WESTERN FOREST INSECT WORK CONFERENCE

Snow King Resort, Jackson Hole, Wyoming, USA

May 1 – 4, 2017

Adapting in a Time of Transitions

Organizing Committee:

Darren Blackford (Chair)

Joel Egan

Program Committee:

Barbara Bentz (chair)

Darren Blackford

Seth Davis

Ryan DeSantis

Nadir Erbilgin

Chris Fettig

Monica Gaylord

Lorraine Maclauchlan

Posters:

Carl Jorgensen

Student Presentations:

Monica Gaylord

Conference Overview

Monday, May 1

1500-2000	Registration open	Grand Teton Mezzanine
1600-1700	Executive meeting	Timberline Two
1800-2000	**Meet and Greet Social** Cash bar, light hors d'oeuvres	Hayden's Post Deck

Tuesday, May 2

0700-1000	Registration open	Grand Teton Mezzanine
0700-0800	Continental Breakfast	Teton Room
0800-0815	**Welcome to Jackson** Hotel details, announcements/housekeeping	Grand Room
0815-0845	***Ecological resilience, historical ecology, and climate change: managing northern Rocky Mountain ecosystems for an uncertain future*** **Dr. Bob Keane**, US Forest Service, Rocky Mountain Research Station	Grand Room
0845-0915	***Challenges of managing forest projects for an uncertain future*** **Liz Davy**, District Ranger, Caribou-Targhee National Forest	Grand Room
0915-0945	Memorial Scholarship (2015) Presentation **Jennifer Klutsch**	Grand Room
0945-1015	Break	Teton Room
1015-1145	Concurrent Workshops 1	
	Forest resistance and resilience	Timberline One
	Pollinators in forest ecosystems	Timberline Three
1145-1315	Lunch (on your own)	
1315-1445	Concurrent Workshops 2	
	Cumulative effects of drought on forest disturbances and tree mortality	Timberline One
	All stocked up here: Strategies for optimizing forest density to increase resilience to bark beetles	Timberline Three
1445–1515	Break – Teton Room	Teton Room
1515-1615	Graduate Student Session 1	Grand Room
1615-1700	**Initial Business Meeting**	Grand Room
1730-1830	**Sheryl Costello Memorial Fun Run**	
1900-2100	Reception – cash bar, snacks	Teton Room
1900-2100	**Poster Session** **Silent Auction** to benefit the Memorial Scholarship	Grand Room

Wednesday, May 3

0700-1000	Registration open	Grand Teton Mezzanine
0700-0800	Coffee/Tea	Teton Room

0800-0930	Concurrent Workshops 3	
	Deciphering historical patterns and range of variability for key forest disturbance agents	Timberline One
	Balancing dynamics of ski area operations with forest health challenges	Timberline Three
1000-1700	Field Trip (lunch provided – pick up at 10:00 a.m. at the registration table in the Grand Teton Mezzanine)	
1800-2200	Founders Award Banquet ***Celebrating Forty-Four Years of Collegiality*** **Dr. Nancy Gillette**	Grand Room

Thursday, May 4

0700-0800	Continental Breakfast	Teton Room
0800-0830	***Opening the 'Windows of Opportunity' to maintain aspen in western US forests*** **Dr. Karen Mock**, Utah State University	Grand Room
0830-0900	Memorial Scholarship Presentation (2016) **Andrea Hefty**	Grand Room
0900-1000	Final Business Meeting	Grand Room
1000-1030	Break	Teton Room
1030-1200	Graduate Student Session 2	Grand Room
1200-1330	Lunch (on your own)	
1330-1500	Concurrent Workshops 4	
	High Elevation Pines	Timberline One
	Open session: submitted presentations on topical issues in forest entomology	Timberline Three
	Defoliators	Summit Two
1500-1530	Break	Teton Room
1530-1700	Concurrent Workshops 5	
	What's new with invasive forest insect species in the western USA?	Timberline One
	Biomimicry: Adapting insect behavior and biotic interactions to help manage their impact to our forests	Timberline Three
	Mountain pine beetle's changing range and challenges for forest management decision-making	Summit Two
1700	Meeting adjourns	

