

61st Western Forest Insect Work Conference

Living On The Edge



April 5-8, 2010
Flagstaff, Arizona

Conference Proceedings

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WESTERN FOREST INSECT WORK CONFERENCE

2010 Executive Committee

Katharine Sheehan, Chair
Darci Carlson, Secretary
Karen Ripley, Treasurer
Sheryl Costello, Councilor
Bill Riel, Councilor
Jennifer Burleigh, Councilor



Organizational Standing Committees

Barbara Bentz, Founders Award Committee Chair
Darrell Ross, Memorial Scholarship Committee Chair
Boyd Wickman, Malcolm Furniss, & Sandy Kegley, History Committee Co-Chairs
Brytten Steed and Bill Ciesla, Common Names Committee Co-Chairs
Monica Gaylord, Memorial Scholarship Fundraising Committee Chair

2010 Conference: Living on the Edge Flagstaff Arizona April 5-8, 2010

Planning Committee Chair: Joel McMillin
Program Coordinators: Joel McMillin and Richard Hofstetter
Local Arrangements: John Anhold and Mike Wagner
Registration Coordinator and Souvenirs: Ryan Hanavan
Field Trip: John Anhold and Tom DeGomez
Silent Auction: Monica Gaylord
Technical Equipment Assistance: Ryan Hanavan and Daniel Ryerson
Poster Session: Seth Davis and Kasey Yturalde
Banquet: Tom DeGomez
Photographs: Bill Ciesla and Ron Billings
Student Presentations: Monica Gaylord
Local Transportation: Mike Wagner
Proceedings: Richard Hofstetter
WFIWC website: Katharine Sheehan



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Conference Schedule

Monday – April 5, 2010

- 15:00-19:00 **Registration**
- 16:00-17:30 **Executive Committee meeting**
- 19:00-21:00 **Opening Mixer**



Tuesday – April 6, 2010

- 07:00-16:45 **Registration**
- 08:00-08:45 **Initial Business Meeting** (Katharine Sheehan, WFIWC Chair)
- 08:45-09:00 **Welcome to Flagstaff** (Joel McMillin)
- 09:00-09:30 **Keynote Address** (Vicki Christiansen, AZ State Forester)
- 09:30-10:00 **Morning Break and group photos**
- 10:00-11:30 **Plenary Session: Living on the Edge in the Southwest** (Moderator Tom Kolb)
- 11:30-12:00 **Memorial Scholarship Presentation** (David Jack; Introduction by Darrell Ross)
- 12:00-13:30 **Lunch**
- 13:30-15:00 **Graduate Student Presentations**
 - Group A (Moderator Monica Gaylord)
 - Group B (Moderator Darrell Ross)
 - Group C (Moderator Richard Hofstetter)
- 15:00-15:30 **Afternoon Break and group photos**
- 15:30-17:00 **Breakout Session I**
 - Ecosystem community genetics (Moderator Tom Whitham)
 - GIS/Remote sensing applications for forest health (Moderator Ryan Hanavan)
 - Monitoring and assessment of mountain pine beetle assessment on Rocky Mountain forests (Moderator Jesse Logan)
 - Invasive species (Moderator Kristen Waring)
- 17:00-18:00 **Fun Run** (Organizers John Anhold and Richard Hofstetter)
- 18:00-21:00 **Banquet and Founders Award** (Moderator Tom DeGomez)
Entertainment included classical music performed by Northland Prep Academy violin trio and Traditional Native American Dances Puente De Hozho Elementary students



Wednesday – April 7, 2010

- 06:30-09:00 **Breakfast at Hotel**
- 07:30-17:00 **Riparian Forest Health Field Trip**
- 19:00-21:00 **Poster Session**
- 19:00-21:00 **Silent Auction and Ice cream social**



Thursday – April 8, 2010

- 07:00-12:00 **Registration**
- 08:00-09:30 **Breakout Session II**
 - Tree mortality processes (Moderators Monica Gaylord, Jeff Kane, and Tom Kolb)
 - International research and collaborations (Moderator Nadir Erbilgin)
 - Climate change and insect dynamics (Moderator Tom DeGomez)
 - Bark beetle prevention and effectiveness of thinning (Moderator Cynthia Snyder)
- 09:30-10:00 **Morning Break**
- 10:00-11:30 **Plenary Session: Living on the Edge of Economic Change** (Moderator Mike Wagner)
- 11:30-13:00 **Lunch** (provided)
- 13:00-14:00 **Final Business Meeting** (Kathy Sheehan, WFIWC Chair)
- 14:00-15:30 **Breakout Session III**
 - Digital and micro photography (Moderator Bill Ciesla)
 - Regional Insect Conditions Reports (Moderator Amanda Garcia-Grady)
 - Epidemic/Endemic populations (Moderators Deepa Pureswaran)
 - Bark beetles, fuels & fire – A synthesis of our present understanding and implications for management (Moderator Michael Jenkins)
- 15:30-15:45 **Afternoon Break**
- 15:45-17:00 **Breakout Session IV**
 - Data sources for forest impacts (Moderator Eric Smith)
 - Research updates on bark and wood boring beetles (Moderators Dan Miller and Brytten Steed)
 - Research and management updates on defoliators (Moderator Beth Willhite)
- 17:00-18:00 **Disc Golf Tournament** (organizer Joel McMillin)
- 18:00 **WFIWC Adjourns!**



MINUTES OF THE EXECUTIVE COMMITTEE MEETING

April 5, 2010 – 4:00 to 5:30 pm

Flagstaff, AZ

Attendees:

Kathy Sheehan (Chair)
Darci Carlson (Secretary)
Karen Ripley (Treasurer)
Bill Riel (Councilor)
Sheryl Costello (Councilor)
Dan Miller (representing Councilor
Jennifer Burleigh)
Joel McMillin (Program, Founders Award)
John Anhold (Local Arrangements)
Sandy Kegley (History Committee Co-Chair)
Darrell Ross (Memorial Scholarship Committee Chair),
Brytten Steed (Common Names Committee Co-Chair),
Joel Egan (WFIWC member)



Joel Egan - Proposal for new Ad-hoc Technology Committee

Joel presented a proposal to create a temporary committee to explore options for using new technology at WFIWC meetings to record/preserve some or all presentations. Examples include digital video recordings. Face to face communication is the best way for presentations, but budget and time constraints sometimes limit members' attendance at meetings. The California Forest Pest Council has produced some video files from their meetings – digital media is a great way to get the word out. Presentations are only recorded with the consent of the presenter. Should we start with formal presentations such as those given by Founders Award and Memorial Scholarship recipients?

Concerns –Darrell Ross: video gets away from the desired informal format – it becomes less personal. How would people use it? People may not speak as freely on video. How would we guard against misuse of the information that is presented? On the other hand, the Founders Award presentations would be valuable to preserve for prosperity. Dan Miller: The context is gone – the public doesn't speak "entomologist"; also, this option could result in fewer people coming to conferences. Other concerns (from various attendees): Results of draft data may change – or may be misquoted – so people may be reluctant to speak freely. Who would be responsible for the recordings?

Decision: The Executive Committee agreed that this proposal to create a temporary committee to explore the pros and cons of various new technology options should be presented to the WFIWC membership for their consideration.

2009 Final Business Meeting minutes – Highlights were read by Secretary Darci Carlson.

Joel McMillin & John Anhold reported on WFIWC Meeting 2010 – About 130 attendees have pre-registered - roughly 140 with guests included. Joel McMillin discussed 2010 WFIWC Budget (see handout)

Expenses = \$ 35,323.19

Income = \$43,884.00 (Profit of \$8,560.81)

This year, major problems were encountered with registration payments from US Forest Service members. John Anhold suggested contracting with an organization or business to provide an option for paying with credit cards. Potential options include the Western Forestry & Conservation Association or a Montana company through a contract facilitated by Amy Gannon (see handouts for details on cost estimates for various options). Since the next regular meeting will be in Canada, John Anhold will check on whether these credit card options would be affected for meetings in Canada.



Future Meetings – Lorraine Maclauchlan and colleagues have offered to host the 2012 WFIWC in Kelowna, BC. This option will be presented at the Initial Business Meeting and voted upon at the Final Business Meeting.

Memorials – Members and colleagues who have passed away during the previous year include Gary Daterman, Terry Shore, and Stephen Wood. In addition to presenting brief obituaries during the Initial Business Meeting, more personal recognition will be given for Terry Shore (by Bill Riel) and Gary Daterman (by Darrell Ross) during the Silent Auction to reach more members.

Recent Retirements- Jerry Beatty (R6), Bobbe Fitzgibbon (R3), Ken Gibson (R1), Terry Rodgers (R3), Denny Ward (R8), and Larry Yarger (WO).

2009 Proceedings --Kathy Sheehan announced that Proceedings from 2009 are almost completed, and should be posted in a week or two.

Treasurer's Report

Karen Ripley submitted a written report that describes current account balances, recent revenue, and financial activities. This report will be read at the first business meeting and Karen is available to discuss any item. The Councilors must schedule time to review the annual bookkeeping ledgers.

Treasurer Karen Ripley reminded us that scholarship donations of at least \$50 in the name of an honored (departed) person, add the name of the honored person to the Memorial Scholarship Fundraising Plaque, while donations over \$1,500 add the option of being recognized in the "significant donors" section of the plaque.

The WFIWC has accumulated substantial savings of approximately \$75,000 during the past several years. These funds are invested in CDs with proceeds going to the Memorial Scholarship fund. The Executive Committee generally agreed that the financial goal for each WFIWC meeting should be to break even. Because meeting organizers want to be sure that meeting income covers expenses, they tend to be very conservative – resulting in net income for most meetings. The Executive Committee agreed to inform meeting organizers that general WFIWC funds would be available to cover meeting deficits, and to encourage those organizers to be less conservative about breaking even. For example, registration fees might be lowered, especially for retirees and students. Also, meeting organizers may contact the Treasurer if an advance deposit is needed to reserve a meeting location.

New bank regulations have led to our current bank (Bank of America) requiring that our Treasurer be specifically authorized by the Executive Committee to perform common banking activities such as reinvesting CDs when they mature. This requirement is a problem because our Executive Committee generally meets annually. A motion to delegate to the Chair and Secretary the authority to approve common banking activities was made by Sheryl Costello, seconded by Joel McMillin, and approved unanimously.

Common Names Committee Report – Co-Chair Brytten Steed announced that five common names previously approved by WFIWC members had been approved by ESA (Entomological Society of America) for review by ESA membership. Acceptance of these 5 names is expected. These names will be listed on Common Names webpages of the WFIWC website when finalized. Brytten will send the Secretary an electronic copy of this report.



Founders Award Committee Report Joel McMillin announced that the 2010 recipients will be Skeeter Werner and Ed Holsten.

History Committee Report

Co-Chair Sandy Kegley reported that Mal Furniss wrote a biography of Andrew Hopkins for the Heritage feature of American Entomologist. Currently Mal is working on gathering material on John Aldrich (renowned Dipterist).

Manuscript on “Beginnings of forest entomology in Alaska” has not found an outlet.

The WFIWC archives at the University of Idaho collection are in limbo because the curator, Nathan Bender, has left. Boyd Wickman is adding an office to his residence and is working on his recollections of his career in CA from 1948-1970.

Sandy Kegley moderated a History Workshop at the 2009 WFIWC in Spokane.

Karen Ripley collected documents and pictures about European pine shoot moth for Mal Furniss and is holding these documents and pictures for Mal.

Memorial Scholarship Committee Report

Chair Darrell Ross reported that despite the extended deadline, only three applications were received this year. One application was not considered because the student had not previously attended a WFIWC meeting and did not plan to attend a future meeting, and thus is not a WFIWC member. Two other applications were evaluated (1 Ph.D. student, 1 M.S. student). Daniel Ott, an M.S. student from UNBC was selected as the 2010 recipient.



Memorial Scholarship Fundraising Committee Report

Joel McMillin spoke on behalf of Monica Gaylord, who has organized this year's Silent Auction fundraiser. She is still collecting donations to the Silent Auction.

Additional New Business –

Ad Hoc Nominating Committees are needed to replace the Chair and Councilor Bill Riel, whose terms are ending. These committees will be chaired by those officers, who will recruit committee members as needed. Kathy noted that we should strive to have the Executive Committee and Committee Chairs be representative of the agencies and geographic regions that make up this work conference.

In recent years, members have been voting on whether to approve the Executive Committee Meeting minutes (even though most members do not attend that meeting) and on the Final Business Meeting minutes from the previous meeting (even though those minutes often have already been published as part of that year's proceedings). The Executive Committee agreed that generally the minutes of the Initial Business Meeting would be read and voted upon at the Final Business Meeting, and minutes from the Executive Committee and Final Business meetings would be included in the proceedings but not voted upon at a WFIWC meeting.

Joel McMillin motioned to adjourn the meeting; this motion was seconded by Sheryl Costello and approved unanimously.

Minutes recorded by Darci Carlson, Secretary

MINUTES OF THE INITIAL BUSINESS MEETING

April 6, 2010 – 08:00 to 08:45 pm

WFIWC Chair Kathy Sheehan brought meeting to order at 8:00 AM

Old Business

Recognition of WFIWC members and friends who have passed on- A moment of silence was observed for Stephen L. Wood, Gary Daterman, & Terry Shore. Members are invited to share memories at the Ice Cream Social on Wednesday night. We also have sympathy cards that members can sign at the Ice Cream Social.

Recent Retirements

Jerry Beatty, Bobbe Fitzgibbon, Ken Gibson, Terry Rogers, Denny Ward, and Larry Yarger have retired this year.

Our colleague Alan Berryman is in poor health, and would appreciate encouraging words. A card for Alan is also available for members to sign.



Future WFIWC Meetings

2011: Darrell Ross announced that the North American Forest Insect Work Conference will be held in Portland, OR, on May 9-12, 2011, at the Marriott in downtown Portland. Volunteers to help with the meeting are needed – Please contact Dan Herms.

Lorraine Maclauchlan offered to host the 2012 WFIWC in Kelowna, BC. This offer will be voted upon at this year's Final Business Meeting.

2009 WFIWC Proceedings

Kathy Sheehan announced that these proceedings are almost complete, and will be posted on the website soon.

Treasurer's Report

Treasurer Karen Ripley reported that the 2009 WFIWC returned a \$9,000 profit with only the proceedings costs yet to be paid.

Lower registration fees for students and retirees were suggested for future meetings. The WFIWC general fund can be used to cover advance meeting costs (such as hotel deposits) until the meeting registration fees are received.

Several CD investments have matured and several more will mature soon.

As of Feb. 28, the checking account balance had \$5,014.98 and the savings account had \$7,442.45.

Mal Furniss sold an image for a textbook, and donated the fee he charged to the scholarship fund.



Karen prepared and filed the 2008 tax return for WFIWC and is eagerly awaiting the preparation of the 2009. (See attached report.)

Common Names Committee Report

Co-Chair Brytten Steed announced that five common names previously approved by WFIWC members had been approved by ESA (Entomological Society of America) for review by ESA membership. Acceptance of these 5 names is expected (see attached report).

One more member is needed to fill all 7 slots on the Common Names Committee. Current protocols are working well and the Committee encourages submission of proposals corresponding to revision of Western Forest Insects and for forest insects new to the West

Founders Award Committee Report

Chair Barbara Bentz announced that this year for the first time a team was selected to receive the award. The 2010 recipients are Skeeter Werner and Ed Holsten. The Committee will work with these recipients and the NAFIWC program committee to determine whether the Founders Address will be given in 2011 (at NAFIWC) or 2012 (the next regular WFIWC).

The committee asked Steve Seybold to be on the committee; however, one more member is needed.

History Committee Report

Co-Chair Sandy Kegley presented the attached report. Mal Furniss has written a biography of Andrew Hopkins for the Heritage Feature of American Entomologist that is to appear in the Spring or Summer Issue.

The manuscript on 'Beginnings of Forest Entomology in Alaska' has still not found an outlet. It tells of a spruce beetle outbreak on Kosciusko Island in 1946 that was investigated by Robert L. Furniss and led to the stationing of Bill McCambridge in Juneau in 1952.

Currently Mal is gathering material on John Aldrich, the renowned 'Dipterist', who was among the first faculty hired by University of Idaho after its creation in 1892.

Aided by Webmaster Kathy Sheehan, Mal posted more historical photos accompanied on the WFIWC website.

Professor Nathan Bender, head of special collections and archives at the University of Idaho, has left that position. A replacement is being sought.

Boyd Wickman is adding an office to his residence and plans to resume work on his recollections of his career in California from 1948 – 1970.

Sandy Kegley moderated a history workshop at the 2009 WFIWC in Spokane looking at the value of historic reports in keeping current insect outbreaks in perspective.

Memorial Scholarship Committee Report

Chair Darrell Ross reported that two applications were reviewed, and the recipient for this year's scholarship is Daniel Ott, a M.S. student at UNBC. Recipients receive a stipend (\$750 in recent

years), free registration, lodging for one night, and the opportunity to address the work conference at a plenary session – so please encourage students to apply.

Memorial Scholarship Fundraising Committee

WFIWC Chair Kathy Sheehan reported that Monica Gaylord has stepped in as the Acting Committee Chair, and has organized the Silent Auction for this year's meeting. Kimberly Wallin has stepped down due to teaching commitments that usually conflict with our meetings; please speak to Kathy Sheehan if you are interested in this position.

New Business:

Bill Riel's term as Councilor and Kathy Sheehan's term as Chair will end at the conclusion of this meeting. These officers are serving as Chairs of the Ad-hoc Nominating Committees seeking candidates for these positions – please contact them if you are interested in serving the WFIWC. It is a great experience, and a good way to meet new colleagues.

Joel Egan suggested an Ad-hoc Technology Committee to explore possible applications of new technology at our WFIWC meetings. For example, with the presenters' consent, digital recordings of parts of the program – such as the Founders Award or plenary sessions could be made for the WFIWC archives and/or the WFIWC website. A brief discussion addressed which portion (if any) of the program should be digitized, and the relative costs of the proceedings. If approved, this committee would explore the pros and cons of using digital recordings and other technology for various portions of WFIWC meetings. A vote on whether to create an Ad-hoc Technology Committee will be held during the Final Business Meeting.

This year, the organizing committee discovered that many US Forest Service employees are no longer able to pay registration fees by check and the organizing committee did not have a method of accepting credit card payments. John Anhold has looked into several options for accepting credit card payments for future meetings. A small additional fee may be applied to registrations paid with credit cards.

The Executive Committee has decided not to read the minutes from its meeting at the Initial Business Meeting because all subjects are covered during the Initial Business Meeting. The minutes from the Executive Committee Meeting, Initial Business Meeting, and Final Business Meeting will all be included in the proceedings.

At about 8:45 am, Bill Riel moved to adjourn the meeting; this motion was seconded by Bobbe Fitzgibbon, and approved unanimously.

TREASURER'S REPORT Submitted by Karen Ripley, April 2010

Highlights of 2009:



- Total interest income from CD's and savings account \$2427.42
- Awarded \$750 Memorial Scholarship to David Jack
- Received final fund balance from 2008 Boulder meeting (\$311.85)
- 2009 Spokane meeting has a net balance of \$9260.28. The remaining expense will be proceedings production and distribution.
- New contributions to scholarship funds

At Spokane registration	165.00
Spokane Auction proceeds:	940.00
Donation for Nancy Hale "From the Bugs"	9.70
Misc. Donations	5.00
<u>Photo, Drive & Buckle sales</u>	<u>210.00</u>
Total	\$1,329.70
- Filed 2008 tax return in 2009. As part of our 501 (c) (3) status, anyone who wants to see the tax return may do so. No requests yet.

Assets of WFIWC as of February 28, 2010:

Checking Account	\$5014.98	(February 28, 2010 Statement)
Savings Account	\$7442.45	(February 28, 2010 Statement)

CD22298260 Mark McGregor Memorial
 \$6728.71 earning 2.08% interest. 2.10% Annual percentage yield.
 Issued 4/03/09. Matures 4/3/10 at \$6870.12 (\$141.41)

CD22351219 Memorial Scholarship
 \$68,976.91 earning 1.44% interest. 1.45% Annual percentage yield.
 Issued November 14, 2009. Matures May 24, 2011. (approx. + \$1500)

Issues in 2009:

- Ripley will prepare and file the 2009 tax return by May 15, 2010. She'll attend a one-day IRS workshop for small and mid-sized tax exempt organizations May 11, 2010.
- Surplus funds from prior meetings: Spokane (2009): \$9,000; Boulder (2008): \$8,813; Boise (2007): \$12,400; Ashville (2006): zero; Victoria (2005): \$20,000; San Diego (2004): zero; Guadalajara (2003): \$600.
- Expenses associated with Scholarship Awards: Scholarship \$750, award plaques and engraving \$80, one night hotel (expense of subsequent conference).
- Expenses of Founder's Award: \$300 plaque and 1 night's hotel.
- Expenses of Scholarship Fundraising: Contech

COMMON NAMES COMMITTEE REPORT FOR CY 2010
March 2009 through March 2010

As of March 2010, the Common Names Committee (CNC) included six members of seven possible: Bobbe Fitzgibbon, Lee Humble, Iral Ragenovich, Lee Pederson, and co-Chairpersons

Brytten Steed and Bill Ciesla. Beverly Bulaon has offered to participate as the committee's 7th member.

This year the Committee continued to encourage and coordinate the submission of common names for insects discussed in Furniss and Carolin's "Western Forest Insects" that do not have ESA approved common names. We also support common names for new exotic forest insects in the West. The established review and comment process, using links available on the WFIWC official website, continues to work well.

During the period March 2009-2010, five common names submitted previously to ESA were sent to ESA's membership for comment. Although final confirmation has not been received from ESA we expect the following proposals will be approved:

Agrilus coxalis - goldspotted oak borer

Dasychira grisefacta (Dyar) – western pine tussock moth

Ips hunteri - blue spruce engraver

Ips pertubatus - northern spruce engraver

Lophocampa ingens - southwestern pine tiger moth

Members interested in submitting proposals for common names should use the form available on WFIWC Common Names website, seek peer review and comments, and submit their proposal to either Brytten Steed or Bill Ciesla.

Respectfully submitted,

/s/ *Brytten E. Steed* and /s/ *William M. Ciesla*, co-Chairs

For WFIWC – Common Names Committee

HISTORY COMMITTEE REPORT, 2009-2010

MEMORIAL SCHOLARSHIP COMMITTEE REPORT, 2009-2010

MINUTES OF THE FINAL BUSINESS MEETING

April 8, 2010

WFIWC Chair Kathy Sheehan brought meeting to order at 1:00 PM.

Initial Business Meeting notes were read by Secretary Darci Carlson.

Old Business

Recognition of WFIWC members and friends who have passed on- A moment of silence was observed for Stephen L. Wood, Gary Daterman, & Terry Shore. Members were invited to share memories at the Ice Cream Social on Wednesday night. We also have sympathy cards that members can sign.

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Treasurer's Report

As of Feb. 28, the checking account balance had \$5,014.98 and the savings account had \$7,442.45.

CD investments totaling approximately \$75,000 are earning low interest. As they mature, the funds are re-invested in CD's. This produces enough income to support the annual scholarship award.

Treasurer Karen Ripley reported that the 2009 WFIWC returned a \$9,000 profit with only the proceeding costs yet to be paid. Lower registration fees for students and retirees were suggested for future meetings. The WFIWC general fund can be used to cover advance meeting costs (such as hotel deposits) until the meeting registration fees are received.

Mal Furniss sold an image for a textbook, and donated the profits to the scholarship fund.

Karen prepared and filed the 2008 tax return for WFIWC and is eagerly awaiting the preparation of the 2009. (See attached report.)

In addition to the scholarship fund donations made with registration and the silent auction, Karen was given \$100 in Gary Daterman's name, \$50 in Terry Shore's name, and \$30 of miscellaneous contributions during this meeting.

Common Names Committee Report

Co-Chair Brytten Steed announced that five common names previously approved by WFIWC members in 2009, had been approved by ESA (Entomological Society of America) for review by ESA membership. Acceptance of these 5 names is expected (see attached report).

Current protocols are working well and the Committee encourages submission of proposals corresponding to revision of Western Forest Insects and for forest insects new to the West.

Beverly Bulaon stepped into the open Common Names Committee member slot.

The Committee encourages submission of proposals corresponding to revision of Western Forest Insects and for forest insects new to the West.

Founders Award Committee Report

Chair Barbara Bentz announced that this year for the first time a team was selected to receive the award. The 2010 recipients are Skeeter Werner and Ed Holsten. The Committee will work with these recipients and the NAFIWC program committee to determine whether the Founders Address will be given in 2011 (at NAFIWC) or 2012 (the next regular WFIWC).

The committee asked Steve Seybold to be on the committee; however, one more member is needed. (See attached report.)

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Currently Mal is gathering material on John Aldrich, the renowned ‘Dipterist’, who was among the first faculty hired by University of Idaho after its creation in 1892.

Aided by Webmaster Kathy Sheehan, Mal posted more historical photos accompanied on the WFIWC website.

Professor Nathan Bender, head of special collections and archives at the University of Idaho, has left that position. A replacement is being sought.

Boyd Wickman is adding an office to his residence and plans to resume work on his recollections of his career in California from 1948 – 1970.

Sandy Kegley moderated a history workshop at the 2009 WFIWC in Spokane looking at the value of historic reports in keeping current insect outbreaks in perspective.



Memorial Scholarship Committee Report

Chair Darrell Ross reported that two applications were reviewed, and the recipient for this year’s scholarship is Daniel Ott, a M.S. student at UNBC. Recipients receive a stipend (\$750 in recent years), free registration, lodging for one night, and the opportunity to address the work

conference at a plenary session, – so please encourage students to apply, the deadline for applications is February 15, 2011.

Ward Strong joined the committee this year as a replacement for Terry Shore.

Memorial Scholarship Fundraising Committee

WFIWC Chair Kathy Sheehan reported that Monica Gaylord has stepped in as the Acting Committee Chair, and has organized the Silent Auction for this year's meeting. Kimberly Wallin has stepped down due to teaching commitments that usually conflict with our meetings; please speak to Kathy Sheehan if you are interested in this position. No report was filed for 2010.

New Business:

After the reading of the Initial Business Meeting Notes, Kathy Sheehan proposed thanking the Local Organization Committee for the 61st WFIWC, and all in attendance obliged with applause.

A motion to accept Kelowna, BC as the 2012 WFIWC site was brought forth by Dan Miller, and seconded by Brytten Steed. All were in favor and the motion passed.

Sandy Kegley made a motion to have the 2013 WFIWC in Region 1 and Brytten Steed seconded the motion. All members were in favor of the motion. (Site to be determined)

Joel Egan suggested an Ad-hoc Technology Committee to explore possible applications of new technology at our WFIWC meetings. For example, with the presenters' consent, digital recordings of parts of the program – such as the Founders Award or plenary sessions could be made for the WFIWC archives and/or the WFIWC website. A brief discussion addressed which portion (if any) of the program should be digitized, and the relative costs of the proceedings. If approved, this committee would explore the pros and cons of using digital recordings and other technology for various portions of WFIWC meetings. A vote on whether to create an Ad-hoc Technology Committee will be held during the Final Business Meeting. Joel McMillin made a motion to make Joel Egan the Chair of the Ad Hoc Technology Committee with David Jack as a Co-Chair. Bill Riel seconded the motion and it was approved by all.

Bill Riel nominated David Jack to take his place as Councilor, the motion was seconded by Dan Miller. All members approved the nomination and it passed. Bill Riel was thanked for 3 years of service.

Bruce Hostetler nominated Rich Hofstetter to replace Kathy Sheehan as WFIWC Chair, Bobbe Fitzgibbon seconded the motion. All members approved the motion and it passed. The gavel passed from Kathy Sheehan to Rich Hofstetter.

Kathy Sheehan was awarded a WFIWC t-shirt from the Local WFIWC Organization Committee for her good work as Chair.



Pat Ciesla asked about the Silent Auction proceeds and Karen Ripley announced that approximately \$1200.00 was generated by the Silent Auction.

Please get all WFIWC information to Rich Hofstetter for the proceedings.

Dan Miller motioned to adjourn the meeting, and was seconded by Mike Wagner. All members accepted the motion and the meeting adjourned at approximately 2:00 PM.



IN MEMORY

Gary E. Daterman: June 26, 1939 Freeport, Illinois - December 7, 2009, Corvallis, Oregon

Gary Daterman, 70, of Albany, Oregon died at his home Monday, December 7, 2009. Gary grew up in northern Illinois exploring the outdoors and developing an appreciation for the natural world around him. However, he did not plan a career in a natural resources field until after completing his undergraduate degree. He earned a B.A. in political science from the University of California, Davis in 1962 with plans to pursue a law degree. During his undergraduate program, he worked on a fire crew in Lassen National Forest in northern California. After witnessing an *Ips* outbreak in the area around the guard station in 1960, his focus shifted from law to entomology. Although the trees in that forest suffered from the outbreak, the forest entomology community reaped the benefit of Gary's chance encounter with that little beetle for the next 42 years!



