have a hierarchy of keywords, e.g. 1) journal, trip report, etc., 2) area, 3) other keywords
- Need to develop a "new record" entry form for the database clearinghouse website.
- Need to establish "stewards" of the database in each Region for each subject area who will be responsible for soliciting, compiling, editing, submitting, and maintaining citations and pdf's on a regular basis.
- Need to decide whether to scan the reports (yes or no?) and if yes, whether to scan everything or only selected documents?

The role of the WO

When asked whether the WO would provide any money to support this effort, Ralph Thier suggested that the group prepare and submit a 1-page proposal for either FY07 or FY08. The proposal should outline clearly what we want to do by when, the cost, and the reason (one paragraph) "why do this?" We should funnel the proposal through Ralph Thier or Larry Yarger. The group felt that FY08 was the most reasonable timeline to shoot for, given the work yet to be done developing the details of the database and submission process.

Action Items

1) The attendees proposed that we form a committee to work out details and develop a funding proposal for FY08. The committee was formed by volunteers, and consists of the following people: Joel McMillin, Darren Blackford, Kathy Sheehan, Joy Roberts, Mike Bohne, Jonathan Marston, and Beth Willhite

2) The attendees proposed that we meet again during the Bark Beetle Technical Working Group meeting this fall.

Attendees: Joel McMillin, Beth Willhite, Darren Blackford, Jonathan Marston, Lia Spiegel, Danny Cluck, Mike Bohne, Karen Ripley, Joy Roberts, Ralph Thier, David Beckman, Gail Durham, Cheryl Costello, Amy Gannon , Robbie Flowers, Zach Heath and additional undocumented attendees.

Workshop 13
Forest Silviculture and Bark Beetles
Moderator: Steve Munson, USDA Forest Service, Ogden UT

Managing Host Stands to Reduce Mountain Pine Beetle-Caused Mortality in the Northern Region

Ken Gibson, USDA Forest Service, Region 1, Forest Health Protection, Missoula, MT

Mountain pine beetle is the most damaging forest insect in the Northern Region. Early management targeted beetles; but we later learned stand conditions fostered beetle outbreaks. Hazard-rating systems led to the development of effective silvicultural means of lessening host-stand susceptibility. Alternatives now consist of: regeneration, sanitation/salvage of beetle-killed trees, basal area reductions to reduce hazard, partial cuts discriminating against host trees, and creating "mosaics" of age, size, and species. In mid '80s pheromone tools became available. Attractants were used as tree baits or in traps. Anti-aggregative ones show promise in protecting high-value trees. Chemical treatments remain the standard for individual tree protection.

Silviculture, Bark Beetles, and Southwestern Pine Forests

Joel McMillin[1] and Jose Negrón[2]
[1]USDA Forest Service, Region 3, Forest Health Protection, Flagstaff, AZ
[2]USDA Forest Service, Rocky Mountain Research Station, Ft. Collins, CO

An extensive body of research throughout western North America has demonstrated correlations between certain stand conditions, such as stand density, and bark beetle-caused mortality of pine. Relatively little research has been conducted that examines such relationships, and their implications for silvicultural treatments, in the southwestern US. Based on studies of recent bark beetle outbreaks in ponderosa pine forests and piñon-juniper woodlands, pine mortality was related to elevation and measures of tree/stand density on several National Forests in Arizona. In addition, an inverse relationship between probability of tree mortality and tree diameter was found on the Prescott National Forest, where Arizona five-spined ips is the primary tree-killing bark beetle. Other recent research has demonstrated *Ips* preference for pine trees heavily infected by dwarf mistletoe (Kenaley *et al*. 2006). Findings from these studies suggest that stand hazard rating system developed in other regions for *Dendroctonus* beetles may not be appropriate for the Southwest, especially during drought events that are dominated by *Ips*-caused pine mortality. An alternative stand hazard rating system was proposed based on site characteristics, tree size and density, and dwarf mistletoe infection level. Finally, current silvicultural treatments for a variety of Forest objectives (i.e., fuels reduction, forest health restoration) were reviewed in relation to stand susceptibility to bark beetles. Monitoring of these treatments for bark beetle response was encouraged.

Kenaley, S.C., R.L. Mathiasen, and C.M. Daugherty. 2006. Selection of dwarf mistletoe-infected ponderosa pines by *Ips* species (Coleoptera: Scolytidae) in northern Arizona. Western North American Naturalist 66: 279-284.

Potential For Silvicultural Management of Douglas-fir Beetle.

Art Stock
BC Forest Service, Southern Interior Region, Nelson, B. C., Canada

Silvicultural management of Douglas-fir from young stands through to mature stands can be used to reduce Douglas-fir beetle impacts. Maintenance of vigorous healthy stands by ensuring suitable regeneration practices and stand densities is a key issue. Stand management practices (uneven *vs.* even aged management) can result in stand structures that may impact the behaviour of various disturbance agents such as root disease, defoliators, and mistletoes. Other disturbance factors such as windthrow, snow breakage, fire, and logging can also influence stand or tree susceptibility to DFB. Over time, it is important to recognise and minimise the impact that these disturbance factors may have.

Assessment of Silvicultural Treatments to Reduce Spruce Beetle-Caused Mortality in the Rocky Mountains

Matt Hansen[1] and Jose Negron[2]
[1]USDA Forest Service, Rocky Mountain Research Station, Logan, UT
[2]USDA Forest Service, Rocky Mountain Research Station, Ft. Collins, CO

A "retrospective" study was undertaken in Arizona, Utah, and Wyoming to: 1) determine if partial cutting in advance of a spruce beetle outbreak offers any protection to the residual spruce; and 2) compare stand conditions among treated and untreated stands in the aftermath of spruce beetle activity. Twenty-six partially cut (i.e., treated) stands were randomly selected from a pool that was subjected to beetle pressure after the treatments. These were paired with nearby (within one mile) untreated stands, and all selected stands were sampled with: 1) nine fixed radius plots to characterize stand conditions, including regeneration; and 2) a 10 acre square block that was 100% cruised for infested spruce. Preliminary results indicate that treated stands had fewer infested stems and less infested basal area compared to untreated stands. Treated stands also had a smaller proportion of available trees infested, whether expressed as stems or basal area per plot. Untreated stands had more living residual spruce (>5" dbh), however, whether expressed as stems or basal area per plot. Finally, treated stands had more spruce regeneration (<3" dbh) than untreated stands. Additional plots are scheduled to be installed in Colorado and Wyoming during summer 2007.

A Sensitive Ecosystem: Ideas on Management of Western Balsam Bark Beetle

Lorraine Maclauchlan[1] and Art Stock[2]
[1]B.C. Ministry of Forests & Range, Southern Interior Region, Kamloops, BC, Canada
[2]B.C. Ministry of Forests & Range, Southern Interior Region, Nelson, BC, Canada

Subalpine fir-spruce forests experience low level, constant mortality caused by *D. confusus,* and other mortality agents, creating small to medium sized gaps. The mortality pattern caused by *D. confusus* is spatially aggregated with small gaps regenerated by subalpine fir and medium gaps mirroring the size and pattern of spruce found within these ecosystems. Small diameter trees die first in these stands, often killed by secondary insects, disease or suppression. These trees cumulatively occupy up to a quarter of the dead tree basal area in a stand. Initially, *D. confuses* attack in a

stand is spatially random. Over time, attacked trees are spatially aggregated, displaying a shift of position to new clusters of susceptible trees, as clusters of susceptible trees are "used up". Blowdown is spatially random and has minor influence over the dynamics of *D. confusus* except when these events are of a larger scale. *D. confuses* does not fully utilize fresh blowdown but often selects susceptible, slow growing, live standing subalpine firs. Management could "mimic" these natural spatial patterns through various harvesting options such as small or medium patch harvesting. Baiting in multiple bait-centres prior to harvest can create small patches of attack that could be then be removed. Larger cutblocks are also effective in managing *D. confuses* given site specific requirements for regeneration. Cut block edges incur more blowdown and *D. confusus* attack in the first 10 years following harvest but equilibrate over time. Seedling regeneration and recruitment is comparable among these harvesting regimes and is largely a function of micro-site and aspect.

Workshop 14
Roles of Tree Terpenes in Modifying Insect-Plant Interactions: Implications for Insect Attraction and Plant Defenses

Moderator: Nadir Erbilgin, University of California, Berkley, CA and David L. Wood, University of California, Berkley, CA

Speakers:

Nadir Erbilgin (University of California, Berkeley, Division of Organisms and Environment, Berkeley, California): Poisons or pastes: What are the modes of action of terpenes serving as conifer defense

Kenneth F. Raffa (University of Wisconsin, Madison, Department of Entomology, Madison, WI): A volatile mix: Terpenes, trees, beetles, and microbes

Brian Sullivan (USDA Forest Service, Southern Research Station, Pineville, Louisiana): Interactions between host monoterpenes and the pheromone system of the southern pine beetle

Richard (Skeeter) Werner (University of Alaska, Institute of Arctic Biology, Fairbanks, Alaska): Toxicity and repellency of spruce monoterpenes to the spruce beetle in Alaska

Richard Hofstetter (Northern Arizona University, School of Forestry, Flagstaff, Arizona): Differential responses of predators and bark beetles to terpene and pheromone combinations in Arizona

Summary

Conifer trees contain complexes of terpenes that mediate interactions with many organisms. These compounds may be component of plant resistance to a wide range of herbivores or pathogens. The same terpenes also may attract herbivores and natural enemies of the herbivores that attack the tree. Terpenes often show strong dose-dependent effects, with different concentrations being either attractive or repellent to

the same insect species. Emissions of volatiles from trees are influenced by environmental conditions, such as temperature, wind, and humidity. In this workshop, the speakers discussed various aspects of tree terpenes, including their roles in resistance against herbivores and their associated microorganisms and attraction of herbivores and natural enemies.

These are the general conclusions and implications from this workshop.

1. Investigations in chemical ecology have played an important role in the mechanistic understanding of tree-insect interactions and will continue to play an important role in future studies.
2. Conifer terpenes affect all phases and components of tree-insect interaction. Insects usually show differential responses to quantitatively different doses and qualitatively different mixtures of terpenes. The relationship between insect pheromones, e.g., bark beetles, and tree terpenes is dose-dependent and often curvilinear. Attraction of natural enemies of bark beetles to beetle pheromones is often mediated by host volatiles.
3. Interactions between insect herbivores and host trees are very complex and require an understanding of both patterns and processes that control tree-insect interactions. The speakers indicated that the following studies should be focused on ecological interactions (insect behavior, plant chemistry (both constitutive and induced), and insect-microbe, plant-microbe interactions), and molecular interactions (plant genotype-insect interactions, genetic constraints of tree selection by insects, genetic variation in insect feeding response, insect feeding induce genes in trees, insect detoxification mechanisms).
4. Characterization of chemical pathways and their regulation operating in diverse tree species will help to determine the importance of various secondary compounds alone and in combinations in tree defenses. A solid foundation of knowledge, combined with more accessible tools, opens up new methods to explore previously intractable problems.
5. Finally, impacts of both constitutive and induced (both local and systemic) tree defenses on the population dynamics of insects should be investigated.

Workshop 15: Defoliating Insects

Moderator: Laura Lazarus Moffitt,
USDA Forest Service, Forest Health Protection, Boise, ID

Insect Defoliators Occurring in the Sacramento Mountains

Terry Rogers
USDA Forest Service, Albuquerque, NM

Numerous defoliation events occurred in the Sacramento mountains from 2000-2006. From 2000-2003 Douglas-fir tussock moth defoliation occurred and a biological evaluation of the defoliated area was completed. New Mexican fir looper defoliation occurred from 2002-2005, western spruce budworm in 2006 and *Nepytia janetae* looper in 2006. A ten-year drought in the Sacramento Mountains coincided with the occurrence of these defoliators. Impacts of these defoliators have been new openings in the forest leading to more diversity of forest stands.

The *Nepytia janetae* defoliation event in the Scott Able Canyon of the Sandis Mountains is interesting because this looper feeds in the winter. An Enterprise team will write an environmental impact statement to salvage some of the *Nepytia janetae* defoliated trees. *Nepytia janetae* inefficiently feed on the older needles of white fire, Douglas-fir, and white pine from the bottom of the tree upwards.

Integrated Approach to Managing B.C.'s Interior Douglas-fir Forests to Mitigate Damage from Western Spruce Budworm.

Leo Rankin
British Columbia Ministry of Forests and Range, Southern Interior Region,
Williams Lake, BC, Canada

Southern interior British Columbia implements an integrated management strategy for budworm control, mainly by manipulating stands in dry areas and aerially spraying *Bacillus thurengiensis* (Bt). Developing the management strategy involves an aerial detection survey in July. Next, an egg mass survey is done to project severe to moderate defoliation. Afterwards stand hazard assessments are conducted to determine what stands are highest priority for treatment.

Stand hazard assessments involve a number of steps. Stand structure is the most critical component of hazard assessments and involve tree density and distribution within the stand. Next, stands are ranked by geographic locations; drier sites are typically most susceptible. Then stands are ranked by historic records of duration and severity of outbreak interval between defoliation periods. With the hazard assessment complete, constraints are factored in, such as exclusion of private land, first nations lands or federal lands; however, private landowners have a growing acceptance of the protocols and want to protect high value timber, watersheds and highly visible areas. There is a comment period for positive or negative public input on treatment areas. This is followed by final selection of treatment blocks and a treatment map is created. Finally, acres can be sprayed with Bt.

Some Effects of Western Spruce Budworm Defoliation on Northern Spotted Owl Habitat

Elizabeth A. Willhite
USDA Forest Service, Forest Health Protection, Sandy, OR

Despite protections offered by the 1990 listing as "Threatened" under the Endangered Species Act of 1973, and implementation of the Northwest Forest Plan in 1994, northern spotted owl (*Strix occidentalis caurina*) populations are declining in the northern portions of its range, including Washington State (USFWS 2004). East of the Cascades, owls use mixed conifer stands that include grand fir, Douglas-fir, and ponderosa pine. They require a multi-layered, multi-species canopy with moderate to high canopy closure. These stands are also prime western spruce budworm (*Choristoneura occidentalis*) habitat, and are prone to repeated defoliation during outbreaks. It is evident, based on field observations in south-central Washington, that budworm can have significant effects on the quality and quantity of eastside owl habitat. The effects of a 19-year period (1985 – 2003) of western spruce budworm defoliation on northern spotted owl populations and their habitat in the southern portion of the Washington Cascades East

province were studied with the following objectives: 1) Quantify effects of western spruce budworm defoliation on northern spotted owls and their habitat. 2) Examine relationships among defoliation, owl demography, and habitat at the greater landscape scale. 3) Characterize landscape-level trends during 1985-2003.

Landsat 5 TM imagery from 1985 and 2003, ground-based vegetation verification plots, Forest Inventory Analysis (FIA), and USDA FS Region 6 Current Vegetation Survey (CVS) data are being used to examine landscape-level changes and to characterize vegetative conditions. We also are analyzing stand-level changes in three owl core habitat and assessing available owl demographic information.

Ground vegetation plot sampling for satellite image model verification was completed in 2006. We sampled a total of 223 plots scattered throughout the study area. For one component of the analysis, plots were categorized as, Host-Defoliation, Host-No Defoliation, Nonhost-Defoliation, and Nonhost-No Defoliation and analyzed for differences stand conditions and characteristics. Host-Defoliation plots had higher stocking levels and mortality, and less canopy cover than Host-No Defoliation plots. The distribution of canopy cover classes of the Host-Defoliation plots was more similar to the Nonhost-No Defoliation distribution than to the Host-No Defoliation distribution.

Indicators of balsam woolly adelgid presence, such as gouting, crown abnormalities, and the adelgids themselves, were strongly associated with defoliation, particularly on plots where grand fir was present.

Spruce Budworm Defoliation and Mortality on Flesher Pass in Thinned and Unthinned Areas

Nancy Sturdevant
USDA Forest Service, Forest Health Protection, Missoula, MT

During June 2006, Nancy Sturdevant and Sandy Kegley conducted a survey near Flesher Pass to measure defoliation and mortality from heavy western spruce budworm feeding on Douglas-fir. Out of 50 trees in an unthinned forested stand, 29 trees were rated as alive during this sampling period. Of the remaining 21 trees, nine died as a direct result of budworm feeding and 12 were attacked by Douglas-fir beetle. They did not record any mortality from budworm or Douglas-fir beetle in an adjacent unthinned stand. Although these results may portray what we can expect on Flesher Pass, they can not be extrapolated to the Helena National Forest in general or other National Forests in the Northern Region. More surveys are needed to assess conditions for specific projects or areas.

Workshop 16: Current Status of Chemicals Being Used to Manage Forest Insects: Issues of Registration, Policy, and Efficacy for Selected Pesticides and Semiochemicals

Moderator: Tom Eager, USDA Forest Service, Gunnison, CO

This workshop was a discussion of the status of various materials used to manage forest insects. Due to the recent changes in the registration status of verbenone, much of the conversation was focused on the EPA registration process. Participants expressed concern that verbenone might not be available for the upcoming field season, but by the end of the session it was generally felt that it would be available. A short PowerPoint presentation was provided by Hank Appleton that brought attendees "up to speed" on recent developments in the registration process.

There was a wide range of expertise in the workshop, and the information provided by several retired participants was especially useful. These individuals provided an historical background for the discussion and provided insight on the de-regulation of pesticide marketing in the mid-1980's. This movement impacted pesticide use by removing the need to prove efficacy during the registration process for a given material. At the time it was felt that market forces would provide controls for what materials would remain viable as a commercial entities. In other words, the idea was that if something did not live up to its promises, it would be driven out of the market simply because it would not be purchased. There was then some discussion regarding the validity of this philosophy. In general, two drawbacks were pointed out: 1) there would be a lag time between when a new material was placed on the market until the time that it was recognized as not being suitable. During this time, much economic loss might be suffered by the consumers. 2) Some of the materials are fairly subtle in nature and their efficacy might not be worked out for some time.

It was suggested that an important aspect of determining the efficacy of any treatments necessarily involved the testing and presentation of results in an ethical manner. However, the discussion of ethics was determined to be beyond the goals of this session and that this subject would be appropriate for a session at a future WFIWC.