WORKSHOP SUMMARIES

Concurrent Workshops 1

Forest Resistance and Resilience *Moderator: Nadir Erbilgin*

- *A ground-up view of resistance and resilience to herbivory in forest ecosystems*. **Ken Raffa**, University of Wisconsin
- *Forest resilience and disturbance interactions in fire-prone landscapes: what happens when we alter fire regimes?* **Sharon Hood**, USDA FS, Rocky Mountain Research Station, Missoula, MT
- *A paradigm shift in tree improvement: from volume to forest health*. **Barb Thomas**, University of Alberta

Forests comprise of biotic and abiotic factors interacting at various temporal and spatial scales. Two of important characteristics of forests are resilience–capacity to recover following major disturbances– and resistance–capacity to resist disturbances over time. Under most natural disturbance regimes, forests maintain in their resilience and resistance, but due to recent climate change which has changed the temporal and spatial aspects of disturbances, the novel disturbance regimes have altered ability of forests to resist and recover following disturbances, resulting in many cases of a loss of resilience and resistance. In this workshop, three speakers provided perspectives on how altered forest resilience and resistance affect forest-insect herbivory interactions (Ken Raffa, University of Wisconsin, Department of Entomology, Madison, Wisconsin), forest-fire interactions (Sharon Hood, USDA-FS, Rocky Mountain Research Station, Missoula, Montana), and tree breeding efforts (Barb Thomas, University of Alberta, Depart Renewable Resources, Edmonton, Alberta). Ken Raffa described mechanisms that contribute to two components of stability in interactions between forests and insect herbivores, resistance and resilience. He discussed the relative amount of attention that has been given to these two components, specific examples of each mechanism, and commonalities between resistance and resilience processes. Sharon Hood and her colleagues focused on forest resilience and disturbance interactions in fire-prone landscapes. In particular, she discussed how altered fire regimes affect forest succession and forest resilience to climate change and future disturbances. She provided examples how reducing fire frequency affects plant communities in fire-dependent systems. She also examined the possible effects of silvicultural and fuel treatments to improve forest resilience to disturbances. Barb Thomas described the current paradigm shift in tree improvement from volume to forest healthy in Canada. She talked about how 'omics' such as genomics, metabolomics, and phenomics, can help us to understand mechanisms underlying forest resilience and resistance to insect outbreaks and drought. As a case study, she discussed how RESFOR (Resilient Forests) project will integrate genomics, metabolomics, and modeling into existing tree breeding programs to generate pest- and drought- resistant trees with improved wood quality. She mentioned that this project will shorten the time it takes for a complete tree-breeding cycle from ~30 to ~10 years. Tree breeders will be able to rapidly select a broader range of important tree traits to improve wood quality and develop trees resilient to drought and resistant to emerging threats from climate change and associated pest outbreaks.

Pollinators in Forest Ecosystems *Moderator: Rob Progar*

- *Why all the attention?* **Rob Progar**, US Forest Service, Pacific Northwest Research Station.
- *Recent developments in controlling for Douglas-fir beetle (Dendroctonus pseudotsugae) infestation in high risk stands using the anti-aggregation pheromone, 3-methylcyclohex-2-en-1-one (MCH), and potential implications for associated bee communities.* **Gabriel Foote**, Oregon State University.
- *Native bees in western forests: an overview of their natural histories and conservation needs.* **Jim Cane**, ARS, Logan UT.
- *Pollination: What you thought you knew, is probably not so!* **Andy Moldenke**, Oregon State University.

Pollinator populations in the U.S. have been falling for decades. Domestic managed honeybee populations dropped from 6 million colonies in 1947 to 2.5 million currently, and the Monarch butterfly is at risk of a failed migration. While no single factor is causing the current crisis, a combination of stressors contribute to the declining populations. Inadequate diets, natural habitat loss, diseases, loss of genetic diversity and exposure to potentially harmful pesticides all contribute to population losses. At least 18 states have enacted pollinator-related legislation in recent years. Legislation generally falls into one of five categories: research; pesticides; habitat protection; awareness; and beekeeping. Most forest managers have only a poor or fair understanding of plant pollinator relationships. There is a lack of baseline information on species abundance, richness and community composition. There is a lack of knowledge on the impacts of herbicides on pollinator species, best practices for restoring floral resources and standardized long term monitoring protocols. In addition research is needed on how beneficial pollinator management in wildlands would affect nearby agriculture.