Gary preparing to apply MCH beads to research plots in Montana, 2001

Gary chose to pursue graduate studies in forest entomology at Oregon State University because of the allure of Pacific Northwest forests and the quality of fishing in the region. He received his M.S. degree in forest entomology in 1964 upon completing his studies of seasonal and diurnal flight patterns of bark beetles in Coast Range forests under the direction of Dr. Julius Rudinsky. It was during this research project that Gary first witnessed the power of insect pheromone communication that set the path for the rest of his career. One of his passive sampling devices happened to be near a branch that was heavily infested with *Trypodendron lineatum* and caught large numbers of this insect. He conducted some simple experiments with *T. lineatum* boring dust that confirmed the presence of a potent aggregation pheromone.

Gary was hired by the USDA Forest Service Pacific Northwest (PNW) Research Station in 1965 as a Research Entomologist. He went on to earn his Ph.D. degree in entomology at Oregon State University in 1969 while continuing to work for the PNW Research Station. In 1973, he assumed the additional responsibilities of Project Leader. This was the beginning of a series of administrative positions that Gary held for the rest of his career. From 1991 until 1996, he served as Acting Program Manager for two different research programs within the PNW Research Station. For nine months from November 1992 until June 1993, he also served as Acting Director of the National Forest Health Center in Morgantown, WV for the Forest Health Protection branch of the Forest Service and was stationed in Washington, DC. From 1996 until his retirement on January 3, 2003, he served as Team Leader for the "Behavioral Chemistry and Ecology of Forest Insects and Disease Team," in the Managing Disturbance Regimes R&D Program. In these administrative positions, Gary was highly effective in obtaining support for forest entomology research and development programs. This support facilitated the work of many other forest entomologists within the Forest Service and cooperating agencies and institutions.

Gary was a pioneer and leader in the field of forest insect chemical communication research. He not only contributed to our basic understanding of forest insect pheromones, but continually strived to develop practical applications of that knowledge to improve the management of natural resources. Gary was a team player throughout his career and worked with many people from a wide range of organizations. Some highlights of research and development accomplishments in which he played a major role are:

- Confirmed that *T. lineatum* produced a potent aggregation pheromone
- Identified sex pheromone and developed detection surveys for European pine shoot moth
- Identified sex pheromone of the Douglas-fir tussock moth and developed the early warning system to predict outbreaks
- Identified sex pheromone of the western pine shoot borer and developed a highly effective mating disruption management system
- Identified sex pheromones for western spruce budworm, Modoc budworm, ponderosa pine tip moth
- Developed MCH treatments to protect high-value trees and stands from Douglas-fir beetle infestation

Gary received the WFIWC Founders' Award in 2004 as recognition of his outstanding contributions to forest entomology in the West. A more complete and personal account of Gary's career can be found in his Founders' Award Address available on the WFIWC website and published in the 2005 WFIWC proceedings.

Gary was a true gentleman in every sense of the word. His positive attitude, good humor, and generosity were experienced by all who knew him. He was truly one of the Giants in the world of forest entomology!

Prepared by Darrell Ross from information in Gary's Founders' Award nomination packet and acceptance address.

Terence Leckie Shore: April 21st 1951 – March 17th 2010



Terry was born and raised in Vancouver, British Columbia where he eventually attended the University of British Columbia and completed a B. Sc. (Hons) thesis in biology under the guidance of Dr. John Mclean in 1978. This seemed to cement his future, and he followed Dr. McLean to the faculty of forestry at UBC to complete a PhD in which he explored a mass-trapping program for ambrosia beetles in a commercial sawmill. After successfully defending his thesis in 1982, Terry joined the Canadian Forest Service in Victoria where he began a prolific career in applied bark beetle research.

Throughout his career, Terry made numerous contributions to bark beetle management, publishing more than 100 scientific papers, technical reports and proceedings. His most famous

contribution came through his development of a mountain pine beetle risk rating system which is in use today throughout western Canada.

On three occasions Terry received awards for excellence in research from the Canadian federal government. In addition, Terry was a registered professional forester, and a substantial contributor to several professional entomological societies. Terry was incredibly active in the Entomological Society of Canada, The Entomological Society of British Columbia and the Western Forest Insect Work Conference: he held numerous leadership positions with each of these organizations, organized conferences for each society and contributed much to the professional community.

Terry's professional accomplishments are particularly impressive in light of the health problems he faced for most of his adult life: many of his friends and colleagues were completely unaware that Terry had received a kidney transplant in the mid 1980s and suffered many life-threatening illnesses and complications as a result.



People were unaware of this because Terry had an incredibly positive attitude, always maintained a great sense of humour and refused to complain or make excuses. While Terry's years with us were low in number, they were exceptionally high in quality. Terry lived life to the full, made friends wherever he went and earned respect throughout the world for his personal and professional contributions.

Terry is remembered as a father, a husband, a friend, a respected scientist and a mentor – while his passing has been a painful shock for many of us, we are richer for the wonderful times we've had with him. The good times we shared and his professional contributions are a lasting legacy, and Terry would have liked nothing more than for us to remember him by living our lives the way he did: making the most of what we've got, always finding the ability to laugh, and fearlessly pursuing what we love. *Prepared by Bill Riel.*

INTRODUCTION AND ORIENTATION

Joel McMillin: Planning Committee Chair

Joel welcomed attendees to the 61st Western Forest Insect Work Conference. A brief comparative analysis was made between the 1988 work conference held in Flagstaff with the current meeting. Approximately 10% of those attending the 1988 meeting were also in attendance in 2010 and female participation increased by about 25%. There was a 9-fold increase in total meeting expenses. Joel reminded those in attendance of the overall work conference objectives established in 1949:

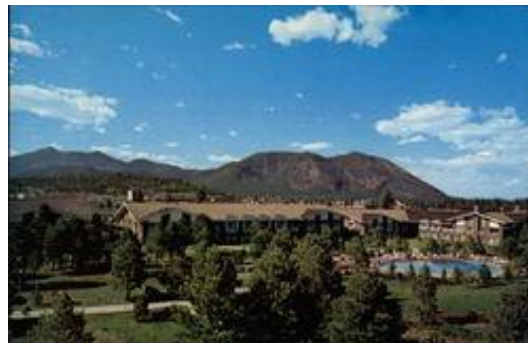


1. Advance the science and practice of forest entomology
2. Provide a medium of exchange of professional thought
3. Serve as a clearing house for technical information on forest insect problems of the western US and Canada (North America)

Members of the planning committee were graciously thanked for their hard work and reliability.

John Anhold and Mike Wagner: Local Arrangements

John Anhold provided an additional welcome to Flagstaff and the 61st WFIWC. John covered some of the house keeping items such as; conference room layout, restroom locations, emergency exits, break locations, and logistics for the Fun Run and Banquet. He introduced both Ron Billings and Bill Ciesla as the conference photographers and covered logistics regarding the conference group pictures. A few minutes were taken to cover the riparian forest health field trip (aka, Colorado River Float Trip) logistics for the day. A few additional items covered as reminders of times and locations were the poster session/silent auction/ice cream social, and the disc golf tournament.



KEYNOTE ADDRESS

Speaker: Vicki Christiansen, Arizona State Forester, Phoenix, AZ

Bio: Vicki is the Arizona State Forester and Director of the Arizona Division of Forestry. She is responsible for the protection of 22 million acres of state and private lands in Arizona. This includes the prevention and suppression of wildland fires as well as oversight of forest health, stewardship forestry and urban and community forestry programs in the state. As State Forester, Vicki represents Arizona at the national and state level in advocating the practice of sustainable forestry and the protection of forest lands for current and future generations to use and enjoy. Vicki is the Chair of the Wildland Fire Committee for the National Association of State Foresters and has worked at the national level on wildfire and sustainable forestry issues.

Vicki has been the Arizona State Forester since March 2009. Prior to that she served as the Washington State Forester where she had a 26 year career with Washington State Department of Natural Resources (DNR). She started as a wildland fire fighter while still in college and held many different positions at Washington DNR with a strong emphasis in operations. Her first permanent position was as a forester responsible for the reforestation of trust lands in the Mt. Saint Helens blast zone. Vicki has been a wildland fire fighter and fire manager for 30 years. She has numerous credentials in the wildland fire program with a special expertise as a fire line-blasting advisor. Vicki has a B.S. in Forest Management from the University of Washington (1983, cum laude). She is married to a Fire Chief and has two sons.

WFIWC MEMORIAL SCHOLARSHIP PRESENTATION 2010

David Jack, Forest Sciences, University of British Columbia, Vancouver, British Columbia

Bio: David's education started with a couple of diplomas in outdoor recreation. This led him to the University of Northern British Columbia where he completed his BSc in Resource Management Forestry in 2005. He has worked for the Ministry of Forest and Range (MoFR) in Forest Health conducting aerial surveys during the height of the recent mountain pine beetle infestations. He later worked as an Assistant Ecologist with MoFR remapping the Biogeoclimatic ecosystems throughout the Southern Interior of BC. He has spent the last four years working on his PhD at the University of British Columbia. Living on site as much as possible he has been researching how a mature high elevation forest responds to the mountain pine beetle infestation and fertilizer treatments.



WFIWC FOUNDER'S AWARD 2010

Jesse Logan, USDA Forest Service, Rocky Mountain Research Station (retired), Emigrant, Montana

Bio: After finishing his PhD at Washington State University in 1977, Jesse held faculty positions at Colorado State University and Virginia Polytechnic Institute and State University before joining the U.S. Forest Service as Project Leader for the Interior West Bark Beetle Project in Logan, Utah. After retiring from the Forest Service in June, 2006, Jesse and his wife Catherine moved to Emigrant, MT, where he continues to conduct and publish research, and participate in advocacy for high-elevation, Rocky Mountain ecosystems.



Jesse has published over 100 scientific articles on the influence of weather and climate on insect population dynamics and related topics. In recent years, this work has focused almost entirely on the climate change-altered role of mountain pine beetle in Greater Yellowstone Ecosystem (GYE) whitebark pine. He is an enthusiastic citizen of the GYE who spends over 100 days a year skiing the backcountry, many of those days in whitebark pine forests. When not skiing, he can often be found scaring cutthroat trout with a fly rod.

Announcement: Tom DeGomez

The Founders Award is given to an individual who has made an outstanding contribution to forest entomology in the western North America. The award recognizes significant contributions in pest management, extension-consultation, research, and teaching. Ed Holsten and Skeeter Werner are the Founders Award recipients for 2010, and will present an acceptance address at the 2011 NAFIWC in Portland, Oregon or the 2012 WFIWC meeting in British Columbia.

Introduction of Jesse Logan: Ken Raffa

Jesse Logan has made substantial contributions to our understanding of western forest insects, especially in the development of age-structured population models that characterize the role of temperature in mountain pine beetle biology. He has played a major role in identifying and modeling insect responses to anticipated climate change, and has been a strong advocate for protecting the integrity of high-elevation ecosystems. Jesse has provided strong leadership to developing entomologists and mentored some of our most prominent scientists.



2009 Founder's Award Address:

[Contains text only; for images, figures tables, and footnotes visit <http://www.fsl.orst.edu/wfiwc/awards/speeches/logan-address.pdf>]

Title: Ecology of Place: Mountain Pine Beetle, Whitebark Pine and the Greater Yellowstone Ecosystem

Introduction

As some of you may remember, this is my second Founder's Award presentation. Presented, not received. Gene Amman was the 1994 Founder's Award recipient; unfortunately, Gene suffered a serious medical setback and was unable to make his presentation at the 1995 meeting in Rapid City, SD. As a result, Gene asked me to present the talk he had prepared. I was, of course, honored that Gene trusted me enough to make his presentation, but I really never expected that I would one day myself receive the same award. The highest compliment a scientist (or just about anyone else) can receive is the respect of those who you yourself respect, and this award is an expression of that respect. It is, therefore, an unexpected but welcomed pleasure to receive this award, and I thank Ken Raffa for nominating me, Diana Six and Allan Carroll who wrote supporting letters, and the WFIWC Founders Award Selection Committee.

Preparing a Founder's Award presentation is an interesting experience, you can say *absolutely* anything you want, which is both a blessing and a curse; while you can talk about anything, you *do* need to talk about *something*. For inspiration, I read previous Founder's Award presentations on the WFIWC web-site. The science oriented addresses generally fall into three categories: (1) Personal antidotes based on a career's experience in forest entomology. Ron Stark's entertaining 1993 address exemplifies this approach. (2) A second category is loosely autobiographical presentations, for example, Les Safranyik's narrative of a professional life caught in the current of world events makes compelling reading. The Hungarian uprising, fleeing the subsequent Russian occupation, and ending with the generosity and kindness of the Canadian people - this is the stuff of novels! (3) And finally, review of a key life-time research contribution. Dave Wood and Gene Amman's addresses follow this later model. As for me, lacking the charm and wit of a Ron Stark or the exceptional life-story of a Les Safranyik, it seems that my only recourse was to follow Dave and Gene's example (not bad company, by the way!).

In his 1995 presentation, Gene asked, "How is global warming going to affect beetle infestations, and what management strategies will be needed to mitigate those effects?" My talk today is a response to Gene's question, and it is additionally focused on one particular place, the Greater Yellowstone Ecosystem (GYE). In fact, if it were not for anthropogenic global warming, I'm convinced life as a retired forest entomologist would be much simpler, focused almost entirely on skiing the Absaroka mountain backcountry, and fly-fishing the Yellowstone River. Unfortunately, however, predictions from the early climate models have been exceeded by actual events (Logan et al. 2010). The degree of warming already experienced has resulted in catastrophic impacts on some highly sensitive places, including the high-elevation forests of the GYE, a unique and special place indeed. "Ecology of place" is terminology I first heard used by my friend Craig Allen, an ecologist who has spent his entire professional career working in piñon-juniper forests of Bandelier National Monument. In the sense that Craig uses the phrase, the high-elevation forests of the GYE are increasingly becoming my "place." So, this is the story of my involvement and interest in the life history effects of climate and weather on insect populations, and in particular, the applications of these interests to climate change impacted whitebark pine forests of the GYE.

Background

For this audience, I don't think it necessary to introduce the mountain pine beetle, perhaps there is a little more motivation for an introduction to whitebark pine, particularly as expressed in the high-elevation forests of the GYE. The best I can do on both accounts is refer the reader to a recent article Logan and Macfarlane (2010) that attempts both objectives (<http://actionbioscience.org/environment/loganmacfarlane.html>). The central role that climate (expressed proximately as weather) plays in mountain pine beetle life history has long been recognized. The seminal work of two previous Founder's Award recipients, Gene Amman (1973) and Les Safranyik (1976) clearly described the climatic limitation to both the northern (Les) and elevational (Gene) distribution of this species. Both authors recognized that suitable host range far exceeded that of the beetle's historic geographical range that was constrained by climatic factors. Fig. 1 [not shown here] is a stylized representation of the central idea in Gene's 1973 paper. In lower elevation pine forests, primarily lodgepole and ponderosa pine, there is typically enough thermal input to complete the entire life cycle in one year. As elevation increases, often passing through nonhost spruce-fir forests, there is not enough annual thermal input to reliably complete an entire lifecycle, and fractional voltinism (sometime one year, sometimes two) is expressed. Finally, in the high elevation pine forests, there was simply not enough thermal input to complete the life cycle in one year, and two years were routinely required. Gene went on to describe why semi(or hemi)-voltinism did not work for the mountain pine beetle, lack of synchronous emergence and winter mortality of susceptible life-stages being the primary reasons. It is interesting to me that Gene's high-elevation field sites were located in GYE whitebark pine forests.

Early Career

I was in the final stages of my PhD at the time of the 1976 WFIWC meeting in Wemme, Oregon. Back in those days, an official program sanctioned day was set aside for recreation, typically skiing. At the time, I was not a skier, and neither was Gene Amman or Walt Cole. As a result, I found myself sitting at the Timberline Lodge bar on Mt. Hood drinking a beer with Gene and Walt. I had recently published a paper (Logan et al. 1976) on modeling insect phenology; and I was, of course, aware of Gene's 1973 paper. From this casual encounter over beer, there developed a career long collaboration and interest in modeling mountain pine beetle life-history. The first half of my career was spent primarily working in fields (literally and figuratively) other than forest entomology. I was also simultaneously perusing application of mathematical modeling approaches, in particular dynamical system analysis, applied to insect population dynamics. Even though I was not officially a "forest entomologist," Gene and Walt actively involved me in their mountain pine beetle research through a series of small grants. Although the funding they provided was never great in absolute terms, it provided a life-line at several crucial junctures in my professional life. Forest Service funding from the bark beetle project also legitimized my work modeling mountain pine beetle response to weather (temperature), and Gene and I published our first mountain pine beetle phenology modeling paper in the mid 1980s (Logan and Amman 1986). Most fortuitous of all was a professional association with Barbara Bentz, which came about through my association with the FS mountain pine beetle project.

Barbara had worked several years as a seasonal field technician, and in fact, the MPB-Project had supported her Master's degree working with Molly Stock at the University of Idaho. Finishing her MS degree in the late 1980s, both the project and Barbara were considering places

for her to pursue a PhD. At about the same time, I was finishing a New Zealand Research Advisory Council Fellowship³ and, hence, looking for support. Walt and Gene provided a small FS-MPB grant that allowed me to reestablish a soft-money position at Colorado State University, and simultaneously, take on Barbara as a PhD student. It was a great opportunity, I got to work with a bright young student, and Barbara got to live in the Colorado Rocky Mountains. Much to Barbara's chagrin, soon after she arrived in Colorado, I was offered and accepted a position as Associate Professor at Virginia Tech. Eventually Barbara did re-locate to Blacksburg, and as a part of her dissertation project, completed the MPB phenology model (Bentz, et al. 1993). My job at Virginia Tech was the best of my life, and I knew it at the time. A chance meeting⁴ at the 1987 WFIWC with Tom Payne, who had recently accepted the position of VPI Department Head, had resulted in my moving from a tenuous, 100% soft-money position to a tenure-track, 100% funded position. Best of all, finally at mid-career, I could officially call myself a Forest Entomologist! It was an exciting time to be a forest entomologist at VPI&SU: funding was abundant; my teaching responsibility was minimal, with interesting courses and good students; I got to work with people like Bill Ravlin, David Gray, and Lucas Schaub; Tom Payne was highly supportive of our work; and my old friend Jacques Régnière came down from Quebec to do a sabbatical with our group. Even though this was the best of all possible jobs, the pull of the Rocky Mountains was too strong, and when I was offered the Project Leader position for the Forest Service Western Bark Beetle Project in 1992, I accepted in less than a heartbeat.

Forest Service Mountain Pine Beetle Project

On completing her PhD, Barbara had returned to the bark beetle project as a full-time scientist. Among her first priorities was to establish an intensive MPB life history research project in the Sawtooth Valley of central Idaho. An important aspect of this project, which included high-tech field-habitat temperature monitoring in lodgepole pine phloem tissue, was field validation of the MPB phenology model (Powell and Bentz 2009). As a result, we had at our disposal a phenology model based on Gene's controlled temperature experiments (dating back to the 1970s), and data from a well designed field study that was supporting the validity of model predictions. For a modeler, life doesn't get much better than that! Shortly after my arriving in Logan, UT to start as Project Leader, Gene Amman (who was transitioning to retirement) got a call from Dana Perkins, a MS student working with Tom Swetnam at the University of Arizona Tree Ring Lab (Perkins and Swetnam 1996). Dana was interested in whitebark pine ecology and had established several study sites in the Sawtooth and White Cloud mountains near her home in Stanley, ID. Dana was interested in several old, dead whitebarks ("ghost trees") that she had come across on all of her study sites. Dated mortality for all of these dead trees dated back to the 1930s - and most interestingly, Dana suspected that mountain pine beetle was the culprit in their demise. She contacted Gene to verify her suspicions, and I was able to tag along with Gene and Dana on a visit to one of her field sites. It was an eye-opener. Given the slow decomposition rates of high-elevation environments, Gene was able to find conclusive evidence of MPB (parent galleries and pupal chambers) by examining protected areas on the tree boles. This immediately raised two interesting questions: (1) was this mortality a result of beetles being carried (blown) in from an active outbreak in lower elevation lodgepole forests, or did it result from a warm weather release of a resident population? (2) The first IPCC report on climate change had come out in 1990, and given that we now had a verified phenology model, I became interested in what the magnitude of warming predicted by the climate models might hold for mountain pine beetle in these high elevation forests.

Whitebark Pine on Railroad Ridge, White Cloud Mountains, Idaho

Motivated by these two interesting questions, in 1994 we established four state-of-the-art weather stations at one of Dana's research sites; a place called Railroad Ridge in the White Cloud Mts., central Idaho. The whitebark pine forest on Railroad Ridge is an extensive high-elevation (10,000 ft.), climax forest. This is a beautiful whitebark pine site - little subalpine fir encroachment, very low densities of white pine blister rust infection, and at the time we established our weather stations, almost no indication of current mountain pine beetle activity (we were able to find only one successfully attacked tree) - and it is home to the oldest recorded whitebark pine (Perkins and Swetnam 1996). After having established our four weather stations (one on each of S, N, E aspects, and ridge-Top), we really weren't spending much time or resources on the Railroad Ridge study. Jim Vandygriff and I would go up there a couple times a year; Jim would service the weather monitoring instrumentation and we would poke around for a few days thinking about mountain pine beetle, whitebark pine, mountain weather patterns, and otherwise generally having a good time. Jim, in particular, was gaining important insights regarding mountain pine beetle life-history in these harsh environments. One important observation Jim made was that counter to the conventional wisdom of the time that MPB doesn't attack downed trees, every time he looked along the bottom of snow-thrown, downed trees, he would find living mountain pine beetles and brood. This observation convinced us that there was probably always a resident population in whitebark, but making a living only in the marginal habitat of downed or otherwise vulnerable trees in thermally protected habitats. Subsequent events have reinforced the idea that recent outbreaks primarily result from climatic release of resident, low-level populations rather than migrants from other habitats. Although we were not spending a lot of time on Railroad Ridge, we were doing interesting conceptual/theoretical work, including model analysis of our high-resolution temperature data. Analysis of model results using data from Barbara's Sawtooth life history studies (Logan and Bentz 1999) revealed interesting threshold behavior in which observed temperatures from her cold site resulted in complex, maladapted emergence cycles; while those from favorable warm sites resulted in synchronous, uni-voltine, adaptive emergence. The significance of these results in a climate change scenario was not lost, and one of our conclusions was that, "mountain pine beetle is an important indicator for climate change ... should be monitored in geographic regions of marginal thermal environments (e.g. high elevation pines, such as whitebark ...)" Subsequent quantitative work (Logan and Powell 2001) confirmed our empirical simulation results and provided the mathematical basis for the threshold behavior (instantaneous shift from complex, maladapted emergence cycles to synchronous, adaptive cycles) we had observed in our simulations. Bifurcation analysis (in which dynamical model properties are observed as temperature is varied by small increments) indicated that temperature increases well within IPCC predictions would shift the thermal regime on Railroad Ridge from a maladaptive cycle to an adaptive one, and that due to the threshold behavior, this shift would be expressed catastrophically, rather than gradually. Similar model analysis predicted expansion of suitable thermal habitat northward into previously unoccupied Canadian boreal jackpine forests. At the time we were addressing theoretical questions with our model, weather conditions for the mountain pine beetle were steadily improving on Railroad Ridge. The influence of global warming was beginning to be expressed at both west-wide (Fig. 2 [not shown here]) and local (Table 1 [not shown here]) scales. Simulations using phloem temperature data from our north Railroad Ridge site indicated that temperatures had become favorable on south aspects of the

bole starting in 2000, and by 2003, even the north aspect had become favorable. Unfortunately, mountain pine beetle population response confirmed our model predictions. Significant mortality was first observed in 2003, and by 2006 many Railroad Ridge whitebark pine stands had virtually collapsed due to widespread mountain pine beetle mortality (Plate 2 [not shown here]).

Retirement and the Greater Yellowstone Ecosystem

Prior to my retirement from the Forest Service in the summer of 2006¹¹, I was contacted by Melly Reuling who was working for Louisa Willcox, Senior Wildlife Advocate for the Natural Resources Defense Council's (NRDC) Livingston, Montana office. Louisa was familiar with my work modeling climate change, and was curious about what our model predictions might hold for the Greater Yellowstone Ecosystem. This seemed like a question for an interesting and important landscape, and using a BioSIM (Régnière 1996) implemented version of our model, we performed simulations for business-as-usual climate change scenarios. Results were alarming (Fig. 3 [not shown here]). As sobering as our simulation results were, there were also significant regions of the GYE predicted to be at low risk, including the Wind River mountains in the S. E. part of the ecosystem. Given this result, I became interested in possibly verifying this prediction. Knowing that Louisa was a former NOLS instructor based out of Lander, WY, and therefore familiar with the Winds, I contacted her about possibly going on a backpack trip in the Wind River range, and coincidentally checking out model predictions. She was enthusiastic. One thing led to another, and our original informal backpack trip blossomed¹² into a serious reconnaissance of whitebark pine condition in the central core of the Wind River mountains, with the stated goal of performing an on-the-ground, landscape-level evaluation of historic and current mountain pine beetle activity in whitebark pine forests. I considered the Wind River trip to be the most rigorous test of our model to date, since previous predictions were for occurrence of an outbreak event; this, on the other hand, was prediction of non-occurrence of the event. I had also contacted Steve Munson, Forest Health Protection in Ogden, UT, to inquire about what he knew regarding whitebark condition in the Winds. Since most of the Wind River whitebark distribution is either in designated Wilderness or Shoshone/Arapaho Reservation lands, Forest Service Aerial Detection Surveys did not exist for the region. Apparently, the whitebark condition of the Wind River Mountains was a blank map. Working with Wally Macfarlane and Jacques Régnière, a set of protocols for ground assessment of whitebark pine condition was developed that involved: (1) an aerial overflight¹⁴ of the route; (2) landscape viewpoint assessment, (3) trail observations, and (4) stand mortality classification. Our assessment of Wind River climax whitebark pine forests resulted in series of interesting observations (Plate 3 [not shown here]). First, we verified model predictions and thus strengthened my confidence in the model; generally the condition of whitebark we observed was robust and healthy. We also "discovered" locations of ancient whitebark pine stands with an abundance of trees with truly awe inspiring proportions. Finally, the bonding experience of a rigorous ten day backpack trip cemented our commitment to more fully understand the nature and implications of increasing mountain pine beetle activity in GYE whitebark pine. The loss of whitebark was especially troublesome to Louisa. As the Senior Wildlife Advocate for the NRDC's Livingston, MT. office, Louisa was well aware of the importance of whitebark pine to GYE grizzlies. Previous work, notably that of David Mattson and coworkers (Mattson 1998, Pease and Matson 1999, Mattson 2000, Mattson and Merrill 2002) documented the critical importance of whitebark pine to Greater Yellowstone Grizzlies. Not only do whitebark pine seeds provide the necessary nutrition required for successful survival and reproduction; but perhaps even more importantly, they serve

to hold the bears out of harm's way in the remote high country habitat of whitebark pine (Swartz, et al 2006). In the words of science journalist Charles Petit referring to our Wind River trip, "Logan seems, in fact, to be on a collision course with the federal government, in the debate over whether to lift Endangered Species Act protections from the grizzly bears in and around Yellowstone National Park." Charlie's presage turned out, unfortunately, to be prophetic. The "collision course" that Charlie referred to occurred with the decision by the U. S. Fish and Wildlife Service to delist the Yellowstone distinct grizzly bear population. In 2007, The U.S. Fish and Wildlife's document supporting delisting the GYE grizzly bear (Department of Interior 2007) stated that, "Using aerial detection survey data, (Gibson 2006, p. 13) estimated 16 percent of the total area of whitebark pine found in the GYA (693 sq km / 4,308 sq km (268 sq mi / 1663 sq mi) has experienced some level of mortality due to mountain pine beetles." This estimate was based on one year (2005) of Aerial Detection Survey (ADS) data. Since the needles of trees successfully attacked turn red the year following attack, this is a measure of mortality during the summer of 2004 *in areas that were flown in 2005* (not all areas are flown every year). Even using the ADS data that was available at the time (i.e. summing reported mortality beginning in 1999) this figure was clearly an underestimation. Additionally, since retirement, I had been spending a great deal of time traveling throughout the GYE high-country, including skiing over 100 days a year in the backcountry - much of that in whitebark pine forests. Everywhere I traveled, it seemed, the whitebark pine was in serious trouble. Although the figure of '16% experiencing *some* level of mortality' was suspect, information regarding the full extent of MPB impact in GYE whitebark pine simply did not exist. Motivated in part by the fact that critical policy decisions were being made based on this inadequate information, we initiated a pilot study in summer 2008 that was specifically designed to assess the cumulative impact of mountain pine beetle in whitebark pine at the landscape level (Logan, et al. 2009). Results from this pilot project demonstrated that we had developed a reliable monitoring technique (Landscape Assessment System, LAS) that was capable of assessing the level of MPB impact on whitebark pine at the landscape level for the entire GYE (approximately 20 million ac.). Briefly, the LAS approach that Wally developed (Macfarlane et al. 2009) applies an outbreak classification system that rates the intensity of mortality ranging from zero, (no unusual MBP activity) to six (the residual gray forest), see Appendix A. This rating system is applied on the landscape through a combination of high resolution aerial photography, Geo-rectification using a Google Earth platform, and GIS analysis (text box 1 [not shown here]).