Workshop 17: Fire and Beetles: Restoration, Tree Survival, and Biodiversity

Moderator: Andris Eglitis, USDA Forest Service, Bend, OR

Temporal Gradient of the Impacts of Forest Restoration Treatments on Host Tree Physiology and Bark Beetle Response

Kimberley Wallin
Oregon State University, Corvallis, OR

We examined the 7-year effects of three restoration treatments on leaf physiology and insect-resistance characteristics of pre-settlement age ponderosa pines (*Pinus*

ponderosa Dougl. ex Laws.) at the Gus Pearson Natural Area (GPNA) in northern Arizona. The treatments were: (1) thinned in 1993 to approximate pre-Euro-American settlement stand structure, (2) thinned plus prescribed burned in 1994 and 1998, and (3) untreated control. Tree physiological and insect-resistance characteristics were measured in year 2000, 7 years after thinning, using the same procedures as an earlier study performed in 1996. Pre-dawn water potential, foliar nitrogen, leaf gas exchange, carbon isotope content, resin volume and leaf toughness were measured in 2000 and compared to those measure in 1996. Our results show that many beneficial effects of restoration treatments on carbon, water, and nitrogen relations and insect-resistance characteristics of pre-settlement ponderosa pines continue to be expressed 7 years after treatment at the GPNA.

Wallin, K.F., Skov, K.R., Kolb, T., Wagner, M. 2007. Temporal gradient of the impacts of forest restoration treatments on host tree physiology and bark beetle response

Delayed Conifer Tree Mortality Following Fire in California

Danny Cluck
USDA Forest Service, Forest Health Protection, Susanville, CA

Accurately estimating tree mortality following wildfires is an important aspect of post-fire forest management. In most burned areas there are trees that initially survive the fire, but suffer from various levels of fire injuries. Predicting the survival of these trees is controversial and conflicting studies often lead to delays in implementing time-sensitive treatments. To better understand what level of fire injury causes death of partially burned trees, Forest Health Protection in Region 5 initiated a study to track mortality and tree injury following fire in 1994. The Fire Sciences Lab of the Rocky Mountain Research Station became involved in the project in 2002, when the project was greatly expanded to sample more trees. Our dataset now includes 6,272 trees, 1,237 of which have been followed from 3-10 years post-fire. Species include ponderosa, Jeffrey, and sugar pine, red and white fir, and incense cedar. We measured dbh, tree height, crown base height, crown length scorched, cambium damage, and beetle activity on each tree one year post-fire and monitored for changes in condition in subsequent years. We have now developed mortality models to predict tree death following fire. Forest Health Protection has used these models to develop new salvage marking guidelines for post-fire salvage and restoration project implementation. The models will also be incorporated into the First Order Fire Effects Model (FOFEM), Forest Vegetation Simulator-Fire and Fuels Extension (FVS-FFE) and BehavePlus. Having the new models included in the current fire behavior and effects software will assure they are easily accessible, defensible, and used by managers in post-fire treatment decisions and developing prescribed fire burn plans. This paper presents preliminary mortality equations to predict tree death within two years post-fire. Current salvage marking guidelines are based on three year data.

[Presentation based on the paper: *Delayed Tree Mortality Following Fire in California*, Sharon M. Hood, Fire Science Lab, Rocky Mountain Research Station, Missoula, MT, Sheri L. Smith, USDA Forest Service, Forest Health Protection, Susanville, CA and Daniel R. Cluck USDA Forest Service, Forest Health Protection, Susanville, CA. In:

Proceedings for the 2005 National Silviculture Workshop: Restoring Fire-Adapted Forested Ecosystems, USDA Forest Service General Technical Report (in press).]

Effects of Fire on Species Diversity of Bark Beetles and Wood Borers in Boreal Forests

Richard "Skeeter" Werner
PNW Research Station, Fairbanks, AK (retired)

Disturbances such as wildfire, ice and wind storms, outbreaks of defoliating insects, and timber harvest can cause fluctuations in populations of phloeophagous insects. Although major disturbances such as fire or insect outbreaks may appear to be independent events, they are often related. Insect outbreaks that are followed by fire can effectively disrupt or redirect plant succession in forest ecosystems.

Disturbances of forest ecosystems in Alaska have a direct impact on the diversity of species of scolytid bark beetles and buprestid and cerambycid wood-boring beetles. Fire and timber harvest are the two major disturbances that alter these forest ecosystems. Populations of scolytids, buprestids, and cerambycids are compared at 1, 5, 10, and 20 years after burning and timber harvest on flood-plain and upland white spruce sites. Diversity of beetles was measured in areas burned by wildfire and prescribed fire, clearcut and thinned stands, areas in the fringe areas surrounding burned stands, and untreated control stands of spruce. Both fire and timber harvest provided habitats in which population densities of bark beetles and wood borers increased the 1st year after the disturbance. Beetle populations and diversity remained high for up to five years after fire, and then decreased as hardwood stands replaced spruce in the burned areas. Fire removed most of the host trees inhabited by scolytids and cerambycids; however, scorched trees provided habitat for buprestid species. Trees in the fringe area surrounding the fire, whose roots and lower bole were partially burned or whose needles were damaged from smoke, provided excellent habitat for breeding populations of both bark beetles and wood borers.

Bark Beetles and Wood Borers Associated with a Wildfire in Central Oregon

Andris Eglitis
USDA Forest Service, Forest Health Protection, Bend, OR

A wildfire in August 2000 on the Ochoco NF in central Oregon provided an opportunity to study the timing of the appearance of agents of wood deterioration, primarily bluestain fungi, bark beetles and wood borers, within the first year after the fire.

The wood deterioration study was carried out in a stand of large-diameter ponderosa pine that experienced high-severity fire with no surviving trees. Beginning in May, eight months after the fire, twelve trees were felled each month through October 2001, and another 12 trees were felled in September 2002, two years after the fire. Sample trees were bucked into 16.5' logs and disks were cut from the end of each log for monitoring the development of bluestain. Each month, random samples of bark were removed from each log in order to determine the rate of development of wood borer

larvae. Before the first sampling period, six unbaited panel traps were placed throughout the study site in order to capture insects flying through the area. These traps were monitored during the first, second and fourth year after the fire.

Bluestain was evident in the base of only one sample tree in May, eight months after the fire. One month later, 11 of the 12 felled sample trees had bluestain in the first log but the higher logs did not begin to show significant staining until the October sampling period. By September 2002, two years after the fire, bluestain was extensive throughout all of the sample logs.

The flight periods of bark beetles and wood borers spanned the entire period from April through October in all three sampling years. Species diversity from the flight traps was impressive, with 19 species from 16 genera of Cerambycidae and 14 species from eight genera of Buprestidae being captured. In addition, three species of siricids (two genera) and 10 species of scolytids (five genera) were collected. The most commonly collected cerambycids included *Stictoleptura canadensis* and *Spondylis upiformis*, while *Chalcophora angulicollis* and *Cypracis aurulenta* were the most common buprestids in the traps. Other commonly collected insects included *Dendroctonus valens* (Scolytidae) and *Temnochila chlorodia* (Trogossitidae).

The first wood borer larvae were found beneath the bark in June 2001, nine months after the fire. By September the first wood borer exit hole was found, suggesting that at least some of the damaged trees were probably infested almost immediately after the fire.

There was significant buildup of the western pine beetle, *D. brevicomis*, within the sample trees by the end of September, 2002, and extensive pine mortality occurred two years later outside the perimeter of the fire.

Workshop 18: Technology Applications and Future Needs

Moderator: Joy Roberts, USDA Forest Service, Boise, ID

Modeling Bark Beetles and Fuels on Landscapes: A Demonstration of the Westwide Pine Beetle Model and the Fire and Fuels Extension of FVS within ArcFuels

Andrew McMahan
Information Technology Experts, Inc./FHTET, Ft. Collins, CO

The Westwide Pine Beetle Model and the Fire and Fuels Extension were used within the ArcFuels "shell" to simulate a bark beetle outbreak and an aggressive fuels treatment scenario, and to analyze their effects to fuel dynamics, on a circa 173,000 acre landscape in the Deschutes National Forest. Effects of thinning and the beetle outbreak were analyzed by comparing results from 4 simulation scenarios: a 2x2 factorial design using with- or without-thinning as one factor and with- or without-beetles as the second factor. In the two thinned scenarios, SDI-based thins-from-below were imposed on

about 1/3 of the landscape, in overstocked mixed conifer stands. In the two with-beetle scenarios, a bark beetle outbreak was simulated, lasting approximately 10 years, and beginning shortly after the thinning treatments. In general, thinning treatments reduced within-stand fire hazard and beetle mortality, and landscape average fire hazard. Although landscape average beetle mortality was reduced in the thinned, with-beetle scenario (relative to the unthinned, with-beetle scenario), many unthinned stands in the thinned landscape experienced significantly more beetle-caused mortality than the same stands in the unthinned (with-beetles) landscape. The ArcFuels shell facilitated the performance of spatial analyses of model outputs.

The Bugwood Network (www.Bugwood.org): Developing Tools, Programs and Resources That Can Be Used to Support Forest Pest Survey, Detection, Management and Educational Programs

Presented by Dwight Scarbrough, USDA Forest Service, Boise, ID,
For G. Keith Douce and David Moorhead.
The Bugwood Network, The University of Georgia,College of Agricultural & Environmental Sciences
and Warnell School of Forestry & Natural Resources, Tifton, GA

The Bugwood Network (www.bugwood.org) provides information and programs on forest health, invasive species and integrated pest management to a wide array of users both directly through educational programs and through the use of information technologies.

The mission of The Bugwood Network is: to serve a lead role in development, consolidation and dissemination of information and programs focused on: invasive species, forest health, natural resource and agricultural management through technology development, program implementation, program implementation, training, applied research and public awareness at the state, regional, national and international levels.

The Bugwood Network began development in 1994 and now operates 15 web sites that received over 118 million hits in 2006. Our strategy includes packaging and / or developing resources that can be used by educators and end users as tools to help address their needs. Subject matter covered by Bugwood systems include: Multi-taxa invasive organisms, forest health , entomology, plant pathology, silviculture, abiotic damage, agricultural IPM, wildlife.

The Bugwood Network serves high-quality/high-resolution digital images through 4-topic focused image archive systems that make over 55,000 images from 1,200 photographers taken in 80 countries available for educational use. Bugwood systems are database driven, fully-searchable and taxonomically based. Images are linked to information and are available for educational use at no cost as long as appropriate credits are given to photographer and to the website. See (www.bugwood.org) as the entry point to Bugwood systems.

We work closely with and develop partnerships with other agencies as well as co-sponsor many educational programs and training sessions. We work with a wide array of cooperators and contributors of images and information, and our systems are used directly by many individuals as well as are incorporated into many web sites. We are

evolving into *The Center for Invasive Species and Ecosystem Health* to be housed at The University of Georgia.

The Workshop Challenge:

- Figuring out how to use technology to do our jobs better, and
- Then developing the collaborations and necessary expertise to enable the technology systems to be developed and operational.

Future Needs Group Discussion

Discussed current and future uses of Global Position Systems (GPS) as it relates to digital photography and data storage. This technology can be used for location and time stamping and stored in a database system. Are GPS's used as data records? Some folks use them for mistletoe surveys. How can the different technologies, such as GPS, PDA, video cameras, work together? Possible uses could include storing flight lines from remote sensing imagery. Geo-referencing could be stored on a frame by frame process. It was suggested that a session about GPS and PDA technology be a part of the next WFIWC.

Workshop 19: Comparison of State Programs

Moderator: Rob Flowers, Oregon Department of Forestry, Salem, OR

The forest health programs in the western states often have unique structures, responsibilities and approaches to handling forest health issues. Representatives from 5 of the 11 western states in attendance provided an overview of their programs, and this was followed by group discussion.

Forest Health Program Review for Alaska

Robert Ott and Roger Burnside
Alaska Department of Natural Resources, Fairbanks, AK

The Forest Health Program of the Alaska Department of Natural Resources Division of Forestry (DOF-FHP) consists of three staff members: the Forest Health Program Coordinator, the state Entomologist, and a GIS specialist. DOF-FHP provides technical assistance, forest health monitoring and research, and administration of Forest Health Protection Grants across state-owned and privately-owned lands totaling 69.4 million acres. The majority of DOF-FHP's activities are related to forest insect problems, although it also deals with issues related to invasive species, forest pathogens, and abiotic stressors such as climate change. Many of DOF-FHP's activities are conducted in cooperation with the Region 10 Forest Health Protection Unit of the USDA Forest Service, State and Private Forestry Program (USFS).

DOF-FHP, in cooperation with the USFS, annually conducts an aerial forest damage survey during the month of July. Typically, out of the 157.7 million acres of forested land in Alaska, >30 million acres of land are surveyed each year. An effort is made to survey areas known to be experiencing insect infestations, outbreaks of forest pathogens, and decline from abiotic factors. In addition, surveys are conducted over areas requested by land management agencies and private land owners. Aerial surveys

are constrained by factors such as the locations of fuel stops (i.e. locations of villages and towns), forest fires and concentrations of fire smoke, and military installations.

Insect-related projects being conducted by DOF-FHP, most of which involve the cooperation of the USFS and other collaborators, include:

- The introduction of a host-specific ichneumonid parasitoid (*Lathrolestes luteolator*) to control the population of the invasive, amber-marked birch leafminer (*Profenusa thomsoni*) in Alaska birch (*Betula neoalaskana*) in southcentral Alaska;
- Determining the impact of spruce budworm (*Choristoneura fumiferana*) on white spruce (*Picea glauca*) regeneration in interior Alaska during a spruce budworm outbreak;
- Mapping the distribution of healthy larch (*Larix laricina*) stands throughout interior Alaska after an infestation of larch sawfly (*Pristiphora erichsonii*) and eastern larch beetle (*Dendroctonus simplex*);
- Maintaining EDRR (Early Detection/Rapid Response) monitoring sites in the port cities of Anchorage, Fairbanks, and Juneau to detect potentially invasive exotic bark and wood boring insects.

Besides two invasive species projects mentioned above, DOF-FHP also continues a multi-year project to determine if pinewood nematode (*Bursaphalenchus xylophilus*) is present in Alaska. The pinewood nematode is a major concern in China with a current mandatory fumigation requirement for all round-log shipments from North America into China.

Climate change-related projects in which DOF-FHP is involved include:

- Describing the decline of Alaska birch stands in south-central Alaska;
- Determining the relationships among spruce budworm populations and climate variables;
- Determining the relationships among forest health conditions and climate change variables.

DOF-FHP also administers Forest Health Protection Grants (i.e. Insect and Disease Prevention, Suppression, Restoration Grants) where activities are being conducted on state-owned and privately-owned lands. These grants are used to conduct management activities such as pruning and thinning of Sitka spruce (*Picea sitchensis*) stands to prevent infestation by the spruce beetle (*Dendroctonus rufipennis*); reforestation of white and Sitka spruce stands impacted by spruce beetle and spruce budworm; and prevention and suppression of the northern spruce engraver (*Ips perturbatus*) in shaded fuel breaks created in white spruce stands around settlements.

DOF-FHP staff are also members of regional and national committees:

- Western Forestry Leadership Coalition, Forest Health and Invasive Species Committee;
- National Forest Health Monitoring Management Team.

Update on Recent Activities in the Forest Health Program in Washington

Karen Ripley
Washington Department of Natural Resources, Olympia, WA

The Washington State Department of Natural Resources (DNR) Forest Health Program has 4.5 permanent positions (1 Entomologist/Program Manager; 1 Sr. Forest Pathologist; 1 Forest Pathologist; 1 Research Technician; 0.5 Summer Trapper). In recent years Western Bark Beetle grants have temporarily funded about 3 positions in Eastern Washington (1 Entomologist; 2 Field Foresters). In spite of increasing awareness and recognition of serious forest health problems in overcrowded eastern Washington forests, sustaining the state funding for the base program has been challenging in recent years. Growing the program in the future seemed unlikely.

We have long recognized that our current insect/disease control law is out of date. The law directs forest landowners to "control, destroy or eradicate" forest insects and diseases that threaten stands of timber. If they fail to do so, the DNR has a duty to perform the control activities and bill the landowner for the treatments. It has not been used since 1968.

In 2001, we decided to focus on updating the law, increasing publicity for forest health conditions, and strengthening our statutory position in state government. This coincided with the August 2001 detection of citrus long-horned beetle near Seattle. In Washington, forestry activities that involve tree removal and aerial treatments with forest insecticides require Forest Practices permits. We realized that there is no way for regulatory agencies such as the Washington State Dept of Agriculture (WSDA) to obtain such permits without all affected landowners' signatures (and frequently they are unwilling to sign). Moreover, some tree removal activities such as cutting down all hardwoods in a riparian area (a prescription for Asian or citrus long-horned beetle eradication) are simply never allowed. Thus began a long, continuing, effort to update the forest health law.

In 2002, we proposed changes that would give the DNR authority to survey and monitor forest insects and diseases, provide technical assistance to landowners, and coordinate cooperative forest management projects (later called "the velvet glove" proposal). WSDA and DNR would also be given emergency authorities to control newly detected exotic forest pests that had a high likelihood of successful eradication without obtaining a normal forest practices permit (Forest Health Emergency). The Emergency Authorities received broad support and were passed. The "velvet glove" was rejected because it was seen as too soft to motivate landowners to manage their forests.

In 2003, we proposed a regulatory structure that included giving DNR the right to enter forest land to survey and monitor insects and diseases, the right to declare infestation districts where treatments were required, the right to bill landowners for a portion of the cost of those treatments, and removal of the requirement for all landowners to sign the Forest Practices permit application in DNR-coordinated control areas. This bill was not even introduced. We couldn't find legislators willing to sponsor it. Private property rights proponents were ready to kill it immediately.

In 2004, we proposed a "study bill". DNR wasn't able to solve/propose a new regulatory structure on its own. The Legislature formed a 14-member "Forest Health

Strategy Work Group" that had a year to meet and report on opportunities and barriers to achieving forest health improvements on all land ownerships, propose a new law, and describe necessary funding. Members of this group included representatives of industrial forest landowners, small forest landowners, the Forest Service, Society of American Foresters, the Universities, Washington Dept of Fish and Wildlife, the Governor's Office, the County Commissioners, tribes, the environmental community, and a professional entomologist, a fire ecologist, and a hydrologist. The State Forester was the Chair. They met monthly and reported their findings. (Information about the Work Group and its reports are at: http://www.dnr.wa.gov/htdocs/rp/forhealth/fhswgc/index.html)

The Work Group recommended a Three-Tier Forest Health Program. The first tier is regular monitoring and technical assistance. The second tier occurs when a forest health problem or outbreak is recognized and, with the assistance of a technical committee and "Warning" declaration by the Commissioner of Public Lands, focuses attention on that area including coordinated, voluntary suppression projects. If the second tier warning doesn't successfully reduce the problem, then a third tier "Order" could be declared whereby landowners are required to treat the problem. The penalty for not participating in an "Order" is that if increased dead or down wood results and meets the "additional fire hazard" thresholds currently applied to logging slash, the landowners would be liable for fire suppression costs if a fire started on their property or burned across it.