New research was presented examining the relationship between semiochemical treatments for the Douglas-fir beetle, *Dendroctonus pseudotsugae*, the anti-aggregation pheromone, 3-methylcyclohex-2-en-1-one (MCH), and the associated bee community. The use of MCH has been challenged on some forests based on concerns regarding a potential repellency against bees, which have drawn increased attention due to evidence suggesting declines in pollinator communities worldwide. The data indicates that using MCH for managing DFB should have no negative effects on the associated bee community.

A basic synopsis of forest pollination ecology was presented. A handful of intrinsic traits of bees, the primary pollinators in western forests, profoundly condition their heterogeneous responses to habitats, and so their responses to land management and plant community restoration. Expect several hundred bee species per forest with the most important montane pollinators comprising ~20 species of social bumblebees. These and most solitary bee species generally nest underground. Others nest in emergence tunnels of wood-boring buprestids and cerambycids. Social species actively forage season-long, but many solitary bees are univoltine, with new foraging communities appearing monthly. Many solitary bee species are taxonomic pollen specialists focused on a few related genera or small families of plants in a community. Where those plants are extirpated, so are their specialist bees. Without bees, many western forest trees, shrubs and grasses would still reproduce, but forb communities would suffer greatly. We don't know how to directly assist bee recolonization, nor do we know how to provide suitable soil nesting conditions. Native bee conservation depends on retaining and restoring rich and diverse wildflower communities (think alpine meadows), both by limiting depletion of bloom and pollen/nectar resources, as well as adding back wildflowers through seeding of practical, broadly-adapted native forbs (e.g. northern sweet-vetch in the Rockies) and thoughtful use of controlled burns.

We also examined some common false beliefs of most forest managers: (1) Self-pollination is a very bad option; (2) Most flower-visiting insects you observe are probably helping to pollinate the plant; (3) Plants want potential pollinators to visit their flowers as often as possible; (4) The insects that visit flowers are doing so principally to find nectar and pollen to feed upon; (5) If plants did not attract pollinators to their flowers they would go extinct; (6) Pollination exclusively by the wind, and not by insects, is not very successful; (7) In a normal natural meadow with 5-10 dozen species of flowering plants, there can't be enough pollinators to go around; (8) Multi-year studies show that rare pollinators may come and go and come again, but the dominant pollinators have stable populations; (9) All bees can sting!

Concurrent Workshops 2

Cumulative effects of drought on forest disturbances and tree mortality

Moderator: Christopher J. Fettig

- *Drought and fire: Ecohydrologic controls on future fire regimes in the West.* **Jeremy Littell**, Alaska Climate Science Center, USGS, Anchorage, AK, Donald McKenzie, Pacific Northwest Research Station, USFS, Seattle, WA, Samuel Cushman, Rocky Mountain Research Station, USFS, Flagstaff, AZ, Ho Yi Wan, Northern Arizona University, Flagstaff, AZ, and David L. Peterson, Pacific Northwest Research Station, USFS, Seattle, WA.
- *Cessation of landscape-level surface fires promotes establishment of fire-intolerant tree species and long-term increases in drought stress in ponderosa pine forests of central Oregon*. **Steve Voelker**, Utah State University, Logan, UT
- *Drought impacts on forest insects and diseases, with emphasis on the tree mortality event in California*. **Christopher J. Fettig**, Pacific Southwest Research Station, USFS, Davis, CA, Thomas E. Kolb, Northern Arizona University, Flagstaff, AZ, Mathew P. Ayres, Dartmouth College, Hanover, NH, Barbara J. Bentz, Rocky Mountain Research Station, USFS, Logan, UT, Jeffrey A. Hicke, University of Idaho, Moscow, ID, Robert Mathiasen, Northern Arizona University, Flagstaff, AZ, Jane E. Stewart, Colorado State University, Fort Collins, CO, and Aaron S. Weed, National Park Service, Fredericksburg, VA.
- *The impacts of drought on tree defenses and bark beetle attacks in southwestern pines*. **Monica L. Gaylord**, Forest Health Protection, USFS, Flagstaff, AZ, Stephen J. Burr, Forest Health Protection, USFS, Fairbanks, AK, Thomas E. Kolb, Northern Arizona University, Flagstaff, AZ, Richard Hofstetter, Northern Arizona University, Flagstaff, AZ, and Nate McDowell, Los Alamos National Labs, Los Alamos, NM.