In contrast to ADS, the LAS was designed to specifically measure the cumulative ecological impact of MPB on whitebark pine rather than the seasonal mortality for all forest insects and pathogens. As such, the traditional ADS approach is area (polygons) and number based (estimated number of dead trees), whereas, LAS is ecological landscape assessment based. There is not an area estimate associated with individual photographs, rather, a landscape assessment is made for a minimal mapping unit, in this case the sub-catchment, that the photograph(s) represent. Area can then be estimated by the GIS based summation of sub-catchment areas. With encouraging results from our 2008 study, we were able to convince the Forest Service that we could fly the entire GYE for a reasonable cost, and we were funded to do so during the summer of 2009. The not yet published results from this assessment were sobering (Plate 4 [not shown here]). Analysis of 4,653 oblique aerial photographs representing 3,185 sub-catchments resulted in forty six percent (46%) of whitebark by area classified with a high mortality rating (Cat. 3-6), indicating coalesced MPB outbreaks and widespread mortality. Thirty six percent

(36%) were classified as medium mortality levels (Cat. 2-2.9), indicating significant mortality. An additional thirteen percent (13%) were identified with low levels of mortality (Cat 1-1.9), and only five percent 5% showed no unusual MPB-caused mortality (Cat. 0-.75) (Fig. 4). In contrast with the US Fish and Wildlife estimate of 16% whitebark experiencing some level of mortality, our results indicated that by summer 2008, more like 95% had experienced some level of mortality. Perhaps even more discouraging was the realization that 46% of whitebark in the GYE has already experienced high enough levels of mortality to initiate loss of ecological services 21. Although results from subsequent empirical assessment were qualitatively similar to those predicted by the earlier simulations, there are also distinctive differences. The most important difference between model predictions and observed mortality is that the impact occurred much earlier and was more widespread than predicted. The pattern of observed mortality (Fig. 5 top [not shown here]) also differs from the map of predicted high risk (Fig. 5 bottom [not shown here]); in particular, our simulations missed the east/central portion of the ecosystem that has already been severely impacted. The logical question to ask regarding these differences is, Why? there are several obvious possibilities: (1) Lack of knowledge regarding the expression of mountain pine beetle ecology in whitebark pine undoubtedly plays a role (Logan et al. 2010). Prior to current events, mountain pine beetle in whitebark was understudied and considered almost a footnote to "real" bark beetle research. Increased mountain pine beetle activity first became evident on Railroad Ridge in 2003 and by 2006 mortality was extensive. Even for seasoned mountain pine beetle researchers with extensive experience in both lodgepole and ponderosa pine, the progression of the outbreak was remarkable (Plate 1). We hypothesized that either the reproductive potential of the beetle was much higher in whitebark than the other two hosts, that whitebark chemical defenses were less effective, or both. Subsequent research (Gross 2008) indicated that the reproductive potential was dependent on phloem thickness of either parent or brood host, confirming earlier work by Amman (1972, 1982) that indicated the importance of phloem thickness to mountain pine beetle reproductive success, and the suitability of whitebark as a host, respectively. Gross' result indicated the likelihood that the major reason for volatility of mountain pine beetle outbreaks in whitebark resulted from lack of effective defensive chemistry. Subsequent field observations (Logan et al. 2010) are consistent with this hypothesis. Research efforts currently underway, including those by Ken Raffa and students, will further elucidate the nature of whitebark pine defensive chemistry. (2) Global change (warming) is also exactly that, global in scale. The weather data (VMAP) we used for model predictions was down-scaled from the Canadian Climate Change CGCM1 model. So, while our projected weather was globally based, ecological systems are responding on a regional, or even smaller scale. The earliest, and most extreme, expression of global warming has occurred in high latitudes and high elevations, resulting in the earliest and most pronounced ecological disturbances also occurring in these extreme situations. On even a more proximate scale, topography in the GYE is complex (over 20 major mountain ranges), any and all of which effect local weather patterns. Using data the scale of VEMAP (0.5 arc-degree resolution) cannot be expected to accurately reflect these complex patterns. As the resolution of down-scaled GCM predictions improve, so will the ability to predict complex local temperature patterns and resulting model simulations. (3) Model redictions of risk were based on one assumed necessary condition, enough thermal energy to complete an appropriately timed life-cycle in one year. Other weather impacts are equally (and situationally perhaps even more) important. In addition to adaptive seasonality, winter mortality, or lack thereof, also plays a critical role in mountain pine beetle population ecology. Recent work by Régnière and Bentz (2010) provides the

modeling framework necessary to address this source of weather impact. Applying their model to analysis of the Togwotee the dramatic effect that recent milder temperatures can exert on survival of GYE mountain pine beetle in whitebark (Fig. 6. [not shown here]). In historic climatic regimes, the simultaneous occurrence of these two events were uncommon; with climate warming, their simultaneous occurrence has become increasingly likely. Recent advances in the BioSIM framework (providing capabilities for parallel-processing, personnel communication, Jacques Régnière) will allow rapid advances in powerful, flexible modeling approaches such as individual-based models that allow rapid incorporation of realistic ecological responses, like winter mortality or host susceptibility. The combination of environmental factors (a warming climate) and the nature of ecological/biological interactions between mountain pine beetle and whitebark pine has led to a highly volatile situation in a sensitive ecosystem - the perfect storm. We recently (Logan et al. 2010) published a paper detailing the reasoning behind the perfect storm scenario, and the major points from this paper are summarized in Text Box 2 [not shown here]. Although the conditions in Text Box 2 [not shown here] cannot be expected to occur every year, so long as the temperature trend line in Fig. 2 [not shown here] remains more-or-less the same, the simultaneous occurrence of weather conditions that result in univoltinism and high winter survival will continue to be expressed with increasing frequency. There is no doubt that a significant loss on whitebark pine has already occurred in the GYE, and a reasonable expectation is the these losses will continue for the foreseeable future.

Conclusion

The work I've described spans a greater than 30 year period, starting with publication of a paper relating environmental temperature to insect phenology (Logan et al. 1976). At that time, almost nobody was considering the possibility of human induced global warming, certainly I wasn't. Although this early work provided the foundation for much of what was to follow, the external event of relentlessly greenhouse gas accumulation and accompanying global warming served to focused this work in a way that would not have otherwise happened. Motivated by a rapidly changing climate, we began to seriously address the dynamical properties of the model apart from the merely predictive applications that dominate in applied entomology. This altered perspective motivated a productive collaboration between ecologists and mathematicians, and resulted in uncovering a basic threshold dynamic with profound ecological implications. This work independently reinforced the theoretical work of Berryman et al. (1984) with a real-world example of regime shift. The devastating mountain pine beetle outbreaks that are now occurring in GYE whitebark pine are perhaps the clearest example to date of a predicted ecological response to global warming that was borne out by subsequent events. Even whitebark in landscapes as resilient to global warming as the Wind River Range will eventually succumb given sufficient warming. Make no mistake about it, what we are experiencing with whitebark pine collapse in the GYE is a direct consequence of a rapidly warming climate.

The clear link between a warming climate and release of previously climatic constrained mountain pine beetle populations in high-elevation forests leads to two inescapable conclusions: (1) since this is a problem of largely our own making, it is unethical to simply walk away from it; (2) The only chance we have for managing or mitigation lies in first understanding the ecological strategies that have helped whitebark bridge past warm periods, and then apply this knowledge in insightful ways to assist this remarkable species to withstand the current, unprecedented rate of greenhouse gas accumulation and accompanying warming. The only viable goal in my opinion is

to maintain enough genetic material on the landscape that when (if) a future climate stabilizes, whitebark will remain a player in the evolutionary/adaptive process that leads to a viable ecosystem in these spectacular landscapes.

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FIELD TRIP

Hosts: John Anhold, Mike Wagner and Tom DeGomez





A fun filled and educational day was spent traveling north through the high elevation desert country of the Colorado Plateau and then floating the mighty Colorado River. The day started early with a full breakfast at the hotel followed by a bus tour guided trip north to Page, AZ. Jerry Snow provided many interesting stories and facts regarding the native American history, culture and life as we traveled through the Navajo Nation. Once in Page we loaded up in buses that took us to our waiting rafts at the base of Glen canyon dam. John Spence, with the Glen Canyon National Recreation Area, floated with us and provided information along the way and at a couple stops regarding riparian health and some of the non-native plant species they are confronted with. One of those plant species of concern is tamarisk or salt cedar. We had a chance to see some of the tamarisk control work the Park Service is doing. Also, the tamarisk leaf beetle has made its way into the canyon and efforts are underway to monitor impacts to tamarisk and other plant and animal species associated with tamarisk. We beached our rafts for lunch and visited a rock art panel where our guides interpreted what they knew. Some animal and hunting scenes needed no explanation. But others, like a symbol possibly associated with the birth of twins, were mysterious. The float trip took about 4 hours. It's about 15 miles from Glen Canyon Dam to the old homestead and river crossing at Lees Ferry. From Lees Ferry we traveled a short distance to Navajo Bridge, which spans the Colorado River. There we met Chris Parrish from the Peregrine Fund and he gave a presentation on the California condor reintroduction program. Apparently a few folks saw a condor while on the river!

PLENARY SESSION I: “LIVING ON THE EDGE IN THE SOUTHWEST”

Moderated by **Tom Kolb**, School of Forestry,
Northern Arizona University, Flagstaff, Arizona

History of forest conditions in the Southwest & restoration strategies

J.J. Smith,

School of Forestry, Northern Arizona University, Flagstaff, Arizona

The ponderosa pine forests draped across the southern edge of the Colorado Plateau exist because of a unique physiological setting, a monsoon climate, and thousands of years of Native

American land management. Rapid ecological changes began occurring with the introduction of grazing animals, railroad logging, and fire suppression in the 19th century.

In the 1990s forest industry in much of the southwestern U.S. had collapsed due to a combination of economic factors and endangered species concerns stemming from these 100+ years of unsustainable land use practices. The change from a forest dominated by larger, widely spaced trees to smaller, densely-packed forests, and from a low-intensity, rejuvenating fire regime to a fire-replacing fire regime forced a shift in forest management.

Ecological restoration has become the new paradigm for Southwest forests, and Flagstaff area land managers are attempting to implement restoration treatments in a zone of forest around the city. Utilization of small diameter trees is an important part of this effort because restoration treatments are expensive. Proposals for an oriented strand board mill, and a multi-national forest timber supply analysis are among the efforts to leverage private industry strengths to accomplish landscape-level ecological restoration in the Southwest.

Historic and current insect issues in the Southwest's pine forests

Tom DeGomez,

University of Arizona Extension, Flagstaff, Arizona

Historically, insect issues in the southwestern U.S. have been variable. Until the pine bark beetle outbreak of 2002 to 2004 it had been rare for insect damage in a single year to have exceeded 100,000 hectares. Needle miners (*Coleotechnites ponderosae* and *C. edulicola*) in 1957 and 1999 accounted for mortality across 14,000 and 18,000 hectares, respectively. Significant outbreaks were documented in 1986 and 2007 of sawflies (*Zadiprion* spp. and *Neodiprion* spp.). Tiger moth (*Lophocampa ingens*) outbreaks were seen in 2006 in both pinyon and ponderosa pine. Tip moths and shoot borers (*Rhyaciona* spp. and *Eucosoma sonomana*) were serious pests in the early 20th century when there was a large cohort of seedling and sapling trees in the region. The tip moth *R. neomexicana* was responsible for damage across 40,000 hectares from 1966 to 1971. Pandora moth (*Coloradia pandora*) is a cyclic insect, the last large outbreak started in 1978 and culminated in 1983 when 12,000 hectares were defoliated north of the Grand Canyon. Local Native American Indians relish the larvae of this insect as a culinary delicacy. Pinyon needle scale (*Matsucoccus acalyptus*) has a long history of outbreaks throughout the Southwest. Prescott scale (*Matsucoccus vexillorum*) has been responsible for twig bight in 1918, 1932-34, 1942, and most recently in 1990-91 when over 30,000 hectares were damaged. The Southwest is one of the most robust areas in the world for bark beetles species; there are no less than 17 species that infest pine. Significant drought prior to 2002 coupled with overly dense stands precipitated an unprecedented level of mortality in both ponderosa and pinyon pine throughout the region. Aerial surveys documented over 400,000 hectares of ponderosa and more than double that number in the pinyon woodland that had mortality. Historically, minor outbreaks occurred throughout the 20th century with the most significant event occurring during the drought of the early 1950's.

Climate and high elevation defoliators in the Southwest

Ann Lynch,

USDA Forest Service, Rocky Mountain Research Station, Tucson, Arizona

PLENARY SESSION II: “LIVING ON THE EDGE OF ECONOMIC CHANGE”

Moderated by **Mike Wagner**, USDA Forest Service, Forest Health Protection, Flagstaff, Arizona

Impacts of current economy on managing insect outbreaks in the western US Sky Stephens,

Colorado Forestry, Fort Collins, Colorado

The current economy has had impacts on almost all facets of life and business including forestry. State and private forestry agencies, departments of lands, departments of agriculture and departments of natural resources for the 18 western states from North Dakota to Texas, westward to California and Alaska were interviewed regarding the impacts of the current economy on their agencies. Agencies were asked to address key areas of economic impact including: budget impacts; staffing; accessibility of matching funds; impacts on specific agency programs; challenges and mechanisms for coping. Overall, 14 states had budget reductions of less than 20 percent, however some states budgets were affected as much as 60 percent. These reductions have impacts throughout the state agencies. Some of the largest affected staffing. Overall, the western states faced reduction in full-time equivalent staff positions, the inability to fill vacancy due to hiring freezes, required furloughs, and travel and spending restrictions. Budget reductions, the impacts on staff and other implications have reduced the ability of approximately half of the western states to secure federal funds that require matching; engage in private landowner programs that require matching; reduced number of special and seasonal programs; and in some severe cases have included program loss. The future of state budgets received poor marks with a number of state agencies feeling ‘on the bubble’ and waiting to see what the next state legislative session determines. Throughout the difficulties, the western state agencies have found creative ways to cope, including growing collaborative approaches, looking for new partnerships, creative use of existing resources, prioritizing activities and going virtual for meetings and seminars. Some things are certain – the economy will continue to play a role in western state forestry agencies ability to provide services and forest insects and diseases will continue to be indifferent to geographical, fiscal and agency boundaries.

Trends and impacts of non-native forest insects: Who pays the price?

Deborah McCullough

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Non-native forest insects and pathogens affect trees in forested and urban settings across the U.S. and introductions are likely to continue as global trade and travel expand. Past efforts

to assess economic impacts of invasive forest pests have suffered from issues such as potential double counting of costs, a lack of attention to non-timber losses and over- or under-inflation of costs resulting from a lack of economic data for > 98% of non-native forest pests. A broad, rigorous analysis of costs associated with non-native forest pests is necessary to provide an economic basis for decisions related to trade policies, regulations and management of these organisms.

A 12-member working group was organized by The Nature Conservancy at the National Center for Ecological Analysis and Synthesis (Santa Barbara, CA) to address this issue. We developed an exhaustive list of > 450 non-native forest insect and pathogen species established in the U.S., identified a subset of “high impact” species and assigned insects to feeding guilds. We evaluated five cost categories, representing three economic sectors, for sap-feeding, foliage-feeding and phloem-/wood-boring insects.

Results suggest economic impacts of non-native forest insects exceed previous estimates by orders of magnitude. The phloem-/wood-boring guild accounted for < 16% of all non-native forest insects but was the most costly guild in all but one cost category. Timber and related market losses comprised a relatively small proportion of the costs associated with any of the insect feeding guilds. Homeowners and municipal governments bear the greatest proportion of the costs.

Carbon Credits and International Trade: Implications for Forest Management

Ching-Hsun Huang

Northern Arizona University

The voluntary carbon market includes all carbon offsets trades that are not required by regulation and may offer income opportunities for landowners who participate in forestry offset projects such as afforestation, reforestation, sustainably managed forests and forest conservation resulting in increased forest carbon sequestration. The voluntary carbon markets include 1) the Chicago Climate Exchange, a voluntary but legally binding cap-and-trade system, and 2) “Over-the-Counter” offset market, a broader, non-binding voluntary market which operates largely outside of exchange and is based on bilateral deals occurring when a company sponsors a forestry project to gain early-action carbon credits and experience. The potential of a forest ecosystem to sequester carbon depends on the species, site quality and management regimes utilized. A variety of forest project protocols have been developed to quantify and monitor the carbon benefits of forest projects; however, they differ in terms of transaction costs, measuring, monitoring and verification requirements and accounting methodology resulting in a wide variation in the eligible carbon credits in forest carbon offset projects. Although policies have included financial compensation for landowners who manage their lands to sequester more carbon and offset emissions, the current low carbon price and various costs of participating have been the economic constraints for the average family forest landowners to incorporate carbon management into their forest planning. Therefore, land managers should address critical questions such as suitable offset programs, trade-offs between carbon sequestration and timber yields, time constraints on selling carbon credits prior to participating in carbon markets and mitigating climate change.

GRADUATE STUDENT PRESENTATIONS

Group A moderated by Monica Gaylord

Historical Landsat data as a tool to detect forest canopy change during a native insect outbreak

Joshua S. Jones,

J. A. Tullis, and F. M. Stephen,
University of Arkansas, Fayetteville, Arkansas

A model developed to detect changes in forest canopy cover was implemented in response to an outbreak of a native oak boring insect, red oak borer (*Enaphalodes rufulus* (Haldeman) (Coleoptera: Cerambycidae)) in the Ozark National Forest of Arkansas. A Normalized Difference Water Index (NDWI) was used to detect forest cover change between two dates of Landsat satellite imagery. The resulting Δ NDWI was obtained by subtracting one image from the other. Thresholds for extreme levels of positive and negative changes over time were derived from Δ NDWI, and the resulting areas were described as either growth or decline. Forest variables were measured *in situ* within both growth and decline areas. Growth plot trees were smaller and younger, while decline plot trees were larger, older, displayed varying levels of crown dieback, and were often dead. Logistic regression was used to determine which forest measurement variable was the best predictor for the growth and decline categories. Age and DBH were the most successful predictors, DBH being preferable because it takes less time and effort to measure *in situ*. Growth plots were comprised mostly of sprouts from cut stumps, while decline plots had a relatively high frequency of northern red oaks in varying states of decline, with dead trees possessing numerous red oak borer heartwood galleries. Decadal detection of forest canopy change using NDWI can reveal areas of forest decline, and areas of regenerating even-aged stands that could be considered potential hazards for future disturbances.

Historical activity of a native wood borer in relation to climate in the Ozark and Ouachita Mountains, Arkansas, USA

Laurel J. Haavik,

and F. M. Stephen, University of Arkansas, Fayetteville, Arkansas

Tree-ring studies of forest insects provide long-term records of population levels and aid in understanding causal factors of density fluctuations over time. We used tree-ring techniques to date larval gallery scars of a native wood borer, *Enaphalodes rufulus* (Haldeman), in host *Quercus rubra* L. from eight sites within the Ozark and Ouachita National Forests of Arkansas. We dated scars according to a previously developed sampling system that used the lower 20% of tree boles to estimate within-tree historical borer activity. We quantified borer densities throughout the past century as indicated by scars within host tree boles, calculated per capita rate of increase from one generation to the next, and extrapolated both of these variables to the site and regional levels. Scar data from 78 *Q. rubra* (162.55 m bole) reveal that at the regional level borer population growth was increasing from 1976 – 2000, or eleven generations prior to a recent outbreak. Forest-wide observations of host mortality were generally consistent with the peak of the outbreak, which occurred in 2001, though duration and intensity of eruptive behavior were

variable geographically. Sites with higher outbreak densities also sustained incipient (i.e. growing) populations for a longer time period than sites with lower outbreak densities, which indicates that a greater potential for exponential increase existed at these sites as more borers were present when conditions became favorable for an outbreak. An index of summer soil moisture availability explained almost half of the variation in *E. rufulus* population growth, which suggests that drought may have been an important causal factor in the recent outbreak. Endogenous, stand-level factors were also likely important due to geographic and temporal variability in borer infestation.

Mountain pine beetle-caused lodgepole mortality from the 1980's and subsequent fire occurrence in Colorado

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A need for understanding the interaction between post-epidemic bark beetle stands and subsequent fire occurrence has escalated due to recent unprecedented mountain pine beetle epidemic in lodgepole pine dominated forests of Colorado. Mountain pine beetle (*Dendroctonus ponderosae* Hopkins) populations in the early 1980's resulted in substantial tree mortality across Colorado. Outbreaks on the Arapaho and White River National Forests, delineated by the Aerial Detection Survey, involved approximately 190,000 acres and 450,000 trees. Mountain pine beetle-caused tree mortality is generally thought to increase subsequent fire occurrence but this hypothesis has yet to be supported by published research results. Thus, our objectives were to assess: if a relationship exists between mountain pine beetle outbreak areas of the 1980's and subsequent fire occurrence in Colorado; if there is a correlation between associated weather and fire occurrence in 1980's mountain pine beetle outbreak locations; the temporal range of fire occurrence since the 1980's outbreak initiation. We used historic USDA Forest Service Aerial Detection Survey maps dating from 1980 to 1990 in conjunction with USDA Forest Service digital fire location records to look for outbreak MPB and ignition occurrence relationships. Sixty eight maps were scanned to spatially identify *Dendroctonus ponderosae*-caused mortality over the Arapaho and White River National Forests from 1980 through 1990. The combined datasets delineate areas containing lodgepole pine dominated forest type, aerially detected tree mortality from *Dendroctonus ponderosae* (1980-1990) and subsequent historic fire ignition locations. During the summer of 2008, we located 57 ignition points on the Arapaho and White River National Forests. The field assessment was conducted to verify the presence of mountain pine beetle-caused mortality prior to the fire as well as to confirm the location of the recorded fire. We found two of 57 ignition points had fuels from trees killed by mountain pine beetle prior to the ignition.

Chi square tests for differences were conducted on densities of fire occurrence in areas within and without previous mountain pine beetle-caused mortality polygons as denoted by the Aerial Detection Survey. No statistical differences were noted between combined human and lightning caused fire densities and mountain pine beetle-caused mortality on the Arapaho NF. Significant differences were found on the White River NF between combined human and lightning caused fire densities occurring with and without mountain pine beetle-caused lodgepole pine mortality. A logistic regression was used to model the probability of an ignition occurring with 1980's mountain pine beetle-caused lodgepole pine mortality on each forest. Elevation of

fire occurrence was the most significant variable to predict fire occurrence with MPB-caused mortality. Probability density functions were created using elevation ranges of MPB-caused lodgepole pine mortality, lightning caused fires prior to 1980, and elevations of fire occurrences intersecting aerially detected MPB-caused mortality post-1980 through 2005 (during and post-outbreaks). Maximum 30 m² probabilities of 0.0046 and 0.0019 were reported for the occurrence of a lightning fire in a 1980's MPB-caused mortality area within the Arapaho NF and White River NF, respectively. Probability quartiles of a lightning fire occurring in MPB-caused mortality were generated across each National Forest for dominated lodgepole pine stands (species composition of lodgepole pine > 50%). Chi square tests for differences in densities of lightning caused fires with and without MPB-caused mortality indicated no significant differences on the Arapaho NF and White River NF. Our analysis suggests that 1980's MPB-caused lodgepole pine mortality has not contributed to an increase in fire frequency over the subsequent twenty five years. The current MPB epidemic is far greater in extent and intensity than reported in the 1980's. The variability in fire occurrence and spatial location intensity of mountain pine beetle outbreaks, past and present, between the Arapaho and White River National Forests demonstrates the limited nature of comparability to other locations. Fire occurrence and spatial relationships with beetle related tree mortality should be reevaluated after the present epidemic has waned.

Evaluation and monitoring mountain pine beetle infestation in fire-injured lodgepole and ponderosa pines

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Mountain pine beetle (*Dendroctonus ponderosae*, MPB) and wildfire are important disturbance agents in western pine forests. The implications of MPB infestation and subsequent mortality of fire-injured trees are of substantial interest to forest managers due to the frequency of wildfire and prescribed burns in western forests. Some bark beetles are known to colonize fire-injured trees such as *D. pseudotsugae* and *Ips spp.* However, previous studies on MPB have yielded conflicting results. In this study we attempt to clarify MPB's role following fire by evaluating 1) if the manner and extent to which variable degrees of fire injury affect MPB colonization and reproduction, 2) whether these relationships differ between lodgepole (*Pinus contorta*) and ponderosa (*P. ponderosa*) pines, and 3) whether beetle colonization occurs within adjacent, unburned trees. We established plots, monitored beetle attacks, and caged infested trees within areas affected by the Neola North Fire of 2007, in the Uinta Mountains of Northern Utah. Our results indicate that MPB is colonizing fire-injured trees, especially those with complete crown damage. In ponderosa pine, colonization occurred in trees of moderate or high fire-injury and reproductive rates increased with the degree of injury. It is unknown if uninjured ponderosa pine will be colonized due to their infrequency within the burn area. Populations have been declining each year since the fire. In lodgepole pine, colonization initially occurred within trees of moderate fire-injury, and then shifted to low and uninjured trees during the two years following the fire. Population levels are remaining stable. We found no relationship between the degree of fire-injury and beetle reproduction rates in lodgepole pine. These results suggest that the initial pool of weakened trees allowed populations to build locally and infest uninjured lodgepole pine the following year. The population

dynamics of MPB following wildfire are dependent on the tree species, and likely, the characteristics of the wildfire (e.g. fire type, intensity), and the resulting mosaic of trees of varying fire injury.

Persistent mitigation and detection to control mountain pine beetle infestations –

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University of British Columbia, Vancouver, British Columbia

Over the period 1999 to 2010, the area of pine forest infested by mountain pine beetles (*Dendroctonus ponderosae* Hopk.) in British Columbia, Canada peaked at over 10 million hectares. The infestation has spread eastward into Alberta over recent years, with various mitigation techniques utilised in an attempt to control the spread of the infestation. Surveys are conducted to determine the location, size, and impact of infestations with three types of surveys commonly utilised: field, airborne, and most recently satellite perspectives. Importantly, the differing survey approaches characterize the infestation over dissimilar spatial scales (*i.e.*, trees, stands, landscapes), and with varying levels of detection accuracy. The data collected from these surveys can be used to inform on the success of mitigation activities. No survey method can be expected to be error free, and therefore some residual infestation can persist as mitigation is based upon removal of infested trees. In this research tree mortality recorded within a network of research plots is used to demonstrate mitigation efficacy in northern British Columbia and Alberta. Following on, we provide background for understanding differing survey approaches, the nature of the information generated, the resultant detection accuracies that may be expected, and the link between survey accuracy and the ability to mitigate a given mountain pine beetle infestation. Based upon this understanding, we model the number of years of mitigation effort required to maintain endemic beetle population levels, as a function of the survey approach used and the expected detection accuracy.

Group B moderated by Darrell Ross

A potential hurdle for MPB spread in the boreal? The jack pine-mediated interaction between jack pine budworm and a MPB fungal associate

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Climate change has facilitated the range expansion of the mountain pine beetle (*Dendroctonus ponderosae* Hopkins; MPB) over the Rocky Mountains from lodgepole pine dominated forests to lodgepole-jack pine hybrid forests and it may soon spread into the jack pine forests of the boreal. In the boreal forest the MPB may interact with a suite of new organisms that could influence its establishment and rate of spread. One important species to consider is the outbreak defoliator the jack pine budworm (*Choristoneura pinus pinus* Freeman; JPBW), which is absent from MPB's historical habitat. Our study was designed to investigate the induction of jack pine seedlings' defences by an induction treatment and the resulting susceptibility or resistance to a successive challenge treatment. Two-year-old jack pine seedlings were defoliated by JPBW and subsequently inoculated with the MPB fungal associate, *Grosmania clavigera*, or

inoculated with *G. clavigera* and subsequently defoliated by JPBW. We found that JPBW defoliation increased seedling resistance to *G. clavigera* but there was no effect of *G. clavigera* induction on JPBW pupal mass. The findings of this research are important to predict future susceptibility of jack pine stands to MPB attacks prior to MPB establishment in jack pine forests.