Although the Forest Health Strategy Work Group meetings were open to the public, this proposal hadn't received wide publicity. The Work Group asked that, instead of introducing the new legislation in 2005, they be funded to hold public meetings in order to publicize forest health issues, get input, and be alerted to possible unforeseen consequences of the legislation. This was not funded in 2005, but did get funded in 2006. In 2006, the Work Group re-formed, held eight public meetings, and wrote a new report with two legislative proposals: a Two-tier system and a Three-tier system. The Work Group really liked the Three-tier system more, but recognized there was a lot of mixed input on which route would be most effective policy.

In the 2007 Legislative session, both the Three-tier bill and a heavily amended Two-tier bill were introduced. Many stakeholders testified that Washington has serious forest health issues that need attention, their preferred bill was great, and the other bill was bad. (This would have killed both bills). At this point, DNR's Executive Leadership really came through. The Commissioner of Public Lands and the DNR's Chief Policy Officer challenged all stakeholders with, "So you don't want a forest health bill to pass this session?" The stakeholders agreed to compromise and a new bill was introduced (SSB6141, http://www.washingtonvotes.org/Legislation.aspx? ID=52479). It included: Three tiers, softer pest language, new definitions and more diverse scientists on the Technical Advisory Group. The bill passed the Senate 49-0 and is currently in House Committee.

Attached to the bill is notice that implementing this program will cost about $1 million per year into the future. Initial capacity building would include a new Entomologist, a communication specialist, a Forest Health policy specialist to coordinate to improve active forest management on federal lands, a field forester, and one office support staff. A pilot inventory/analysis project over a 1-2 county size area would be implemented to assess risks and develop specific management prescriptions. This has been a huge learning experience regarding the legislative process and supporting a diverse advisory

committee. Hopefully, it will result in updating Washington law and improving the DNR's Forest Health program's capacity and effectiveness at addressing forest health problems in the state.

Overview of Forest Pest Management on State and Private Lands in California

Donald Owen
California Department of Forestry and Fire Protection, Redding, CA

California is a large state with a high diversity of tree species and forest types. Conifer forests cover roughly 23 million acres and hardwoods, mostly oaks, cover 9.5 million acres. Annual precipitation limits where trees grow and fluctuations in precipitation have a significant impact on insect and disease outbreaks. The State's Forest Pest Management Program has three technical staff– Jack Marshall, Tom Smith, and Don Owen – and an additional vacant position. The State Board of Forestry and Fire Protection establish the regulations for timber operations on state and private lands and provide policy and direction to the Department of Forestry and Fire Protection. Serious forest pest outbreaks are managed by the Department with approval by the Board of Forestry through the formal declaration of a Zone of Infestation. Zones are currently in effect for sudden oak death, pitch canker, and bark beetles. The Forest Practice Rules also have various provisions for mitigating the impacts of forest insects and diseases. Invasive forest pathogens are among the most serious threats to California's forest resources.

University of Arizona Forest Health Program

Tom DeGomez
University of Arizona, School of Natural Resources, Flagstaff, AZ

Current activities include: Surveys of state and private forest lands in Arizona utilizing aerial and ground methods as set forth by the USFS; Developing educational outreach tools (publications, electronic bulletins, etc.) and including these on the Forest Health website; Conducting forest health training session with county extension staff and other non-federal municipal land managers; Conducting biological evaluations of insect, disease and invasive plant infestations and outbreaks; Providing technical assistance to non-federal municipal and private land managers and owners as requested via email, phone, postal mail, and field visits; Securing funds to conduct cooperative suppression and prevention activities; Distributing funds to manage invasive plants that threaten forested lands; Applying for additional funding to support the forest health program including the State Fire Assistance Grant, Title III funding, Rural Community Assistance Grants, Forest Health Restoration Grant and Ecological Restoration Institute Grants; Conducting after-schools forestry programs; Conducting research to support the extension activities listed above.

The State Forest Pest Management Program in Texas

Ronald Billings
Texas Forest Service, College Station, TX

The Texas Forest Service initiated the Forest Pest Management (FPM) Section (formerly Forest Pest Control Section) in 1963, in response to a severe outbreak of the southern

pine beetle. FPM has grown from a single entomologist to a staff of 9 full-time employees, including three entomologists and three staff foresters in East Texas and several multiple-program foresters in Central Texas. In addition to the southern pine beetle, FPM now addresses a myriad of other forest pest problems in Texas. Additional (7) TFS foresters handle insect and disease problems in Central Texas. Responsibilities of FPM in Texas include administration of the USFS cooperative forest health program for the state, organizing and conducting pest prevention and suppression projects, and conducting off-plot monitoring and other pest-related duties common to state forestry programs. With two entomologists at the Ph.D. level, TFS also has the capability and responsibility to conduct applied research and technology transfer for major forest pests in Texas. In 1996, FPM initiated the Western Gulf Forest Pest Management Cooperative (WGFPMC) as a means to generate financial support for research. Members of forest industry and federal agencies pay annual membership dues to support targeted research activities. To date, WGFPMC has focused research on control methods for cone and seed insects in pine seed orchards and evaluation of systemic insecticides for pests of young pine plantations and conifer bark beetles. Concurrently, FPM foresters are involved in delivering the federally-funded Southern Pine Beetle Prevention Project and the Oak Wilt Suppression Project, as well as programs to address invasive insects, diseases and plants throughout the state. Success of the FPM program in Texas has been increased through collaboration and partnerships with other federal, state, and private organizations with vested interests in forest pest management.

Workshop 20: Bark Beetles and Fire – Fuel Model Interactions

Moderator: Elizabeth G. Hebertson, USDA Forest Service, Forest Health Protection, Odgen, UT

Fuels and Fire Behavior in Bark Beetle-Affected Coniferous Forests

Michael J. Jenkins[1], C. Arik Jorgensen[1] Elizabeth G. Hebertson[2] and Wesley G. Page[3], [1]Department of Wildland Resources, Utah State University, Logan, UT; [2]USDA Forest Service, FHP, Ogden, UT; [3]USDA Forest Service, Fire Management, Mendecino National Forest, Willows, CA

The mountain pine beetle (*Dendroctonus ponderosae* Hopkins) is a forest insect that infests lodgepole pine (*Pinus contorta* Dougl. var. *latifolia* Engelm.) forests in the Intermountain West. The often widespread mortality caused by the mountain pine beetle has been suggested to cause significant changes to stand structure, composition, and total fuel loading; however, little quantitative information is available that documents these changes. We examined mountain pine beetle induced changes to ground, surface, and aerial fuels in lodgepole pine stands during current epidemics and 20 years following an epidemic. Results indicated that there were statistically significant increases in the amounts of fine surface fuels in recently infested stands, i.e. those stands $\leq$ 5 years past peak mortality. In the previously infested stands, there were large increases in the amounts of dead woody fuels in all but the smallest size classes, with a 7.8-fold increase in down woody fuels $\geq$ 7.62 cm in diameter. Live shrubs and the amount of subalpine fir (*Abies lasiocarpa* Nutt.) regeneration were also significantly greater in the post-epidemic stands. The net result of epidemic mountain pine beetle activity was a substantial change in species composition and a highly altered fuels complex in which large dead

woody fuels and live surface fuels dominate.

Using custom fuel models developed for use with Rothermel's (1972) surface fire spread model we predicted and compared fire behavior in lodgepole pine (*Pinus contorta* Dougl. var. *latifolia* Engelm.) stands with endemic, current epidemic, and post-epidemic mountain pine beetle (*Dendroctonus ponderosae* Hopkins) populations using standardized sets of wind speeds and fuel moistures. We also compared our fire behavior results with those from standard fuel models. Results indicated that for surface fires both rates of fire spread and fireline intensities were higher in the current epidemic stands than in the endemic stands, due to increases in the amounts of fine surface fuels. In the post-epidemic stands, rates of surface fire spread and fireline intensities were higher than the endemic stands due to decreased vegetative sheltering and its effect on mid-flame wind speed. Total heat release of surface fires, including post-frontal combustion, was also higher in the post-epidemic stands due to heavy accumulations of large diameter fuels. Crown fires were more likely to initiate in the post-epidemic stands due to greater fireline intensities and lower crown base heights. However, the critical rate of spread needed to sustain an active crown fire was higher in the post-epidemic stands due to decreased aerial fuel continuity. We suggest here that crown fire initiation in the current epidemic stands was also greater due to an abundance of dead aerial fuels; although, this relationship is unclear.

Fire Management Tools for Bark Beetle-Affected Coniferous Forests

C. Arik Jorgensen[1], Michael J. Jenkins[1], Elizabeth G. Hebertson[2], Wesley G. Page[3]
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Bark beetles in coniferous forests have been attributed to alter stand structure, composition, and most of all fuel complexes. Bark beetle mortality has long been associated with increased fire behavior, severity and occurrence. Current research is focused on quantifying and comparing fuel complexes and fire behavior in bark beetle affected Douglas-fir, lodgepole pine, and spruce/fir forests. Fire management tools are being developed to effectively manage bark beetle – altered fuels. We are using data from bark beetle affected forests to develop landscape based fire spread models. We are also producing photo guides to assist managers with appraising fuels and predicting fire behavior in forests with varying levels of bark beetle activity.

Mountain Pine Beetle in Lodgepole Pine: Mortality and Fire Implications

Daniel R. West[1], José F. Negrón[1], Sheryl L. Costello[2], Rick Caissie[3],
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Lodgepole pine forests of North Central Colorado are currently experiencing eruptive populations of mountain pine beetle *Dendroctonus ponderosae* Hopkins (Coleoptera: Scolytidae). The role mountain pine beetle plays in relation to fire risk and hazard, changes in stand conditions, and extent of tree mortality is largely unknown in Colorado. Stand and fuel data was collected in 81 infested and 24 uninfested locations throughout

the Sulphur Ranger District. Modeling using the Fire and Fuels Extension of the Forest Vegetation Growth Simulation Model (FVS) was utilized to simulate the potential fire behavior and possible extent of mortality. We used 90th percentile fuel moistures coupled with 25 mph sustained winds. FVS modeled a large portion of uninfested plots as crown or active fire type, whereas infested stands are largely modeled as surface or crown fire. The winds required for crown fire gradually decreased as infested year became closer to present. Models indicated that lower wind speeds are necessary to carry a potential crown fire in uninfested stands, possibly due to canopy gaps created by the epidemic. Stand conditions associated with mountain pine beetle infested areas compared to uninfested areas resulted in non-significant differences in basal area, trees per acre, and quadratic mean diameters of trees. Stands infested earlier in the outbreak had a higher average percent mortality than stands infested later in the outbreak. Individual mean tree diameters of uninfested lodgepole pine were larger than infested mean tree diameters. Additional stand and fuel data will also be collected in the summer of 2007.

Long-term Records of Spruce Beetles and Fire from Utah

Andrea Brunelle
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Sedimentary records of beetle infestation are being utilized in the spruce forests of Utah in order to better understand long-term relationships among beetles, fire, vegetation composition and climate. Preliminary results from the Wasatch Plateau, Utah, indicate that

water chemistry affects the preservation of beetles in lake sediments, but that palynological indicators provide evidence of outbreaks even in the absence of chitinous remains. Preliminary data also suggest that for at least the last several thousand years large fires have been very infrequent and that it is likely that beetles are the main agent of forest disturbance and regeneration.

Workshop 21: Latest Developments in Aerial Remote Sensing

Moderators: Jim Ellenwood, Forest Service, FHTET, Fort Collins, CO

Investigation of Automated Image Classification Procedures in the Detection of Mountain Pine Beetle Damage

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Tree mortality estimates provide forest managers with important information regarding forest health. Automated computer procedures utilizing digital aerial imagery and remote sensing software can rapidly quantify tree mortality. This exploratory study uses Feature Analyst (an ArcGIS image analysis extension developed by Visual Learning Systems) to identify tree mortality due to the mountain pine beetle. Results are compared to photographic interpretation results for 16 one-acre sample plots. Results

indicate that differences in image characteristics—i.e. aspect, landcover, etc.—may have a significant effect on automated classification procedures. Future investigations will employ a stratified approach utilizing DEM and landcover data layers.

Using Digital-Photo Strip Samples to Estimate Spruce-Fir Mortality

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Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*) in many regions of the western United States have experienced extensive mortality due to unprecedented bark beetle outbreaks in association with drought stress and diseases. Methodology for assessing the mortality across large areas, using a multistage sample design, was developed. The sample design incorporated systematic strips of high-resolution, color-infrared, digital aerial imagery. As part of the sampling methodology, a procedure was developed to map the species and mortality status of individual tree crowns from the strips of imagery. In fall 2005, strips of imagery were acquired over the Bighorn National Forest (Wyoming). The mapping methodology was evaluated on only one of the strips. The strip was segmented, using eCognition, to isolate individual tree crowns within the spruce/fir cover type. Field data consisting of the species (Engelmann spruce or subalpine fir) and mortality status (live, current year beetle attack, dead year 1, dead year 2, or dead year 3) were collected for more than 600 tree crowns within the strip. All combinations of species and mortality status were represented. Digital numbers (DNs) of the field-verified tree crowns were extracted from the aerial imagery and from topographic layers including slope, aspect, and elevation. Using these data, stepwise logistic regression models were developed to predict the species and mortality status of all other tree crowns in the strip. Based on cross validation and validation using the model data, the models performed well with good ability to discriminate among the various combinations of species and mortality. When the models were applied to all tree crowns in the strip of aerial imagery, the models performed well within photo frames where field data were collected. However, in frames where field data were not collected, the models performed poorly. This was likely because field-verified tree crowns did not adequately represent the full range of variability occurring among photo frames and natural variability occurring in the spruce/ fir population.

Assessing Forest Health Risk: Development of a National 30-meter Forest Parameter Map

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The USFS developed a national insect and disease risk map (NIDRM) dataset for forest health concerns (Krist et. al. 2007). The process incorporated host-type characteristics, soils, climate, terrain, and existing pest distributions to generate a 1-km dataset for the continental United States and Alaska. The utility of this dataset is functional for national

planning but limited at a local scale. In order to provide for local planning and assessment needs, regional risk maps for forest health are being developed using a similar process with a 30-meter dataset of forest parameters. Three existing national datasets were utilized to develop the host-type datasets. The National Land Cover Database (NLCD) project developed a 30-meter three-season Landsat dataset for each of 65 mapping zones. The USDA NRCS developed a localized soils dataset, SSURGO, and regionalized dataset, STATSGO. The USDA Forest Service FIA collects a nationwide forest inventory. Each of these datasets were acquired and processed utilizing Cubist data mining software. For each species a mapping zone, basal area and trees per acre models were developed. By incorporating the risk models developed from the National Risk Map, regional scale risk datasets were developed.

Workshop 22: Systemic Insecticides: Use, Efficacy, and Options

Moderators: Sheri Smith, USDA Forest Service, Forest Health Protection, Susanville, CA; and Brian Strom, USDA Forest Service, SRS, Pineville, LA

Evaluation of Insecticides for Protecting Southwestern Ponderosa Pines from Attack by Engraver Beetles

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Insecticides that might protect pine trees from attack by engraver beetles (*Ips* spp.) have not been rigorously tested in the southwestern U.S. We conducted a field experiment to evaluate the efficacy of two potentially labeled preventative insecticides for protecting high value ponderosa pines (*Pinus ponderosa* Dougl ex. Laws.) from attack by engraver beetles. Systemic implants (0.875 g/capsule acephate [Acecap®] and 0.650 g/capsule dinotefuran) were assessed on bolts (sections of logs) as a surrogate for live trees for a period of 13 mo post-treatment. The pine engraver, *Ips pini* (Say) was the most common bark beetle found attacking control and treated bolts, but sixspined ips, *I. calligraphus* (Germar) and *I. lecontei* Swain also were present. After ≈13 mo post-treatment the acephate and dinotefuran systemic insecticides provided inadequate (≤36%) protection in this experiment. We concluded that under the conditions tested, 0.875 g/capsule acephate [Acecap®] and 0.650 g/capsule dinotefuran were unacceptable preventative treatments for protecting ponderosa pine from successful engraver beetle attack for one entire flight season in the Southwest.

Options: Formulations

Sheri Smith, USDA Forest Service, Forest Health Protection, Susanville, CA;
Brian Strom, USDA Forest Service, SRS, Pineville, LA

An increasing number of systemic insecticides are becoming available for tree injection, and their cost and injection methodology are evolving rapidly. Formulations of more traditional systemic insecticides such as acephate and bidrin are still available; however, the so-called neonicotinoid and avermectin insecticides are playing a major role in the

increasing popularity of injectable and systemic insecticidal products. In addition, products with the active ingredient fipronil are being evaluated for many applications and may be available in the near future. Features that have made newer products attractive to entomologists include their promise of effectiveness against a wider array of pests, a lack of cross-resistance, their ability to move to tissues heretofore unreliably reached, and their longevity.

Neonicotinoids and avermectins offer hope for systemic treatment of plants due to their toxicity to target insects, movement, and residual duration. Avermectin was discovered in 1981 from the soil bacterium *Streptomyces avermitilis*. Products evolving from this initial compound include abamectin, ivermectin and emamectin. There are also many different neonicotinoids available today, both first and second generation, including imidacloprid, the most widely used (e.g., Merit), and Dinotefuran among others. All are nerve toxins with exposure through contact or ingestion (stomach poisons). Movement of neonicotinoids and avermectins in plants (and animals) is promoted by movement across cell walls or membranes, a desirable property having yet-to-be-determined effects on injected products or target insects. Few data are available in the public domain on the movement patterns of injected insecticides, especially with newer products. As biological activity, movement patterns and residual concentrations are determined; questions can be answered regarding their utility and nontarget effects.

Activity of available injectable products varies widely toward insect targets. Acephate is a general-use insecticide with broad application. Imidacloprid is thought to be particularly effective against sucking insects: Hymenoptera, Homoptera, and some Coleoptera. Avermectin and Emamectin are considered more effective against Coleoptera and Lepidoptera.

There are at least 5 companies that provide injectable insecticides for tree injection. ARBORjet sells ACE-jet (acephate) and IMA-jet (imidacloprid) formulations and is testing a formulation based upon the active ingredient emamectin benzoate. Arbor Systems offers two imidacloprid formulations (Pointer & Pointer ALB) and an avermectin B1 formulation (Greyhound). Creative Sales offers Acecap 97, which contain acephate. At this time, Mauget offers the greatest number of products, with two imidacloprid formulations (Imicide & Imicide HP), two abamectin B products (Abacide & Abacide 2*), a metasystox-R formulation (Inject-A-Cide) and Inject-a-A-Cide B, which includes bidrin as its active ingredient.