The western U.S. appears to have entered a period of protracted aridity, the impacts of which have been exacerbated by anthropogenic-induced warming. In forests, recent droughts have contributed to reduced tree growth, increased vulnerability to forests disturbances, and large-scale tree die-offs. For example, in California USDA Forest Service Aerial Detection Survey (ADS) reported extensive tree mortality in the central and southern Sierra Nevada in 2015, and estimated >22 million trees had been killed due to drought and outbreaks of native bark beetles, primarily western pine beetle. Winter 2015-16 brought near normal precipitation to much of California, but drought stress remained high in many areas. ADS estimated an additional 62 million trees died in 2016, bringing the total to at least 102 million trees in the last 10 years. Such events effect the composition, structure and function of forests, and the ecological goods and services we have come to expect from them. In this workshop, we discussed the impacts of drought on trees, fire regimes, and forest insects and diseases.

All stocked up here: Strategies for optimizing forest density to increase resilience to bark beetles *Moderators: Robbie W. Flowers and Andrew D. Graves*

- *Meta-analysis of stand density index threshold relationship with* Dendroctonus *spp. attack in yellow pine forests across the western U.S.* **Joel Egan**, USDA Forest Service, Forest Health Protection; Tom W. Coleman, Forest Health Protection; Chris Fetting, USDA Forest Service, Pacific Southwest Research Station; Chris Fettig; Russ Graham, Jose Negron, Sharon Hood, USDA Forest Service, Rocky Mountain Research Station, Chris Keyes, University of Montana, Dept. of Forest Management.
- *Risk of bark beetle-caused tree mortality following various forest management regimes in southern California and Northern Baja California, Mexico*. **Tom W. Coleman**, Adrian Poloni and Andrew D. Graves, USDA Forest Service, Forest Health Protection
- *Fifteen-year growth response of legacy pines to local (radial) and stand-level thinning*. **Danny Cluck**, USDA Forest Service, Forest Health Protection; Sharon Hood, USDA Forest Service, Rocky Mountain Research Station; Bobette Jones, USDA Forest Service, Lassen National Forest
- *Using historical range of variability to inform future management strategies*. **Andrew Sánchez Meador**, Ecological Restoration Institute, Northern Arizona University.

Joel Egan from the USDA Forest Service began the workshop by presenting a meta-analysis of stand density index threshold relationship with *Dendroctonus* spp. attack in yellow pine forests across the western U.S. Numerous stand density thresholds (provided in either basal area or stand density index [SDI] metrics) have been suggested in recent decades to promote indirect bark beetle control in western yellow pine forests. SDI thresholds have been suggested to provide resistance to beetle-attack and numerous studies indicate mechanism promoting efficacy may be driven by microclimatic-based bark beetle habitat suitability associated with various density levels. Oliver (1995) alluded to this decades ago after summarizing studies evaluating forest conditions and beetle-caused mortality across California, Oregon, and Washington. Findings concluded beetle-caused mortality thresholds were 230 SDI for western yellow pine forests and the range of thresholds proposed holistically from all available studies during that period was 200-265 SDI. However, these findings were during time periods in which bark beetle population pressure was limited to low or moderate levels. Recent studies, where stand conditions were challenged with high levels of bark beetle population pressure indicate lower SDI thresholds are needed to protect vegetation during severe and widespread, landscape-scale outbreaks. Preliminary analysis indicates < 110 SDI is needed to promote resistance and reduced beetle-caused mortality levels when yellow pines are exposed to high levels of beetle pressure. Interestingly, density levels near 110 SDI are consistent with restoration targets and density levels associated with historic, open park-like yellow pine stand density levels regulated by frequent low intensity, surface fire events.