Paleoecological data and their utility in identifying past bark beetle outbreaks and vegetation response

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Rocky Mountain Research Station, Utah, USA

The landscapes of North America are continuously changing and arguably even more so with the recent changes in climate. The role and nature of disturbance in this changing environment is not well understood. In particular there is very little known about past bark beetle outbreaks and the environmental conditions surrounding them. Currently in North America there are epidemic levels of both spruce beetle (*Dendroctonus rufipennis*) and mountain pine beetle (*D. ponderosae* (MPB)) outbreaks, thought to be exacerbated by warmer and drier climatic conditions. Though fire is better understood, its relationship with MPB outbreaks is not clear. Using paleoecological data will provide land managers with a better understanding of past disturbance events and the corresponding climate conditions, increasing their ability to manage public lands in the future.

Using sedimentary proxies to infer past spruce beetle outbreaks

Jesse Morris,

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University of Utah, Salt Lake City, Utah

Subalpine forests North America are susceptible to fire and bark beetle disturbances, though information regarding the timing and role between these disturbance episodes differs considerably. The recurrence and function of fire throughout the Holocene has been assessed using charcoal from lake sediments. Despite the ecological significance of bark beetle outbreaks, no methodology for detecting these disturbances has been developed. Using pollen records from six subalpine basins in Utah, a calibration study was performed documenting changes in pollen accumulation concurrent with several 20th century spruce beetle (*Dendroctonus rufipennis*) outbreaks. Following the loss of mature Engelmann spruce (*Picea engelmannii*), pollen from subalpine fir (*Abies lasiocarpa*) and other understory components increases relative to spruce. This situation is due to invigorated plant growth resulting from increased available sunlight, moisture and nutrients. The ‘release’ of the understory specimens following a severe spruce beetle outbreak is well documented in US Forest Service stand inventories as well as in tree ring records. The calibration set was then applied to pollen data from a Holocene-length sediment core retrieved from the Wasatch Plateau, located in central Utah. This study provides an important first step in determining the feasibility of using lake sediments to reconstruct non-fire disturbances, specifically for spruce beetle in subalpine forests.

Playing with fire: the effect of prescribed burns on mountain pine beetle population dynamics

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J. Park, D. Perrakis, and N. Erbilgin,
University of Alberta, Edmonton, Alberta

Mountain pine beetles (MPB) are significant insect pests of Alberta's lodgepole pine. Prescribed fires are used to remove potential hosts but physiologically stressed trees may be more susceptible to attack and fire poses the risk of leaving live, yet partially burned—and therefore stressed—trees in its wake. This may promote MPB population growth in burned areas and allow the beetles to overwhelm healthy adjacent trees. However, the responses of MPB natural enemies and competitors to prescribed fire may mediate MPB-fire interactions. Therefore, an integrated approach addressing multiple scales is needed to improve our understanding of beetle responses to fire-injured trees. Our main objectives therefore are 1) to investigate how prescribed fire influences MPB populations across a landscape of lodgepole pine forests over a three-year period, 2) to determine whether burned stands will become sinks or sources for MPB populations, and (3) to provide ecologically meaningful explanations for these responses, specifically in relation to natural enemies and competitors.

Effects of interactions between mountain pine beetle-associated bacteria, fungi, and combinations of the two on beetle reproduction in three host tree species

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Each year bark beetle outbreaks in the United States and Canada are responsible for the destruction of millions of hectares of forests. In the western parts of the United States and Canada, focus has shifted specifically to the mountain pine beetle (*Dendroctonus ponderosae* Hopkins) because this beetle species has caused significant economic and ecological impact on the western conifer forests.

Much research has been conducted to determine the causes of outbreaks and to search for potential methods of controlling beetle populations. This research has led to the discovery of microbial species that are commonly associated with the mountain pine beetle. The majority of this research has focused on the fungi, while little research has been done to determine the role of the bacteria. Thus, the aim of our research is to determine the role of combinations of beetle-associated bacteria and fungi on mountain pine beetle reproduction in three host tree species; Jack Pine, Lodgepole Pine, and hybrid Jack-Lodgepole Pine. To achieve this goal, fifteen individuals of each host tree will be felled and used to create phloem sandwiches. Each phloem sandwich will be inoculated with one of the fungal species or a sterile broth (control). One male-female beetle combination that has been treated with one of the bacterial species will be introduced to each phloem sandwich. The beetles will be monitored until the pupal phase. Factors including egg and larval gallery length, oviposition, and larval survival and emergence rates will be recorded.

Group C moderated by Richard Hofstetter

The secret acoustic life of bark beetles

Kasey Yturralde,

and Richard Hofstetter,

Northern Arizona University, Flagstaff, Arizona

Bark beetles use sound during pair formation and both acoustic and chemical signals are used to coordinate mate acceptance, release of anti-aggregation pheromones and mating. Despite the importance of acoustic signals for bark beetle reproduction and aggregation in host trees, research has lagged behind that of their chemical ecology. Indeed, the structure(s) used to detect sound are wholly unknown in bark beetles. We describe a research program that aims to better understand how acoustic communication mediates interactions among and within bark beetle species. This research will incorporate ecological interactions and evolutionary history into our understanding of how scolytid beetles utilize acoustic signals. Patterns in bark beetle acoustic communication and structures may mirror phylogenetic patterns in life history strategies and mating systems. For example, acoustic signals used during reproduction may vary according to the number of individuals in a gallery, which varies in polygynous mating systems such as *Ips* spp. In addition, unintended receivers of bark beetle acoustic signals, such as Trogositid and Clerid beetles, may potentially exploit acoustic calls in a manner similar to their use of kairomones.

**I can see clearly now the paint is gone: The role of vision in host selection of
Warren root collar weevil, *Hylobius warreni***

Laura Machial,

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Canadian Forest Service, Natural Resources Canada, Prince George, BC

Warren root collar weevil, *Hylobius warreni*, is a native insect found throughout Canada's boreal forest. In British Columbia, the weevil's primary host is lodgepole pine, *Pinus contorta*. While adults inflict minimal damage upon their hosts, larvae feeding can girdle young trees potentially causing tree death. Little is known, however, about the weevil's mechanisms of host selection. Two experiments testing the use of vision in weevil host choice were conducted using plastic Christmas trees and ABS pipe "trunks" during the summer of 2009. In one experiment, movement of blinded and non-blinded weevils towards conifer tree silhouettes was compared. In the other experiment, four treatments comparing the effects of different silhouettes were investigated. The treatments included plastic silhouettes of a tree trunk, tree foliage, full trees, and blank controls. Preliminary results from these experiments indicate that visual cues influence host selection. Findings from this study may aid in the development of management strategies using traps in plantations that are at high risk of weevil-induced mortality. Such plantations may become more numerous in the central interior of British Columbia due to landscape changes as a result of the mountain pine beetle epidemic.

**Characterizing the ecology of a yeast associated with the western pine beetle,
*Dendroctonus brevicomis***

T. Seth Davis,

Richard Hofstetter, J. Foster, P. Keim, and N. Foote,
Northern Arizona University, Flagstaff, Arizona

The ecological roles of symbiotic yeasts in bark beetle systems are poorly understood. We isolated the yeast *Ogataea pini* from mycangia of western pine beetle (*Dendroctonus brevicomis*) populations in northern Arizona (U.S.A.) with a frequency of 56%. We performed a series of *in vitro* assays to test whether compounds produced by *O. pini* affected growth rates of mutualistic and antagonistic species of filamentous fungi commonly found in association with the beetle, including *Entomocorticium* sp. B, *Ophiostoma minus*, *Beauveria bassiana*, and an *Aspergillus* sp. We also determined the compounds produced by *O. pini* when grown on 2% malt extract agar using a gas chromatography/mass spectrometry (GC/MS) analysis of headspace volatiles. In *in vitro* assays, the presence of *O. pini* significantly enhanced growth of the mutualistic *Entomocorticium* sp. B, and inhibited growth of the entomopathogenic fungus *B. bassiana*. GC/MS revealed that *O. pini* produced ethanol, carbon disulfide (CS₂), and Δ-3-carene in headspace. These results indicate that yeast species may play an important role in mediating interactions between multiple fungal associated of beetles, and that compounds produced by yeasts may contribute substantially to the chemical environment in colonized trees.

The heritability of size and the effects of size on fitness and fecundity in bark beetles

Chris Foelker,

Richard Hofstetter, and T. Seth Davis,
Northern Arizona University, Flagstaff, Arizona

Phleophagous herbivores in the insect family Curculionidae are both ecologically and economically influential to many coniferous forests in the western United States. There has been considerable research focus on the population dynamics of bark beetles because of widespread host mortality and their importance in natural resource management. Beetle fitness is a key factor in achieving stand-replacing population levels. Beetle size is often used as a proxy for fitness because it is known to have a significant effect on the quality and quantity of breeding opportunities. Our pilot study investigated parental influences on offspring phenotype in a primary bark beetle, *Dendroctonus brevicomis*. We tested the narrow-sense heritability of beetle size and its significance in fecundity through a controlled laboratory experiment using live beetles and individual bolts of *Pinus ponderosa*. We examined the influences of parental beetle size and sex on progeny size, number of progeny, and oviposition gallery length. We discuss results with an emphasis on beetle size's influence on behavior and evolution. We also outline improvements and plans for future studies.

Evaluating alternative approaches to using carabid beetles (Coleoptera: Carabidae) as bioindicators in coastal forests of British Columbia

Sean G. Henderson,

M.A. Todd and B. S. Lindgren
University of Northern British Columbia, Prince George, British Columbia

Carabid beetles (Coleoptera: Carabidae) have received a great deal of attention as biological indicators (bioindicators) due to their well established taxonomy and ubiquitous nature

in addition to several other appealing characteristics. Unfortunately there is a shortage of trained taxonomists, and of those that remain many are unavailable to researchers due to limited time and resources. In this presentation, I compare two alternative approaches to bioindication compared to a traditional taxonomic approach using carabid beetles. A functional approach yielded slightly more in-depth information than the taxonomic approach, but at a considerable additional investment of time. On the other hand, using a recognizable taxonomic unit approach yielded similar results to the taxonomic approach in some respects, but failed to provide the same level of precision in others. All three approaches were found to have advantages and disadvantages, so I conclude that the choice of approach will largely depend upon the goals of individual bioindication studies and the availability of resources.

Population dynamics of secondary bark beetles on the rate of tree mortality in the collapse phase of an outbreak of *Dendroctonus ponderosae* (Coleoptera: Scolytidae)
Ewing Teen,

Allan Carroll², and Brian. H. Aukema¹,

¹University of Northern British Columbia, Canada. ²University of British Columbia, Canada.

³Canadian Forest Service, Natural Resources Canada.

Dendroctonus ponderosae (Hopkins), or mountain pine beetle (MPB), is a natural disturbance agent found throughout pine forests of British Columbia, Canada. All pines are suitable hosts for *D. ponderosae*, but in British Columbia, the primary host is lodgepole pine (*Pinus contorta* var. *latifolia* Engelman). *D. ponderosae* has killed mature pines over a cumulative area of 14.5 million hectares, or a total of 620 million cubic meters of timber, in British Columbia and Alberta, since the current outbreak began around 1997. *D. ponderosae* typically acts as a biotic disturbance that maintains forest hygiene by removing weakened and decadent trees at endemic populations, but in outbreak mode, that same agent can exert a landscape-level mortality.

As *D. ponderosae* depletes the larger trees in outbreak situations, there is a correlation in the increase of breeding materials for secondary bark beetles, such as *Ips pini* (Say) and *Pseudips mexicanus* (Hopkins). These secondary bark beetles may sustain the outbreak, since at high-density population levels, secondary beetles have the ability to kill healthy, smaller-diameter, residual trees within the stands, in which *D. ponderosae* does not reproduce or compete very well. We present preliminary data on a project that examines the stand-level interactions between the bark beetle species and their association with residual trees at the post-outbreak stage of *D. ponderosae* in the north central region of British Columbia. This study evaluates for the future timber supply of the surviving trees, examining their species composition and health conditions, and the rate of tree mortality for future preventive measures and greater understanding of the interactions between *D. ponderosae* and secondary bark beetles.

BREAKOUT SESSION I

“Ecosystem community genetics”

moderated by Tom Whitham, Northern Arizona University, Flagstaff, Arizona

Overview of the community genetics of foundation forest trees as drivers of arthropod diversity and evolution

Thomas G. Whitham, Northern Arizona University, Flagstaff, Arizona

The community phenotypes and genetic structure of foundation species, often forest trees, are especially important to quantify as these species are by definition, “community and ecosystem drivers”. A key finding from the research of this field is that different tree genotypes support different communities of organisms and that these differences can be quantified as heritable plant traits. Thus, genetic diversity in a foundation tree species affects biodiversity and is very important to conserve even when these trees are extremely common on the landscape. Using diverse examples from microbes to vertebrates, the community phenotypes of forest trees can be traced from the individuals possessing the trait, to the community, and to ecosystem processes such as leaf litter decomposition and N mineralization. Any agent of selection such as climate change that affects the distribution and genetic structure of foundation trees is likely to have cascading impacts, both ecological and evolutionary, on the rest of the ecosystem. Such a community genetics approach allows us to place community and ecosystem ecology within an evolutionary framework, and make better management decisions concerning conservation, biodiversity, climate change, and genetic engineering. With this as an introduction to the field of community genetics, the four speakers in this session develop specific case studies with the arthropod communities of *Populus* and *Pinus*.

**Climate alters the expression of genetic-based interactions of pine and herbivores:
Consequences for diverse arthropod community**

Adrian C. Stone, Northern Arizona University, Flagstaff, Arizona

Understanding genetic by climate interactions among species will help improve predictions of the effects of climate change on biodiversity. However, few studies have examined such interactions, particularly within a community context. Pinyon pine shows genetic-based resistance and susceptibility to pinyon needle scale (*Matsucoccus acalyptus*). Scales alter the architecture of susceptible trees making it difficult to separate the direct influences of susceptibility from the indirect influences of scale-altered tree morphology. To separate these influences, scales were excluded from susceptible trees for 15 years creating susceptible trees with the morphology of resistant trees. We contrast findings from a record drought year with a moderate drought year to describe how susceptibility to herbivory interacts with extreme drought to affect arthropod community diversity. Two patterns emerged. 1) In both record and moderate drought conditions the indirect influence of susceptibility to scale reduced arthropod richness 2-3X and abundance 3-4X on susceptible trees, but there was a significant interaction with year in which the reduction in richness and abundance on susceptible trees was greater in the moderate drought year. 2) Under moderate drought conditions, the indirect influence of scale susceptibility played a central role in determining community composition, while under record drought conditions the herbivore’s role is minimal relative to the direct genetic influence of pinyon on the arthropod community. These results argue that extreme climatic events have the potential to change fundamental interactions among foundation plants and herbivores to affect important community traits, and should be considered when modeling the affects of climate on biodiversity.

Community genetics of Fremont cottonwood and allopatric/sympatric relationships with willows define arthropod community

Sharon M. Ferrier, Randy K. Bangert, Erika Hersch-Green, Kevin Grady, Alicyn Gitlin, Karla Kennedy, Laura Hagenauer, Gery Allan, & Tom Whitham; Northern Arizona University, Flagstaff, Arizona

In a large restoration garden experiment, we find that plant phenotypic traits and the dependent arthropod community are driven by intra-specific genetic variation in Fremont cottonwood among multiple source populations that range across the Basin and Range Province in Arizona (171,000 km²). The population variation in phenotypic traits and arthropod community are correlated to the elevational cline of the source populations, suggesting that local adaptation could be driving population differentiation. Additionally, we find that planting intact plant communities increases plant productivity and scales up to positively effect arthropod richness and abundance. Intact communities are where all individuals come from the same source population. These blocks were compared with blocks where all plants were randomly selected from all source populations.

Community genetics of heritability, repeatability, and stability of narrowleaf cottonwood
Arthur R. Keith, Northern Arizona University, Flagstaff, Arizona

Recent studies have shown that genetically based traits of plants can structure associated arthropod and microbial communities, but whether the effects are consistent and repeatable across years is unknown. If communities are both heritable (i.e., related individuals tend to support similar communities) and repeatable (i.e., the same patterns observed over multiple years), then plant genetics may also affect community properties previously thought to be emergent such as ‘stability’. Using replicated clones of narrowleaf cottonwood (*Populus angustifolia*) and examining an arthropod community of 103 species, we found that: 1. Individual tree genotypes supported significantly different arthropod communities, which exhibited broad-sense heritability. 2. These findings were highly repeatable over 3 consecutive years ($r = 0.91$) indicating that community responses to individual tree genotypes are consistent from year-to-year. 3. Differences among tree genotypes in community stability (i.e., changes in community composition over multiple years) exhibited broad-sense heritability ($H^2_C = 0.32$). In combination, these findings suggest that an emergent property such as stability can be genetically based and thus subject to natural selection while this study demonstrates the potential for a community genetics perspective to aid in understanding complex community traits.

Natural forest hybrid zones drive cryptic speciation in arthropods
Luke M. Evans,
Northern Arizona University, Flagstaff, Arizona

Interactions with plants can have evolutionary consequences for herbivores. Understanding these interactions is important to understand arthropod diversity, speciation, and economically important pest management. Plant genetic variation is one factor that can have strong effects on herbivores. However, this host genetic variation occurs along a scale, from differences among species, to plant hybrids versus parental species, to different populations, to differences among individuals. At what point along this scale does herbivore adaptation and differentiation occur? We addressed this question by exploring differentiation of *Aceria parapopuli*, a bud-galling mite found on *Populus* throughout North America, at these different levels of variation in its *Populus* hosts. We found strong evidence of morphologically cryptic

species of mites occurring on different *Populus* species and also on *Populus* hybrid trees. We also found genetic differentiation of mites on different populations of host trees, but this was less than that found among host tree species. Little differentiation occurs among individual host trees; however, reciprocal transfer experiments indicate adaptation of mites to individual trees, indicating strong selection in the face of homogenizing gene flow. Overall, mite differentiation was diminished at finer levels of the scale of host plant genetic variation, although there is still evidence for performance differences of mites at the lowest host levels. We conclude that *Populus* genetic variation at multiple scales can have important evolutionary consequences for *A. parapopuli*. Furthermore, levels below that of the host species must be investigated, as well as additional arthropods, to understand herbivore differentiation.

“GIS/Remote sensing applications for forest health”

**moderated by Ryan Hanavan, USDA FS, Forest Health Protection, Flagstaff,
Arizona**

Beginning the Risk Map Revision – Examples from the Interior West

Daniel Ryerson

U.S. Forest Service, Region 3 Forest Health, New Mexico Zone Office

The National Insect and Disease Risk Map is an effort to assess the risk of tree mortality due to major insects and diseases. The 2012 risk map revision builds upon the multi-criteria framework and progress of the 2006 effort. The Forest Service’s Forest Health Technology Enterprise Team is leading the revision effort through development of an application to standardize and streamline the methodology used in the 2006 map, while still remaining flexible to accommodate the variability of regional models. Additionally new, more detailed host tree species data are being developed. These new data layers are a significant improvement and will allow a finer resolution nation-wide product at a 240 meter pixel resolution, with the ability to run models at local levels with 30 meter versions of the host base data. The improved data alone will result in better assessments that will be usable at scales that were not suitable with the previous version. Currently in the Interior West, the 2006 models are being entered into the new application and evaluated with input from cooperating specialists. The results of the models are different than in the prior version from the updated base data alone. Additionally, revision of some models has begun. Draft models and map products will be available for review at the 2011 Forest Health Monitoring workshop.

Data Sources for Forest Impact Analyses

Eric Smith

USDA Forest Service, Forest Health Technology Enterprise Team, Fort Collins, Colorado

The focus this session was the use and abuse of Forest Inventory and Analysis (FIA) data and Aerial Detection Survey (ADS) for insect impact studies and other research applications. Mike Thompson gave an overview of FIA design basics and how the FIA tree mortality per year estimate is calculated. He then reviewed the bark beetle mortality analysis and results from the paper he recently published in the Western Journal of Applied Forestry.

Dan Ryerson gave a demonstration of how the digital sketch map system works and provided a system for the participants to examine. Differences in Regional procedures and protocols were discussed. Keith Sprengel discussed the aerial survey program and showed the results of a user survey from a previous WFIWC. The survey showed uses of ADS data for reporting, planning, and analysis.

Mike Simpson described a recent study performed by he and coauthors involving the comparison of ADS mortality data from mountain pine beetle in lodgepole pine with sampled ground plot data. The major finding of the study was that the ADS data missed a significant amount of mortality, particularly in smaller trees and where the mortality was lighter. In an area which had considerable mortality in the past, it appears newer mortality didn't show up well and was missed.

Current Remote Sensing Applications for Forest Health **Jim Ellenwood**

USDA Forest Service, Forest Health Technology Enterprise Team, Fort Collins, Colorado

The 2011 National Insect and Disease Risk Map will have improved host mapping for individual tree species. Products for the intermountain will be demonstrated. The status of the MODIS-based Forest Disturbance Mapping Project, a joint project between RSAC and FHTET, will be updated and plans for the 2010 season will be discussed.

Pinaleño LiDAR: Evaluating forest landscape and health factors and their relationship to habitat of an endangered red squirrel

Craig Wilcox, John Anhold, Denise Laes, Tom Mellin, Donald Falk, John Koprowski, Melisa Merrick, Tyson Swetnam, Kit O'Connor, Ann Lynch and Marit Alanen

USDA Forest Service, Coronado National Forest, Safford, Arizona

The Pinaleño Mountains, an isolated sky island in southeastern Arizona, contains the southern most expanse of a spruce-fir forest type in North America as well as one of the most extensive mixed-conifer forest types this far south. The high elevation ecosystems support the only habitat for the Mount Graham red squirrel (*Tamiasciurus hudsonicus grahamensis*) (MGRS), an endangered species. Changes in forest composition and structure along with several recent large and severe wildfires and devastating insect outbreaks, has greatly altered the habitat for the MGRS. This has led the forest to begin a forest restoration effort, attempting to balance fuels reduction and habitat conservation. As part of this restoration effort, the Coronado NF is pursuing airborne lidar technology as a potentially cost effective way to provide current and detailed information on forest structure.

Airborne lidar data was collected in 2008, covering 85,000 acres of the Pinaleños. After a quality assessment of the data, numerous base raster GIS layers were developed containing forest canopy, structure, and fuels related information extracted from the lidar point cloud. These lidar-derived raster data layers included forest floor and fuel bed models, canopy surface and height models, volume and outer surface area models, and bare earth models. This process is described in the report RSAC-0118-RPT1 (June 2009). Field data will be used to establish statistical relationships between the conditions on the ground and the lidar raster GIS data. These relationships will be used to model forest structural components to improve the understanding of

current forest conditions. The final phase of the project – establishing the statistical relationships between the field and lidar-derived layers – will be completed in 2010.

**“Monitoring and assessment of mountain pine beetle assessment on
Rocky Mountain forests”**

**moderated by Jesse Logan (USDA Forest Service, Rocky Mountain Research
Station, Emigrant, Montana), Steve Munson & William Macfarlane**

Using Remotely Sensed Imagery to Map Insect-Caused Tree Mortality

Jeffrey A. Hicke

USDA Forest Service Western Wildland Environmental Threat Assessment Center
University of Idaho

The widespread tree mortality caused by bark beetle outbreaks in western North America suggests large scale impacts to forest ecosystems. However, evaluating impacts requires accurate information about the spatial extent and severity of tree mortality. Databases of tree mortality produced by aerial surveys in the US and Canada are a rich source of information, but have distinct disadvantages that include lack of complete spatial coverage, subjectivity, and inability to replicate or improve upon past observations. Satellite remote sensing offers the capacity to augment aerial surveys through objective, consistent, repeatable methods that can span decades and continents. Such methods also have disadvantages that may include coarse spatial and temporal resolution, contamination by atmospheric effects, cost, and limited temporal extent. In this talk, I will discuss multiple instruments potentially suitable for mapping and monitoring tree mortality, and will describe advantages and disadvantages of each. I will also highlight difficulties associated with evaluation. I will present results of mapping efforts based on very fine resolution (30 cm) aerial imagery to coarse resolution (1 km) MODIS imagery as illustrations.

**Aerial assessment of mountain pine beetle-caused whitebark pine mortality
in the Greater Yellowstone Ecosystem**

W. W. Macfarlane¹, J. A. Logan² and W.R Kern³

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An aerial survey method called the Landscape Assessment System (LAS) was used to assess mountain pine beetle (*Dendroctonus ponderosae*)-caused mortality of whitebark pine (*Pinus albicaulis*) in the Greater Yellowstone Ecosystem. The LAS method consisted of 8,673 km of flightlines, along which 4,653 geo-tagged, small catchment-level aerial photos were captured and processed. During processing, the condition of the whitebark pine in each small catchment was examined and a mortality rating from zero to six was assigned based on the amount of red (recent attack) and gray (old attack) trees visible. Zero represents no unusual mortality, one represents the occasional spot of red trees, two represents multiple spots of red trees, three represents large coalesced spots of red trees, four represents an entire small catchment that is red and five through six represents small catchments where the outbreak cycle

has ended (no remaining red trees) with ratings assigned depending on the amount of gray versus green trees visible (a five rating some green and a 6 rating no green remaining) Within a GIS the photo point locations were intersected with small catchment boundaries to create a polygon-based mortality layer for the photo-inventoried whitebark pine distribution (79% by area). For the remaining non-photo-inventoried small catchments (21% by area) a surface was interpolated that served as a mortality estimate for these areas. Results that combine the photo-inventoried and interpolated mortality values indicate that 46 percent of the small catchments showed high mortality, 36 percent showed moderate mortality, 13 percent showed low mortality and 5 percent showed no unusual mortality. These results reveal that whitebark pine mortality is more severe and widespread than indicated from either previous modeling research or aerial surveys and has likely resulted in the depreciation of ecological services provided by this foundation and keystone species. Future research aimed at documenting and quantifying the ecological impacts of whitebark pine decline is warranted.

Ground Plots for Measuring Mountain Pine Beetle Activity Brytten Steed,

USDA Forest Service, Forest Health Protection, North Region, Missoula, Montana
When evaluating hazard, risk, or tree mortality associated with mountain pine beetle (MPB) ground plots are often used by Forest Health Protection (FHP) staff. Both existing and new plots are used to evaluate stand susceptibility or current beetle impacts. The use of Forest Inventory and Analyses (FIA) ground plots, although installed for reasons other than MPB evaluation, may have some utility to assess bark beetle activity, hazard and risk. To understand the utility associated with FIA plots and FIA protocols a potential user should be aware of what data is collected and how it could be used, the benefits of revisiting their plots to take additional data, and why you might intensify the FIA grid with additional plots. Examples, most from the Northern Region (R1), help demonstrate how FIA data is currently being applied to address questions related to the current MPB outbreak. A second type of ground plot data, Forest Insect and Disease Tally system (FINDIT) plots, can also be very useful for these assessments and are easy to install and analyze. Although this tool has been available for many years, most of its use has occurred in the Intermountain and Northern Regions of the Forest Service. We highlighted this tool - its inputs and outputs – and described some of the efforts being undertaken to update it.

Assessing MPB Damage: 10 Year Summary of Aerial Survey and Potential for Remote Sensing Monitoring Using MODIS Jim Ellenwood,

USDA Forest Service, Forest Health Technology Enterprise Team, Fort Collins, Colorado

“Invasive insects” moderated by Kristen Waring, Northern Arizona University, Flagstaff, Arizona

This session will focus on a wide variety of invasive species, from newly detected to insect/pathogen interactions. The new detections include four species recently found in Washington state (mountain ash sawfly, California fivespined ips, a sawfly in Oregon white oak,

and spotted wing Drosophila), and a new seed beetle in Mexico. Also included will be emerald ash borer and mites and Dutch elm disease. Following the four presentations, the last 15 minutes will be devoted to a panel discussion and Q & A with the speakers.

Will EAB Kick Your Ash?

Deborah G. McCullough, Michigan State University, East Lansing, Michigan

***Specularius impressithorax* (Coleoptera: Bruchidae): An exotic seed beetle hazardous to Mexican *Erythrina* species (Leguminosae)**

Jesús Romero Nápoles, Colegio de Postgraduados, Montecillo, Estado de Mexico, Mexico

Specularius is an Old World genus, according to Kingsolver & Decelle (1979) there are nine species and two subspecies; however, the genus must be reviewed in the future. The most important species in the genus is *Specularius impressithorax* (Pic) because of its wide distribution and that it feeds in various species of *Erythrina*. The other species of *Specularius* feed on other legumes, except *Specularius ghesquierei* that feeds on unidentified species of *Erythrina*.

The genus *Erythrina* is a flowering plant that is pantropic in distribution. In 1974, Krukoff & Barnaby (*Lloydia* 37:332-458) did a revision of the genus and recognized 105 species, later in 1977, Gunn & Barnes (*Lloydia* 40:454-470) described the seeds of 101 species. Neil (1988. *Ann. Missouri Bot. Gard.* 75:886-969.) studied the biosystematic relationships of the species and recognized 112. Barrera *et al.* (2002. *In: Tropical Tree: Seed Manual*. J.A. Vozzo Editor. USDA Forest Service, USA. 455-457) mentioned that *Erythrina* includes 117 species, most of the them are used as ornamentals, however some species such as *Erythrina edulis* are used in South America as food because their flowers are prepared in salads and sweets and infusion taken for anxiety and urinary problems. In agroalimentary programs seeds are transformed in flour with high protein content.