As mentioned, the costs of these products are changing rapidly. From supplier websites, the current approximate insecticide costs to treat a 20 inch diameter tree are:

Supplier	Product	Cost for 20" dbh tree	Amount of AI
ARBORjet	ACE-jet	$23.50	29.1 g AI
	IMA-jet	$62.40	160 ml, 8 ml AI
Mauget	Imicide	~ $50.00	10 injectors, 3 ml each, 3 ml AI
Arbor Systems	Pointer	$25.44	Wedgle; 10 sites, 1 ml ea., 0.5 ml AI
	Pointer (ALB –USDA only)	$339.20	8 ml/ dbh inch
Creative Sales	Acecap 97	~ $15.00	11.5 g AI

Western Bark Beetle Injection Studies: Mountain Pine Beetle in Lodgepole Pine (ID), Western Pine Beetle in Ponderosa Pine (CA), Spruce Beetle in Engelmann Spruce (UT), and Southern Pine Beetle in Loblolly Pine (AL)

Carl Jorgensen[1], Chris Fettig[2], Steve Munson[3], and Don Grosman[4]
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Emamectin benzoate (Syngenta) and fipronil (BASF) injected treatments were tested in three western bark beetle systems and one in the southern pine beetle system for efficacy using the Shea et al. 1984 standard. This standard for evaluating individual tree protection treatments requires 60% mortality in the untreated controls to make definitive conclusions regarding efficacy. Based on the number of treatment replicates for each site, treatments were considered "efficacious" if <7 trees faded from beetle attack.

In Idaho, the injection treatments and a carbaryl spray treatment were evaluated as individual tree protection treatments for protection of lodgepole pine from mountain pine beetle (MPB). Trees were treated 6 weeks prior to being baited for MPB. Although less than 60% of the controls faded at the time of the evaluation, it was concluded that there was sufficient MPB pressure to validate treatments, because adjacent to many of the control and treated trees were MPB-attacked, faded trees. In addition, all the controls showed signs of MPB mass attacks. Faded trees of the emamectin benzoate, fipronil, and control treatments were 8, 11, and 11, respectively. Almost all of the injected treated trees and the control trees exhibited signs of MPB attacks, such as frass and pitch tubes. None of the carbaryl treated trees showed signs of MPB attacks.

In California, the injection treatments and a bifenthrin (Onyx) spray were tested for protection of ponderosa pine from western pine beetle (WPB). Trees were treated 6 weeks prior to being baited for WPB. Less than 60% of the controls were attacked and had faded. None of the bifenthrin or emamectin benzoate trees had faded. However, 6 of the fipronil and 10 of the control trees had faded in the second year of monitoring.

In Utah, the injection treatments were tested for protection of Engelmann spruce from spruce beetle (SB) attack. Trees were treated in August 2005 and baited in April 2006 before adult beetle flight. Preliminary field evaluations of the treatment replicates were conducted in February 2006 to determine if successful attacks may have occurred on the treated and control trees prior to the trees fading. Successful SB attacks were reported in 23, 32, and 33 trees for the emamectin benzoate, fipronil, and controls treatments, respectively. A final assessment will be made of the treatment replicates in August 2007 after successfully attacked trees have faded.

In Alabama, the injection treatments were tested as individual tree protection treatments for loblolly pine from southern pine beetle (SPB) attack. Trees were treated 5 weeks prior to being baited for SPB. Faded trees of the emamectin benzoate, fipronil, and control treatments were 5, 11, and 23, respectively.

Injection treatments were not efficacious for protecting lodgepole pine from MPB in Idaho, or Engelmann spruce from SB in Utah. Emamectin benzoate protected loblolly

pine from SPB in Alabama, and looks promising in protecting ponderosa pine from WPB in California. Fipronil may also be efficacious in protecting ponderosa pine from WPB and SPB, although some tree mortality was reported. Failures of the injection treatments may be attributed to timing of applications, lack of available soil moisture, temperature, or other environmental factors.

Systemic Injections Against the Erythrina Gall Wasp in Hawaii

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The erythrina gall wasp (EGW), *Quadrastichus erythrinae*, was described as a new species in 2004 from collections made in Taiwan. It attacks *Erythrina* (coral trees) which are found in the tropical, subtropical and warm temperate regions of the world. The origin of EGW remains unknown; however, it is thought to be native to Africa. Facilitated by a rapid life-cycle (~20 d), plentiful, high-quality host material and inadvertent movement by humans, EGW is now widespread throughout the Pacific. The wasp was first detected in Hawaii on Oahu in April 2005 and spread to the remaining Hawaiian Islands within 6 months. In Hawaii EGW attacks the endemic *E. sandwicensis* (wiliwili), and two non-native species, *E. variegata* and *E. crista-galli. E. variegata* have been widely planted as wind break trees on many islands which likely facilitated rapid movement of the gall wasp from the initial points of detection on the islands into the more isolated populations of native trees.

Young tissues of *Erythrina*, especially leaves, shoots and petioles, are preferred by EGW for oviposition. Severe infestations cause serial defoliation, physiological disruption, loss of seed production, and tree death. During January 2007, we initiated a test (20 replications per treatment) on Maui with emamectin benzoate (EB) and imidacloprid (IMA-jet) injected with the ARBORjet Viper system (3/8" drill bit and #4 size plugs). Average uptake time was 17 minutes/tree and 21 minutes/tree for EB and imidacloprid, respectively. Our objective was to evaluate insecticide efficacy and effective duration for protecting native wiliwili trees from EGW. Foliar measurements, seed pod (reproduction) estimates and leaf collections for chemical analysis were completed pre-treatment. Phytotoxic reactions (leaf discoloration) were observed on some of the EB treated trees within two weeks. Follow-up sampling and analysis is underway to determine the cause of the phytotoxicity. We will continue to evaluate all study trees for changes in EGW infestation levels and complete additional tissue sampling (leaves, flowers, seed pods) for chemical analysis of target tissues. Results of this study will aid in the survival of selected wiliwili trees in Hawaii and in the development of prevention, detection, and response strategies in the face of rapid EGW range expansion in other areas of the world.

An Evaluation of Injection Systems for Applications of Systemic Insecticides

Don Grosman
Texas Forest Service, Lufkin, TX

The systemic insecticide, emamectin benzoate, was recently discovered to be effective in preventing the colonization of conifer trees and tree mortality by *Ips* and

Dendroctonus (Coleoptera: Curculionidae, Scolytinae) bark beetles. Injection of systemic insecticides has advantages over bole sprays by reducing or eliminating drift, worker exposure and/or nontarget insect/animal mortality. Several injection systems are currently being manufactured or in development. Some (Mauget, ArborSystem's Wedgle Tip, and Arborjet's Microinjector, BioForest's Ecoject and Rainbow Tree's M3) are designed for low volume applications. Others (Arborjet's Tree IV, ArborSystems's Portle, and Sidewinder) are generally designed for high volume applications. A trial is to be initiated in 2007 to evaluate several of these systems (Mircoinjector, M3, Portle, Tree IV and Sidewinder) in their ability to inject emamectin benzoate into pine trees. The system evaluation criteria were described and focuses on system safety, time to fill, install and clean system, time to inject product, and efficacy of treatment were discussed.


Don't I owe you some money?
I'm so pretty –
Oh so pretty

Graduate Student Presentations

Moderators: Mike Wagner , Northern Arizona University, Flagstaff, AZ and Darrell Ross, Oregon State University, Corvallis, OR

23: Comparison of Chemical Defenses Against Mountain Pine Beetle (*Dendroctonus ponderosae*) Attack in Populations of Lodgepole, Hybrid, and Jack Pine in British Columbia and Alberta.

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University of Northern BC, Prince George, BC, Canada

The ability of mountain pine beetle (*Dendroctonus ponderosae*, MPB) to utilize its host is a factor that determines the spread and scope of infestations in forested areas. Lodgepole pine (*Pinus contorta*) is the primary host of MPB in central British Columbia (BC), but they are capable of successfully utilizing other species such as jack pine (*Pinus banksiana*), stands of which extend across northern Alberta and are contiguous with an unprecedented infestation in neighboring BC. Because terpenoid-based resins are one defense employed by pine trees against MPB attack, we are attempting to relate chemical characteristics of lodgepole and jack pine trees to beetle success. Identifying a correlation between oleoresin chemistry and beetle attack will provide a useful tool for refining models that predict the spread of beetles. To compare the oleoresin chemistry between lodgepole pines that were more susceptible to attack with those that appear to be more resistant, numerous trees were sampled in baited, fixed-radius plots at four locations in BC along a north/south transect. Sites and locations were chosen based upon historical beetle pressure and climatic suitability. In addition, lodgepole, lodgepole x jack pine hybrid, and jack pine trees were sampled in an east/west gradient ranging from central BC to the Alberta-Saskatchewan border in order to predict the ability of MPB to utilize the jack pine based upon similarities and differences between jack pine and lodgepole pine resin chemistry. Phloem samples are currently being processed using gas chromatography to determine their chemical composition.

24: Frequency of Southwestern Dwarf Mistletoe, Mountain Pine Beetle, and *Ips* spp. in Colorado's Northern Front Range Ponderosa Pine

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A random ground survey was conducted to determine the incidence and severity of Southwestern dwarf mistletoe (*Arceuthobium vaginatum* subsp. *cryptopodum*), mountain pine beetle (*Dendroctonus ponderosae*), and *Ips* spp. within Colorado's Northern Front Range ponderosa pine (*Pinus ponderosa* var. *scopulorum*). Because the northern distribution limit of southwestern dwarf mistletoe bisected our study area, we had a unique opportunity to look at endemic bark beetle activity in ponderosa pine forests both with and without southwestern dwarf mistletoe. A total of 31, 1500 m extent transects, were located in randomly selected ponderosa pine dominated polygons from the USDA Forest Service Common Vegetative Unit for Roosevelt National Forest. There was a significantly higher occurrence of mountain pine beetle and *Ips*

spp. in plots that had dwarf mistletoe than those plots without dwarf mistletoe, with the highest bark beetle incidence occurring in plots with the highest dwarf mistletoe severity. These results strengthen the idea of bark beetles utilizing pockets of stressed trees in endemic populations.

25: Fuel Loads Associated with Ponderosa Pine Stands Infested with Southwestern Dwarf Mistletoe and Mountain Pine Beetle in the Northern Front Range of Colorado

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[1] Colorado State University, Department of Bioagricultural Sciences and Pest Management, Ft. Collins, CO;[2] USDA Forest Service, Rocky Mountain Research Station, Ft. Collins, CO

The amount of downed woody debris and fuel arrangement were assessed in ponderosa pine stands infested with southwestern dwarf mistletoe (*Arceuthobium vaginatum* subsp. *cryptopodum*) and mountain pine beetle (*Dendroctonus ponderosae*) in the Canyon Lakes Ranger District, Colorado. One hundred fifty plots, each 0.04 ha, were measured in areas within and surrounding stands infested with southwestern dwarf mistletoe and endemic population levels of mountain pine beetle induced mortality. Using ANCOVA and Tukey's Multiple Comparison Procedure, significant differences of fuel level adjusted means in plots with high infestation level compared to plots with trees not infested were determined. All adjusted means were adjusted for stand and site characteristics, such as stand basal area and aspect. Adjusting for mountain pine beetle induced mortality, there were significantly greater ($p<0.05$) 1 hour and 100 hour time lag fuel load in plots with trees with > 4 DMR when compared to plots with trees not infested with dwarf mistletoe. One, 10, 100, and 1000 hour time lag fuel loads in plots with > 100 stems/ha of mountain pine beetle induced mortality were significantly greater compared to plots without mountain pine beetle induced mortality. Percent vegetation cover was greater in plots with > 50 stems/ha of mountain pine beetle induced mortality that had occurred in the previous 5 to 6 years compared to plots without mountain pine beetle induced mortality. All downed woody debris levels associated with the mortality of ponderosa pine due to mountain pine beetle infestation that had occurred later than the last 5 or 6 years were greater than stands without mountain pine beetle induced mortality, while plots with more recent mountain pine beetle induced mortality were not associated with greater downed woody debris levels. Further analysis will be conducted to determine stand characteristics associated with stands infested with southwestern dwarf mistletoe and mountain pine beetle induced mortality.

26: The Effects of Host Tree Quality on Lipid Content and Pheromone Response of the Mountain Pine Beetle

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The survival and reproductive success of mountain pine beetles, *Dendroctonus ponderosae* Hopkins, (MPB) depends on their ability to find a suitable host tree. MPBs preferentially select larger trees as their hosts, since these trees are best suited for reproduction. As the outbreak escalates and the MPB population density grows, there is an increased frequency of attacks on small-diameter, less suitable trees, which provide

inadequate conditions for breeding. The objectives of this research are to determine how the quality of brood trees affects the fitness of emerging mountain pine beetles (MPB) by measuring fat content of emerging beetles, relative to host quality, and determining if the beetles responding to aggregation pheromones have the same population distribution as those emerging from infested trees. We found that the beetles emerging from the largest trees were largest in size, but did not contain the highest lipid contents. We also found that beetles emerging during the middle of the emergence period had the highest lipid contents. An expected population distribution was calculated using lab emergence data (emerging population), and compared to a population distribution from pheromone-baited funnel traps (responding population). These two populations were compared for size and sex ratio, and it was found that for both males and females, responding beetles were significantly larger than emerging beetles. We also found that in the responding population, the sex ratio was strongly skewed towards males.

27: Effects of Overstory Tree Diversity On Ground Foraging Ants in Ghana West Africa

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[2] Forestry Research Institute of Ghana, West Africa

Interactions between forest type or complexity and biodiversity and other environmental services are poorly understood for most forest types. We assess ground foraging ants (Hymenoptera: Formicidae) as biological indicators of overstory tree species diversity in four experimental plantations in Ghana, West Africa. We examined an exotic species monoculture, a native species monoculture, a six native species polyculture and an eleven native species polyculture. Traditional diversity indices show increases in diversity in native versus exotic species monocultures. However, a ten fold increase in overstory species diversity, native species monoculture to eleven native species polycultures, ant species diversity only increased by nineteen percent. Functional group assessment is also performed and show more distinct trends in ant response to overstory species diversity.

28: A Retrospective Look at Thinning and Bark Beetle-Induced Mortality in Northeastern California – A Study in Progress

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In the Warner Mountains of Northeastern California on the Modoc National Forest has recently experienced below average precipitation between 1998 and 2005. Interactions between drought conditions, bark beetles, and stand conditions have resulted in increased annual tree mortality since at least the year 2000. Various silvicultural prescriptions were implemented over the last several decades throughout the Warner Mountain range to reduce stand density. These silvicultural treatments, combined with the subsequent protracted drought period, presented a unique opportunity to study the effect of thinning on bark beetle-caused tree mortality. Our study will test the hypothesis that treated forest stands have significantly fewer bark beetle-killed trees relative to similar, non-treated stands.

Stands of interest included pine plantations and mixed-conifer stands that were thinned between 1985 and 1998. Candidate stands were identified, then randomly selected, using a combination of stand record card research and the U.S. Forest Service FACTS geospatial database. Stands with prescribed fire, artificial regeneration planting, firewood cutting, fertilizing, overstory removal, and individual tree release treatments were excluded due to their potentially confounding effects. A dual-part sampling design was created to sample forest composition and the bark beetle-caused conifer mortality independently. Forest composition was sampled in 2005 through five 1/20th acre fixed area subplots per plot and conifer mortality was sampled with four 330 x 66 feet belt transects per plot. These subplot and transect data were then averaged to provide plot data.

We compared mean bark beetle-caused mortality (trees/acre) that occurred from 2001-2005 to identify differences in the thinned and non-thinned stands for each stand type. The results for both the plantation stand and mixed-conifer stands were not significant at the alpha=.05 level (p = .11 and .14, respectively). These results are preliminary and only based on data collected from 6 thinned and 6 non-thinned plantation stands and 12 **(**thinned and 12 non-thinned mixed-conifer stands. Additional stands will be sampled during 2007 to complete the field portion of the study.

29: Mountain Pine Beetle Outbreak Effects on Forest Structure

Eric Pfiefer and Dr. Jeffrey Hicke
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Bark beetle outbreaks are the single greatest source of insect disturbance in western North American forests, although the variability and distribution of their effects upon forest structure and variability within and among outbreaks have yet to be quantified. We propose an interdisciplinary study to assess the effect of these disturbances on forest structure using an intensive and extensive study design. At multiple sites within the Sawtooth National Recreation Area (SNRA) in central Idaho, we will measure stand structural characteristics for live and dead tree killed by the mountain pine beetle (*Dendroctonus ponderosae* var. Hopkins). In addition, we will collect and analyze measurements from past studies of bark beetle epidemics across the West. Our study will apply widely-used survey and detection methods to quantify changes to forest structure and associated biomass following outbreaks. We will use these methods to assess regional variability in severity across outbreaks and species. Land and water managers will benefit from improved knowledge of how insect disturbances affect ecosystems, as well as from improved prediction capabilities.

30: Associations Between the Mountain Pine Beetle, Mites, and Fungi: Can Mites Influence Mountain Pine Beetle Population Dynamics?

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The role of mites living on the exoskeleton of mountain pine beetles (*Dendroctonus ponderosae Hopk. Coleoptera: Curculionidae: Scolytinae*) is unknown. The objectives of this study are to determine (1) which mites are present, (2) the three most prevalent

species of mites, (3) which fungi are present on these mites and beetles, and (4) which fungi promote reproductive success of mites. Beetles were collected in the Black Hills National Forest of western South Dakota. Fungi were isolated from the exoskeleton of beetles and mites; additional isolations were attained from the University of Montana. Later, mites were reared upon different isolated fungi to determine the relative growth rates of each mite species on a particular fungus and whether the mite species are mycetophagous. *Tarsonemus ips* and *Proctolaelaps subcorticalis* are the two most prevalent mite species. Each species are regularly found in different places on the beetle exoskeleton. Bioassays will ascertain the specificity of feeding behavior for each mite species, which is currently unknown for mites associated with the mountain pine beetle. Mites may have effects on beetle population dynamics by playing important roles in the transport of certain fungi that are either beneficial or detrimental to beetle larvae survival and brood production.