Andy Graves from the USDA Forest Service presented on the risk of bark beetle-caused tree mortality following various forest management regimes in southern California and recent work in New Mexico. The USDA Forest Service, Forest Health Protection's (FHP) Western Bark Beetle Initiative (WBBI) provides prevention and suppression funding to reduce the risk or stop the undesired impacts associated with pine bark beetles in the western U.S. In 2016, WBBI provided approximately 4 million dollars in prevention and suppression funding to the national forests. However, the effectiveness of these treatments largely goes undocumented. Their objective was to compare the risk of bark beetle-caused tree mortality across four treatment areas by assessing the forest stand conditions, bark beetle activity, and mistletoe infection on the four national forests (Angeles, Cleveland, Los Padres, and San Bernardino) in southern California and on the Sierra San Pedro Martir National Park in Northern Baja California, Mexico. They surveyed three

different forest stands using 0.04 ha fixed radius plots in southern California: 1) recently thinned for bark beetle prevention; 2) no recent forest management (>15 years); and 3) wilderness areas. Historically unmanaged, virgin forest stands were surveyed in the Sierra San Pedro Martir National Park as the fourth comparison for these forest stand treatments. From 2011 to 2014, 39 forest stands have been surveyed in recently thinned areas, 46 stands with no recent management history, and 24 wilderness stands in southern California. Twenty-nine forest stands were surveyed in 2011 and 2012 in Northern Baja Mexico. Preliminary data suggest stands with no recent forest management had the highest stand densities, whereas the Baja stands had the lowest stand density. Total basal area followed similar trends for each forest stand. Ranking of dwarf mistletoe infections and tree mortality was highest in wilderness stands and these stands also had the highest stand density index, suggesting elevated risk to bark beetles. Baja stands and recently thinned areas had the lowest stand density index, representing low risk to bark beetle-caused tree mortality. Recent work in New Mexico continues to assess the risk of pine bark beetles in ponderosa pine stands by coupling LIDAR, FIA, and national forest stand data with FHP ground surveys and aerial detection survey data. They are also assessing the extent of bark beetle-caused tree mortality across a range of forest stand densities.

Danny Cluck from the USDA Forest Service presented on the fifteen-year growth response of legacy pines to local (radial) and stand-level thinning. Restoration efforts to improve vigor of old trees and decrease risk to high-intensity wildland fire and insect-induced mortality often include reductions in stand density. However, evidence is limited if old, legacy trees can respond to these treatments. They examined 15-year growth response of old ponderosa pine (*Pinus ponderosa*) and Jeffrey pine (*Pinus jeffreyi*) trees in northeastern California to two levels of thinning treatments compared to an untreated (control) area. Density reductions involved radial thinning (thinning around individual trees) and stand thinning. Annual growth of trees in the stand thinning increased immediately following treatment and was sustained over the 15 years. In contrast, radial thinning had no effect on growth. Soil moisture measurements in the stand thinning and control units show thinning increased available soil moisture for 5 years post-treatment and likely extended seasonal tree growth. Their results show that large, old trees can respond to restoration thinning treatments, but that the level of thinning impacts this response. Restoration of old-growth forests is multi-faceted, involving many other considerations besides annual growth. Stand thinning was the most effective in improving old tree growth and health and would also likely provide a higher level of protection from wildfire than radial thinning. While radial thinning did not affect tree growth rates, this treatment may still be effective if the radius is increased or for other resource objectives, such as protecting wildlife habitat, reducing the risk of severe fire-injury and reducing the susceptibility to bark beetle attacks through changes in microclimate to improve retention rates of these valuable, and increasingly rare, trees on the landscape.

The workshop concluded with Andrew Sánchez Meador from the Ecological Restoration Institute at Northern Arizona University who described efforts to use the historical range of variability to inform future management strategies.