In January 6, 2007 were collected seeds of *E. coralloides* DC. on campus of Colegio de Postgraduados, Montecillo, Estado de Mexico. The coordinates site are 19°27'45.73''N and 98°54'13.03''W at 2256 m above sea level. After some days emerged bruchids of the seeds. For identification we followed the Kingsolver (1986. *Entomography* 4:109-136) and Romero & Johnson (1999. *Coleopt. Bull.*, 53:87-98.) technique for genitalia study. The genitalia were compared with specimens of *S. impressithorax* deposited in the Entomological Collection of Fitosanitary Institute at Postgraduate College (CEAM). All material was pinned and labelled and stored at CEAM.

The bruchid species was identified as *Specularius impressithorax* (Pic), and constitutes the first report for this exotic species to Mexico. The analysis of 293 seeds showed that 169 (57.68%) were healthy, 84 (28.67%) seeds had eggs on them but without operculum of emergence; however, some of these were fertile. This was easy to corroborate because after removing the egg the entrance hole that the larva made could be seen and dust could be seen inside of the egg, however none of these reached the adult stage. Translucent eggs were not fertile, sometimes it was possible to see the small dead larva inside of the egg. The remaining 40 seeds (13.65%), showed one to nine glued eggs plus one to six per seed.

According to Romero & Johnson (2004) the only species of *Specularius* that feed on *Erythrina* are *Specularius ghesquierei* on *Erythrina* sp. (Democratic Republic of Congo) and the following host for *S. impressithorax*: *Erythrina abyssinica* DC. (Sudafrica & Zimbabwe), *Erythrina abyssinica* DC. subsp. *abyssinica* DC. (Tanzania), *Erythrina caffra* Thunb., *Erythrina cristagalli* L., *Erythrina humeana* Sprengel (Rhodesia), *Erythrina latissima* E. Mey., *Erythrina lysistemon* Hutch., *Erythrina mildbraedii* Harms (Nigeria), *Erythrina orophila* Ghesq., *Erythrina pallida* Britton, *Erythrina sandwicensis* Degener (Hawaii), *Erythrina senegalensis* DC. (Angola, Ghana, Nigeria), *Erythrina variegata* L. (India). Therefore, *Erythrina coralloides* DC. is a new host record for this species.

At this moment, I do not know how widely *S. impressithorax* is distributed in the world, but the first introduction out from Africa occurred in Hawaii in 2002, where it fed on endemic species (*Erythrina sandwicensis*); later in 2004 the bruchid was found in Los Angeles, California, feeding on an indeterminate species of *Erythrina*, then in 2007 in Distrito Federal, Mexico.

New Detections of Exotic or Invasive Pests in Washington State

Karen Ripley and Glenn Kohler,
Washington DNR, Olympia, Washington

Briefly introduced 4 insects newly observed in Washington in 2009:

- The mountain ash sawfly *Pristiphora geniculata*, a defoliator of *Sorbus spp.* Originated in Europe, was first reported in North America in 1926 in New York State, and now is in most of NE US and eastern Canada. Was reported defoliating mountain ash in Seattle in 2009. Two generations were observed. No regulatory action is anticipated. <http://www.fs.fed.us/r6/nr/fid/invasives/mtn-ash-sawfly.shtml>
- *Ips paraconfusus*, the California fivespined ips, was previously known from Southern Oregon and California, west of the summit of the Cascade and Sierra Nevada mountains. All species of pines may be hosts. Ponderosa pine is most susceptible. In late 2009, it was collected from dying ponderosa pine trees near Underwood, WA, just north of Oregon. This is probably simply new documentation, rather than a true range expansion. *I. paraconfusus* does not respond to the “exotic Ips” lure used in the EDRR program and has not been previously known from WA. It responds to an *I. paraconfusus* lure used recently in western Oregon by Flowers and Willhite (WFIWC poster in 2009). More sampling will occur in 2010 to further evaluate the range. See FIDL#102 www.fs.fed.us/r6/nr/fid/fidls/fidl-102.pdf
- A “slug” sawfly was observed causing heavy defoliation (skeletonizing) of Oregon white oak *Quercus gerryianna* near Olympia, WA in June, 2009. “The genus *Caliroa* includes seven species that feed on oak foliage. All are found in the eastern half of North America and all are potentially important defoliators (W.T. Johnson and H.H. Lyon. 1976. Insects that Feed on Trees and Shrubs. Cornell University Press, 2nd ed., pg 130.)” An attempt will be made to collect adults and seek identification in 2010.
- Spotted Wing Drosophila (*Drosophila suzukii*) “SWD”. Of 3000 described species of *Drosophila*, only two are known as pests of ripening fruit (vs. overripe or damaged fruit). SWD has been observed in high numbers on/in many thin-skinned berries and fruit crops in many places including BC, WA, OR, CA and FL. Blackberries, blueberries, cherries,

grapes, strawberries, peaches, and many other fruit crops are affected. This is going to be a very serious pest. Over 90% of blackberries in Karen's yard were infested in 2009. SWD originated in Hokkaido Japan, so cold temperatures are unlikely to prevent its establishment in most of North America. Specimens were collected all winter 2009-2010 near Seattle. SWD is easily trapped in BROWN apple cider vinegar (not white). http://oregon.gov/ODA/PLANT/docs/pdf/ippm_alert_d_suzukii.pdf

Mites that drive Dutch Elm Disease

John Moser, USDA Forest Service, Pineville, Louisiana

Dutch elm disease (DED) is a destructive vascular wilt disease of elm (*Ulmus*) trees caused by the introduced ascomycete fungus *Ophiostoma novo-ulmi*. In Europe this DED pathogen is transmitted by elm bark beetles in the genus *Scolytus*. These insects carry phoretic mites to new, suitable habitats. The aim of this study was to record and quantify conidia and ascospores of *O. novo-ulmi* on mites phoretic on the three elm bark beetle species *Scolytus multistriatus*, *S. pygmaeus* and *S. scolytus*. Spores of *O. novo-ulmi* were found on four of the ten mite species phoretic on *Scolytus* spp. These included *Elattoma fraxini*, *Proctolaelaps scolyti*, *Pseudotarsonemoides eccoptogasteri* and *Tarsonemus crassus*. All four species had spores attached externally to their body surfaces. However, *T. crassus* carried most spores within its sporothecae, two paired, pocket-like structures adapted for fungal transmission. Individuals of *Pr. scolyti* also had *O. novo-ulmi* conidia and ascospores frequently in their digestive system, where they may remain viable. While *E. fraxini* and *Ps. eccoptogasteri* rarely had spores attached to their bodies, large portions of *Pr. scolyti* and *T. crassus* carried significant numbers of conidia and/or ascospores of *O. novo-ulmi*. *Proctolaelaps scolyti* and *T. crassus*, which likely are fungivores, may thus contribute to the transmission of *O. novo-ulmi*, by increasing the spore loads of individual *Scolytus* beetles during their maturation feeding on twigs of healthy elm trees, enhancing the chance for successful infection with the pathogen. Only *S. scolytus*, which is the most efficient vector of *O. novo-ulmi* in Europe, carried high numbers of *Pr. scolyti* and *T. crassus*, in contrast to *S. multistriatus* and *S. pygmaeus*, which are known as less efficient vectors. The high efficiency of *S. scolytus* in spreading Dutch elm disease may be partly due to its association with these two mites and the hyperphoretic spores of *O. novo-ulmi* they carry.

BREAKOUT SESSION II

“Tree mortality processes”

**moderated by Monica Gaylord, Jeff Kane & Tom Kolb,
Northern Arizona University, Flagstaff, Arizona**

Recent increases in tree mortality have been documented in a number of forest types throughout the western United States and Canada. Many of these forest types have been subject to multiple stressors including warmer temperatures, drought, and/or insect attack; highlighting our uncertainty in the mechanisms of tree death. In this workshop, we explore some new insights into the internal properties of trees that may improve our understanding of tree mortality processes.

Novel interactions with naïve hosts: consequences of range expansion

by an eruptive herbivore –

Allan Carroll (University of British Columbia, Vancouver, British Columbia), K.P. Bleiker, E.L. Clark, D.P.W. Huber, T.J. Cudmore, B.S. Lindgren

Importance of resin ducts in reducing ponderosa pine mortality from bark beetle attack

Jeff Kane, and T. Kolb,
Northern Arizona University, Flagstaff, Arizona

The relative importance of growth and defense to tree mortality during drought and bark beetle attacks is poorly understood. We addressed this issue by comparing growth and defense characteristics between 25 pairs of ponderosa pine (*Pinus ponderosa*) trees that survived and trees that died from drought-associated bark beetle attacks in forests of northern Arizona, USA. The three major findings of our research were: 1) xylem resin ducts in live trees were > 10% larger (diameter), > 25% denser (# of resin ducts mm⁻²), and composed > 50% more area per unit ring growth than dead trees; 2) measures of defense, such as resin duct production (# of resin ducts yr⁻¹) and the proportion of xylem ring area to resin ducts, not growth, were the best model parameters of ponderosa pine mortality; and 3) most correlations between annual variation in growth and resin duct characteristics were positive suggesting that conditions conducive to growth also increase resin duct production. Our results suggest that trees that survive drought and subsequent bark beetle attacks invest more carbon in resin defense than trees that die, and that carbon allocation to resin ducts is a more important determinant of tree mortality than allocation to radial growth.

Mechanisms of drought-induced tree mortality: current hypothesis and future research

Anna Sala¹, Frida Piper² and Günter Hoch³

¹Division of Biological Sciences, The University of Montana, Missoula MT-59812; ²Centro de Investigación en Ecosistemas de la Patagonia Bilbao 449, Coyhaique Chile; ³Institute of Botany University of Basel Schönbeinstrasse 6 CH-4056 Basel Switzerland

Two intrinsic physiological mechanisms have been proposed to explain drought-induced tree mortality (McDowell et al. (2008): interruption of water transport due to hydraulic failure, and exhaustion of carbon reserves leading to carbon starvation and death (carbon starvation hypothesis; CSH). We argue that the CSH as stated is problematic because it rests on untested assumptions which involve other possible mechanisms. Evidence so far indicates that: 1) C-reserve exhaustion preceding tree mortality under water stress has not been directly demonstrated to date; 2) concentration of stored C in woody plants do not necessarily decrease under water stress; 4) the mobilization and translocation of stored C is sensitive to water stress which violates an implicit assumption of the CSH. Accordingly, insufficient C supply to cells could occur regardless of amount of stored C. In other words, carbon starvation at the cellular level could occur under drought not as a result of exhaustion of carbon reserves but as a result of the inability of trees to mobilize and transport these reserves. This distinction is critical because it involves fundamentally different mechanisms with important implications for physiology, ecology, and management. For instance, the assumption that water stress reduces carbon availability for defense production requires further testing. Because the mechanisms responsible for drought-induced tree mortality are still elusive, premature acceptance of the CSH as stated

(depletion of reserves) is dangerous because it detracts from critical research in tree physiology to fully understand tree, forest, and ecosystem responses to global change.

Does drought predispose piñon pine trees to insect attack?

Monica Gaylord, T. Kolb, N. McDowell, W. Pockmann, E. Yezpe, J. Plaut
Northern Arizona University, Flagstaff, Arizona

Regional-scale tree mortality after drought is a common occurrence and is predicted to increase with climate warming, however; isolating the mechanism of tree mortality is challenging. Our study addresses two hypotheses regarding regional piñon pine (*Pinus edulis*) mortality that occurred after the 2002 drought in the southwestern USA. Hypothesis one – hydraulic failure – posits that drought directly kills trees by desiccation induced by xylem cavitation. The second hypothesis– carbon starvation – posits that drought results in depletion of carbon reserves because carbon assimilation is less than carbon use which in turn reduces carbon allocation to resin defenses and predisposes trees to mortality from insect attack. Our objectives were to quantify insect attacks and resistance mechanisms at an experimental drought study started in 2007 at the Sevilleta LTER in central New Mexico. It includes four 40 x 40 m treatment plots replicated in three blocks. Treatments consist of ambient, removal of 50% ambient annual precipitation, irrigation to produce 150% addition of ambient annual precipitation, and an infrastructure control that measures the impact of precipitation removal/addition equipment without changing the annual amount. Measurements of insect resistance mechanisms including twig and bole resin flow wounding, and insect surveys were conducted for one pretreatment year (2007) and two post-treatment years (2008-2009). Measured insect resistance characteristics have been similar among treatments to date. In addition, analysis of ¹³C indicates that constitutive resin is not from recently assimilated carbon, and suggests that resin was formed and stored over long-periods. These isotope results could explain why no significant differences in resin flow were found 2 years post-treatment. By August of 2009, 21% of all trees were attacked and killed by bark beetles (*Ips confusus*). 78% of these trees were located in the water removal treatment 14% in the water addition treatment, and the remaining 7% in the ambient control treatment. This result suggests that the experimental drought predisposed some trees to bark beetle attacks despite no significant differences in constitutive resin volume. We suspect that unexamined factors, such as reduced induced defenses, differences in resin chemistry and/or changes in tree volatiles may explain the susceptibility of higher susceptibility of drought-stressed trees to bark beetle attacks.

“International research & collaborations”

**moderated by Nadir Erbilgin, Department of Renewable Resources,
University of Alberta, Edmonton, Alberta**

As increasing international trade has resulted in an ever-increasing arrival and establishment of alien species in new parts of the world, research conducted in different countries or continents is invaluable for understanding of the potential risks associated with several exotic insect pest species in other regions. In this workshop, we will discuss what we learn from the international collaboration and research on forest entomology.

Evaluation of the Antiaggregation Pheromone, MCH, for Controlling the Douglas-fir Beetle in Mexico

Guillermo Sánchez-Martínez¹, Constance Mehmel², Debra Allen-Reid³,
Nancy E. Gillette⁴, and Sylvia R. Mori⁴

¹INIFAP, Campo Experimental Pabellón, Aguascalientes, México

²USDA Forest Service, Forest Health Protection, R6, Wenatchee, WA

³USDA Forest Service, Forest Health Protection, R3, Albuquerque, NM (presenter)

⁴USDA Forest Service, Pacific Southwest Research Station, Albany, CA

Outbreaks of *Dendroctonus pseudotsugae barragani* began appearing in the States of Chihuahua and Coahuila, Mexico in 2001, and in the State of Durango's Sierra Madre Mountains in 2006. The host, *Pseudotsuga menziessii* var. *glauca* (known as the Rocky Mountain Douglas-fir in the U.S), has a very limited range in Mexico, and thus is subject to special protection by law. Because the use of conventional silvicultural practices is restricted, the application of MCH to control *D.p. barragani* is an attractive option; however, prior to this research, MCH had not been tested or registered for use in Mexico. In this study, conducted in Durango, the experimental protocols for pesticide registration in Mexico were followed. A complete randomized block design tested 14.4 g. A.I./ha (15 bubblecaps/acre); 28.8 g. A.I./ha (30 bubblecaps/acre); 44.0 g. A.I./ha (45 bubblecaps/acre), and a control (no MCH). Four replicates (16 experimental units, each 0.5 ha) were installed. Two funnel traps with Douglas-fir beetle lure were placed in each plot center and were serviced weekly from April through August, 2009. Preliminary results suggest that even when a baited trap is present, doses of 28.8 and 44.0 g. A.I./ha significantly reduce the number of beetles flying into the stand, compared with stands having either no MCH or a low dose (14.4 g. A.I./ha). In every treatment, some unsuccessful basal attacks by beetles were observed. Except for one case, successful attacks occurred only in control plots and plots having the lowest MCH dose. Further research using the pheromone flake formulation is planned.

The Boomerang Project: *Dendroctonus valens* and its ophiostomatoid hitch-hikers, the global perspective

Nancy Gillette,

USDA Forest Service, Pacific Southwest Research Station, Davis, California

In addition, Debra Allen-Reid, Nancy Gillette, **Andrew (Sandy) Liebhold** (USDA-FS, Northern Research Station, Morgantown, WV) will discuss and critically evaluate potential implications of international collaborations to future and stability of North American forests. The workshop contributors have extensive experience and research projects in Mexico, Europe and China.

“Climate change and insect dynamics”

moderated by Tom DeGomez, University of Arizona Extension, Flagstaff, Arizona

This session will present a wide range of perspectives on the subject of climate variability and forest insects. Speakers will report on their work from as far north as Alaska to Arizona in the south.

Effects of climate change on Alaskan defoliators and bark beetles

Richard “Skeeter” Werner,

Institute of Arctic Biology, University of Alaska Fairbanks

Historically, the boreal forest has experienced major changes and it remains a highly dynamic ecosystem even today. During cold phases of climatic cycles, forests were virtually absent from Alaska. Alaska warmed rapidly at the end of the last glacial period about 15,000 to 13,000 years ago. Climate was warmest and driest during the latter part of the glacial period. Subsequently, moisture increased and the climate gradually cooled. These changes were associated with shifts in vegetation dominance from deciduous woodland and shrub land to white spruce and then to black spruce. Since the postglacial re-establishment of forests about 13,000 years ago, there have been periods of both relative stability and rapid change. Today, Alaskan boreal forests appear to be on the brink of further significant change in composition and function triggered by recent changes that include climatic warming.

Repeated defoliation by a variety of insects over several years can lead to reduced annual growth and even mortality. Historical records of defoliating insects indicate that populations of the spear-marked black moth on paper birch occurred at 10-year intervals, and high populations of the large aspen tortrix on aspen occurred at 12-year intervals. The most recent outbreaks of spear-marked black moth occurred from 1975 to 1979, whereas, those of the large aspen tortrix from 1965 to 1974. Average annual temperatures in interior Alaska have increased since 1980 which may contribute to the frequency of outbreaks of these two insects. However, other species of defoliating insects such as the spruce budworm on white spruce, larch sawfly on larch, and aspen leaf miner on aspen had negligible populations prior to 1990, but since then have defoliated thousands of acres of forests. Climatologists at the University of Alaska Fairbanks have concluded that temperature-induced drought has reduced the growth of white spruce. This could probably predispose trees to infestation by defoliating insects and once weakened by repeated defoliation they would be susceptible at attack by bark beetles and wood-boring insects.

From 1990 to 1996, 1.5 million hectares of white spruce were infested and killed by the spruce beetles. During this 6-year period, 30 million trees were killed and 60% of the spruce forests were decimated. This massive outbreak was related to the relatively high densities of large-diameter spruce in an aging forest and to a warming trend which increased spruce susceptibility to beetle attack and reduced the life cycle of many spruce beetles from a two-year to a one-year life cycle, thus increasing the number of maturing beetles in a given year.

Monitoring of carabid ground beetles at different latitudes in Alaska over a 10-year period indicate increased population levels and species richness with increased annual temperatures and latitudinal increase northward.

Common trends in high elevation and high latitude ecosystems

Ann Lynch,

USDA Forest Service, Rocky Mountain Research Station, Tucson, Arizona

Climate Change and Insect Dynamics: A Global Overview

Bill Ciesla,

Forest Health Management International, Fort Collins, Colorado

This presentation raised several questions: (1) How might the behavior of damaging forest insects change under a climate change (warming) scenario, (2) Are there examples of these changes and (3) If so, can factors other than climate change explain these changes?

Anticipated changes in forest insect behavior include:

- Shifts in natural ranges: north in the northern hemisphere, south in the southern hemisphere and upward in elevation.
- Additional generations
- Occurrences of outbreaks in new or unusual locations
- Changes in population cycles

SHIFTS IN NATURAL RANGES

Several examples of shifts in natural ranges are reported. These include the northward movement of processionary caterpillars, *Thaumetopoea* spp. in Europe. The pine processionary, *Th. pityocampa*, a major defoliator of pine forests in the Mediterranean Region, has been observed further north in portions of France and Italy including the foothills of the Alps. The oak processionary, *Th. processionea*, formerly of central and southern Europe and the Near East, has recently been detected in the Belgium, the UK and Sweden

In western North America, a walnut twig beetle, *Pityophthorus juglandis*, formerly distributed in southern California, Arizona, New Mexico and northern Mexico began a northward spread around 2002. This spread was facilitated by planting of black walnut in urban areas throughout the West, where species of *Juglans* were not part of the native forests. However, many of these trees have been in place for over 50 years. This insect has adapted to black walnut and developed an association with a fungus of the genus *Geosmithia*, which causes a canker disease known as “thousand cankers disease.” This disease has killed large numbers of ornamental black walnuts and poses a threat to areas in the central and eastern US, where this highly valued tree is part of the natural forest.

Two ambrosia beetles have made significant range shifts in recent years. In Japan, the range of *Platypus quercivora*, has shifted north since the 1980s and come in contact with new hosts of the genus *Quercus*. Its associated ambrosia fungus, *Raffaella quercivora* is pathogenic to its new hosts and thousands of trees have been killed. In South America, *Megaplatypus mutatus*, a tropical/subtropical species, has moved south into central Argentina, where it has adapted to a number of temperate zone tree species and become a major pest of poplar and willow plantations.

ADDITIONAL GENERATIONS

Two forest insects known to have additional generations at lower latitudes are the southern pine beetle, *Dendroctonus frontalis* of the southern USA, Mexico and Central America and the pine caterpillar, *Dendrolimus punctatus*, of China and Vietnam. These species could be expected to have additional generations in a given location as temperatures rise and become more damaging. However, there is no documented evidence of this having occurred.

Spruce beetle, *Dendroctonus rufipennis*, normally has one generation every two years but some individuals can complete a generation in one year at lower elevations where temperatures are warmer. Recent outbreaks in Colorado have eliminated the mature spruce type in a short period, in some cases as little as three years, with new faders present every year. This is suggestive of a significant portion of the population completing a generation in one year.

OUTBREAKS IN NEW OR UNUSUAL LOCATIONS

“Mega” outbreaks of mountain pine beetle, in portions of British Columbia and Alberta Canada, have encompassed millions of acres of lodgepole pine forests in locations north of where outbreaks have occurred previously. In northern Alberta, infestations have developed in lodgepole/jack pine hybrids and there is a potential for the insect to spread into boreal jack pine forests. In Colorado, massive outbreaks have caused heavy mortality in lodgepole pine forests at elevations above 8000 feet where outbreaks have previously been short-lived. These outbreaks are believed favored by mild winter temperatures, which have allowed more overwintering beetles to survive. In addition, these areas have a high component of mature, large diameter and thick barked lodgepole pine, which are excellent host material for this beetle.

CHANGES IN POPULATION CYCLES

Larch bud moth, *Zeraphia diniana*, is found in high elevation forests of larch in the Swiss, French and Italian Alps. This insect has reaches outbreak levels at 9-year intervals. Tree ring analyses suggest these outbreak cycles have occurred at an average of 9.3 years for the past 1200 years. Outbreaks continued during the Medieval Optimum (ca 800-1300), a period of warm temperatures and the Little Ice Age (ca 1300-1850), a cooler period. In 1981, these outbreak cycles ended. It has been suggested that the reason for the cessation of regular outbreak cycles has been a period of unprecedented warming.

CONCLUSION

Are these observed changes in behavior of forest insects the result of rising temperatures due to increased levels of greenhouse gases in the earth’s atmosphere? The answers range from “maybe, perhaps, very likely.” Each case must be analyzed separately. In some cases, there is strong evidence to suggest climate change as a contributing factor. In others, occurrence of susceptible host type, new host/insects/symbiotic fungus relationships may also play a significant role in these observed changes.

Mountain Pine Beetle Risk Assessment Under Changing Climate

Bill Riel,

Canadian Forest Service, Victoria, British Columbia

The mountain pine beetle is encroaching further east in Alberta than previously observed. Given the uncertainty over changing climatic impacts and mountain pine beetle population dynamics in different host conditions, new approaches to estimating risk and susceptibility are required. A flexible approach to large scale risk assessment for the mountain pine beetle is presented.

Climate change can increase the risk of mountain pine beetle outbreaks in western Canada

Kishan R. Sambaraju

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Global temperatures are projected to rise by 2 - 4°C under several greenhouse gas emission scenarios of the Intergovernmental Panel on Climate Change (IPCC) by the end of the 21st century. An intriguing aspect of such climate change is its impact on the population dynamics and range expansion of insect pests. The mountain pine beetle, *Dendroctonus ponderosae* Hopk., is an aggressive tree-killing bark beetle that has had a devastating impact on forests of western North America. In Canada, after an unprecedented outbreak in the province of British Columbia during the past decade, the beetle populations have crossed the Rocky mountain barrier into north western Alberta, which has historically been unfavorable for mountain pine beetle survival due to very cold winter temperatures that cause extensive mortality of beetle populations. However, warmer winters resulting from climate change can transform a previously unsuitable habitat into a good breeding ground for mountain pine beetles potentially leading to outbreaking populations. The objectives of this study were to 1) develop an auto-logic model by associating known mountain pine beetle outbreaks in a particular area to several temperature variables, including novel cold temperature terms, spatial neighbourhood structures, and occurrences of previous infestations, and 2) simulate the impacts of climate change and climatic variability on future mountain pine beetle outbreak trends using the model. Results of our simulations indicate that an average temperature increase of 1°C or higher compared to baseline temperatures during 2003-2004 can significantly increase the outbreak risk due to mountain pine beetle. The outbreak trend was more a function of average temperature increase over an entire area rather than the variability associated with that increase.

Forests, Woodlands and Climate: Cooperative Extension Activities

Tom DeGomez,

University of Arizona Extension, Flagstaff, Arizona

The University of Arizona was awarded a grant from the National Institute for Food and Agriculture (NIFA) to organize a Climate, Forests and Woodlands community of practice on the NIFA sponsored extension website <www.extension.org>. A community of practice is a loosely knit group of professionals working together in a wiki format (a wiki is a website that allows the easy creation and editing of any number of interlinked web pages via a web browser using a simplified markup language) to provide research based information to Cooperative Extension educators, individuals, local, state, regional and national resource professionals. Once the website is launched in March of 2011 it will provide an on-line resource that will 1) assess the current state of climate change knowledge and research for forests and their management; 2) assist with the dissemination of research results and practical applications relating to climate change impacts on forests; 3) create and maintain a system that will continuously track new advancements and information. The community of practice is actively recruiting professionals who would like to participate in populating the website with content pages and answers to frequently asked questions. To participate contact <degomez@ag.arizona.edu>.

“Bark beetle prevention and effectiveness of thinning”

moderated by Cynthia Snyder,

USDA Forest Service,

Forest Health Protection, Redding, California

The effectiveness of thinning for preventing bark beetle infestations in western North America

Christopher J. Fettig, **Christopher J. Hayes** and Stephen R. McKelvey

USDA Forest Service, Pacific Southwest Research Station, Davis, California

Craighead (1925) and Miller (1926) were among the first to demonstrate that slower growing trees were more susceptible to bark beetle attack. Since that time, a considerable amount of effort has been devoted to the identification of tree and stand conditions associated with bark beetle attack in western coniferous forests. In this presentation, I review these factors and analyze the effectiveness of thinning for preventing bark beetle infestations. I concentrate on ponderosa pine and lodgepole pine forests, but draw inference from works conducted in other cover types. Thinning not only affects the amount of growing space available, but also the physical environment within stands. I discuss how these factors primarily influence stand susceptibility through effects on host vigor, host finding, and microclimate. Finally, I discuss options (e.g., green chaining, chipping, lopping-and-scattering) for proper treatment of logging residues.

Forest thinning to prevent southern pine beetle

John T. Nowak,

USDA Forest Service, Forest Health Protection, Southern Region, Asheville, North Carolina

The southern pine beetle is the most destructive insect pest of pines throughout the South causing an average loss of \$70 million per year with an estimated 8.4 million acres at risk. From 1999 to 2003, southern pine beetle caused unprecedented damage to pine forests in Alabama, Florida, Georgia, Kentucky, North Carolina, South Carolina and Tennessee. Almost one million acres on private farms and forests, industry lands, state lands, national forests, and other federal lands were affected. In an effort to mitigate and reduce future losses to this insect, the Southern Pine Beetle Prevention and Restoration Program was created in 2003. The program is administered by R8 Forest Health Protection and is implemented by its primary partners including 12 national forests and 13 southern states. In total, more than 800,000 acres have been treated on federal, state, and private land as part of the program. More than half a million acres of this work has been accomplished through cost-share support to more than 8,000 non-industrial private landowners and more than 100,000 acres of work occurring on national forest land. Thinning is the preferred practice for reducing a forest's susceptibility to southern pine beetle and thus constitutes the predominant strategy of prevention efforts. It is well-documented that forest thinning decreases the frequency and severity of southern pine beetle infestations and often has the added benefits of increasing tree value and growth rates, reducing the risk of wildfire, and encouraging diversity in herbaceous plant communities.