31: Heritability and Defenses in Lodgepole pine to the Mountain Pine Beetle/Fungal Complex

Dan Ott, Y. Yanchuk, D. Huber, and K.F. Wallin,
University of Northern British Columbia

Lodgepole pine (*Pinus contorta*) has evolved to deal with many abiotic and biotic stressors across its wide range. Mountain pine beetle *(Dendroctonus ponderosae*, MPB) and its associated fungi are likely among the most important biotic factors influencing the evolution of defense responses in this tree. The co-evolution between the tree and the beetle-fungus complex is intimately linked as evidenced by the ability of MPB to utilize secondary metabolites from the pine as precursors for pheromone production. The intent of this research is to investigate the heritability of lodgepole pine defenses related to resistance to MPB and its pathogenic fungi. In established test plots, consisting of a variety of genetic families of lodgepole pine, we investigated differences in resin flow, constitutive and induced resin chemical composition, and the ability of infected pines to rapidly establish necrotic lesions following inoculation with blue stain fungi. In our preliminary analyses of the data, lesion creation appears related to families, and further analysis is ongoing. Resin secondary metabolites from phloem samples have been processed using gas chromatography. Future research will hopefully show that many secondary metabolites are passed down from parents to their offspring. These traits will later be compared with beetle fitness.

32: Battle of the Beetles: Interspecific Interactions Between Primary Dendroctonus Species(*Dendroctonus frontalis* and *D. brevicomis*) in Northern Arizona

Seth Davis, Richard Hofstetter, and Kier Klepzig,
Northern Arizona University

A variety of biotic factors affect bark beetle populations, including competition, predation, host-interactions, and fungal associations. Our studies focus on the population effects of competition between two primary bark beetle species, *D. frontalis* and *D. brevicomis*. Interspecific competition potentially affects adult behavior, reproduction, offspring size and vigor, and fungal associates. To test this, live adult beetles were introduced into declining ponderosa pine (*Pinus ponderosa*) trees in

Flagstaff, Arizona at a density of 3 pairs per dm.². Mycangial fungi were later isolated from the offspring beetles. In addition, a field study was conducted on beetle-killed ponderosa pine to determine the approximate rate of co-occurrence of beetle species. The initial investigation yielded a co-occurrence rate in approximately 80% of trees sampled. Average gallery length, offspring per parent, and number of offspring per unit gallery were only weakly affected by the presence of competing species. Average beetle size was maximized when species occurred in even ratios, and fungal growth rates and competitive ability varied widely by strain. However, *D. brevicomis* produced nearly two times as many offspring beetles overall than did *D. frontalis*, in addition to capturing more gallery space. We conclude from the initial investigation that the density of introduction was too low to adequately test all hypotheses, and that intraspecific competition has greater effect on population dynamics at low attack density. Future studies will utilize a density a 5 pairs per dm.² or higher.

33: Factors Influencing Pine Engraver Colonization and Development in Ponderosa Pine Slash in Northern Arizona

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Thinning projects conducted to reduce fire hazard within the Wildland Urban Interface (WUI) and improve general forest conditions have resulted in the creation of large volumes of slash (small diameter trees and branches and their foliage), increasing the potential for pine engraver *Ips pini* Say outbreaks. A critical examination of slash management guidelines is needed to minimize bark beetle impacts associated with thinning treatments. We examined effects of season of slash generation, sunlight intensity and log size on pine engraver reproduction in north-central Arizona, USA. Ponderosa pine trees were felled and cut into logs of 16 different sizes in October, January, April and July, for two years. Logs were placed in stands with high, partial, and low sunlight levels. Response variables included phloem moisture, attack density, emergence density, and beetle population growth rate. Log length and diameter had significant effects on all response variables; log length showing a positive relationship with phloem moisture, attack density, emergence density, and growth rate, while log diameter had a significant effect on attack density, emergence density, and beetle growth rate, with a preference shown for intermediate diameter bolts. Cutting date and the interaction of date and light level influenced emergence density, but light level alone did not. In both years, emergence density was lowest in spring cut logs. Extended time since cutting (e.g. fall cutting), high light levels and small log diameter did not consistently cause reductions in beetle attack and reproductive performance as predicted. Implications for slash management guidelines were discussed.

34: Host Selection of the Douglas-fir beetle, *Dendroctonus pseudotsugae* (Hopkins), Following Extended Periods of Flight: Are Weak Individuals More Likely to Become Pioneers?

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Members of bark beetle aggregations do not receive equal costs and benefits throughout the 'mass attack' sequence. Early attackers ('pioneers') have the choice of the best oviposition sites and maximum resources but they also must face the brunt of the tree's defenses. On the other hand, beetles colonizing later in the sequence suffer less mortality from resinous pitch flows. Under what circumstances then would a beetle choose the pioneer strategy instead of waiting? We predicted that female *D. pseudotsugae* with low fat reserves would be less choosey of hosts because they would have lower capacity to fly in search of alternative hosts than beetles with more ample fat reserves. Before decreasing fat levels in individuals, we first determined the rate of fat loss during flight using rotary flight mills and Soxhlet fat extraction. Estimates of initial fat content were made prior to flight using externally-measured variables and AIC. The best model contained the parameters of body condition scores (residuals of mass/volume relationship) and density of developing brood (measured as the number of emerging adults per surface area), both of which had significant positive effects on the percentage of fat in newly emerged beetles. Then, female *D. pseudotsugae* were assigned flight treatments ranging from 90 – 1380 minutes. We found that every hour of flight approximately decreased the percentage of fat by one. However, the effect of flight on fat reserves was not significantly different than periods of non-flight activity, most likely because individuals spent 50% of their time in non-flight activity. Three beetle treatment groups, Flight (F), Non-flight (NF), and Non-flight low fat (NFL) were established, and their host selection behaviors on live (standing) and dead (felled) hosts were recorded. The odds of entering either live or dead hosts at three sampling times (20 min, 60 min, and 48 h) for each beetle group were assessed using multiple logistic regression. Contrary to predictions, NF and NFL beetles were three to 17 times more likely to enter either host type at each sampling time than were those in the F group. There were no significant differences between NF and NFL beetles at any of the three sampling times. There was also no effect of tree type on entry behavior. However, at 48 h beetles were 42 times more likely to leave a standing tree than they were a felled tree. Although 20 out of 97 beetles showed this departure behavior, none were covered in resinous pitch from the host. Thus, one possible explanation is that beetles have the ability to 'sample' hosts and can reject them if deemed unsuitable. Since NF and NFL beetles behaved similarly throughout the experiment, the experience of flight, rather than fat reserves per se, appears to have affected pioneer behavior in this study. The accumulation of metabolic by-products from flight activity or unrealistic flight times may have contributes to the behavioral difference detected in the study.

35: Impacts of Thinning Ponderosa Pine on Pine Bark Beetles in Northern Arizona

Monica L. Gaylord, Richard W. Hofstetter, and Michael R. Wagner
NAU School of Forestry, Flagstaff, AZ

Since the arrival of Europeans, the ponderosa pine (*Pinus ponderosa*) forests in northern Arizona have been altered by fire suppression, grazing and logging. There is

extensive interest in using thinning and/or thinning and burning as a tool to help restore the ponderosa pine forests to pre-European condition. We investigated the response of several species of pine bark beetles (Coleoptera: Curculionidae, Scolytinae) to an experimental range of stand densities in a ponderosa pine forest. We tested three alternative hypotheses of changes in; a) bark beetle and predator movement/host selection, b) microclimate, and c) host plant defenses. We used sticky traps and passive traps to examine variation in the number and species of bark beetle and bark beetle predators across the thinning treatments (30 to 150 ft^2/ac). Few bark beetles were captured on sticky traps. We captured a higher number of bark beetle predators on sticky traps in stands with lower basal areas than in stands with higher basal areas. In addition, more bark beetles and bark beetle predators were captured in passive traps in stands with lower basal areas than stands with higher basal areas. Similarly, when we used funnel traps with *Ips pini* lure (+3/-95 % ipsdienol and lanierone), we captured higher numbers of *I. pini* and bark beetle predators in lower density stands than higher density stands. These results suggest that higher numbers of bark beetles and their predators are moving through stands with lower tree densities and, contrary to our expectations, microclimate changes in stands with lower tree densities did not negatively affect the attraction of pheromone plumes for *I. pini*. We found no differences in host plan defenses among the thinning treatments. Mean resin flow was similar across all treatments and fungal inoculations using *Ophiostoma minus* produced no, or a very minimal lesion response in all treatments. We anticipate continuing this research in 2007. These experiments will provide us with regionally appropriate experimental data that supports or refutes the conventional wisdom that stand density regulation is the most effective strategy to prevent pine bark beetle damage to southwestern ponderosa pine forests.

Poster Abstracts

Organizers: Joy Roberts, Terri Johnson ; USDA Forest Service, Boise, ID
Lee Pedersen, USDA Forest Service, Coeur d'Alene, ID

36: An Outbreak of Douglas-fir Tussock Moth, *Orgyia pseudotsugata* (Lepidoptera: Lymantriidae), near Aspen Park, Colorado – 2004-06

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An outbreak of Douglas-fir tussock moth, *Orgyia pseudotsugata*, northeast of Aspen Park, CO from 2004-2006 is described. This is the second documented outbreak of this insect in a forested area in Colorado. To date, the outbreak has consisted of a series of localized spots of defoliation. Heavy populations of larvae stripped all of the foliage from trees during the first year and in two areas, populations collapsed after a single year of defoliation. Virtually all of the completely defoliated trees were killed after one year of defoliation. The outlook for additional defoliation in 2007 is uncertain.

37: Application of Scolytid Semiochemicals: Improving Releasers and Information Integration

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Releasers for semiochemicals have remained relatively rudimentary, primarily due to constraints on cost and field durability. Passive releasers elute semiochemicals through a membrane or wick and respond significantly to meteorological conditions, making the amount of semiochemical dispensed unpredictable. This, in turn, causes inconsistencies and inefficiencies in field applications, confounding already complex interactions between semiochemical applications and insect behavior.

This project seeks to: (1) develop more consistent semiochemical releasers; (2) improve the utility of elution data through increased standardization of field-based evaluations; and, (3) to increase the integration and availability of elution data.

To overcome the limitations of passive releasers, we have been developing and evaluating semiochemical release devices that are less dependent on environmental conditions. Med-e-Cell has developed a prototype of a general-purpose releaser for use with semiochemicals. These releasers actively push or pump fluid to the outside, potentially providing more control over elution rates. Other active releasers (e.g., 'puffer' types) are also being evaluated.

Measurement of elution rates is not typically performed in the field, and a lack of standardization among studies makes comparisons and inferences difficult. Certain designs and chemicals perform better than others (e.g., more stable, more useful

lifetimes) and may be good enough for the purposes intended; however, others are not. Regardless, more information is needed to determine the fit of semiochemical releasers to the goals of a management program. Standardizing protocols and collecting meteorological data, in conjunction with elution data, is integral to explaining release rates and improving their predictability. Availability of interpretable data should also aid in discourse with manufacturers and the development of improved products. Potential standards will be developed during 2007 based upon input from users.

To improve the integration and availability of releaser information, we are developing a webpage via the Forest Health Technology Enterprise Team. The webpage is designed to serve as a clearinghouse for elution data at no cost to users and will be online by July 2007.

The preliminary web address is: *http://www.fs.fed.us/foresthealth/technology/elutionrate.*

38: A Retrospective Look at Thinning and Bark Beetle-Induced Mortality in Northeastern California – A Study in Progress

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See abstract in graduate student presentation #28 same title.

39: A Spatial Decision Support Tool for Reducing Gypsy Moth Trap Density

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The Gypsy Moth, *Lymantria dispar*, is an exotic defoliator of hundreds of tree and shrub species. The survey Program is cooperative effort among Idaho Department of Lands, U. S. Forest Service, U.S. Department of Agriculture Animal Plant Health Inspection Service, Idaho Department of Agriculture, Idaho Department of Transportation and the University of Idaho. Annual detection surveys have been conducted throughout Idaho since 1974 in order to detect introductions early, thereby reducing the expense and environmental impacts of extensive treatments. In 2006, a GIS model was created to reduce overall Program costs through reduction of trap densities while maintaining the effectiveness of the detection Program. The tool was created using Python Scripting and was implemented in ArcGIS using a weighted criteria system that takes into account proximity to other trap sites, distance to major roads, and distance to railroad tracks. Major roads and railroad tracks were selected based upon their potential for moth introduction into an area. A 40% reduction in traps and a 25% reduction in labor costs is predicted. During the 2007 season, results of this application will be assessed for 11 zones in north Idaho. This tool allows managers to make landscape level decisions about pest management programs, and once established, the tool is portable and parameters can be modified to fit Program requirements.

40: Biological Control vs. Herbicide to Suppress Leafy Spurge Over A Six-Year Period

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Leafy spurge is an exotic, deep-rooted, invasive perennial weed native to Eurasia. It replaces native grasses and forbs favorable to livestock, and can reduce cattle carrying capacity of forest and range lands by 50 to 75%. It aggressively invades by means of high seed production and underground shoots. It is estimated that leafy spurge infests over one million hectares (2.5 million acres) in North America. Current methods to control this highly invasive weed are the use of chemical herbicides and through the introduction of insects specific to the non-native invasive plant that kill, reduce the vigor and competitive ability, or ability to produce seeds (biological control). To compare the efficacy of long term control using biological control agents and herbicide treatment, we established six plots treated with herbicide (picloram/Tordon), six plots where *Aphthona* sp. flea beetles were released and six plots untreated for use as a comparison. All plots were monitored annually from 2000 to 2006. At each study plot 100 ft. transects were established in each cardinal direction. Measurements were collected every 10 ft. along each transect on: Coverage of leafy spurge, height of leafy spurge, coverage of grass, forb, shrub and bare ground, and the number of *Aphthona* beetles in 5 net sweeps. Spurge coverage on the untreated plots varied annually between 30-40%. On the herbicide treated plots, spurge coverage increased from approximately 5% to nearly 40% and then began to decline as flea beetles dispersed from the biological control treated plots, as the availability of spurge in these areas declined. In the plots treated with *Aphthona* sp. beetles spurge coverage declined from nearly 70% in 2000 to near 5% in 2005. There was a rise in spurge coverage to 25% in 2006. This rise may be from several factors such as: beetles dispersing from initial release plots to surrounding areas, heavy collecting for redistribution the previous few years, and/or poor winter survival or other environmental conditions for the biological control agents.

41: Determing Effective Sampling Area Of A Western Pine Beetle Pheromone Trap System

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The goal of this multi-year study is to measure the sampling range and effective sampling area of a semiochemical attractant-baited trap system used for western pine beetle (WPB, *Dendroctonus brevicomis*). To determine the long-range probability of beetle recapture, we are using beetles labeled with fluorescent powder released at a central point within an array of pheromone-baited traps (16-funnel Lindgren funnel traps with attractant lures of frontalin, exo-brevicomis, and myrcene) distributed in cardinal directions at intervals from 50 to 1500 m. During 2006, we conducted 4 trials each in June and Augusts that corresponded to the first and second generations of WPB in the Blue Mountains of northeastern Oregon. Overall, we found >60% of all recaptures

occurred between 500-700 m of the release point. In June, 80% of recapture occurred within 700 m, but this extended to > 900 m in August. Flight appears to be affected by the prevailing NNW winds with a slight increase in recapture south of the release point. Knowledge of sampling range and effective sampling area of this trap systems could greatly enhance the value of this tool providing information about effective placement of traps for monitoring or use in suppression.

42: Do Phoretic Mites on Elm Bark Beetles Contribute to the Transmission of Dutch Elm Disease?

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Larvae of *Scolytus scolytus* feeding in galleries cannot develop in presence of Dutch elm disease (DED), whereas spores and/or hyphae of this pathogen may be essential to the nutrition of two phoretic mites, *Tarsonemus crassus* and *Proctolaelaps scolyti*, both of which can carry enough DED spores to infect *Ulmus* spp. Hence it should not be in the interest of *Scolytus* spp. To transport DED; whereas it should greatly enhance the survival of the spore-feeding mites to to so. It is therefore possible that populations of these two mites and not those of *Scolytus* spp., may be the most meaningful drivers of DED in Austria, at least.

43: Ecology of Invasive Weevils in a Northern Hardwood Forest

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A complex of invasive weevils has recently undergone a population eruption in the upper Great Lakes region. Adult and larval ecology is being examined in the Ottawa National Forest in the Upper Peninsula of Michigan. Adult weevils are folivores, feeding primarily on the leaf margins of sugar maple, ironwood, and raspberry. Weekly adult censuses in 2006 indicated the presence of four species: *Phyllobius oblongus*, *Polydrusus sericeus*, *Sciaphilis asperatus*, and *Barypeithes pellucidus*. *Phyllobius oblongus* were the most common; weekly sweep net samples captured from 0 to 79 adults. *Polydrusus sericeus* was less common than *P. oblongus*, but still much more abundant than *S. asperatus* or *B. pellucidus*. Adult weevil populations peaked in June, and nearly all adults were gone by mid-July. Larvae are rhizophagous, and feed primarily on fine (i.e., <1 mm diameter) roots. Significanly more larvae occur in the upper 15 cm of soil, which coincides with the greatest amount of fine root biomass. The highest larval mortality occurred in January. Studies are underway to determine the effects of larval and adult feeding on seedling growth and fine root dynamics in this northern hardwood ecosystem.

44: The Effects of Mechanical Fuel Reduction Treatments on the Activity of Bark Beetles Infesting Ponderosa Pine

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Selective logging, fire suppression, forest succession and climatic changes have resulted in high fire hazards over large areas of the western USA. Federal and state hazardous fuel reduction programs have increased accordingly to reduce the risk, extent and severity of these events, particularly in the wildland-urban interface. In this study, we examined the effects of mechanical fuel reduction treatments on the activity of bark beetles in ponderosa pine, *Pinus ponderosa* Dougl ex. Laws., forests located in Arizona and California. Treatments were applied in both late spring (April-May) and late summer (August-September) and included: (1) thinned biomass chipped and randomly dispersed within each 0.4 ha plot; (2) thinned biomass chipped, randomly dispersed within each plot and raked 2 m from the base of residual trees; (3) thinned biomass lopped-and-scattered (thinned trees cut into 1-2 m lengths) within each plot; and (4) an untreated control. The mean percentage of residual trees attacked by bark beetles ranged from 2.0% (untreated control) to 30.2% (plots thinned in spring with all biomass chipped). A three-fold increase in the percentage of trees attacked by bark beetles was observed in chipped versus lopped-and-scattered plots. Bark beetle colonization of residual trees was higher during spring treatments, which corresponded with peak adult beetle flight periods as measured by funnel trap captures. Raking chips away from the base of residual trees did not significantly affect attack rates. Several bark beetle species were present including the roundheaded pine beetle, *Dendroctonus adjunctus* Blandford (AZ), western pine beetle, *D. brevicomis* LeConte (AZ and CA), mountain pine beetle, *D. ponderosae* Hopkins (CA), red turpentine beetle, *D. valens* LeConte (AZ and CA), Arizona fivespined ips, *Ips lecontei* Swaine (AZ), California fivespined ips, *I. paraconfusus* Lanier (CA) and pine engraver, *I. pini* (Say) (AZ). *Dendroctonus valens* was the most common bark beetle infesting residual trees. A significant correlation was found between the number of trees chipped per plot and the percentage of residual trees with *D. valens* attacks. A significantly higher percentage of residual trees was attacked by *D. brevicomis* in plots that were chipped in spring compared to the untreated control. At present, no significant difference in tree mortality exists among treatments.