Concurrent Workshops 3

Deciphering Historical Patterns and Range of Variability for Key Forest Disturbance Agents

Moderators: Joel Egan, Seth Davis, Barbara Bentz

- *A century of drought-related mountain pine beetle disturbance throughout Northern Region forests from 1915-2016.* **Joel Egan**, Forest Health Protection, Missoula, MT
- *Multidecadal time series from aerial survey data reveals climatic and landscape factors underlying tree mortality from spruce beetle across the western US*. **Seth Davis**, Colorado State University
- *A multi-method approach to studying disturbance in the Northern Rocky Mountain, USA.* **Jenn Watt**, University of Utah; Andrea Brunelle, University of Utah, Barbara Bentz, US Forest Service, Kurt Kipfmueller, University of Minnesota.
- *Genetic analyses reveals mountain pine beetle historical distribution patterns driven by Pleistocene glaciation*. **Barbara Bentz**, Rocky Mountain Research Station, Logan, UT; Greg Ragland and Eddy Dowle, University of Denver; Ryan Bracewell, University of California; Karen Mock, Utah State University, Mike Pfrender, Notre Dame.

Historical range and variability (HRV) provides a tool for incorporating native structure and processes in forest ecosystem management. The concept is that HRV considers all organisms and patterns on a landscape, and is a reference or benchmark that represents conditions describing fully functional ecosystems. Existing forest conditions are then evaluated against the reference to describe changes in status, and can be used to develop effective treatments for returning ecosystems to their native condition. Describing HRV for bark beetle-caused disturbances, however, can be challenging due to the relatively long frequency between events and lack of pre-20th century data. Our workshop included two presentations on understanding bark beetle-caused disturbances within the past ~100 years, a presentation on using lake sediment cores and tree rings to extend disturbance records back 1000's of years, and a presentation on using next generation genomic tools to describe the historical distributional pattern of a bark beetle species.

Joel Egan used historic Bureau of Entomology and Plant Quarantine reports in addition to aerial detection information to reconstruct widespread mountain pine beetle outbreaks documented since 1905 and ask the question 'are the recent mountain pine beetle outbreaks in lodgepole pine unprecedented'? Relative to outbreaks in the 1920s and 1980s, after adjusting for susceptible host distributions, perhaps our recent outbreak was not unprecedented. The magnitude of mountain pine beetle-impacted area was found to progressively increase throughout the reconstructed outbreaks in direct proportion to the magnitude of change in abundance of mature, susceptible lodgepole pine host. The importance of host abundance and climactic influences on reconstructed outbreak periods was discussed.

Using aerial detection information and associated weather data, Seth Davis analyzed the landscape signal of recent spruce beetle-caused tree mortality relative to prior outbreaks. Climate factors that limit tree mortality in non-outbreak landscapes do not appear to limit population activity in outbreak landscapes and other factors must play a role.

Jenn Watt provided an overview of using dendrochronology and lake sediment core (paleoecology) information for describing bark beetle disturbances. Dendrochronology provides high resolution-short time frame (several hundred years) and paleoecology provides a somewhat lower resolution-longer time frame

(thousands of years). Combining the techniques provides a means for quantifying pre-1900's historical range of variability.

Barbara Bentz discussed a project using next-generation genomic tools to analyze historical patterns that influenced the current mountain pine beetle genetic structure in western North America. The current genetic structure of mountain pine beetle is consistent with periods of population isolation during the Last Glacial Maximum and follows post-glacial expansion patterns of *Pinus* host trees. Results suggest a long history of association between the insect and its host trees.

Balancing Dynamics of Ski Area Operations with Forest Health Challenges

Moderator: Darren Blackford

- **Bill Schreiber**, Jackson Hole Mountain Resort
- **Christian Santelices**, Snow King Ski Area
- **Mark Pollish**, Alta Ski Area
- **Nancy Bockino**, Grand Teton National Park