Thinning lodgepole and ponderosa pine forests to minimize damage caused by mountain pine beetle in the Northern Region: Is it working?

Sandy Kegley, USDA Forest Service, Forest Health Protection, Northern Region, Coeur d'Alene Field Office, Idaho

Silvicultural manipulations to reduce high hazard stands provide the best long-term treatment to reduce mountain pine beetle-caused tree mortality. In the Northern Region, recommendations to reduce losses by mountain pine beetle in lodgepole and ponderosa pine stands is thinning to a basal area of about 80 square feet per acre. When determining whether a stand is suitable for thinning, stand attributes such as site productivity, slope, tree diameter and age, current basal area and wind firmness should be considered. In addition, current beetle infestation rate within the stand and proximity of the stand to large populations will influence whether or not thinning will result in acceptable levels of beetle-caused tree mortality.

Currently, the Northern Region is experiencing a very large outbreak of mountain pine beetle. These high beetle populations have provided increased pressure on thinned pine forests. Certain thinned areas have shown significantly less mortality than adjacent unthinned areas. Some experienced higher mortality than desired. Thinned stands that experienced unacceptable mortality were not thinned to the recommended basal area or were not evenly spaced with clumps of trees within the thinned area. Leave strips between thinned stands and trees on the edges of thinned stands may be killed with heavy beetle pressure. However, when beetles cause mortality in thinned stands, larger green trees remain compared to unthinned stands.

In general, if lodgepole and ponderosa pine stands are thinned to a basal area less than 80 sq.ft./ac., and leave trees are evenly spaced, mortality is much less than unthinned stands.

***Scolytus ventralis*-caused *Abies concolor* mortality in thinned and non-thinned mixed conifer stands, Warner Mountains, Northeastern California**

Joel M. Egan,

William R. Jacobi, Jose F. Negron, Sheri L. Smith, and Daniel R. Cluck
USDA Forest Service, Forest Health Protection; Colorado State University, Bioagricultural Sciences and Pest Management; USDA Forest Service, Rocky Mountain Research Station; USDA Forest Service, Forest Health Protection; USDA Forest Service, Forest Health Protection, Northeastern California Zone, Pacific Southwest Region

The Warner Mountains of Northeastern California on the Modoc National Forest experienced a high incidence of tree mortality (2001-2007) that was associated with drought and bark beetle attack. Various silvicultural thinning treatments were implemented over the last several decades to reduce stand density in an economical manner to increase residual tree growth and vigor. Our study 1) compared bark beetle-caused mortality in stands thinned from 1985-1998 to similar, non-thinned stands, 2) identified site, stand and individual tree characteristics associated with conifer mortality, and 3) assessed conifer mortality spatial autocorrelation. We sampled mixed conifer stands primarily composed of ponderosa pine (*Pinus ponderosa* var *ponderosa* P. and C. Lawson) and white fir (*Abies concolor* var *lowiana* Gordon) that were commercially thinned, salvage-thinned, and non-thinned. Clusters of five subplots (1/50th ha) and 4 transects (20.1 x 100.6 m) were averaged to plot-level to estimate stand, site and mortality characteristics. A total of 20 commercially thinned, 20 salvage-thinned and 20 non-thinned plots were sampled. Fir engraver beetles (*Scolytus ventralis* LeConte) (FEN) caused greater density of white fir mortality in non-thinned (adjusted mean 18.0 trees ha⁻¹) compared to both the

commercially thinned (9.6 trees ha⁻¹) and salvage-thinned plots (6.6 trees ha⁻¹). Percent mortality was constant among the commercially thinned (adjusted mean 12.6%), salvage-thinned (11.0%), and non-thinned (13.1%) plots. Thus, FEN-caused mortality occurred in direct proportion to the density of available white fir. The density of FEN-caused mortality was associated with white fir density, elevation, and elevation². No evidence of spatial autocorrelation was detected between plots.

A Canadian silviculturist's perspective on the effectiveness of "thinning" to reduce susceptibility to mountain pine beetle (*Dendroctonus ponderosae* Hopk.)

Roger J. Whitehead,

FPInnovations/Canadian Forest Service, Canadian Wood Fibre Centre, British Columbia

The forest cover of western Canada includes over 20 million hectares (50 million acres) of lodgepole pine (*Pinus contorta* Dougl. ex Loud. var. *latifolia* Engelm.). The disturbance history of these forests left an age-class distribution highly skewed to mature stands by the 1970's when commercial exploitation intensified. Most basic principles needed to prevent beetle-caused losses were known by that time, but very difficult to apply in a largely undeveloped landscape. Since then, preventive management has increasingly focused on access development to facilitate response to incipient infestations and planned stand replacement to reduce the amount, contiguity and concentration of susceptible stands on the landscape. Within this context, thinning is recognized as a valuable stand-level tool that may also be used to achieve other management objectives. Based on research and experience, the current strategy focuses on altering within-stand microclimate, tree vigour and inter-tree distance by thinning from below to regular spacing. The basis for this prescription and its efficacy under several levels of beetle pressure from surrounding stands will be discussed, using published and unpublished data from 5 research installations monitored up to 13 years following treatment. Application of this research to forest operations in southeastern British Columbia will be discussed, based on published data from 10 sites where reducing susceptibility to mountain pine beetle was a management objective identified in the original site prescriptions 5 to 14 years earlier.

BREAKOUT SESSION III

"Digital & micro photography"

moderated by Bill Ciesla,

Forest Health Management International, Fort Collins, Colorado

Close up photography of insect specimens

Jim LaBonte,

Oregon Department of Agriculture, Salem, Oregon

The Oregon Department of Agriculture (ODA) has been utilizing extended depth of field digital imaging (EDFDI) since 2002. In EDFDI, a series of images, each with a shallow plane of focus, is taken throughout the depth of a subject and then digitally combined into a single image conserving those pixels in sharp focus. This image is in focus from top to bottom. Like any technology, EDFDI has limitations and problems. To varying degrees, these problems can be compensated for with technique, hardware, and post-acquisition image processing.

ODA has used EDFDI to expedite identification of suspect agricultural pests, e.g., banded elm bark beetle (*Scolytus schevyrewi*) and brown marmorated stink bug (*Halyomorpha halys*). It has also been used to aid staff in the recognition and screening of survey targets such as fire ant (*Solenopsis invicta*) and exotic wood boring insects. EDFDI images support ODA outreach via pest alerts, websites, and presentations, such as for spotted wing drosophila, *Drosophila suzukii*. EDFDI has been used to support the taxonomic description of a new species of carabid beetle and a taxonomic treatment of *S. schevyrewi*. EDFDI images are the core of screening aids and identification guides developed by ODA, including the first book based on EDFDI image, the first treatment of the Siricidae of North America, and screening aids for western U.S. Buprestidae, eastern U.S. Scolytinae, and western U.S. Scolytinae.

A Fast and Simple Method for Digitizing 35mm Slides

Ronald F. Billings

Texas Forest Service, College Station, TX 77845

Faced with a closet full of 35mm color slides, I developed a simple and inexpensive means for digitizing these images. Equipment requirements are a digital camera with a minimum of 5 megapixel resolution and capable of close focusing (preferably 1:1). I initially used a Canon A-640 compact camera but recently have switched to using a Nikon D90 DSLR with 60mm macro lens. Also needed are a small light table, tripod with reversible center post, and a small bubble level. The tripod is set up directly over the light table (or just to the side, if the tripod's center post is not reversible). A small cardboard holder, with a 2cm x 5cm x 2cm slot cut along one edge to hold each slide and taped to the top of the light table, facilitates copying a large series of slides. Mount the camera on the tripod and position it over the light table, using the bubble level on the top of the camera to ensure the camera lens and light table are aligned horizontally.

Camera settings I use are a shutter priority setting of 100-200 (allowing the camera to select the aperture, based on available light through the slide), ISO 100-400, white balance of sunny or auto, macro setting and manual focus, no flash, and resolution of 5 megapixels or greater. Place the slide to be copied on the light table, in the cardboard slide holder, emulsion side down. Fill the camera's viewer with the slide and focus as accurately as possible. For small digital cameras, use a two-second timer to reduce camera shake (not required with DSLR cameras).

Results I have achieved are as good or better than slides digitized with a commercial scanner, such as the CanoScan FS-4000, and take much less time. Slight adjustments in color or brightness to your digitized images can be made with Adobe Photoshop or another photo software program, but are usually not required. Each slide will need to be cropped using available software programs to eliminate the slide mount image around the border. Once digitized your slides can be uploaded to make a photo book, utilizing one of many available web pages (i.e., Shutterfly.com, blurb.co, snapfish.com, etc.). Google "photo book" on the Internet for many more options. In each case, read the terms of agreement closely, because some of these websites require you to relinquish the rights to your photos.

Photographing Insects in Their Natural Surroundings

Bill Ciesla

Photographing live insects in their natural surroundings presents several challenges. Insects, especially winged adults, are mobile and may leave where they are resting without warning. Often you will have only one opportunity to capture the insect. Lighting can be tricky because of intermittent sun and shadow. Attention must also be given to the background. If the background is too busy it will be distracting. The following sections provide some tips on how to get high quality digital images of insects in the wild.

EQUIPMENT

A single lens reflex (SLR) camera is essential for quality close-up insect photography. For digital photography started with a Nikon D70S in 2005 and graduated in 2009 to a Nikon D90. The later captures higher resolution images (12.43 vs 6.1 megapixels). It also has a larger view screen and more ISO (light sensitivity) settings. I use two lenses. I have a Nikon DX Nikkor 18-135 mm zoom lens, which I use for general photography but allows me to capture larger insects such as longhorn beetles or large moths and butterflies. For small insects, I use a 60 mm Micro Nikkor lens. I do not use a tripod. When taking photos of live insects, one must be mobile and able to move quickly. Tripods are cumbersome and lack the mobility needed to photograph insects.

CAMERA SETTINGS

I use two options of camera settings: one for natural lighting and one for a fill-in flash. The former works well under bright sunlight and the latter provides maximum depth of field under shady conditions. I use an ISO setting of 200 and a maximum resolution (12.43 megapixels) for both options. Using the highest resolution setting allows me the option of not getting too close to the subject. This provides additional depth of field and allows me crop the image without significant loss of quality.

For natural lighting I set the camera on automatic for close-up images and let the metering system select an appropriate combination of shutter speed and aperture. For shady conditions, I activate the flash, set the camera on manual (M), select a shutter speed of 1:200 and aperture settings ranging between f 22 to f 32. This combination provides enough depth of field to get the entire insect in focus and darkens the background, allowing the insect to stand out. I prefer the fill-in flash option although I have also gotten excellent results using natural lighting and full sunlight.

There are, undoubtedly, other combinations of settings that will produce excellent results. There are also many models and brands of digital SLR cameras available. Some experimenting is necessary to identify the best combination of settings for any given camera.

One final tip: take as many images as your subject will allow. Keep in mind, there are no film or film processing costs associated with digital photography and substandard images are easily deleted.

“Regional Insect Conditions Reports”

moderated by Amanda Garcia-Grady,

USDA Forest Service, Forest Health Protection, Region 5, Susanville, California

This will be an informal workshop where attendees from Mexico, Canada, and the United States will share information regarding current forest insect conditions. This session is held most every Western Forest Insect Work Conference to keep forest entomologists in the West abreast of forest insect conditions and issues surrounding their management. Regions will have 10 minutes to share information on their important current forest insect conditions.

Region 3 (Arizona, New Mexico) 2009 Conditions Report

Bob Celaya¹, Ryan Hanavan², Daniel Ryerson²

¹Arizona State Forestry Division, ²U.S. Forest Service Region 3 Forest Health Protection

Arizona and New Mexico had relatively mild damage mapped during the annual aerial detection survey. Western spruce budworm, *Choristoneura occidentalis*, activity increased in New Mexico and a pine sawfly, *Neodiprion fulviceps*, resulted in approximately 2,500 acres of defoliation in Arizona and New Mexico. The pinyon needle scale, *Matsucoccus acalyptus*, was reported as present with damage potentially expanding in extent and severity near Prescott, AZ. Bark beetle activity was mapped on 38,400 acres across NM, and AZ in 2009 compared to 111,000 acres in 2008 with 9,300 acres in the ponderosa pine type, 8,700 acres in mixed conifer, and 20,400 acres in the spruce-fir type. Douglas-fir tussock, *Orgyia pseudotsugata*, was trapped in the Pinaleno Mountains in AZ and could potentially reach outbreak levels in 2010. Adult Pandora moth, *Coloradia pandora*, were observed on the Kaibab National Forest in AZ and are expected to cause defoliation in 2010. A leaf hopper, *Dikrella readionis*, and the box elder bug, *Leptocoris trivittatus*, were reported as a nuisance in residential areas along the Mogollon Rim.

A Brief Assessment of Forest Insects in Eastern Oregon

Rob Flowers, Oregon Department of Forestry

and Paul Oester, OSU Extension Service

Major forest insects affecting eastern Oregon forests during the past few years are the mountain pine beetle, fir engraver, western pine beetle, western spruce budworm, Douglas-fir tussock moth, larch casebearer and balsam woolly adelgid.

Southcentral Oregon is the focus of a significantly large mountain pine beetle epidemic of approximately 370,000 acres in lodgepole pine. Damage peaked at over 500,000 acres statewide in 2007-08, and then slightly declined to about 460,000 acres in 2009. "Spill-over" into nearby stands of large ponderosa pine are affected from the outbreak. Damage from this beetle is occurring throughout eastern Oregon pine forests. Fir engraver trends are declining from highs in 2003-04 and western pine beetle damage increased about 2-3X in 2008-09 from 2006-07 damage levels.

Western spruce budworm and Douglas-fir tussock moth have defoliated fir stands in the Blue Mountains in the past few years. Western spruce budworm has shown some low-moderate intensity damage near John Day. Douglas-fir tussock moth populations are at low levels currently but defoliated about 160,000 acres near Halfway in 2000. Other defoliators include the larch casebearer and balsam woolly adelgid. Larch casebearer caused over 80,000 acres of defoliation in 2007, and then declined to about half that level. The balsam woolly adelgid has shown a steady progression of stand decline in the high Cascades and Blue Mountains since 2000.

Emerging issues include pine butterfly in the John Day area, as well as increased outbreaks of pine sawflies in 2009. Damage was overlapping and mortality is expected.

Conditions report for R10 Alaska FHP, 2009 aerial survey

R. Burnside, J.J. Kruse, M. Schultz, and K. Zogas

The leading pests in Alaska for 2009 were aspen leaf miner (300,000 acres), willow leafblotch miner (130,000 acres), spruce beetle (100,000 acres), and northern spruce engraver beetle (35,000 acres). Several other species were mapped, but acreage was generally less than 15,000 acres. Additional monitoring work, including evaluation and monitoring, were described.

“Epidemic/Endemic populations – trends in research”

moderated by Deepa Pureswaran, Canadian Forest Service, Laurentian Forestry Centre, Québec and **Richard Hofstetter**, Northern Arizona University, Flagstaff, Arizona

This session will focus on whether and how research fields, funding and publications change during epidemics versus endemic states of forest insect populations. Speakers will address three major areas of forest entomology: population and community ecology, chemical ecology and management. During the last 10 minutes, the floor will be open for discussion.

Research trends during epidemic versus endemic population cycles of forest insect pests

Deepa Pureswaran, Canadian Forest Service, Laurentian Forestry Centre, Québec and **Richard Hofstetter**, School of Forestry, Northern Arizona University

We investigated research productivity in relation to forest insect outbreaks and funding allocated for research at universities during epidemic versus endemic phases of four major tree-killing species in North America. For the mountain pine beetle and the eastern spruce budworm in Canada, we found that the amount of research funding obtained for bark beetle and spruce budworm research were correlated over time with the area of trees destroyed by the insects. Clear funding values could not be obtained for the southern pine beetle and spruce beetle for years earlier than 2001 and thus were not included. We tallied articles by research field to examine trends over time. During epidemic decades, there was a marked increase in papers addressing population and community ecology as well as forest pest management. We also observed an increase in the number of publications in research fields that happened to be “in vogue” at that time, which we attribute to the heightened availability of research funds during epidemic years. We note (i) that insects exhibit different behavioural strategies when they are in the endemic state compared to epidemics, (ii) the drop in funding in years following epidemics, and (iii) the dearth of research on out-breaking insects when they are endemic. We question whether assignment of consistent amount of funds during endemic as well as epidemic population phases would enable us to better understand the factors that trigger epidemics and help mitigate the devastating effects of forest insect outbreaks.

How do interactions among microbial symbionts affect the host and range expansions of an eruptive forest insect?

Kenneth F. Raffa¹, Cameron R. Currie¹, Aaron S. Adams¹, Nadir Erbilgin², & Brian H. Aukema^{3,4}

¹ University of Wisconsin, Madison, WI, USA; ² University of Alberta, Edmonton, AB, CAN
³ Canadian Forest Service, Prince George, CAN; ⁴ Future address (Aug. 2010): University of
Minnesota, MN, USA

Mountain pine beetle (MPB) eruption has expanded from lodgepole pine (LP) in British Columbia to lodgepole and hybrid lodgepole-jack (LP/JP) pines in Alberta. The extent to which this will provide a bridge for expansion into jack pine (JP) and other eastern US pines is unknown. We are investigating one component of this unknown: how interactions among bacteria, fungi, and tree chemistry affect beetle reproduction in these hosts. Our objectives were to: (1) compare bacterial communities of MPB and tree phloem in infested and uninfested LP, JP, and LP/JP, (2) determine how phytochemicals alter interactions between fungi and bacteria, and (3) determine how these interactions mediate beetle reproduction.

We sampled MPB and phloem from LP, JP and LP/JP and compared bacterial communities using culturing, DGGE, and 454 metagenomic sequencing. We also tested bacterial tolerance and degradation of phytochemicals, assessing effects on MPB symbiotic fungi and antagonists. We will evaluate interactions among bacteria, symbiotic fungi, antagonistic fungi, and phytochemistry on MPB fitness.

We found that beetles and galleries from all host trees harbor bacteria. *Pseudomonas sp.* are numerically dominant in beetles, irrespective of host. Beetles from LP harbor bacteria more frequently tolerant to β -pinene. *Pseudomonas* bacteria degrade abietic acid, a component of tree defense.

For the future work, we will compare bacterial communities within and between trees, sites, and hosts. We will assay tolerance of bacteria to host defensive chemicals and determine effects of interactions between bacteria and tree chemistry on MPB and symbiotic fungi.

Semiochemistry of epidemic versus non-epidemic bark beetles

Brian Sullivan,

USDA Forest Service, Southern Research Station, Pineville, Louisiana

For species of aggressive bark beetle, strength lies in numbers. At very high densities (epidemic conditions), beetles can attack any host, regardless of vigor and are under little pressure to disperse -- at least before they use up the immediately-adjacent supply of suitable host species. At low densities (non-epidemic conditions), beetles must attack weakened hosts and may need to disperse long distances to find the 'next' susceptible host. During region-wide population outbreaks, epidemic behaviors by southern pine beetle *Dendroctonus frontalis* Zimmermann, are normally restricted to the interiors of spatially discreet infestations or 'spots' in which brood and reemergent parent adults attack immediately adjacent, healthy trees in a continuous cycle that can persist for weeks or months. In the forest surrounding these spots (which may be infestation-free within a radius of hundreds or thousands of meters) beetles are dispersed and are apparently restricted to colonizing weakened trees. We have found evidence that the responses by southern pine beetle to their pheromones differ inside versus outside of infestations: the male-produced pheromone component *endo*-brevicomins functions as an attraction inhibitor inside of infestations but an attractant synergist outside. Attempts to duplicate this contrast with 'artificial' spots composed of pheromone-releasing traps were not entirely successful. Further, it has been shown that southern pine beetles trapped either inside or outside infestations differ in their expression of esterase enzymes (Florence et al. 1982. Environ.

Entomol. 11:1014-1018), suggesting that beetles under effectively epidemic or non-epidemic conditions differ in either their genotype or gene expression.

Delayed Density Dependence: Funding and Forest Pests in the South.

Doug Streett¹, John Nowak² and Kier Klepzig¹

¹USDA Forest Service, Southern Research Station

²USDA Forest Service, Region 8, Forest Health Protection

Funding cycles for forest pests in the south have displayed a “delayed density dependence” whereby increased funding levels were allocated several years after the insect outbreak. This phenomenon was especially evident in the early 1970’s outbreak of southern pine beetle (SPB) when over 350 counties were affected by SPB outbreaks and in early 2000 when SPB caused nearly 1.3 billion dollars in damages. In both cases, research funding levels increased for several years following the SPB outbreak. Following the most recent extensive SPB outbreak, an increase in funding began in 2003 and has persisted to the present. A stakeholder’s workshop involving universities, Forest Health Protection (FHP), and other federal and state agencies was held in 2003 to identify critical needs. This input, and the increased base funding, has permitted Forest Service Research to expand SPB research and tech transfer efforts. The identified critical needs were used in requests for collaborative research proposals on SPB. The results of which will ultimately lead to the compilation of recent research efforts in a new SPB publication – “SPB II” – which should be published later in 2010. Forest Health Protection has also seen an increase in funding that has led to an increase in on-the-ground management options, landowner education efforts and technology transfer activities such as hazard maps and the economic analysis of SPB impacts. Currently, the SPB program administered by FHP has assisted nearly 6,000 landowners and has restored to forest conditions or thinned under SPB program guidelines over 1,000,000 acres of forest. The SPB program demonstrates the successful management of an important forest pest that involving the efforts of universities, Forest Service Research and Forest Health Protection (FHP), and other federal and state agencies. Funding for recently introduced invasive insect species in the south (e.g., Hemlock Woolly Adelgid, Sirex woodwasp, Emerald ash borer) has not yet significantly increased.

“Bark beetles, fuels and fires:

A synthesis of our present understanding and implications for management”

moderated by Michael Jenkins, Utah State University, Logan, Utah

Recent and ongoing research has provided greater understanding of bark beetle and fire relationships in western North American forest. This workshop will provide participants with the opportunity to provide new results or updates of research and other projects. We will also identify additional research needs and discuss ways we can better disseminate information to the fire community, forest health specialists and other land managers for mitigating bark beetle population increases associated with fuels reduction treatments; for determining the likelihood of bark beetle depredations in fire-damaged stands; for developing ecologically appropriate and economically feasible fuels and bark beetle management alternatives; and for prioritizing landscapes where management activities can best enhance long-term forest sustainability and resiliency to change, especially in light of current climate change scenarios. Bark beetles, fuels and fires: A synthesis of our present understanding and implications for management

Workshop participants provided updates of research on bark beetle and fire relationships in western North American forests and demonstrated new tools for technology transfer. Research to assess relationships between mountain pine beetle outbreaks, weather, and subsequent fire occurrence in Colorado has been completed and manuscripts are presently in review. Similar studies are being conducted in Oregon where the temporal dynamics of ground, surface, ladder fuels may differ in climax lodgepole pine forests affected by mountain pine beetle. The effects of forest insects and diseases on fuel complexes and subsequent fire behavior are also being explored in Central Washington. In California, a case study is underway to further explore raking litter and duff as means to minimize injury to pines during a fire. Other studies in California are being done to quantify bark beetle mortality in thinning treatments followed by burning. A new physics-based fire spread model to simulate crown fire hazard following bark beetle-caused tree mortality is being developed. Manuscripts of spruce beetle, fuels, and fire research in the Intermountain region are in press, while Douglas-fir beetle, fuels, and fire manuscripts are presently in preparation, and research to explore these relationships in high elevation, five-pine systems is underway. Research investigating mountain pine beetle infestation of fire-damaged lodgepole and ponderosa pine in Utah is nearly complete. We identified additional research needs including replicating studies in similar or different bark beetle/host systems and validating fire spread models. The WETAC is currently developing a synthesis of bark beetle/fire research. Utah State has developed a new website (www.usu.edu/forestry/disturbance/bark-beetles-fuels-fire/) including photo guides, a fire spread tutorial, bibliography and photo archive.

Bark Beetle Responses to Fuels Reduction and Forest Restoration Treatments Two and Four Years After the Application of Prescribed Fire in a Mixed-conifer Forest
Christopher J. Fettig, Christopher J. Hayes and Stephen R. McKelvey,
Pacific Southwest Research Station, USDA Forest Service

Mechanical fuel treatments and the application of prescribed fire may influence the amount and distribution of bark beetle-caused tree mortality at various spatial and temporal scales by affecting the health and vigor of residual trees; the size, distribution and abundance of preferred hosts; and the physical environment within forest stands. The objective of this study was to determine the response of bark beetles to fuel reduction treatments two and four years after the application of prescribed fire in a mixed-conifer forest in northern California. Treatments included: untreated control – no manipulation (C); burn – prescribed burning in the fall (B); thin – thinning from below and selection harvest with leave trees including all stems >76.2 cm (T); and thin and burn – thinning from below and selection harvest followed by prescribed fire in fall (T+ B). Four years after treatments 5.1% of all trees were killed by bark beetles, namely mountain pine beetle, western pine beetle, and fir engraver. Significantly higher levels of bark beetle-caused mortality were found on B than any other treatment or the control, with a majority of tree mortality occurring in small diameter trees. The percentage of pines killed by bark beetles was positively correlated with basal area, trees/ha and SDI, and tree mortality was almost evenly distributed between the first two years and the third and fourth years post treatment. In addition, in the first two years post treatment, a greater percentage of the largest diameter class trees (>49.5 cm) died due to bark beetles in B than in any other treatment.

BREAKOUT SESSION IV

“Data sources for forest impacts”

**moderated by Eric Smith, USDA Forest Service,
Forest Health Technology Enterprise Team, Fort Collins, Colorado**

The topic of this session is the use (and mis-use) of Forest Inventory and Analysis (FIA) data and Aerial Detection Survey (ADS) for insect impact studies and other research applications. The focus will be on the both the opportunities these data sets provide, and the issues and potential problems one must be aware of when using these data or the products derived from them.

Analysis of FIA data: **Mike Thompson**, Interior West FIA, Ogden, Utah

ADS Data Panel:

Keith Sprengel, Pacific Northwest Region FHP, Sandy, Oregon

Daniel Ryerson, Southwestern Region FHP, Albuquerque, New Mexico

Steve Dudley, Southwestern Region FHP, Flagstaff, Arizona

Michael Simpson, Pacific Northwest Region, Bend, Oregon

Digital Aerial Sketchmapping System Demonstration

Daniel Ryerson

U.S. Forest Service, Region 3 Forest Health, New Mexico Zone Office

Digital sketchmap systems have become a valuable tool in conducting forest health aerial detection surveys. The GeoLink application is the primary software platform used for forest health aerial detection surveys conducted by the U.S. Forest Service and state cooperators. This software application has been specifically modified to incorporate tools for aerial detection surveys. The system provides the observer with a current GPS position and the ability to display a variety of imagery, base maps, and reference vector data. The observer is able to record the damage directly on the screen into a georeferenced polygon or point. A demonstration of the software using a simulated flight was shown along with a commonly used tablet computer to familiarize the audience with aerial survey methodology and tools.

How Do Aerial Detection Survey Mountain Pine Beetle Cumulative Mortality Maps Compare with Mortality on the Ground?

Michael Simpson, R6-FHP, Ecologist, Helen Maffei, Ph.D., R6-FHP, Pathologist; Eric Smith, Ph.D. Biometrician-FHTET; Vernon Thomas Sanborn, FHTET

Forest Inventory plots from R6 Continuous Vegetation Survey (CVS) were used to field check the spatial and quantitative accuracy of cumulative Mountain Pine Beetle Mortality (MPBM) derived from Aerial Detection Survey (ADS). These 1 ha fixed plots installed from 1993-1997 and re-measured from 1996-2007 occur on a 1.7 mile grid across Forest Service lands in Oregon and Washington. For each CVS plot location, cumulative MPBM trees per acre (TPA) of dominant and co-dominant trees were compared with the ADS estimated cumulative MPBM TPA over the same timeframe as the CVS measurement interval.

The analysis was divided into two parts (Spatial Accuracy and Mortality Intensity).

Spatial accuracy was represented as the percent of time that ADS mapped MPBM presence corresponded with co-located CVS plot measured MPBM.

Mortality intensity was compared only where both data sources agreed mortality had occurred during the CVS plot measurement interval (+/- 1 year).

Spatial attributes were then assessed for their ability to explain ADS mortality detection failures. The attributes included:

- Cumulative ADS MPBM
- Number of sequential years of ADS mapped MPBM
- Percent host species
- Previous disturbances that could mask current MPBM from the air
- Spatial and temporal buffers around ADS cumulative MPBM

Results indicate that ADS under-estimates both the spatial extent of MPBM and the intensity of MPBM where mortality is mapped. ADS detection failure appears to explain the under-estimated extent of mortality better than spatial misalignment of ADS polygons.