In a laboratory study conducted to provide an explanation for the bark beetle responses observed in this study, monoterpene elution rates from chip piles declined sharply over time, but were relatively constant in lopped-and-piled treatments. The quantities of b-pinene, 3-carene, a-pinene and myrcene eluting from chips exceeded those from lopped-and-piled slash during each of 15 sample periods. These laboratory results may, in part, explain the bark beetle response observed in chipping treatments. The implications of these results to sustainable forest management were discussed (Fettig et al. 2006).

Fettig, C.J., J.D. McMillin, J.A. Anhold, S.M. Hamud, R.R. Borys, C.P. Dabney, and S.J. Seybold. 2006. The effects of mechanical fuel reduction treatments on the activity of bark beetles (Coleoptera: Scolytidae) infesting ponderosa pine. For. Ecol. Mgmt. 230: 5- 68.

45: Effect of Season on the Amount of Bark Beetle-caused Tree Mortality Following Prescribed Fire in Eastside Pine

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Prescribed fire is being increasingly used by forest managers as a tool to reduce fuel loads and restore natural ecosystem processes. Undesired levels of tree mortality have occurred following prescribed burns, much of which has been attributed to bark beetle attacks. Prescribed burns are usually conducted in either late spring or fall. In some studies concerning the seasonality of prescribed burns, higher levels of tree mortality were associated with spring burns while in others the opposite occurred. The purpose of this study was to determine the response of bark beetles to the seasonality of prescribed burning in an eastside Sierra Nevada forest. Nine 4 ha plots were established in the Tahoe National Forest with either spring, fall, or untreated control treatments randomly assigned to each. Both spring and fall burns were conducted in 2005, and plots were assessed for mortality in fall 2006. Initial results suggest that fall prescribed burns were more effective in meeting management objectives by reducing ground, surface and ladder fuels while retaining large diameter trees. Fall prescribed burns resulted in slightly higher burn temperatures and percent cambium killed yet crown scorch and bole char were lower. While the percentage of trees killed was nearly equal between burn treatments, there was over twice the basal area killed following spring prescribed burns indicating greater mortality within the larger diameter classes. Much of this mortality was attributed to western and mountain pine beetle attacks. These results are preliminary and a full analysis will be conducted following completion of another census of bark beetle activity in the fall of 2007.

46: Effects of Western Spruce Budworm Defoliation on the Northern Spotted Owl and its Habitat in South Central Washington: *Interim Project Report 2*

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A 19-year period of western spruce budworm (*Choristoneura occidentalis*) defoliation of coniferous forests on the eastern slopes of the Cascade Mountains in southcentral Washington is being analyzed for effects on northern spotted owl (*Strix occidentalis caurina*) populations and their habitat. Analysis includes the use of Region 6 annual insect and disease aerial survey data, owl demographic data, forest inventory plot data (CVS/FIA), and satellite image-based change detection analysis. Landsat 5 Thematic Mapper images of pre-defoliation (1985) and ongoing/post-defoliation (2003) vegetation conditions are being characterized and analyzed for similarities and differences in percent cover. Relationships among vegetation conditions, disturbance history, and owl demography will be examined for trends and associations that characterize the effects and interrelationships of western spruce budworm defoliation, vegetation conditions, spotted owl populations, and other associated disturbances. Cooperators include US Fish and Wildlife Service, USDA Forest Service, Yakama Indian Nation, Washington Department of Natural Resources, Washington Department of Fish and Wildlife, Hancock Resource Group, and Plum Creek Timber Company.

47: Evaluation of Funnel Traps For Characterizing the Bark Beetle Communities in Ponderosa Pine Forests of Northern Arizona

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Funnel traps baited with aggregation pheromones are widely used to monitor populations of economically important pine bark beetles (Coleoptera: Curculionidae, Scolytinae) in forests. However, information is lacking on how useful the trap catch data is for characterizing the actual presence and relative abundance of various species of bark beetles in species-rich ecosystems such as the ponderosa pine (*Pinus ponderosa*) forests in the southwestern U.S. Using a previously established study looking at the effect of elevation on bark beetle populations, we added an additional measure of bark beetle abundance to test if a trapping system designed to catch multiple bark beetle species has the ability to describe relative abundances of those species. Eleven bark beetle species (five *Ips* species and six *Dendroctonus* species) were caught in pheromone-baited traps, using lures designed to attract *Dendroctonus brevicomis*, *Ips pini*, and *I. lecontei*. Pieces of bark (1,000 cm^2) were removed at heights of 1, 3, 5, and 7 m above the ground from the north side of one ponderosa pine brood tree (i.e., the tree had recently been killed by bark beetles) per trap site and galleries were identified. Five species of bark beetles (*D. frontalis, D brevicomis, D. adjunctus, D. approximates,* and *I. calligraphus*) were found in both galleries and baited traps. Comparison of relative abundance of co-occurring species found no significant difference in relative abundances. Contradicting results did appear, however, with the traps finding more *D. frontalis* than *D. brevicomis*, and galleries finding more *D. brevicomis* than *D. frontalis*. We feel that commercial pheromone baits used in this study provided a reasonable assessment of actual relative abundance of four *Dendroctonus* and one *Ips* species recorded from corresponding bark samples.

48: Evidence for a Male-Produced Aggregation Pheromone Component in the Southern Pine Beetle, *Dendroctonus frontalis*

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Aggregation pheromones are essential to the ability of southern pine beetle (SPB), *Dendroctonus frontalis* Zimmermann, to organize lethal mass attacks on healthy pine trees. Studies conducted in the late 1960's and early 1970's identified frontalin, a bicyclic ketal produced by female beetles, as the major aggregation pheromone for SPB. Frontalin in combination with host-produced compounds (turpentine or *alpha*-pinene) was found to be highly attractive to SPB, particularly males, and since the mid 1980's this bait has been used in an annual, south-wide trapping survey for predicting regional population trends for this pest. However, frontalin/host odor combinations alone fail to duplicate the attractiveness of naturally-infested hosts, and the aggregation pheromones for other pine-infesting *Dendroctonus* species in North America have generally been shown to consist of both female and male-produced components. We

therefore investigated the possible existence of overlooked aggregation pheromone components in male SPB.

Live pines infested with both sexes of SPB attracted significantly greater numbers of conspecifics than trees infested only with females, indicating that attacking males can accelerate mass-aggregation. Coupled gas chromatography-electroantennographic detection (GC-EAD) studies revealed that *endo*-brevicomin present in male beetles consistently elicited stronger responses from the antennae of both sexes than frontalin or any other compound isolated from male or female SPB. The antennae of both sexes were much more sensitive to the (+) than the (-)-enantiomer of *endo*-brevicomin, and coupled gas chromatography-mass spectrometry (GC-MS) analyses of headspace collections and hindgut extracts revealed that males produced only the (+)-enantiomer. Male production of (+)-*endo*-brevicomin increased approximately ten-fold following pairing with a female and achieved concentration levels somewhat less than those of frontalin in newly-attacking females. Addition of baits releasing 200 micrograms per day (+)-*endo*-brevicomin to traps baited with frontalin and turpentine increased catch of SPB approximately 40-fold. However, (+)-*endo*-brevicomin alone or in combination with host odors failed to attract more SPB than non-baited traps. Based on these data, we believe that (+)-*endo*-brevicomin is a potent aggregation synergist for SPB and is a male-produced aggregation pheromone component roughly analogous to frontalin in male *D. brevicomis* and *D. ponderosae*, and *exo*-brevicomin in male *D. adjunctus.*

49: Fipronil Soil Treatments Provide Extended Protection of Pine Seedlings from Nantucket Pine Tip Moth

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Trials were initiated in 2004 to evaluate fipronil as a systemic treatment for protection of pine seedlings from Nantucket pine tip moth, *Rhyacionia frustrana* (Comstock). Pine seedlings were treated at different rates prior to lifting in the nursery bed, at planting or both. Fipronil treatments applied in plant holes provided good to excellent protection against tip moth through the third growing season (2006). Overall damage was reduced 84 – 97% in Year 1, 86 – 93% in Year 2 and 42 – 56% in Year 3. Protection against tip moth frequently resulted in significant improvements in tree height, diameter and volume growth compared to untreated checks. Fipronil treatments applied to nursery beds were ineffective against tip moth.

50: Forest Health Protection Grant Program in South Central Idaho - A Tool for Landowners to Keep Their Forests Healthy

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South central Idaho, like many other areas in the western United States and Canada, is experiencing an unusually severe infestation of western bark beetles. Many homeowners were concerned about dead and dying trees on their properties and were seeking solutions to protect their forests. In 2004, the Idaho Department of Lands and Forest Health Protection (Regions 1 and 4) responded to this challenge by forming a partnership to provide technical assistance as well as financial cost share grants for

private landowners with forested land that has been heavily impacted by bark beetles. This program has been a successful tool that has educated private landowners on the value of proactive forest management by implementing suppression and prevention tactics that has protected thousands of high value trees and promoted long-term forest health. The grant program highlights a successful partnership effort to address a widespread condition that crosses private, state, and federal lands.

51: *Hylobius warreni* Wood (Coleptera: Curculionidinae) as a Threat to Regeneration in the Post Mountain Pine Beetle Ecosystem of the Central Interior of British Columbia.

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Warren root collar weevil, *Hylobius warreni* Wood (Coleoptera: Curculionidae) is a native, flightless insect that feeds on all life stages of living pines and spruce. On mature trees, it does little damage. On young trees, however, girdling caused by larval feeding may cause growth loss and/or death. Following the extensive mountain pine beetle outbreak, the landscape of British Columbia is quickly transitioning into new plantings following salvage operations. A significant concern is the movement of Warren root collar weevil from unsalvaged stands with reduced food sources into adjacent regenerating cutblocks. This project (1) investigates mortality patterns in regenerating cutblocks adjacent to mountain pine beetle-killed stands and (2) examines potential weevil movement that may be causing this mortality.

52: Identifying the Mite and Fungal Community Members of *Dryocoetes confuses* in Northern Arizona

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The western balsam bark beetle, *Dryocoetes confuses* (Coleoptera: Curculionidae: Scolytinae) is native to North America ranging from British Columbia to Arizona. The beetle attacks and kills sub-alpine fir, *Abies lasiocarpa*. Over 800,000 trees were killed by the beetle between 1995 and 1999 in the Rocky mountain area. Despite the large scale mortality caused by *D. confuses*, there is little information on its life cycle, ecology, and associated organisms such as mites and fungi. The goal of this study is to identify the complex of fungus and mite species associated with *D. confusus.* Beetles were collected at high elevation in northern Arizona using baited Lindgren funnel traps during the summers of 2005 and 2006. One hundred forty four male and female beetles were inspected for the presence of mites and fungi. Surprisingly, all of the beetles had phoretic mites, with 20 different mite species identified. Fungal cultures were propagated using beetle bodies and mites, but are yet to be identified beyond the genus *Ophiostoma*. Beetles were separated into four body parts and plated. Five strains of *Ophiostoma* spp. have been recognized.

53: Impact and Management of the Invasive Redhaired Pine Bark Beetle in Southern California Urban Pines

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The redhaired pine bark beetle (RPBB), *Hylurgus ligniperda* (F.) is a pest that feeds in the phloem of the basal portion of pine stems, large roots, or woody debris in contact with the soil. This invasive beetle is native to southern and central Europe, Russia, the Mediterranean region, and has also invaded and established populations in Australia, Japan, New Zealand, South Africa, parts of South America, Sri Lanka, and now the U.S. RPBB was first found overwintering in North America in New York in 2000, and then detected in July 2003 in Los Angeles Co., followed by five more counties in southern California. Research to better understand the impacts of RPBB, and to develop pest management tools include: 1) determining host range on native and ornamental pines and conifers, 2) identifying fungal pathogens vectored, 3) developing an attractive semiochemical bait, 4) identifying inhibitory semiochemicals, and 5) documenting natural enemies of RPBB in the field. A ten-month field trapping study of the flight responses of both sexes of the RPBB in southern California has demonstrated that ethanol and (−)-α-pinene functioned synergistically as an attractant. Ethanol was not attractive alone;(−)-α-pinene was attractive to females. The sex ratio of responding beetles was not significantly different from 1:1. RPBB adults were active in flight year round with major peaks in May and July, and a minor peak in November.

54: Influence of Elevation on Bark Beetle Community Structure and Flight Periodicity in Ponderosa Pine Forests of Arizona

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Previous research on the bark beetle community in Arizona's ponderosa pine forests has been limited to study areas occurring at a single elevation band. We examined how the bark beetle community structure and flight periodicity of several species changed across an elevational gradient in the ponderosa pine forests of north-central Arizona. Bark beetle populations were monitored at ten sites in each of three elevation bands (Low: 1,676 m $\pm$ 76 m, Mid: 2133 m $\pm$ 76 m and High: 2,591 m $\pm$ 76 m) for three years using pheromone-baited Lindgren funnel traps. Trap contents were collected weekly from March to December, weather permitting. All species of *Ips* and *Dendroctonus* captured, except for *D. ponderosae*, were found across the entire elevation range of this study. Abundance and flight seasonality were analyzed for five *Ips* and five *Dendroctonus* species. Bark beetles, regardless of species, showed no elevational trend in abundance. *Dendroctonus*, as a genus, was similar across elevation. The abundance of *D. frontalis* and *D. brevicomis* at low and mid elevations offset the abundance of other *Dendroctonus* at high elevations. *Ips*, as a genus, showed no elevational trend. This was driven by *I. pini*, which was the most abundant of the *Ips* collected and found

in similar numbers across all elevations. We also investigated temperature fluctuations across an elevational gradient and what role this may play in flight behavior. Data loggers recorded ambient air temperature at six sites in each elevation band. Flight initiation and cessation seem to be closely related to elevation and associated temperature differences, specifically the maximum weekly temperature. Spring flight threshold temperatures of 15 -20°C (M. Gaylord, personal comm.) were reached 1-4 weeks later with each increase in elevation band, coinciding with flight initiation of several bark beetle species. As fall temperatures fell below threshold numbers, bark beetle activity tapered off. Our results indicate that elevation and associated temperature differences influence abundance and flight seasonality of several bark beetle species, including the length of flight season, the number of peaks in flight activity and/or the timing of those peaks. This knowledge should improve the development of hazard rating systems, timing of silvicultural and semiochemical treatments, and the ability to predict bark beetle population dynamics.

55: Influence of Tree Volatiles on Cross Attraction of *Ips* and *Dendroctonus* and Their Predators in Arizona

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Arizona contains the largest contiguous stand of ponderosa pine in the world. This forest supports 9 *Dendroctonus* and over 10 *Ips* species but extensive tree mortality by bark beetles have only occurred recently. Are these species attracted to pheromones of other species and is the attraction influenced by the presence of host tree volatiles? Our objectives were to determine whether (1) the pattern of attraction to beetle pheromones change with the presence of host tree volatiles, (2) the presence of another beetle pheromone deters primary attraction to a beetle's pheromone, and (3) these patterns vary with secondary and primary bark beetles. The presence of the heterospecific pheromones had little effect on attraction to conspecific pheromones. However the monoterpene present had strong affects on attraction to beetle pheromones for both *Dendroctonus* and *Ips* species. *Ips calligraphus, D. brevicomis and D. frontalis* were strongly attracted to α-pinene. Predators *Temnochila, Enoclerus* and *Elacatis* varied in their attraction to the lures, but overall increased release rates of α-pinene resulted in greater trap catches. Other than *D. valens*, the bark beetles captured show little attraction to pheromones from the other genus. However, the combination of lures did not deter beetles.

56: Insecticides for Protecting Individual, High-value Trees from Bark Beetle Attack: An Overview of Some Recent Research Efforts in the West

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High-value trees, such as those located in residential, recreational, or administrative sites, are particularly susceptible to bark beetle (Coleoptera: Curculionidae: Scolytinae) attack as a result of increased amounts of stress associated with drought, soil compaction, mechanical injury, or vandalism. Tree losses in these unique environments generally have a substantial impact. The value of these individual trees, cost of removal, and loss of aesthetics may justify protection until the main thrust of a bark beetle infestation subsides. This situation emphasizes the need for assuring that effective insecticides are available for individual tree protection. In this poster we reviewed several recent studies, including an assessment of bifenthrin (Onyx™) and carbaryl (Sevin® SL) for protecting: ponderosa pine, *Pinus ponderosa* Dougl. ex. Laws., from western pine beetle, *Dendroctonus brevicomis* LeConte in California, mountain pine beetle, *D. ponderosae* Hopkins in South Dakota, and *Ips* spp. in Arizona; lodgepole pine, *P. contorta* Dougl. ex. Loud., from *D. ponderosae* in Montana; pinyon, *P. edulis* Engelm. in Colorado and *P. monophylla* Torr. & Frem. in Nevada from pinyon ips, *I. confusus* (LeConte); and Engelmann spruce, *Picea engelmannii* Parry ex. Engelm. from spruce beetle, *D. rufipennis* (Kirby) in Utah. We also provided data on permethrin plus-C (Masterline®) for protecting *P. ponderosa* in California, *P. contorta* in Montana, and *P. edulis* in Arizona, and shared preliminary results from a study examining novel tree injection tools for tree protection in California, and an evaluation to determine the amount of drift (ground deposition) occurring during conventional bole sprays.