Concurrent Workshops 4

High Elevation Pines *Moderator: Ken Raffa*

- *Geographic variability in climate suitability for whitebark pine mortality from mountain pine beetles.* **Polly Buotte**, Jeffrey A. Hicke, Haiganoush K. Preisler, John T. Abatzoglou, Kenneth F. Raffa
- *Great Basin bristlecone pine resistance to mountain pine beetle.* **Erika Eidson**, Barbara J. Bentz, Karen Mock
- *Defense syndromes of lodgepole and whitebark pines against mountain pine beetle - fungal complexes.* **Ken Raffa**, Pieruligi Bonello, Stephen Cook, Nadir Erbilgin, Ken Keefover-Ring, Jennifer Klutsch, Charles Mason, Caterina Villari, Phil Townsend
- *Disentangling the effects of white pine blister rust, mountain pine beetle and drought on whitebark pine mortality in the Greater Yellowstone Ecosystem*. **Erin Shanahan**, Kathryn M. Irvine, David Thoma, Siri Wilmoth, Andy Ray, Kristin Legg, Henry Shovic
- *Protection and restoration of whitebark pine ecosystems.* **Carl Jorgensen**

Historically, most of the attention given to western pines has been to the commercially most valuable species, such as ponderosa pine, lodgepole pine and western sugar pine. As a result, research on high-elevation pines has lagged, and we have substantial gaps in our knowledge about them. In recent years, however, there has been increased understanding and recognition of the environmental services that high elevation pines provide for wildlife, soil, and hydrology, and also for the economic values they bring to various forms of recreation. High elevation species face some of the same challenges as other species, such as insect outbreaks, invasive pathogens, altered wildfire regimes, drought, and altered competitive position due to climate change. However, they may experience these threats to different degrees or in different combinations than lower-elevation species, and the harsh physical challenges that high-elevation species face may influence how their resources are allocated. This workshop addresses these challenges from a variety of perspectives.

There were five presentations, by scientists representing multiple universities, the US Forest Service, and the US Park Service. Polly Buotte and colleagues evaluated how the climatic suitability for mountain pine beetle varies regionally among whitebark pine ecosystems, and how these patterns will be influenced by anticipated changes in climate. Erika Eidson and colleagues focused on one of the most under-studied species, bristlecone pine, and demonstrated that mountain pine beetles do not behaviorally accept it as a host and show only minimal development to adulthood when physically introduced into the phloem in the laboratory. Ken Raffa and colleagues analyzed the constitutive and induced composition of a broad array of primary constituents, secondary constituents, minerals, and resin ducts of two pine species along moderate elevational gradients. Erin Shanahan and colleagues broadened the analyses to incorporate the effects of multiple stressors – mountain pine beetle, white pine blister rust, and drought, and their interactions with each other, on whitebark pine mortality in the Greater Yellowstone Ecosystem. Carl Jorgensen presented updated information on protection of highly valued high-elevation whitebark pines in the face of multiple stressors, mountain pine beetle, white pine blister rust, conifer encroachment, and wildfires with particular emphasis on practical lessons learned on the ground regarding whitebark pine protection and restoration.

Defoliators *Moderator: Sky Stephens*

- **Sky Stephens** and **Dan West**, US Forest Service, Forest Health Protection, and Colorado State
- **Andy Graves**, US Forest Service, Forest Health Protection
- **Richard Hofstetter**, Northern Arizona University

Open Session: Submitted Talks on Topical Issues in Forest Entomology

Moderator: Lorraine Maclauchlan

- *Unravelling the biology of Pissodes striatulus: a tree-killing weevil in subalpine fir forests of southern British Columbia.* **Lorraine Maclauchlan** and Kevin Buxton. BC MFLNRO, Kamloops, B.C.
- *Novel trophic interactions for endemic mountain pine beetle and its microbiome in Alberta*. **Jordan Lewis Burke**, Richard C. Hamelin, Allan L. Carroll. Department of Forest & Conservation Sciences, Faculty of Forestry, University of British Columbia, Vancouver, B.C.
- *Factors affecting trap catches of hardwood Cerambycidae - The need for changes in detection programs for exotic species.* **Dan R. Miller**, John D. Sweeney. USDA, Athens, Georgia, USA.
- *Next Year Forecast of Beetle, Borer and Drought-Induced Tree Mortality in California* **Nancy E. Grulke**, Haiganoush K. Preisler, Zachary Heath, Sheri L. Smith.
- *Population genomics of the European spruce bark beetle, Pityogenes chalcographus.* **Martin Schebeck**, Edwina J. Dowle, Dimitris N. Avtzis, Coralie Bertheau, Hannes Schuler, Jeffrey L. Feder, Gregory J. Ragland, Christian Stauffer.