“Research updates on bark and wood boring beetles”

moderated by Dan Miller, USDA Forest Service, Southern Research Station, Athens, Georgia and **Brytten Steed**, USDA Forest Service, Forest Health Protection, Missoula, Montana

The workshop is open to anyone that may wish to speak - to share research plans/results, expound upon some recent field or lab experience, explore the opportunities for collaborators, voice complaints or concerns ... pretty much anything that involves bark and wood boring beetles. We're including cerambycids and buprestids along with bark and ambrosia beetles. Our goal is simple - to provide a forum for anyone within WFIWC to share some thoughts about bark and wood boring beetles. The format is family-style, round-table with no formal presentations (i.e., no slides or PowerPoint).

Approximately 30 people attended this open forum on bark and wood boring beetles. A diverse group of participants provided a wide range of discussion topics, covering management and research concerns of federal, state/provincial, university and commercial organizations from the United States, Mexico and Canada. Specific topics identified by participants prior to the meeting included bark beetle acoustics, beetle symbioses and *Dendroctonus woodi*. During the gathering, many past, present and future studies were described, covering a range of issues such as:

- Chemical ecology of *Ips* species, especially as it may reflect ecology and species interactions;
- *Ips* management concerns with biomass utilization sites;
- Role of acoustics in *Ips* and *Dendroctonus*, and implications for management;
- Use of wildfire-damaged lodgepole and ponderosa pine by mountain pine beetle and other bark and wood boring beetles;
- Updates on the taxonomic status of *Dendroctonus woodi*;

- Upcoming work on bark beetle symbiotic bacteria and fungi;
- Exotics and invasive species including the brown spruce longhorn in Nova Scotia, use of ethanol and alpha-pinene as a lure for exotic ambrosia beetles, and the need to re-evaluate the ‘exotic Ips’ lure.
- Two recent publications by the USDA Forest Service R&D: National Invasive Species Strategy and a Dynamic Invasive Species Research Vision: Opportunities and Priorities 2009-2029

This was the third consecutive year of this session at WFIWC. As evidenced by comments offered by participants at the conclusion of the session, the informal round table format for a concurrent workshop continues to be welcomed by WFIWC members. However, the moderators feel that it might be prudent to hold this session every second or third year to allow time for additional developments. Suggestions by members to improve the format of the session are always welcomed.

“Research updates and management issues of forest defoliating insects”

**moderated by Beth Willhite, USDA Forest Service,
Forest Health Protection, Sandy, Oregon**

This workshop is organized as an informal round-table discussion on topics relating to forest defoliators, including research updates or opportunities, noteworthy field observations, advances or innovations in detection, management, or analysis, and general concerns or issues. The goal of the workshop is to facilitate information-sharing, networking, and dynamic discussion among attendees. Anyone having an interest in forest defoliators is invited to attend. During the workshop, those wishing to provide an update or discussion topic will be given 5-10 minutes to talk about their topic. Update topics will include the 2009 pinyon needle scale and sawfly outbreak in Nevada (**Gail Durham**), research on possible jack pine budworm and mountain pine beetle interactions on jack pine (**Jessie Colgan**), forest tent caterpillar and host tree interaction research (**Nadir Erbilgin**), and research relating larch budworm moth outbreaks in the European Alps with climate change (**Sandy Liebhold**).

Fifteen attendees participated in an open discussion of informally presented defoliator topics. The attendees represented a large array of geographic locations and work associations, including the western US and Canada, eastern US, universities, state and federal agencies, research and management units, and retired professionals. Following is a brief summary of the topics discussed:

- Gail Durham, Nevada Division of Forestry, gave an update on recent pinyon pine defoliator activity in Nevada, caused primarily by pinyon sawfly, *Nodiprion edulicolus*, and pinyon needle scale, *Matsucoccus acalyptus*. She presented two maps, one that showed pinyon defoliation and another depicting mountain mahogany affected by drought. The drought is likely a factor contributing to the sawfly/needle scale outbreak. Hoards of parasites were found attacking the sawfly eggs in August, 2009.
- Jessie Colgan, University of Alberta, talked about her thesis work investigating how trees attacked by multiple agents defend themselves (she also presented a graduate student paper on this topic in another session). She has been working with the jack pine, mountain pine beetle, and jack pine budworm system, employing greenhouse studies that

involve jack pine budworm herbivory and use of fungal lesion induction as a surrogate for mountain pine beetle attack.

- Nadir Erbilgin, University of Alberta, presented an update of his research on the defoliation-induced defense responses of trees. He has been working with the aspen and forest tent caterpillar system; investigating how trees allocate carbon and defensive resources in response to defoliation, how fertilization and shade affect these responses, and what role pollen plays in tree resource allocation. He is working to identify traits indicating tree susceptibility or resistance to defoliation.
- Sandy Liebhold, USFS Northern Research Station, described his investigations into changes in larch budworm moth outbreak patterns in the European Alps and the potential connection with climate change. Historic outbreak patterns derived from dendrochronology studies of existing forest trees (dating back 400 years) and wooden beams in historic buildings (dating back 1200 years) indicate a continuous course of periodic outbreaks every eight to nine years in which the elevation of outbreak epicenters has shifted up and down with warmer and cooler periods until 25-30 years ago, when outbreaks abruptly ceased. The theorized explanation for this change is that the climatic conditions necessary for outbreak development have since occurred at altitudes higher than the elevational extent of host larch forest.

POSTER SESSION

Soapberry Borer, *Agrilus prionurus* (Coleoptera: Buprestidae): Attack Characteristics and Known Distribution of an Invasive Pest of Western Soapberry in Texas.

Ronald F. Billings and Herbert A. Pase III
Texas Forest Service, College Station, TX 77840-7896

The soapberry borer (*Agrilus prionurus*), a native of Mexico, was first reported in Texas in Travis County in 2003. This invasive pest infests only western soapberry (*Sapindus saponaria* var. *drummondii*). As of 2010, trees infested with this insect have been detected in 33 counties, including near or within the cities of Fort Worth, Dallas, Waco, College Station, Austin, Houston and Corpus Christi. As its populations expand rapidly in Texas, this buprestid is killing all sizes of soapberry trees > 2 inches DBH. It may eventually threaten western soapberry populations throughout the tree's range, which extends from northern Mexico to Missouri, and west to Arizona. Infestations of soapberry borer are similar to those of emerald ash borer, *Agrilus planipennis*, a close relative not yet found in Texas. Infested trees can be easily recognized by the exposed sapwood that results when birds and squirrels chip off the bark to feed on the larvae. Bark chips accumulate at the base of the tree. A heavily-infested tree will be completely girdled by white larvae feeding beneath the bark. The adult beetle is about ½ inch-long, shining black and distinctively marked with four small white spots on the wing covers. Larvae are flat-headed wood borers that may attain an inch or more in length as they mature. After feeding beneath the bark, the larvae bore into the wood to complete development and to pupate. The adult leaves a D-shaped exit hole as it emerges. Western soapberry appears to be this insect's sole host in Texas and the tree exhibits little resistance to this introduced pest. The insect appears to have one generation per year and methods of prevention and control are under investigation. For more

information or to report new infestations, contact Ron Billings (rbillings@tfs.tamu.edu) or visit www.texasinvasives.org.

Factors Influencing Northern Spruce Engraver (*Ips perturbatus*) Colonization of Slash and Residual Trees Following Land Use Changes in Alaska

Roger E. Burnside, Alaska Department of Natural Resources, State of Alaska; Christopher J. Fettig and Christopher J. Hayes, Pacific Southwest Research Station, USDA Forest Service; and James J. Kruse and Mark E. Schultz, Forest Health Protection, USDA Forest Service

In interior Alaska, the northern spruce engraver causes mortality of white spruce and is the primary mortality agent of white spruce in areas recently disturbed by human activity. Beetles can reproduce in logging slash and stressed trees, sometimes resulting in eruptions of local beetle populations that cause mortality of healthy spruce trees. Our objectives were to determine if slash management techniques can reduce beetle reproductive success in logging slash and subsequent tree mortality, and to determine if anti-aggregate semiochemicals can reduce attack density and brood production in white spruce logging slash. In interior Alaska, spruce trees were felled to create 60, 1.4 m long by 10.2-20.3 cm diameter bolts on 0.10 ha plots in Fall 2009, and will be again Spring 2010. Bucked logs were either decked or scattered and scored or not scored (four treatment combinations). Logs will be assessed for attack density in July 2010. Exit-hole density will be assessed September 2010, and northern spruce engraver-caused tree mortality will be recorded Fall 2011. In mid-May 2009, 20 slash decks consisting of 15, 1.4 m long bolts with large end diameters of 10.2–20.3 cm were created from freshly felled white spruce trees near Tok, Alaska. Half of the piles were treated with two semiochemicals (verbenone and conophthorin) while the other half were left untreated. Significantly lower northern spruce engraver attack and exit hole densities were found on treated piles compared to untreated piles, suggesting that further investigation of this treatment is merited.

An outbreak of a twig beetle, *Pityophthorus boycei* Swaine (Coleoptera: Curculionidae: Scolytinae) in Bristlecone Pine Colorado 2009

Ciesla, William M., Brian E. Howell, Sheryl L. Costello,
Justin Backsen and Robert J. Cain

An outbreak of a little known twig beetle, *Pityophthorus boycei*, was detected in stands of bristlecone pine, *Pinus aristata*, on Thirtynine Mile Mountain in southeastern Park, County, Colorado in 2009. Approximately 70-80% of the twigs on trees growing near the summit were killed and damage was aerially visible as an area of brown discoloration on about 240 acres.

A New Strategy for Forest Service Invasive Species Research

Mary Ellen Dix and Kerry Britton
USDA Forest Service, Research and Development, Forest Management Science,
Arlington, VA 22209

The USDA Forest Service Invasive Species Research Strategic Program Area was reviewed by an external peer panel in 2006. The panel made 12 recommendations for improving our research program. These include: expanding prevention research; emphasizing research to improve the efficacy and cost-effectiveness of EDRR; maintaining current levels of research on management and control; informing restoration efforts at the landscape scale and recognize the significance of habitat interfaces; and developing holistic anticipatory mechanisms. The panel also recommended: maintaining or enhancing infrastructure; restoring taxonomic capacity; and enhancing partnerships and interdisciplinary research. Overall recommendations included: working with Stations to strengthen national framework; enhancing multi-discipline integration of impact assessments; improving communication of research results; and forming a science advisory board of external partners. Our responses to date include: developing a new strategy that provides a better long term vision of research needs and emphasizes prevention and EDRR research; developing a series of visionary papers that identifies long-term priorities and improves awareness across research stations of opportunities for synergy; and working to improve resources on our website. The Invasive Species Strategic Program Area is continuing our efforts to improve the research program.

Modulators of plant compensatory growth in aspen seedlings: the role of frequency and intensity of herbivory and resource availability

Nadir Erbilgin, David Galvez, and Bin Zhang
Department of Renewable Resources
University of Alberta, Edmonton, Alberta

For more than a century, plant ecologists have hypothesized and debated on strategies used by plants to cope with the impact of herbivore damage. During this time plant resistance mechanisms, which reduce the amount of herbivore damage before and during herbivory, have received most of the attention, while plant tolerance mechanisms, which may minimize the impacts of damage after herbivory, have been less studied.

We developed a theoretical predicting model, the Frequency and Intensity of Herbivory and Resource Availability (FIRA) model, based on carbon sink-source relationships. This model is presented as an initial tool designed to integrate biotic and abiotic interactions into the framework of plant compensatory responses. Our model incorporates the interactions between frequency and intensity of herbivory and resource availability as modulators of plant compensatory responses. These responses range from undercompensatory up to overcompensatory growth after defoliation.

We present results from a greenhouse experiment designed to test the model predictions. In this experiment we applied different intensities (25% - Low and 75% - High) and frequencies (2, 3 and 4 times) of simulated defoliation to aspen seedlings, with and without N enriched media.

We measured several plant physiological and chemical data, including photosynthetic rate, carbon and nutrient content of roots and leaves, and analyzed carbon (phenolics or phenols) and nitrogen (alkaloids) based chemical defenses using Thin Layer Chromatography and High Pressure-Liquid Chromatography.

In this presentation, I will discuss the results of our experiment in the context of our predictive model and past and present views on herbivory-induced compensatory growth, a historically debated plant tolerance response, and plasticity of chemical defenses based on the available nutrients. I will also discuss the intricate relationship between resource availability and

compensatory growth following herbivory, contrasting the vast range of environmental conditions and communities where compensatory growth has been reported.

Landscape-scale old ponderosa pine mortality at Mt. Trumbull, northern Arizona

Chris Erickson and Kristen M. Waring
School of Forestry, Northern Arizona University, Flagstaff Arizona

Between 1870, the time of Euro-American settlement, and the present, ponderosa pine (*Pinus ponderosa*) stands across the southwestern United States have been increasingly stressed by factors such as increased stand density and fuel loads, increased fire severity and intensity, and decreased water and nutrient availability. At Mt. Trumbull, northern Arizona, a landscape-scale ponderosa pine ecosystem restoration project, involving thinning and burning treatments, was established in 1995, beside an untreated control. Permanent plots were established to evaluate treatment effectiveness. Stand-scale old pine mortality has been observed at elevated levels at Mt. Trumbull. Five years post-treatment, old pines were more than twice as likely to die in treated versus untreated areas. The goal of the current research is to investigate landscape-scale mortality trends of old ponderosa pine at Mt. Trumbull. Of the plots established in 1995 and re-measured in 2003, those containing old (pre-1870, >37.5 cm dbh) ponderosa pine are being re-visited to assess mortality in each treatment. Data collection includes assessments of tree characteristics and condition, soil texture, basal area increment and neighboring tree competition. I present results from the summer of 2009 including mortality rates and comparisons, soil properties and trends affecting mortality between treatments. We expect that elevated mortality persists in treated areas, especially where treated with fire twice, and increased mortality in the control since last re-measurements. We expect blowdown, drought, fire, bark beetles, soil properties and their interactions to be major mortality factors. This information is critical in an era of increased implementation of restoration treatments.

Tree mortality in drought-stressed mixed conifer and ponderosa pine forests, Arizona

Joseph L. Ganey and Scott C. Vojta
US Forest Service, Rocky Mountain Research Station, Flagstaff, AZ

We monitored tree mortality in southwestern mixed-conifer and ponderosa pine (*Pinus ponderosa* Dougl. ex Laws) forests from 1997 – 2007, a period of severe, global-climate-change type drought in this area. Mortality was pervasive, occurring on 100 and 98% of 53 mixed-conifer and 60 ponderosa pine plots (1-ha each) sampled, respectively. Most mortality was attributable to a suite of forest insects, mediated by drought stress. The number of trees dying over a five-yr period increased by over 200% in mixed-conifer forest and by 74% in ponderosa pine forest from 1997 – 2002 to 2002 -2007. Extent of mortality was spatially variable in both forest types. Median cumulative mortality in mixed-conifer forest increased from 11.3% in 2002 (range = 3.6 – 36.3%) to 21.1% in 2007 (range = 5.5 – 517.7%). In ponderosa pine forest, median cumulative mortality increased from 2.6% in 2002 (range = 0.3 – 28.4%) to 4.0% in 2007 (range = 0.3 – 111.0%). Median mortality rates from 2002 to 2007 were approximately 2.0% yr⁻¹ in mixed-conifer forest (range = 0 – 28.5%) and 0.4% yr⁻¹ in ponderosa pine forest (range = 0 – 13.6%). Mortality rates generally were not strongly related to stand density. Mortality was nonrandom with respect to availability of tree size classes and species. Proportions of trees dying were greatest in the largest size classes, particularly in mixed-conifer forest, where

mortality in the largest size class exceeded 22% from 2002 to 2007. Proportional mortality of all species was greater in mixed-conifer than in ponderosa pine forest. Mortality in mixed-conifer forest was particularly pronounced for quaking aspen (85%) and white fir (28%), the least drought tolerant species present. These results provide an early glimpse of how these forest types are likely to respond to predicted climate patterns and resulting altered disturbance regimes in the southwestern US.

Comparison of host-based green leaf volatile lures vs sesquiterpene lures for the emerald ash borer, *Agrilus planipennis*

Gary Grant, T. Pollard and B. Lyons.

Great lakes Forestry Centre, Canadian forest service; USDA Forest Service,
Northern research Station, East Lansing, MI

Trapping experiments were conducted against the emerald ash borer, *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae), to compare the sesquiterpene-based lures, Phoebe oil and Manuka oil, against traps baited with the green leaf volatile, (Z)-3-hexenol (Z3-6:OH). Light green sticky prism traps placed in the canopy of green ash trees and baited with Z3-6:OH lures caught significantly more EAB males than the unbaited controls, and were superior to Phoebe oil and Manuka oil-baited traps. There was no difference between Phoebe oil and Z3-6:OH lures for females although more females were caught with Phoebe oil compared to the controls. Catches were analyzed at regular intervals to examine lure performance over the course of the flight season. Z3-6:OH-baited traps consistently caught more males than the controls at each trap reading throughout the flight season. By contrast, female catches with Z3-6:OH and Phoebe oil were significantly better than the controls early in the flight season but declined substantially half way through the flight season. We suggest that a change in the status of the female population from virginal to mated may account for this apparent change in female response to lures.

Potential semiochemicals for western pine beetle.

N.E. Gillette, N., Uzoh, F., Mori, S., and Uzoh, E.

USDA Forest Service, PSW Research Station, Albany and Redding, CA

Forest land managers require a more effective antiaggregation pheromone blend for protecting western pines from attack by the western pine beetle (WPB). To that end, we screened a series of potential semiochemicals for interruption of WPB response to traps baited with their aggregation pheromone in a plantation in northern California. To accomplish this, we established a grid of attractant-baited panel traps spaced 60 meters apart, then added one of the following chemicals contained in 15-ml LDPE vials to each trap:

- 1-hexanol
- E-2-hexenol
- Z-3-hexenol
- Methyl cinnamate
- 1-octen-3-ol , racemic
- 1-octen-3-ol, pure R-enantiomer
- Verbenone

Trap catches were collected weekly, and beetles were identified and tallied after four weeks.

Of the six potential anti-aggregation semiochemicals tested, the three six-carbon alcohols (1-hexanol, E-2-hexenol, and Z-3-hexenol, appeared to reduce trap catch best, although none of the chemicals was as effective as verbenone alone. Future tests will assess efficacy of these hexanols in binary and ternary combinations with verbenone. Two of these hexanols (1-hexanol and Z-3-hexenol) were shown to increase efficacy of verbenone targeting mountain pine beetle in previous experiments, suggesting that the combination may have efficacy for multiple species.

Brood Tree Removal and Verbenone Treatments Mitigate MPB Risk

N.E. Gillette and S.R. Mori (USFS PSW Research Station, Albany CA),
W.J. Murray (San Jose State University, San Jose CA), N.M. Kelly and D.L. Wood, University
of California, Berkeley CA) and J.N. Webster, RPF, Redding CA

To mitigate MPB damage, we designed a demonstration project with treatments targeting beetle populations (VBN = verbenone, BTR = brood tree removal):

- VBN flakes + BTR
- VBN pouches + BTR
- Untreated reference stands

BTR was conducted during winter 2008-2009, and VBN treatments installed early July 2009. Plots were surveyed September 2009 to measure stand structure and MPB attacks. Influences of stand structure, BTR, and VBN treatments were assessed using logistical regression. Our findings:

- BTR reduced new MPB attacks by > 40-fold
- Both VBN+BRT treatments significantly reduced MPB attacks (50-80%)
- The two VBN treatments were not significantly different
- Stand structure differed significantly among the three plots
- High-density stands had significantly higher risk of attack than low-density stands

Stand structure, BTR, and VBN were all significant factors in risk of attack in 2009. These findings suggest that treatments to reduce stand density, eliminate brood, and disperse anti-aggregation pheromones can effectively reduce risk of MPB attack. Our findings confirm that brood trees strongly influence risk of MPB attack, and suggest that removal of susceptible trees may reduce attack. In this study, as in several others, the most susceptible trees were 12-16 inch DBH, but larger trees were less susceptible, suggesting that a strict DBH limit may not be necessary. Our findings indicate that the absolute amount of pheromone active ingredient may be more important than the particular release device; both flakes and pouches gave significant protection.

The influence of mountain pine beetle outbreaks on carbon and nitrogen dynamics in lodgepole pine ecosystems: preliminary results of an ongoing study

E. Matthew Hansen, US Forest Service, Michael C. Amacher, US Forest Service,
Helga Van Miegroet, Utah State University, Michael A. White, Utah State University,
James N. Long, Utah State University, and Michael G. Ryan, US Forest Service

In lodgepole pine (LPP) forests, maximal volumes of C storage occur among mature stands whereas the highest rates of C uptake occur in relatively young stands. A similar, age-

dependent dynamic occurs for N and other nutrients. Thus, the loss of the mature overstory during a mountain pine beetle (MPB) outbreak can substantially alter the flux and storage of C and N within the affected ecosystem. Moreover, killed trees become part of the detrital pool, further affecting C and N cycling. Over several centuries of repeated MPB disturbance, resulting in replacement of mature trees with young ones, cumulative C uptake should be significantly greater compared to a chronosequence with no disturbance. Also, live and detrital C storage may be regulated at a relatively high level (regulated in the sense that MPB outbreaks are quasi-cyclical). A cycle of MPB outbreaks may also contribute to accelerated N cycling and retention. N bound in the dead stems may be immobilized by decomposers and eventually released to the available pool. Meanwhile, N demand by the new and surviving trees should increase with accelerated biomass increment. We will investigate these hypotheses through empirical data and chronosequence simulations using a growth and yield model (Forest Vegetation Simulator, FVS). Furthermore, we will assess landscape-scale affects of MPB disturbance on C flux using a process-based model initialized with remotely-sensed data (Physiological Principles Predicting Growth from Satellites, 3PGS). Understanding these dynamics will enhance managers' ability to match vegetation management with desired outcomes.

Emamectin Benzoate and Propiconazole for Protection of Lodgepole Pine from Mountain Pine Beetle

Christopher J. Fettig, A. Steven Munson, Donald M. Grosman, Parshall B. Bush,
Christopher J. Hayes, and Stephen R. McKelvey

Pacific Southwest Research Station, USDA Forest Service; Forest Health Protection, USDA Forest Service; Texas Forest Service; The University of Georgia;
Pacific Southwest Research Station, USDA Forest Service

Protection of individual high-value trees from bark beetle attack has historically involved applications of liquid formulations of contact insecticides to the tree bole, but recently an experimental formulation of an injected systemic insecticide, emamectin benzoate, has shown promise for this use. Our objectives are to determine: the efficacy of emamectin benzoate (TREE-äge™; Arborjet Inc., Woburn, MA) alone and combined with the fungicide propiconazole (ALAMO®; Arborjet Inc., Woburn, MA) for protecting individual lodgepole pine from mortality attributed to mountain pine beetle attack and the inoculation and spread of blue stain fungi; if timing of injection influences the efficacy of emamectin benzoate and emamectin benzoate + propiconazole for protecting individual lodgepole pine from mortality attributed to mountain pine beetle attack; and the distribution and concentration of emamectin benzoate and propiconazole in lodgepole pine phloem and foliage at several points in time after injection. In lodgepole pine stands in northeastern Utah, lodgepole pine trees were treated 15-19 June 2009 and 16-18 September 2009, and foliage and phloem samples were taken five and 13 weeks after the June 2009 treatment. Five weeks after the June treatment very low levels (<0.25 ppm) of propiconazole were found in phloem tissue, but significantly more (>10.0 ppm) was found in phloem tissue 13 weeks after treatment. In addition, pheromone-baited traps found two mountain pine beetle flight peaks, one in the third week of July and one in the last week of August. Additional phloem and foliage samples will be collected in 2010, and trees will be assessed for mortality in September 2010.

Assessing survey methods for the goldspotted oak borer in southern California

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The goldspotted oak borer (GSOB), *Agrilus coxalis auroguttatus*, is an invasive phloem borer that as of 2009 is responsible for the loss of more than 20,000 oaks in southern California. In California, GSOB aggressively injures and kills three native species of oak. Oak mortality decreases property values, creates health hazards around dwellings and roadways, and changes the structure of forest fuels.

In order to better understand the biology of GSOB and improve our monitoring techniques, we used three-sided purple and lime-green flight-intercept prism traps and commercial lures developed for a congener, the emerald ash borer (EAB), *Agrilus planipennis*, to assess: 1) adult flight period; 2) the most effective height placement of traps (1.5, 3, or 4.5 m); and 3) the attractiveness of GSOB to EAB lures. We collected GSOB adults on traps from May to October, but peak flight activity occurred late June to early July. We found that purple-colored traps caught more GSOB adults than lime-green-colored traps; however, the difference was not significant. Purple traps were most effective when hung at 3.0 m, whereas lime-green traps were most effective at 4.5 m. None of the EAB lures had a significant effect on GSOB trap catch when compared to unbaited controls. In conclusion, current trapping methods are ineffective for monitoring GSOB. To develop an effective semiochemical lure and improve the innate attractiveness of the trap, we are planning additional studies to evaluate the effectiveness of oak host volatiles and trap colors that mimic host foliage reflectance.

Use of acoustics to control bark beetles

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Although acoustic communication in many insects is well known, this communication has rarely been applied to pest mitigation and control. Our study seeks to add a revolutionary tool for minimizing damage and mortality by bark beetles. This acoustic technology could provide a chemical free, non-invasive means of tree protection and treatment of bark beetle infested trees. Our objectives are to develop and adapt acoustic technologies to address specific bark beetle infestations, evaluate the effectiveness of acoustic methods in replicated field conditions, and conduct field demonstration programs to educate the public and private industries for effective integration of acoustic technologies into management programs. The use of acoustic sounds increased *Dendroctonus* beetle mortality, reduced reproduction and egg laying, and reduced tunnel excavation within phloem sandwiches and logs. *Dendroctonus* were deterred and fled from material when sounds were played. The sound patterns appeared to be effective for specific species. Thus there may be limited non-target effects. We have yet to determine the effects of sounds on beetle larvae. We had limited success affecting *Ips* with sounds.

Firewood as a potential pathway for native or exotic forest pest species in the southern Rocky mountains

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Firewood can harbor harmful insects and pathogens and facilitate the transport of these organisms within a state or across state or national borders. There are currently a considerable number of invasive native or exotic species we hope to prevent from moving into new areas of the U.S. In 2008, approximately 4.3 million people camped in National Parks in the southern Rockies (Arizona, Colorado, Nevada, Utah and Wyoming). We propose that camper movement of firewood is a high risk pathway of non-native organisms within and into western states, especially if campers come from infested areas.

In 2009 we conducted personal interviews and quantified the number of campers visiting 30 campgrounds in 13 National Parks and National Recreation Areas in the southern Rocky Mountain region. We personally surveyed 1,658 camper groups, asking questions pertaining to their sources of firewood. Preliminary results indicate that 1,116 campers surveyed had firewood (68% of all campers) and 37% had firewood from outside the park state. When weighted by park camping visitation numbers, this equates to 330,000 incidents in 2008 of campers bringing out-of-state wood into the parks surveyed. Results varied by state: 23% of campers in Arizona parks brought firewood from outside the state, 8% in Colorado parks, 43% in Nevada parks, 57% in Utah and 24% in Wyoming. Fifty-three percent of firewood had the presence of previous insect infestations while 39% had fungal contamination (primarily blue stain fungi). Future movement of non-native pests might be prevented if we can restrict the movement of infested wood, particularly firewood.

Individual-Tree Tests of Verbenone Flakes, Verbenone Pouches, and Green-Leaf Volatiles to Protect Lodgepole Pines from Mountain Pine Beetle Attack

Sandy Kegley, Ken Gibson, Nancy Gillette, Jeff Webster, Lee Pederson, and Sylvia Mori

Verbenone pouches are usually effective in protecting lodgepole pine from mountain pine beetle. In some cases, green-leaf volatiles have increased efficacy of verbenone pouches. However, there have been operational failures in protecting trees with verbenone pouches during extremely high beetle populations. Recently-registered verbenone-impregnated flakes have shown similar promise in protecting lodgepole pine. It has been suggested that verbenone flakes, with multiple points of elution, may have greater efficacy than verbenone pouches. In a side-by-side trial, we tested the efficacy of verbenone (VBN) flakes, pouches, and a combination of verbenone and two green-leaf volatiles (GLV) (a hexenol/hexanol blend) pouches in protecting individual lodgepole pines from mountain pine beetle.

Pheromone-treated trees were protected from mass attack 70-83% of the time while 77% of untreated control trees were killed. All three treatments were significantly different from controls ($p < 0.001$) but not from each other. Of all the treatments, the flake treatment had the least amount of mass attacks (17%) but the greatest amount of pitchouts (20%) and strip attacks (23%). The VBN pouch treatment had the greatest amount of mass attacks (30%) and 10% pitchouts. The VBN+GLV treatment had 20% mass attacks, 7% strip attacks, and 10% pitchouts.