57: Inundative Release of Aphthona Flea Beetles as a Biological "Herbicide" on Riparian Leafy Spurge

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Leafy spurge is an exotic, deep-rooted, invasive perennial weed native to Eurasia. It replaces native grasses and forbs favorable to livestock, and can reduce cattle carrying capacity on forest and range lands by 50 to 75%. It aggressively invades by means of high seed production and underground shoots. It is estimated that leafy spurge infests over one million hectares (2.5 million acres) in North America. Current methods to manage leafy spurge are chemical herbicides, grazing with goats and sheep, and biological control insects that are specific to leafy spurge to kill, reduce plant vigor, or reduce seed production of leafy spurge. This weed is especially difficult to control in riparian areas because of restrictions on herbicide use and the inability of biological control insects to survive the occasional flooding that occurs in the late winter and spring. This study was established to evaluate the efficacy of control of short term (annual releases over two years) populations of large numbers of beetles to inundate leafy spurge in riparian habits. We released treatments of zero (untreated check), 10 and 50 beetles per flowering stem on three 24 square meter plots in each of three riparian study sites distributed across central-south Idaho. The biomass and number of stems of leafy spurge was reduced after one year at all three sites. The impacts of second year releases will be collected during 2007.

58: Is Aspen Decline An Unsuspected Problem?

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Aspen decline is a major issue facing resource managers in the Intermountain states. Fungi, drought, and climate change have been blamed for aspen mortality. It is this author's opinion that the mortality we are seeing is perfectly consistent with what we know of this species. Aspen exists in Utah, but our sites are less than ideal and often prevent aspen from thriving. On poor sites, aspen does not live as long. Our aspen are well beyond an age at which they can be expected to thrive. These factors are behind the decline of aspen in Utah.

59: Investigations on the Ecology and Control of Spruce Aphid in Southeast Alaska

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Sitka spruce (*Picea sitchensis* (Bong.) Carr.), historically has been subjected to attack by the spruce aphid, *Elatobium abietinum* (Walker) (Homoptera: Aphididae). Spruce aphid can cause severe needle drop and death of the tree after several defoliation events. Spruce aphid outbreaks are usually preceded by mild winters, and normally last for a short time, perhaps two or three years. Since 1975 the outbreak has been more or less continuous. Aphid damage may become apparent in March or April before the new spruce growth begins. Populations continue to increase until early summer, when sap nutrition drops off. By midsummer the populations may reach a low point because reproduction rate drops with decreased nutrition, migration by winged females, and increased parasitism. In the fall, the aphids may increase in number and infest the current year needles. This second peak in September and October is usually not as damaging as the spring population, but significant defoliation may still occur if the autumn is a mild one.

Aspect and maritime influence at the beach fringe have a great deal to do with spruce aphid survival. Southern aspects that are sheltered and near the western edge of the archipelago of southeast Alaska islands are many degrees warmer than elsewhere. Warmer temperatures, by 5-10 °C, occurred as much or more than two weeks longer in the fall and two weeks sooner in the spring in Sitka and Craig than in Juneau, AK.

Since 1940, mean annual midpoint temperatures (the midpoint is halfway between the minimum and maximum temperatures) at Sitka, AK increased 2.0°C. The minimum winter temperature has increased by 6°C. The number of winter days with below-freezing temperatures has decreased by 20 days. The date of the last spring frost has retreated 15 to 20 days at Sitka.

The application of Acecaps significantly reduced the density of aphids on Sitka spruce by 92.4% (June 2005) and 100% (September 2006). No other significant differences were observed among treatment (Kioritz or Arborjet) means during these two sample periods. Acecaps were the most effective means of control but during most evaluations relatively few aphids were encountered overall.

Vertical and horizontal digital photographs were taken in April and September 2005 and 2006 to compare the changes in needle density on treated and untreated trees (E). Using the HemiView software, developed by Delta-T Devices, control trees lost on the average one and one-half percent of their needle cover each in 2005 and 2006 and, this includes the gain in needle cover by new growth after leaf-out in June. The Acecap treated trees had an average of about a two percent gain in needle cover.

Little is know about where spruce aphid resides during the summer hiatus and during cold periods or much about how populations recover in the spring. Using fluorescent dyes and netted branches and trees we hope to determine some site specific information about spruce aphid biology.

Winter snowfall and low winter temperature account for over half of the variability in the spruce aphid outbreak frequency.

60: Investigation of Reproductive Isolation in the Mountain Pine Beetle, *Dendroctonus ponderosae* Hopkins

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Recent laboratory experiments have discovered that crosses between mountain pine beetles (*Dendroctonus ponderosae* Hopkins) from southern California, when crossed with two geographically distant populations form Idaho and South Dakota, produce sterile male hybrids. Hybrid sterility is typically the first postzygotic reproductive barrier to develop during incipient speciation (Haldane's rule). Interestingly, previous genetic analyses have identified significant, albeit shallow, rangewide population structuring following an isolation-by-distance pattern, with no sharp boundaries of genetic differentiation. To investigate this apparent reproductive incompatibility and its relationship to genetic divergence, the southern California population will be crossed with increasingly genetically divergent populations. These crosses will answer two critical questions: 1) Is hybrid sterility a phenomenon only exhibited in crosses with this one population? and 2) Will crosses between increasingly genetically divergent populations show increased levels of reproductive isolation (i.e. increased frequency of male sterility, female sterility, or possibly inviability)? Populations will be collected along a rangewide genetic gradient from a variety of host tree species, and crossed in the laboratory using a common host tree and temperature for all brood development (e.g. common garden). PCR based assays will be conducted to test these populations for the intracellular bacteria *Wolbachia*, which is know to cause reproductive incompatibilities. Preliminary results suggest that the mountain pine beetle is not infected (26 individuals negative) but if detected, the bacterial gene will be sequenced for strain identification. This, along with information on infection distribution and frequency, will assist in determining its role in the observed incompatibilities. This research will help determine where these incompatibilities are occurring and whether it is genetically based or induced by bacterial infection.

61: Monitoring Host Selection Behavior and Progression of an Infestation by the Mountain Pine Beetle, *Dendroctonus ponderosae* Hopkins (Coleoptera: Scolytidae), in Mixed Stands of Limber Pine, *Pinus flexilis* James, and Lodgepole Pine, *Pinus contorta latifolia* Engelmann

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Although mountain pine beetle (MPB), *Dendroctonus ponderosae* Hopkins, outbreaks have been studied extensively in pure stands of lodgepole pine, *Pinus contorta latifolia* Engelmann, and ponderosa pine, *Pinus ponderosa* Laws., little is known about the behavior of MPB in limber pine, *Pinus flexilis* James, especially in mixed stands. We conducted a three-year study in southeastern Wyoming to examine the host selection behavior, activity, and impact of MPB in mixed stands of limber and lodgepole pines. Initially (May 2004), each of ten sample plots (0.13 ha) contained at least three attacked limber pines. MPB flight, host colonization, and emergence were assessed in 2004 and 2005. At the end of the 2005 flight season, the cumulative attack ratio (number of attacked to unattacked trees) for limber pine (1:1.7) was substantially higher than that for lodgepole pine (1:14.2), suggesting an overall preference for limber pine. The intermediate and larger diameter classes of limber pine were eliminated from the sample plots. However, as the outbreak progressed, the relative tree mortality of limber and lodgepole pine shifted, so that between 2004 and 2005 the incremental number of attacked lodgepole pine surpassed the incremental number of attacked limber pine. In May 2005, emergence cages were attached to each of ten trees of each host (20 trees total). MPB emergence periods were different in lodgepole as compared to limber. Sex ratios of emerging MPB were the same from both host species, but there were significantly higher emergence densities from limber pine: 1) males from limber (60.3) vs. lodgepole (25.9) pines; and, 2) females from limber (94.5) vs. lodgepole (35.5) pines. We attempted to explain apparent fidelity of MPB to limber pine in the mixed stands by a hypothetical underlying nutritional mechanism. We analyzed stable isotope ratios ($^{13}C/^{12}C$, $^{18}O/^{16}O$ and $^{15}N/^{14}N$) from beetles collected in the emergence cages attached to limber and lodgepole pines. Of the three ratios examined, the nitrogen isotope ratios of the beetles were significantly different between limber (1.495) and lodgepole (0.195) pines, which may be related to why MPB host selection behavior in these mixed stands appears to not be random. Further exploration of stable isotopes as tools for studying host associations by MPB might facilitate the development of predictive tools for natural resource managers of MPB outbreaks in mixed host stands of limber and lodgepole pines. A longer study of population behavior in this area may help determine whether MPB will colonize the remaining lodgepole pine at greater frequency in these mixed stands as the preferred limber pines are depleted.

62: Mountain Pine Beetle Outbreak Effects on Forest Structure

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Bark beetle (MPB) outbreaks are the single greatest source of insect disturbance in western North American forests, although their effects on forest structure and variability within and among outbreaks and major species have yet to be quantified. We propose an interdisciplinary study to assess the effect of these disturbances on forest structure using an intensive and extensive study design. At multiple sites within the Sawtooth National Recreation Area (SNRA) in central Idaho, we will measure stand structural characteristics for live and dead tree killed by one significant species, the mountain pine beetle (*Dendroctonus ponderosae* var. Hopkins). In addition, we will collect and analyze measurements from past studies of bark beetle epidemics across the West. Our study will apply widely-used detection methods to quantify changes to forest structure and associated biomass following outbreaks. We will use these methods to assess regional variability in severity across outbreaks and species. Land and water managers will benefit from improved knowledge of how insect disturbances affect ecosystems, as well as from improved prediction capabilities.

63: Preliminary Evaluation of the Dynamic Wound Reactions of Nitrogen Fertilized Mature Lodgepole Pine Trees

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Mature lodgepole pine trees were fertilized at rates of 200 KgN/ha and 400 Kg/ha and tested with plugs of the mountain pine beetle symbiotic fungus *Ophiostoma claverigerum* to determine the impact on the dynamic wound reaction of the fertilized trees as compared to unfertilized trees. Control plugs had a average lesion length of 18 mm compared to the 20 cm lesion on fungus plugs. A significant treatment by aspect interaction was recorded.

64: Prevention of Southern Pine Beetle (*Dendroctonus frontalis*) Outbreaks in Texas: A State/Federal Partnership Benefits Private Landowners

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The southern pine beetle (SPB), *Dendroctonus frontalis*, is the most destructive pest of pines in the southern U.S. and Central America. SPB outbreaks are cyclic, with peaks occurring every 6-10 years. Overly-dense, unmanaged stands of loblolly pine (*Pinus taeda*) are most prone to SPB attacks and are the target of prevention programs in East Texas. The Texas Forest Service (TFS) has developed a system for hazard rating large areas (18,000 acre grid blocks) for SPB susceptibility, based on the spatial distribution and abundance of dense pine stands on the landscape. Within 25 counties with grid blocks rated as moderate, high, or extreme hazard, TFS is encouraging private forest landowners to take preventive measures by offering federal cost shares for first thinnings of high hazard pine stands. Funding is provided by the USDA Forest Service,

Forest Health Protection, Region 8, as part of the South-wide SPB Prevention Project. The overall goal is to identify beetle-prone areas within East Texas and reduce their susceptibility through public awareness campaigns, forest management and cost-share incentives, prior to the next SPB outbreak. As of March 1, 2007, a total of 40,000 acres of moderate- or high-hazard pine stands in 25 counties have been approved for thinning with use of federal cost shares. Thinning has been completed on 28,000 acres.

65: Propagule Load on Insect Vectors Determines Initial and Subsequent Infection Rates of A Host Tree by An Exotic Fungal Pathogen

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Plant pathogens are known to be potentially strong modulators of plant-herbivore interactions and may make plants resistant or susceptible to subsequent fungal infection depending on both the magnitude and the spatial extent of the initial infection. We demonstrate that the variation in induced resistance in Monterey pine depends upon the propagule load of an exotic pathogen, *Fusarium circinatum,* carried by native bark beetles. *Fusarium circinatum,* the causal agent of pitch canker, was discovered on Monterey pines along central, coastal California in 1986 and is now found in 19 coastal counties in California. Infections by *F. circinatum* appear to result from the wounding activities of twig beetles (*Pityophthorus* spp.). *Pityophthorus* spp. are considered to be vectors of *F. circinatum.* Several field and laboratory studies conducted from 1986 to 2003 indicated a pathogen-induced Systemic Induced Resistance (SIR*)* in Monterey pines, although the mechanism of the induction process is not understood.

Our objective was to determine how *phoresy* (proportion of insects with propagules in a population) and propagule load (number of propagules carried by an individual) on bark beetles relate to risk of disease transmission and induced tree resistance in Monterey pines.

Phoresy rate of *F. circinatum* for the most common bark beetle species and the number of propagules carried by individual beetles were estimated for beetles attracted to synthetic baits.

Both phoresy rate and propagule load of *F. circinatum* showed variation among beetle species over time. Mean phoresy rate for *P. setosus* and *P. carmeli* was 2.3% and 3.3%, respectively. Mean propagule load for *P. setosus* and *P. carmeli* was 13 and 66, respectively.

We caged live *P. carmeli* (Pc) and *P. setosus* (Ps) on branches to demonstrate transmission of *F. circinatum* by beetles. We manipulated spore loads on beetles with different spore suspensions: 1) Ps with high spore load (HS) (390), 2) Ps with medium spore load (MS) (39), 3) Ps with low spore load (LS) (13), 4) *F. circinatum* inoculation (Fc) (positive control) (250), 5) mock inoculation (wounding only), 6) blank control (negative control), 7) Pc with HS (660), 8) Pc with MS (66), 9) Pc with LS (20). Three branches (total 20 trees/trt) were selected per tree, and one beetle was caged on each

branch. Four months later, we cut branches, isolated *F. circinatum*, measured lesion length and inoculated 3 different branches on the same trees with *F. circinatum*. After 4 months, we cut the inoculated branches, measured lesion length and compared 1st and 2nd lesion lengths for each tree for each treatment.

There were significant differences between 1st and 2nd lesion lengths within a treatment. The challenge (2nd) lesions resulting from artificial Fc inoculation were significantly shorter than the lesions (1st) induced on branches by both beetle species contaminated with the highest spore loads (390 or 660) and the artificial Fc inoculation. In contrast, the lesions produced on branches by both beetle species contaminated with the lowest spore loads (13 or 20) were significantly shorter than the challenge lesions.

In summary, we demonstrated that transmission of *F. circinatum* and lesion length on branches increased with the propagule load on beetles, propagule load on beetle vectors determined initial and subsequent infection rates of Monterey pines, and a lower threshold for SIR induction by two species of *Pityophthorus*. The upper threshold value needs to be determined. This study suggests that propagule loads on insects at the early stages of fungal infection may enhance the capability of plants to resist the subsequent infection by the same fungus in the future through Systemic Induced Resistance.

66: Refining the Aggregation Pheromone and Testing Interruption of Flight of the California Fivespined Ips, *Ips paraconfusus* (Coleoptera: Scolytidae)

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The California fivespined ips, *Ips paraconfusus* Lanier, colonizes the main stem and branches of pines, causing topkilling of large trees and mortality of small trees. It is the primary pest of Monterey pine and several Mediterranean pines in urban settings in California. Because *I. paraconfusus* has a both a broad host range and occurs in many climatic zones in California's urban and wildland forests, there is also concern that with increased intra- and international trade, *I. paraconfusus* may be transported to other parts of North America or other countries and establish there as a pest. Thus, there is new urgency to fully understand the behavioral activity of the three-component aggregation pheromone, ipsenol, ipsdienol, and *cis*-verbenol. In flight trapping bioassays at Blodgett Forest (El Dorado Co., California), treatments with (−)-ipsenol were attractive; (+)-ipsenol was neither an attractant nor an interruptant; and a treatment containing 2X racemic ipsenol captured twice as many beetles as did the commercial blend with 1X racemic ipsenol. Treatments with (−)-*cis*-verbenol were attractive and there was a higher response to one commercial formulation of 83%-(−)-*cis*-verbenol vs. another of 95%-(−)-*cis*-verbenol, likely due to a ~4-fold release rate difference between the two commercial products. Treatments with (+)-ipsdienol were attractive, whereas (−)-ipsdienol and conophthorin interrupted flight response. Because *I. paraconfusus* does not respond to (+)-ipsenol or to (+)-*cis*-verbenol, less expensive

mixed enantiomeric blends of these components can be used in efficacious baits, as long as the release rates of the blends are high. Using a higher release rate of racemic ipsenol (>2X) can substantially improve the commercial bait. More care is required with the enantiomeric blends of ipsdienol. We recommend that the commercial trap bait continue to be forumulated with (+)-ipsdienol of high enantiomeric purity; repellent products might include (–)-ipsdienol and conophthorin.

67: Role of Symbiotic Bacteria in Host Plant Utilization by Bark- and Wood- Boring Beetles: Microscale Processes Mediate Landscape-scale Patterns

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Bark beetles are endophytic herbivores that feed within the phloem of trees. These herbivores kill their host plants during colonization, and exert landscape-scale effects on forest ecosystems, including succession, nutrient cycling, fire, albedo, and carbon sequestration. Yet whether populations remain at typically low-densities, that function as canopy-thinning and gap-forming agents, or erupt to high densities, that cause near total host mortality over millions of hectares, is largely determined by microscale processes. Symbiotic associations with bacteria are among the most important, but poorly understood, of these processes. Similarly, native wood boring insects that feed within tree sapwood typically function as important agents of decomposition, food for other animals, and competitors of bark beetles. Yet many of our most damaging invasive species are within this group, owing to lack of coevolved plant resistance. Further, introduced insects should be viewed as multispecies complexes because of the complex microbial assemblages they carry.

We are investigating how symbiotic associations with bacteria contribute to the ability of bark and wood boring beetles to utilize host trees. We are considering three aspects of utilization: Facilitation of Symbionts, Protection of the Acquired Resource, and Digestion. Bark beetles have close associations with fungal symbionts, some of which confer important benefits. Foregut bacteria improve the sporulation and growth of Leptographium terebrantis. Once beetles have overcome host resistance, beetles encounter a new challenge, in that a resource previously available only to them is now accessible to many opportunistic organisms, particularly fungi. These fungi invade beetle galleries and reduce beetle fitness. Beetles counter this challenge by egesting fluids that contain several species of bacteria, which in turn are highly inhibitory to the fungi. Bacteria are present in both adults and larvae. Successful exploitation of host trees poses a further challenge for the developing larvae, in that subcortical tissue is high in cellulose, a digestion-inhibiting material. Sapwood is particularly high in cellulose. Both species of wood borers studied, but neither bark beetle species, have bacteria with cellulolytic activity.

68: Severity and Patterns of Bark Beetle Impacts to Pine Forests of Arizona

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Extensive tree mortality occurred in ponderosa pine and piñon pine forests of Arizona from 2001 – 2004. This mortality has been attributed to a combination of an extensive drought, overstocked stands of pine, and increased bark beetle populations. Primary bark beetle species associated with ponderosa pine mortality were *Ips pini* and *I. lecontei*, while in piñon woodlands the most important bark beetle was *Ips confusus*. Forest Health Monitoring Evaluation Monitoring funds were used to quantify the severity of this mortality and examine patterns in forest structure associated with bark beetle-caused tree mortality. A total of 941 fixed-radius plots were established across five National Forests in Arizona: Apache-Sitgreaves, Coconino, Kaibab, Prescott, and Tonto. Of these 633 were in ponderosa pine forests and 308 in piñon-juniper woodlands. On the Forest level, ponderosa pine basal area killed by ranged from 5 to 23 percent. Ponderosa pine mortality caused by bark beetles was positively correlated with tree density and negatively correlated with elevation (most Forests) and tree diameter (Prescott). Piñon mortality ranged from zero to 48 percent on the Forest level. Piñon mortality was positively correlated with tree density and negatively correlated with elevation on most Forests. In ponderosa pine forests most of the observed mortality was in 10-30 cm diameter classes. In the piñon-juniper woodlands, piñon mortality occurred across all diameter classes with a higher percent of trees killed in the larger diameter classes. Piñon-juniper woodlands have been converted to essentially juniper only in many stands throughout north-central Arizona.

69: Spatiotemporal Dynamics of Invasive Bark Beetles - Modeling Dispersal Strategies

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The extensive timber imports represent potential introduction pathways for exotic bark beetles (Coleoptera: Scolytidae) that may pose ecological hazards and economical risks to native forests. One such species, *Ips amitinus* Eichh., has been intercepted several times at Norwegian ports of entry since 2002. Detection of overwintering individuals of *I. amitinus* at the timber storage site and preliminary results of a stepwise import model may suggest a high risk of establishment and spread in Norway spruce forests in Scandinavia.

Using various modeling approaches, our goal is to reduce the risk of introduction, establishment and spread of introduced bark beetles. Our objectives are to: (1) model the processes of dispersal and establishment of arriving bark beetles; (2) explore to what extent an introduced species interacting with native *Ips typographus* L., the most dominant species in Norway spruce, will lead to stronger and more frequent outbreaks of *I. typographus*; (3) assess potential patterns of spread of newly established species and the spatiotemporal outbreak dynamics resulting from interactions between native

and introduced species; and (4) advise on the implications for forest industry and management.

Here we present current efforts to model dispersal (objective 1). Dispersal patterns, and hence rates of establishment and spread, may vary considerably depending on dispersal behaviors of insects, such as directionality of movement and aggregation propensity. To assess underlying assumptions of dispersal models, we use an individual-based model where traits governing dispersal are inherited with random mutations. Individual reproductive success is determined by resource availability and density-dependence in a simulated landscape governed by external forces (eg. windfellings) and beetle activity (consumption of resources). Evolvable traits include straight line vs. random-walk flight paths and (to be further explored) aggregation propensity. Model simulations show that the chance of successful reproduction is greatest for intermediate to high levels of directionality, and that directionality increases over time up to a certain point. Assuming limited (local) information in a stochastic landscape, intermediate to high degree of flight directionality is selected for.

70: Stand Mortality Due to Mountain Pine Beetle in Northeastern British Columbia and Northwestern Alberta: Outbreak Progression in a Novel Habitat.

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Mountain pine beetle has been a key component of forest ecosystems in British Columbia (BC) for hundreds of years. Currently, a massive outbreak, due to an abundance of susceptible pine and successive years of suitable climate, covers approximately 10 million hectares. Since 2002, the insect has spread over the Rocky Mountains into regions not part of its historical distribution, such as northeastern BC and northwestern Alberta. My thesis is investigating (1) spatiotemporal dynamics of mountain pine beetle at a landscape- level and (2) stand-level characteristics that contribute to the success of mountain pine beetle populations in novel environments.

71: The Use of Larval Morphology in Reassessing the Phylogenetic Relationships Within the Genus *Dendroctonus* (Coleoptera: Curculionidae: Scolytinae)

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Bark beetles of the genus *Dendroctonus* include some of the main pests of coniferous forests in North and Central America. Despite being extensively studied for their ecological and economic significance, some relevant issues of the taxonomy and biogeography of the group remain contentious, particularly those concerning the geographical origin of the genus, the evolutionary relationships among its members, and (consequently) the precise delimitation of species and species groups. In addition, taxonomy of immature stages of *Dendroctonus* -and of scolytines in general- has been largely neglected, with the remarkable exception of the works by J. B. Thomas (1957, 1960, 1965) and Furniss and Johnson (1989). Notwithstanding the few papers published on this subject, morphology of immature stages is a potentially important source of

information for solving taxonomic problems in this group, including reconstruction of its phylogeny. For this reason, the analysis of larval morphology has been considered as part of a reassessment of *Dendroctonus* phylogeny that we are currently conducting. Up to this moment, larval specimens from 12 of the 19 recognized *Dendroctonus* species have been obtained. Specimens from these species were dissected and mounted on microscopic slides for morphological study, following the protocol described by Thomas (1957). Additionally, a subset of these specimens was postfixated in osmium tetroxide (after rehydration from 70% ethanol), dehydrated to absolute ethanol, critical-point dried, mounted on aluminum stubs and gold-coated for examination with SEM (at 15 kV) for further refinement of initial observations and illustration of informative features. Preliminary examination of available immature specimens has shown that larval morphology seems to be a useful source of data for taxonomic purposes, allowing us to recognize some larval features that display constant interspecific variation and apparently are phylogenetically informative. By instance, the cephalic region (i.e., the head capsule plus mouthparts) exhibits a number of attributes that persistently vary among species or groups of species, and interestingly various of them are related to sculpture of surface in different structures or regions on head (in a way analogous to that observed in adults of this group of beetles). Another interesting pattern suggested by larval morphology, as previously noticed by Thomas (1965), is the separation of species within the genus in two groups, that putatively correspond to distinct evolutionary lineages. Characters supporting this distinction are the presence (or absence) of tubercles surrounding spiracles, the structure of spiracles by themselves, the structure of dorsopleural lobes, and the presence (or absence) of sclerotized plates on terguites 8 and 9. Somewhat surprisingly, chaetotaxy in *Dendroctonus* larvae seems to be pretty conserved along the whole genus, but a more detailed evaluation of this aspect is currently in progress. Actually, much of the work is still to be done respecting larval morphology in *Dendroctonus* in order to recognize additional, previously unreported characters that could be useful for phylogenetic (and, more comprehensively, taxonomic) purposes.

72: Use of Remotely Sensed Data to Model Spatial Extent and Spread of Mountain Pine Beetle Infestations

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Remotely sensed data has potential to be incorporated into spread modelling to predict the spatial extent of mountain pine beetle, *Dendroctonus ponderosae* (Hopk.) infestations and guide mitigation to suppress incipient-epidemic populations before they expand to epidemic proportions. In this study, a dataset of 1300 pine trees, delineated on a 10 cm spatial resolution digital aerial photograph, were used to model mountain pine beetle attack. To predict the spatial pattern of beetle attack, a model defined by Mitchell and Preisler (1993) was used to predict the likelihood of a beetle intercepting a recipient pine tree when flying from a previously attacked tree. Outputs consisted of probabilities between 0 and 1, where 1 indicates higher likelihood of interception by a beetle.

Three scenarios were used: Baseline: Expansion of infestation without mitigation; Detection 35%: Expansion of infestation with mitigation, using a detection accuracy of 35%; and, Detection 70%: Expansion of infestation with mitigation, using a detection

accuracy of 70%. The scenarios were run for 8 years, and demonstrated that a 70% detection accuracy will significantly reduce MPB infestations assuming mitigation is 100% effective and that attack status progresses on an annual time-step. This study confirms that high-spatial resolution remotely sensed data allows a full census survey of the forest and enables definition of spatial and stand characteristics in a forest stand. Finally, this data has potential to be incorporated into persistent multi-year mitigation programs required to suppress beetle populations.

73: The Use of Verbenone to Protect Whitebark Pine from Mountain Pine Beetle Attack

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Whitebark pine (*Pinus albicaulis* Engelm.) is currently declining in many areas due to a variety of factors including white pine blister rust, fire suppression, forest successional processes, and periodic outbreaks of mountain pine beetle (*Dendroctonus ponderosae* Hopkins).

In 2005 in northern Idaho and western Montana, mountain pine beetle killed nearly 630,000 mature whitebark pine trees on about 142,000 acres. Almost 200,000 additional whitebark pines were killed on approximately 120,000 acres in 2006. Many of these stands have also been impacted by white pine blister rust. Seed is collected from phenotypically blister rust-resistant "plus" trees, now under threat of mountain pine beetle attack. Silvicultural methods used in other hosts to reduce beetle-caused mortality may not be applicable in less-dense whitebark pine stands. Individual, high-value trees can be protected from beetle attack with topical treatments of insecticides applied to tree boles with high-pressure spray equipment. However, spraying is not practical in inaccessible stands or over large areas. Using mountain pine beetle pheromones to protect high-value trees from attack has been shown to be a viable management option.

We tested the efficacy of verbenone, an anti-aggregation pheromone for mountain pine beetle, in protecting individual whitebark pine trees from beetle attack in 2002, 2003, 2004 and 2006. EPA-registered 5-gram verbenone pouches, replaced at mid-season, were tested along with new thicker-membrane (longer-lasting) pouches, larger (7.5-gram) pouches, and untreated controls. Individual whitebark pine trees baited with an attractant pheromone, placed either on the tree or nearby, were protected from mass attack by mountain pine beetles. Treating individual whitebark pine trees with two registered or two experimental pouches significantly reduced mountain pine beetle attacks compared to untreated controls. These tests provide strong evidence that individual pine trees can be protected from mountain pine beetle attack using verbenone. Verbenone pouches are registered and commercially available for operational use. Used as recommended, they have successfully protected whitebark pine plus trees from mountain pine beetle attack, even in areas of high beetle populations.

74: The Western Bark Beetle Research Group, U.S.D.A. Forest Service Research & Development

Barbara Bentz, Chris Fettig, Nancy Gillette, Matt Hansen, Jane Hayes, Rick Kelsey, John Lundquist, Ann Lynch, Jose Negron, Chris Niwa, Rob Progar, and Steve Seybold

Formation of the Western Bark Beetle Research Group

The last decade has seen elevated levels of bark beetle-caused tree mortality in, among others, spruce forests of south-central Alaska and the Rocky Mountains, lodgepole pine forests throughout its native range, pinyon-juniper woodlands of the southwestern U. S., and ponderosa pine forests of Arizona, California and South Dakota. Given the high regional significance of these impacts on all values derived from forest ecosystems, the executive leadership of the three western U.S.D.A. Forest Service research stations (Pacific Northwest, Pacific Southwest, and Rocky Mountain) proposed a west-wide initiative to strengthen cooperative working relationships among researchers and their many partners. To meet this mandate, the Forest Service R&D Western Bark Beetle Research Group was created in January 2007 during a meeting in Stevenson, Washington. WBBRG is composed of scientists from the three stations with expertise in bark beetle research, development and application in the West.

Mission and Objectives

The mission of the Western Bark Beetle Research Group (WBBRG) is to serve as an ad hoc umbrella organization aimed at fostering communication, and enriching scientific interactions among Forest Service bark beetle researchers in the western U.S.. WBBRG aims to enhance responsiveness, delivery, and impact of bark beetle research. WBBRG emphasizes basic and application-motivated research that will enhance our scientific understanding and ultimately solve problems faced by our diverse stakeholders. We work closely with our cooperators, especially Forest Health Protection, to accomplish our objectives:

- Work with partners and stakeholders to identify western bark beetle research priorities
- Cooperatively pursue priority research, and deliver products
- Promote relevance of western bark beetle research for partners and stakeholders
- Increase overall quality, productivity, and timeliness of research through cooperation and integration among Stations
- Enhance communication and service to partners and stakeholders

75: Western Pine Beetle, *Dendroctonus brevicomis*, Responses to Nonhost Volatiles and Verbenone: from Antennal Responses to Semi-operational Trials

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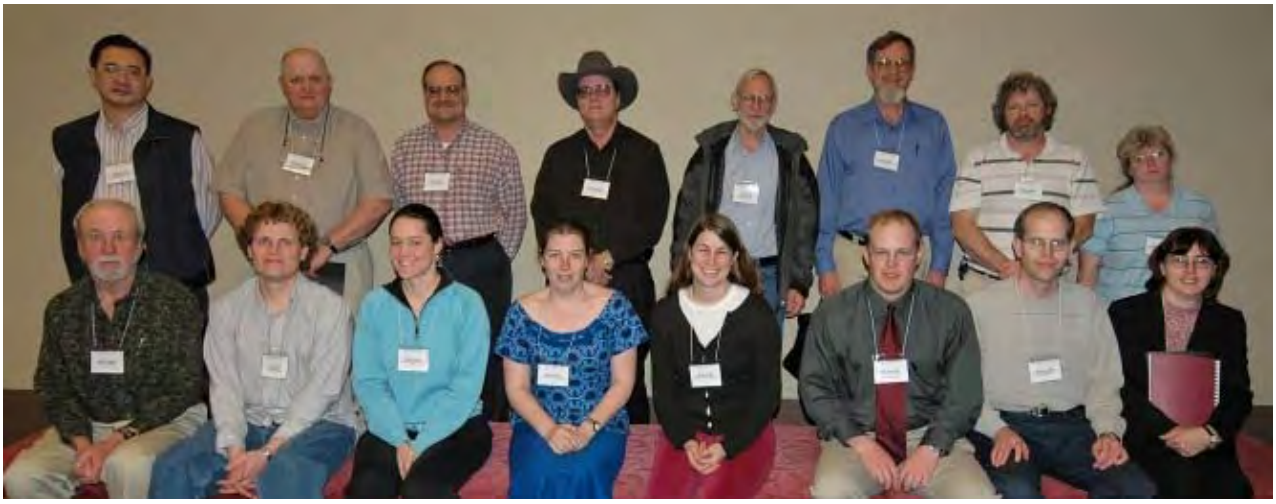
Stem volatile extracts from ten trees that are sympatric with the western pine beetle (WPB), *Dendroctonus brevicomis* LeConte (Coleoptera: Curculionidae: Scolytinae) were

assayed by gas chromatographic-electroantennographic detection analysis (GC-EAD) for antennal responses in that insect. The extracts were from the primary host, ponderosa pine, *Pinus ponderosa* Dougl. ex. Laws. (Pinaceae); two nonhost angiosperms, California black oak, *Quercus kelloggii* Newb. (Fagaceae), and quaking aspen, *Populus tremuloides* Michx. (Salicaceae); and seven nonhost conifers, white fir, *Abies concolor* (Gord. & Glend.) Lindl. ex Hildebr. (Pinaceae), incense cedar, *Calocedrus decurrens* (Torr.) Florin (Cupressaceae), Sierra lodgepole pine, *P. contorta murrayana* Grev. & Balf. (Pinaceae), Jeffrey pine, *P. jeffreyi* Grev. & Balf. (Pinaceae), sugar pine, *P. lambertiana* Dougl. (Pinaceae), Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco (Pinaceae), and mountain hemlock, *Tsuga mertensiana* (Bong.) Carr. (Pinaceae). Forty-two volatile compounds, in total, elicited antennal responses in *D. brevicomis*. Geraniol was that only antennally-active compound that was unique to ponderosa pine, the primary host of WPB. The number of nonhost volatile chemicals that WPB encounters and is capable of detecting, and the diversity of sources from which they emanate, highlight the complexity of the olfactory environment in which this insect forages.

Nonhost angiosperm volatiles and verbenone were tested for their ability to protect individual ponderosa pines from attack by WPB, and red turpentine beetle, *D. valens* LeConte (Coleoptera: Curculionidae, Scolytinae). A combination of (−)-verbenone and eight nonhost angiosperm volatiles [benzyl alcohol, benzaldehyde, guaiacol, nonanal, salicylaldehyde, (*E*)-2-hexenal, (*E*)-2-hexen-1-ol, and (*Z*)-2-hexen-1-ol] (NAVV) significantly reduced the overall density of WPB attacks and also reduced the density of successful attacks on attractant-baited trees. A significantly higher percentage of pitchouts (unsuccessful attacks) occurred on NAVV-treated trees during the final two of the three sample periods. The application of NAVV to individual ponderosa pines significantly reduced tree mortality, with only four of 30 attractant-baited trees dying from bark beetle attack, while 50% mortality (15/30) was observed in the untreated control. In addition, significantly fewer RTB attacks were observed on NAVV-treated trees at all assessment dates.



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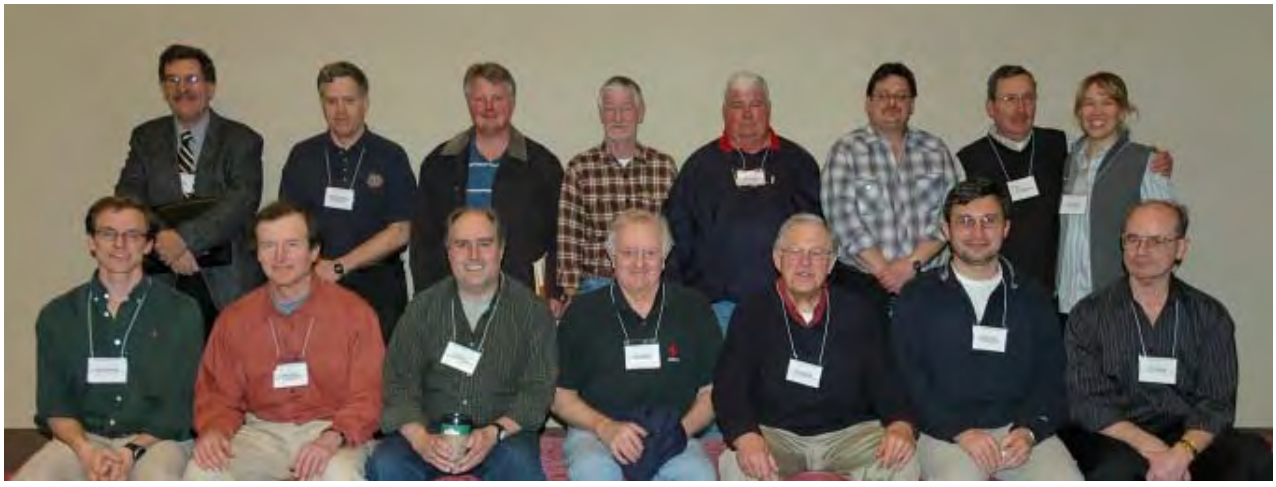

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