Although efficacy of verbenone flakes was similar to pouches, application methodology was more laborious and time consuming. We did not achieve the level of protection from the flake application that would justify using flakes, rather than pouches for individual tree protection. However, the shift seen toward fewest mass attacks but more pitchouts and strip attacks with flakes than with the other products suggests that applying the pheromone

circumferentially around the bole may reduce the numbers of beetles attacking the bole, as compared to a single or two point-source releasers (pouches). This evidence may prove to be useful in the design of other new products with enhanced efficacy.

Area-wide treatments, which do not employ a sticker, remain a desirable option for use of flakes, especially where access by foot is difficult.

Verbenone pouches combined with GLV pouches provided equally good protection. Although not yet registered, GLV pouches are less expensive than verbenone pouches and have the potential to reduce treatment costs.

The green alder sawfly - *Monsoma pulveratum* (Retzius): a new pest in Alaska

Kruse, J.J., K. Zogas, J. Hard, and N. Lisuzzo.

The first U.S. record of *M. pulveratum* was documented from Alaska, the first report since Newfoundland, Canada in the early 1990's. *M. pulveratum* is native to Europe, North Africa and the Near East, where its preferred host is European black alder (*Alnus glutinosa*). By the time of identification *M. pulveratum* was found actively defoliating *A. tenuifolia* in Anchorage, Kenai, near Seward, and in the Matanuska-Susitna River Valley. *M. pulveratum* adults have also been caught in traps in Fairbanks, a distance of more than 300 miles from their first reported Alaskan sightings in 2004. Identification, life history, and potential impacts are described.

Evaluation and monitoring mountain pine beetle infestation in fire-injured lodgepole and ponderosa pines

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Mountain pine beetle (*Dendroctonus ponderosae*, MPB) and wildfire are important disturbance agents in western pine forests. The implications of MPB infestation and subsequent mortality of fire-injured trees are of substantial interest to forest managers due to the frequency of wildfire and prescribed burns in western forests. Some bark beetles are known to colonize fire-injured trees such as *D. pseudotsugae* and *Ips spp.* However, previous studies on MPB have yielded conflicting results. In this study we attempt to clarify MPB's role following fire by evaluating 1) if the manner and extent to which variable degrees of fire injury affect MPB colonization and reproduction, 2) whether these relationships differ between lodgepole (*Pinus contorta*) and ponderosa (*P. ponderosa*) pines, and 3) whether beetle colonization occurs within adjacent, unburned trees. We established plots, monitored beetle attacks, and caged infested trees within areas affected by the Neola North Fire of 2007, in the Uinta Mountains of Northern Utah. Our results indicate that MPB is colonizing fire-injured trees, especially those with complete crown damage. In ponderosa pine, colonization occurred in trees of moderate or high fire-injury and reproductive rates increased with the degree of injury. It is unknown if uninjured ponderosa pine will be colonized due to their infrequency within the burn area. Populations have been declining each year since the fire. In lodgepole pine, colonization initially occurred within trees of moderate fire-injury, and then shifted to low and uninjured trees during the two years following the fire. Population levels are remaining stable. We found no relationship between the degree of fire-injury and beetle reproduction rates in lodgepole pine. These results suggest

that the initial pool of weakened trees allowed populations to build locally and infest uninjured lodgepole pine the following year. The population dynamics of MPB following wildfire are dependent on the tree species, and likely, the characteristics of the wildfire (e.g. fire type, intensity), and the resulting mosaic of trees of varying fire injury.

Insect Pests in Alaskan Forests – What will a Changing Climate do to Them?

John E. Lundquist

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To some, Alaska is considered the poster child of climate change. Alaska is expected to experience changes due to climate change sooner and more severely than locations further south. How rapidly these changes will occur, what their extent and severity will be, or how they will impact forest health can only be guessed. We expect that incidence and severity of some forest insect pests will increase, geographic ranges will expand, multiple pest complexes will become more common, and incidence of invasive species will increase. The evidence is strong but mostly circumstantial for climate driven changes in the behavior and distribution of a handful of insects in Alaska. Infamous spruce beetle outbreaks of the mid-1990s, increasing incidence and prevalence of aspen leaf miner, increasing frequency of spruce budworm in the Alaska interior regions, and other similar observations have all been attributed to a changing climate. Because climate influences so many processes in living ecosystems, proving that changes in the former cause specific effects in the latter is very difficult. In this regard, spruce beetle is arguable one of the best studied. Ed Berg showed a correlation with hot dry summers and spruce beetle outbreaks on the Kenai, and Ed Holsten, John Hard, ‘Skeeter’ Werner and their colleagues conducted a series of studies that could at least partly explain the mechanisms involved in these outbreaks.

Forest Entomologists of the Southwestern Region

Joel D. McMillin

Forest Health Protection, USDA Forest Service, Flagstaff AZ

In order to document the numerous forest entomologists who have assisted land managers in the Southwestern Region of the US, information was collected from historical documents, insect & disease condition reports, and surveys of past and current employees. Prior to 1950, assistance was provided by nearly 20 different entomologists from the Bureau of Entomology and Forest Insect Laboratories located outside of the Southwestern Region. Beginning in early 1950's through the 1960's field assistance was supplied by 15 entomologists primarily from within the Region with the opening of the Forest Insect & Disease Laboratory in Albuquerque, NM and staff entomologists in the Regional Office Division of Timber Management. In the 1970's the Regional entomology staff became part of Forest Insect & Disease Management and the states of New Mexico and Arizona hired their first full-time forest entomologists. In 1988 the Southwestern Region divided insect and disease responsibilities into a New Mexico Zone of Forest Pest Management and Arizona Zone of Forest Pest Management. In addition, the Flagstaff Lab of the Rocky Mountain Research Station hired a research entomologist in the 1980's. Faculty at state universities have also contributed to our knowledge of forest insects in the Region and trained many students. By summarizing these findings, I plan to provide a

historical record of contributions made by entomologists to the management of forests in the Southwestern Region. If you have knowledge concerning the heritage of forest entomologists in the Southwest, please contact Joel McMillin (jmcmillin@fs.fed.us).

Pine volatiles and bark beetle pheromones for longhorn beetles in southeastern USA

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Our objective was to determine the effect of adding the binary combination of pine engraver pheromones, ipsenol and ipsdienol to the binary combination of pine volatiles, ethanol and (-)- α -pinene, on catches of some common pine longhorn beetles (Cerambycidae) in southeastern USA. Six trapping experiments were conducted in stands of mature pine in four states (FL, GA, LA and VA). Four experiments were conducted in the summer of 2006 and two in the fall of 2006. In each experiment, thirty 8-unit multiple-funnel traps were grouped into ten replicates of three traps per replicate with traps spaced 10-15 m within a replicate and replicates spaced 15-30 m apart. Sites contained various combinations of the following species of southern pines: *Pinus taeda*, *P. echinata*, *P. palustris* and *P. elliottii*. Sites were selected based on recent history of thinning or prescribed burns in the past 12 months. In VA, replicates were divided equally between 2 locations (>500 m apart). The following treatments were randomly assigned to one of the three traps within each replicate: ethanol + (-)- α -pinene (EA) ; ipsenol and ipsdienol (SD); and ethanol, (-)- α -pinene, ipsenol and ipsdienol (EA + SD). The release rates for ethanol and (-)- α -pinene were about 1-5 g/day at 23-25 °C whereas ipsenol and ipsdienol were each released at 0.1-0.2 mg/d at 23-25 °C . Collection cups contained RV and Marine antifreeze. Summer collection periods in 2006 were 4 April - 6 June in FL, 11 April - 13 June in GA, 4 April - 31 May in LA, and 25 May - 27 July in VA. Fall collection periods were 23 Aug - 4 Oct 2006 in GA and 6 Sept 2006 - 5 Jan 2007 in LA. Traps baited with the quaternary lure combination of ethanol, (-)- α -pinene, ipsenol and ipsdienol (EA + SD) were attractive to *Acanthocinus obsoletus*, *Astylopsis arcuata*, *A. sexguttata*, *Monochamus titillator*, *M. scutellatus* and *Rhagium inquisitor* in southeastern USA. Attraction of *Xylotrechus sagittatus* to traps baited with ethanol and (-)- α -pinene (EA) was unaffected by the addition of ipsenol and ipsdienol (SD) to traps.

Separate traps baited with ethanol or ethanol + (-)- α -pinene for bark and ambrosia beetles in southeastern USA

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Our objective was to verify the need for separate traps baited with ethanol or ethanol and (-)- α -pinene for bark and ambrosia beetles in pine stands of southeast USA. Eight trapping experiments were conducted in stands of mature pine in AL, FL, GA, NC and SC. Sites contained various combinations of the following species of southern pines: *Pinus echinata*, *P.*

elliottii, *P. palustris*, *P. strobus* and *P. taeda*. In each experiment, 32 eight-unit multiple-funnel traps were grouped into 8 replicates of 4 traps per replicate with traps spaced 10-15 m within a replicate and replicates spaced 15-500 m apart. Each trap was suspended by rope between trees such that the bottom of each trap was 0.2-0.5 m above ground. The following treatments were randomly assigned to one of the four traps within each replicate: (1) unbaited control; (2) ethanol; (3) (-)- α -pinene; and (4) ethanol + (-)- α -pinene. The release rates for ethanol and (-)- α -pinene were about 1-5 g/day at 23-25 °C. Collection cups contained RV antifreeze. Collection periods were as follows: AL - 28 Apr to 10 Jul 2003; FL (3 sites) - 25 Feb to 25 May 2002, 26 Feb to 26 May 2002 & 30 Mar to 16 Jun 2004; GA - 12 Jun to 8 Aug 2002; NC (2 sites) - 20 Jun to 20 Aug 2002 & 1 May to 14 Aug 2003; & SC - 15 Apr to 16 Jul 2003. Traps baited with ethanol were attractive to 10 species of ambrosia beetles (*Ambrosiodmus tachygraphus*, *Anisandrus sayi*, *Dryoxylon onoharaensum*, *Monarthrum mali*, *Xyleborinus saxesenii*, *Xyleborus affinis*, *X. ferrugineus*, *Xylosandrus compactus*, *X. crassiusculus*, and *X. germanus*) and 2 species of bark beetles (*Cryptocarenum heveae* and *Hypothenemus* spp). Traps baited with (-)- α -pinene were attractive to 5 bark beetle species (*Dendroctonus terebrans*, *Hylastes porculus*, *H. salebrosus*, *H. tenuis*, and *Ips grandicollis*) and one platypodid ambrosia beetle species (*Myoplatypus flavicornis*). Ethanol enhanced responses of 5 species (*Xyleborus pubescens*, *Hylastes porculus*, *H. salebrosus*, *H. tenuis*, and *Pityophthorus cariniceps*) to traps baited with (-)- α -pinene. (-)- α -Pinene interrupted responses of some ambrosia beetle species to traps baited with ethanol. Of 23 species of ambrosia beetles captured in our field trials, 9 were exotic and accounted for 70–97% of total catches of ambrosia beetles. Our results provide support for the continued use of separate traps baited with ethanol alone and ethanol with (-)- α -pinene to detect and monitor common bark and ambrosia beetles from southeastern region of the USA.

**Attractant kairomone lure blend for the southern pine sawyer,
Monochamus titillator (Cerambycidae: Coleoptera)**

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Our objective was to determine the effects of the pine tree volatiles [ethanol and (-)- α -pinene] and bark beetle pheromones [ipsenol and ipsdienol] on the attraction of southern pine sawyers, *Monochamus titillator* F. to baited multiple-funnel traps. In 2002–2007, three trapping experiments were conducted in stands of mature pine in southeastern United States as follows: Expt 1 - Determine the additive effects of host volatiles, ethanol and (-)- α -pinene on catches of *M. titillator*; Expt 2 - Determine the additive effects of bark beetle pheromones, ipsenol and ipsdienol on catches of *M. titillator*; and Expt 3 - Determine the additive effects of host volatile blend [ethanol and (-)- α -pinene] and bark beetle pheromone blend [ipsenol and ipsdienol] on catches of *M. titillator* in southeastern US. In each experiment, multiple-funnel traps were grouped into replicates with traps spaced 10-15 m within a replicate and replicates spaced 15-30 m apart. Treatments were randomly assigned to traps within each replicate at each location. The release rates for ethanol and (-)- α -pinene were about 1-5 g/day at 23-25 °C whereas ipsenol and

ipsdienol were each released at 0.1-0.2 mg/d at 23-25 °C . Collection cups contained RV and Marine antifreeze. Sites contained various combinations of the following species of southern pines: *Pinus echinata*, *P. elliottii*, *P. palustris*, *P. strobus* and *P. taeda*. Sites were selected based on recent history of thinning or prescribed burns in the past 12 months. We found that: (1) the combination of ethanol and (-)- α -pinene is more attractive to *M. titillator* than either compound alone; (2) *M. titillator* is attracted to traps baited with ipsenol or ipsenol and ipsdienol; and the blend of ipsenol, ipsdienol, ethanol + (-)- α -pinene is more attractive to *M. titillator* than blends of ipsenol + ipsdienol or ethanol + (-)- α -pinene, separately.

Controlling of bark beetle pPredators by allochthonous kairomones

Michael Mueller and Matthias Hellmund

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Many European bark beetles, serious forest pests, are predated by species of the genus *Thanasimus*, especially *T. formicarius* and *T. rufipes*. These species forage for their prey using bark beetle pheromones as kairomones. The most important bark beetle species in Central Europe are closely related to single host tree species. *T. formicarius* and *T. rufipes*, however, predate a broad spectrum of bark beetle species prevalent in coniferous forests. Therefore, kairomonal relationships between bark beetles and their predators can be used to aggregate *Thanasimus* species by the application of Allochthonous Kairomones. Results of aggregation trials in pine forests (*Pinus sylvestris* L.) using semiochemicals as Allochthonous Kairomones are given in this poster.

Forest disturbance interactions in The Pinaleño Mountains:

Learning from the past to understand the present and plan for the future

Christopher D. O'Connor, Donald A. Falk, Ann M. Lynch, Rachel A. Loehman, Thomas L. Swetnam, Craig P. Wilcox, Denise Laes, John A. Anhold and Robert E. Keane.

Over the last century, many western forests have experienced shifts in species composition and age structure that has contributed to unprecedented levels of catastrophic fire, bark beetle-induced mortality, and defoliation events caused by both endemic and introduced insects. Human behaviors such as fire suppression, livestock grazing, logging, transport of exotic insect pests, and anthropogenic climate change have been implicated as catalysts for these ecosystem changes; however mechanisms by which human landscape legacies affect observed changes and interactions among multiple disturbance events are not well understood. In the Pinaleño Mountains of southeastern Arizona, a 130 year recorded history of human use of the range combined with recent major fires and insect damage provides a unique laboratory to study the interactions between changes to forest ecosystems and a history of human land use. To examine each change individually and as a component of the system, we are conducting a systematic reconstruction of stand age structure and species composition, fire history, and insect disturbance events over the last several hundred years to provide a context for current conditions across the mountain range. We are combining classical field and laboratory-based dendrochronology techniques with recently developed LiDAR 3-D spatial analysis technology and a tree-based landscape composition change model to characterize temporal and spatial

extents of past and current disturbance regimes and to examine the interactions between human land uses and disturbance events. Results from this study will inform management actions for an ecosystem restoration project currently underway in the Pinaleño Mountains and may provide more general insights into the feedbacks from and underlying causes of multiple disturbance events as well as actions that can be taken to mitigate major ecosystem changes in western forests.

Assessing post-fire tree survival in Oregon and Washington

R. A. Progar, D. Scott, C. Schmitt, L. Spiegel, B. Hostetler, B. Wilhite, A. Eglitis, K. Chadwick, C. Mehmel, D. Goheen, S. Acker, L. Ganio, and S. Hart

This project was initiated to refine/calibrate/develop guidelines to assess the survival of trees after fire (wildfire or prescribed burn) in Oregon and Washington. There are many models and methods of evaluating the survival of trees following injury by fire in the western US. Few have been developed to evaluate tree survival in the Pacific Northwest. Even fewer of the methods used by forest managers have been evaluated for accuracy. The unknown ability of these models or rating systems to accurately predict tree survival across a range of habitat and soil types, conifer species, fire conditions, and various other factors has created the need for validation and calibration of existing models. The objectives of this project are to (1) assess mortality of trees in R6 caused by direct fire injury, and secondary mortality caused by insects attacking injured trees, and the causal impacts of factors such as time, spatial correlation, precipitation, elevation, and species; and (2) to assess the application of existing survival models in Oregon and Washington.

Efforts to Reduce Mountain Pine Beetle Attack in Lodgepole Pine Using Verbenone

R.A. Progar, C. Jorgensen, D. Blackford, P. Mocettini,
R. Halsey, S. Munson, D. Cluck, S. Costello, and T. Eager

The mountain pine beetle (MPB), *Dendroctonus ponderosae* (Fig. 1) is considered the primary cause of mortality of mature lodgepole pine (*Pinus contorta* var *latifolia*) (Fig. 2). In recent years much of the pine forest in western North America has reached diameters that are preferred by MPB. As a result, a west-wide outbreak of MPB has progressed over much of the pine forest since the late 1990's. Forest managers and land owners seek tools to protect trees from attack by MPB. One of these is an antiaggregant semiochemical called verbenone. Verbenone has been shown to reduce the incidence of successful MPB attacks on lodgepole pine (Schmitz 1988, Lindgren et al. 1989). Borden et al. (2007) demonstrated that sanitation combined with verbenone resulted in significantly fewer beetle killed trees than verbenone alone. We have been refining the potential application of verbenone in operational studies since 2000. In this poster we present a progression of studies to evaluate and improve the performance of verbenone in deterring mass attack by mountain pine beetle.

Inundative Release of *Aphthona* spp. Flea Beetles (Coleoptera: Chrysomelidae) as a Biological "Herbicide" on Leafy Spurge (*Euphorbia esula* L.) in Riparian Areas

R.A. Progar, G. Markin, J. Milan, T. Barbouletos, M.J. Rinella, and L. Spiegel

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%. Leafy spurge 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 kill, reduce plant vigor, or 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 periodic flooding that occurs in the late winter and spring. This project was conducted from 2005 through 2007 to evaluate the efficacy of releases of large numbers of *Aphthona* spp. beetles (inundative releases) each year for two consecutive years to control 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 from southwest to northeast Idaho. The biomass and number of stems of leafy spurge was reduced after one year at all three sites. Releasing 10 beetles per flowering stem had inconclusive effects on spurge biomass, crown, stem, and seedling density. Alternatively, releasing 50 beetles per flowering stem resulted in a reduction of biomass, crown and stem density from 60 to 80% at all three study sites, and about a 60% reduction of seedling density at one site, compared to untreated plots.

2009 Aerial survey results for Washington

Karen Ripley

Washington Department of Natural Resources

The Washington State Department of Natural Resources and US Forest Service have been cooperatively conducting annual statewide aerial surveys since the late 1940's. The comprehensive survey starts in approximately the second week of July and usually is completed by early September. One federal and one state observer work together, usually each mapping two-mile swaths as the plane flies over all the forests of the state in a 4-mile grid pattern. Cooperators in Oregon contribute data for the Washington portion of the Blue Mountains. The survey is completely digital, with several choices of background images for the surveyors to identify their location and accurately place damage polygons.

Washington has 22 million acres of forest land. In 2009, over 1.73 million acres of this land contained elevated levels of tree mortality, tree defoliation or foliage disease. This is an increase from the 1.36 million acres reported in 2008. Almost 6.4 million trees were recorded as killed. The major damage agents in western Washington were bear/root disease and Douglas-fir beetle (DFB). The DFB outbreak is a legacy of severe windstorms in December 2006 and 2007. In eastern Washington, pine bark beetles, western spruce budworm and the fir engraver beetle were the most significant damage agents. Douglas-fir tussock moth populations are also causing visible defoliation in small areas.

View annual aerial survey maps for Washington (and Oregon) at:
<http://www.fs.fed.us/r6/nr/fid/as/quad09/index.shtml>

Evaluation of the Antiaggregation Pheromone, MCH, for Controlling the Douglas-fir[bark] Beetle (*Dendroctonus pseudotsugae*) in Mexico

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Outbreaks of *Dendroctonus pseudotsugae barragani* began appearing in the States of Chihuahua and Coahuila, Mexico in 2001, and in the State of Durango's Sierra Madre Mountains in 2006. The host, *Pseudotsuga menziessii* var. *glauca* (known as the Rocky Mountain Douglas-fir in the U.S), has a very limited range in Mexico, and thus is subject to special protection by law. Because the use of conventional silvicultural practices is restricted, the application of MCH to control *D.p. barragani* is an attractive option; however, prior to this research, MCH had not been tested or registered for use in Mexico. In this study, conducted in Durango, the experimental protocols for pesticide registration in Mexico were followed. A complete randomized block design tested 14.4 g. A.I./ha (15 bubblecaps/acre); 28.8 g. A.I./ha (30 bubblecaps/acre); 44.0 g. A.I./ha (45 bubblecaps/acre), and a control (no MCH). Four replicates (16 experimental units, each 0.5 ha) were installed. Two funnel traps with Douglas-fir beetle lure were placed in each plot center and were serviced weekly from April through August, 2009. Preliminary results suggest that even when a baited trap is present, doses of 28.8 and 44.0 g. A.I./ha significantly reduce the number of beetles flying into the stand, compared with stands having either no MCH or a low dose (14.4 g. A.I./ha). In every treatment, some unsuccessful basal attacks by beetles were observed. Except for one case, successful attacks occurred only in control plots and plots having the lowest MCH dose. Further research using the pheromone flake formulation is planned.

How do areal detection survey mountain pine beetle cumulative mortality maps compare with mortality on the ground?

Michael Simpson, R6-FHP, Ecologist, Helen Maffei, Ph.D., R6-FHP, Pathologist; Eric Smith, Ph.D. Biometrician-FHTET; Vernon Thomas Sanborn, FHTET

Project Description

Forest Inventory plots from R6 Continuous Vegetation Survey (CVS) were used to field check the spatial and quantitative accuracy of cumulative Mountain Pine Beetle Mortality (MPBM) derived from Aerial Detection Survey (ADS). These 1 ha fixed plots installed from 1993-1997 and re-measured from 1996-2007 occur on a 1.7 mile grid across Forest Service lands in Oregon and Washington. For each CVS plot location, cumulative MPBM trees per acre (TPA) of dominant and co-dominant trees were compared with the ADS estimated cumulative MPBM TPA over the same timeframe as the CVS measurement interval.

The analysis was divided into two parts (Spatial Accuracy and Mortality Intensity).

Spatial accuracy was represented as the percent of time that ADS mapped MPBM presence corresponded with co-located CVS plot measured MPBM.

Mortality intensity was compared only where both data sources agreed mortality had occurred during the CVS plot measurement interval (+/- 1 year).

Spatial attributes were then assessed for their ability to explain ADS mortality detection failures. The attributes included:

- Cumulative ADS MPBM

- Number of sequential years of ADS mapped MPBM
- Percent host species
- Previous disturbances that could mask current MPBM from the air
- Spatial and temporal buffers around ADS cumulative MPBM

Results indicate that ADS under-estimates both the spatial extent of MPBM and the intensity of MPBM where mortality is mapped. ADS detection failure appears to explain the under-estimated extent of mortality better than spatial misalignment of ADS polygons.

Effects of tree overstory diversity on the diversity of understory ants in the tropical forests of Ghana, West Africa

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Plantation forests are becoming an increasingly important component of the world's forested ecosystem. However, relatively little is known about how forest plantation management, overstory tree species composition and diversity impacts biodiversity of non-tree components of the forest. We assess changes in ant functional groups composition as related to changes in overstory tree diversity (monocultures vs. polycultures), species composition (native vs. exotic), and time (one and two years after planting). A pitfall trapping scheme was implemented during the summer months of 2006 and 2007. A total of 7,473 specimens were collected representing 6 subfamilies, 22 genera and 65 species. We found no significant differences in traditional diversity measures or functional group composition between treatments one year after planting. Two years after planting we found significant differences in species richness. Several trends were observed that may indicate that these ant communities are currently in transition and will likely become more distinct over time as the plantations develop.

Innovative funding mechanism for US forest entomology graduate student research abroad: Peace Corps/NAU pilot partnership

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The Peace Corps and Northern Arizona University (NAU) School of Forestry have launched a new pilot program within the Peace Corps Masters International program. Peace Corps Masters International in Forestry is a standing program at several US Forestry Schools including NAU. Elements of the program include two semesters of course work at NAU, a typical Peace Corps service of 26 months in a foreign country, followed by one final semester at NAU where students prepare a publication quality Professional Paper. Students who successfully complete the program receive a Master of Forestry degree. Beginning in 2010 a pilot program called Peace Corps Country Post/University Partnership will link NAU School of Forestry with Peace Corps missions in Ghana and Mexico. Through these linkages the Peace Corp mission and university will jointly develop projects that are designed specifically to utilize NAU graduate students to meet Peace Corps goals in these countries. The partnership will allow NAU to recruit specific students for work assignments in these countries and allow faculty to help design high quality student projects. The goal is to create long term cooperative programs between a specific university and a foreign country to improve the effectiveness of the Peace Corps service in meeting country needs. The pilot project also creates a mechanism for graduate

students with interest in working in these two countries to obtain financial support for their projects. The standard Peace Corps Volunteer receives language and technical training, medical care, living allowance and readjustment allowance upon completion of service. NAU may also provide support for the specific project and faculty oversight. When the pilot project is fully evaluated it is expected to be available to other Peace Corps Masters International Forestry Programs.

Testing Commercial Pheromones for Trapping *Dioryctria abietivorella* in Western White Pine and Douglas-fir Seed Orchards

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Coneworms, *Dioryctria abietivorella*, periodically cause cone and seed damage in western white pine and Douglas-fir seed orchards. Coneworms have been difficult to monitor because they are not usually seen until damage already occurs. Pheromones have been tested for trapping coneworm adults for many years but an effective formulation has only recently been developed. The objective of this study was to test the efficacy of two commercial pheromone formulations. Thirty diamond sticky traps were randomly assigned to one of three different pheromone treatments and placed 100 feet apart in a seed orchard. Study replicates were located at a western white pine seed orchard near Coeur d'Alene, Idaho and a Douglas-fir seed orchard near Philomath, Oregon. Treatments were: 10 traps with Alpha Scents, Inc. pheromone; 10 traps with Synergy Semiochemicals Corp. pheromone; 10 traps with no pheromone (control). Traps were monitored weekly or biweekly and any moths caught were counted and removed. Traps and pheromones were replaced monthly.

At the western white pine orchard, a total of 548 moths were caught in traps baited with Alpha Scents™ lures and 611 moths in traps baited with Synergy lures over a 13-week period. At the Douglas-fir orchard, 630 moths were caught in Alpha Scents-baited traps and 669 moths in Synergy-baited traps over a 14-week period. One moth was caught in the control traps. Data were analyzed in SAS using the GENMOD procedure. Captures by the commercial lures differed significantly from the control treatment ($p < .0001$). The difference in the number of captures between the two commercial lures was marginally significant at the .05 level ($p = .0487$). We feel this difference is biologically insignificant for applications involving coneworm monitoring for presence or flight periods, but could become a consideration when monitoring to assess damage thresholds. Managers should feel confident using either pheromone in seed orchards to monitor coneworm presence or flight periods, but should be aware that the lures are not completely interchangeable.

Geographic range maps for forest insect species

Withrow, John

Lodgepole pine following mountain pine beetle epidemics: Fuel for fire???

Travis Woolley, Dave Shaw, and Stephen Fitzgerald (Oregon State University),
And Laurie Kurth (Fire Science Lab, Missoula)

The mountain pine beetle (*Dendroctonus ponderosae*) (MPB) has caused several waves of mortality over the past 30 years in central and south-central Oregon which peaked at over

1,000,000 acres in 1986. Currently, over 400,000 acres are being impacted in the area. This has raised questions about the potential for catastrophic fire following widespread mortality. Recent literature has suggested that there is a lack of specific data concerning how MPB caused mortality influences temporal and spatial aspects of fuels and potential fire behavior. The objective of this Joint Fire Science funded project (2010-2012) is to address the following questions in south-Central Oregon on the Deschutes and Fremont-Winema National Forests: 1. How do fuel profiles (ground, surface, ladder and crown fuels) in lodgepole pine forests change over time in response to MPB epidemics in south-central Oregon? 2. What are the effects of MPB epidemics on future fire behavior in lodgepole pine forests of south-central Oregon and how does fire behavior change over time following the epidemics? We will use a retrospective approach to understanding post-MPB-epidemic fuels for the lodgepole pine type on the Deschutes and Fremont-Winema National Forests in order to reconstruct stand development and ground, surface, ladder, and crown fuels. We will model fire behavior using standard fuel models and custom fuels models from our collected data, in conjunction with the fire behavior algorithms in *BehavePlus v 4.0.0*, *FlamMap*, and *FARSITE*. The dataset will also be provided to federal and state fire managers for fire management applications.

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