Concurrent Workshops 5

What's New with Invasive Forest Insect Species in the Western USA? *Moderators: Steve Seybold and Carl Jorgensen*

Contributors: **Bob Rabaglia**, **Kate Hrinkevich**, and **Robbie Flowers**

Topics will include: A brief overview of the FS R&D National Invasive Species Assessment; an unusual, new invasive leaf mining insect causing crown dieback in madrone in northern California; an update on the early

detection of invasive forest insects in the West; climate risk modelling of balsam woolly adelgid damage in subalpine fir; and the 2015-2016 eradication program for Asian gypsy moth in Oregon and Washington.

Attendence: Approximately 20 participants cycled through the room during the workshop including Barbara Barr, Don Bright, Christy Buhl, Erika Eidson, Rob Flowers, Andy Graves, Nancy Grulke, Andrea Hefty, Carl Jorgensen, Glenn Kohler, Rob Progar, Bob Rabaglia, Karen Ripley, Steve Seybold, and Kasey Yturralde

Summary: Moderator Seybold introduced the topic of invasive insect species in western forests and asked the participants to keep the workshop informal by thinking of it more as a question and answer session or information exchange on new developments on invasive insects than a series of ESA-style presentations. He began by outlining the background, objectives, and products of the National Invasive Species Assessment, which is an information gathering process directed by the Washington Office of USDA FS Research and Development. The process began in 2015 and will end in 2018 with the publication of a general technical report (GTR) on the topic. A technical monograph (Springer Verlag) may follow the publication of the FS document. Seybold referred to a poster on the assessment process (posted in the workshop room and at the poster session); noted the December 2015 "brainstorming" meeting in Phoenix, Arizona; and presented the provisional chapter titles in the GTR. He also mentioned the regional summaries of invasive species (insects, plants, fungal/bacterial pathogens, vertebrates) that have been developed as appendices for the document. The overall intent of the comprehensive effort was to focus on terrestrial and aquatic forest ecosystems, but agricultural and urban ecosystems were also addressed. Social issues and risk assessment were also key subject areas in the assessment.

Seybold moved on to discuss two more local topics related to his service area, which were a new book chapter on invasive bark and ambrosia beetles in California and the discovery of an unusual, new invasive leaf mining insect that is causing crown dieback in madrone and related species in northern California. The book chapter was published in 2016 in a monograph on Insects and Diseases of Mediterranean Ecosystems edited by Tim Paine and F. Lieutier. The historical overview of the invasive bark and ambrosia beetles includes distribution maps and a summary of research on the species. It is probably most relevant to California and Oregon. Several images of the damage caused by the new leaf mining insect were presented and Riker mounts of the leaves were passed around. The insect appears to be confined to Marin, Sonoma, and Napa Counties so far (northern portions of the San Francisco Bay Area) and has been recorded from several tree and shrub species in the Ericaceae. Its primary host appears to be Strawberry or Marina trees, which are widely planted horticultural forms of *Arbutus* based on Mediterranean species. The insect (an unidentified lepidopteran larva) creates a blotch mine in the leaf and then forms a linear mine to the nearest leaf vein, mines toward the midrib, proceeds along the midrib and through the petiole to enter the phloem of the adjoining twig or branch. It is causing leaves to drop prematurely, branch tips to die, and influencing the health of the crowns of the *Arbutus* used in horticulture. It may become a forest pest in madrone, *Arbutus menziesii*, and manzanita, *Arctostaphylos*.

Bob Rabaglia provided an overview of the National Early Detection and Rapid Response trapping program for invasive bark beetles and wood borers and discussed the issues that might be important for improving the program in the future. The program has had some notable successes such as the detection of the banded elm bark beetle, *Scolytus schevyrewi*, in 2003, and many new xyleborine ambrosia beetles. The lack of recent finds may be an indication that the early finds were of species already well established and the current detection methods are not finding new species at low levels. An approach using more specific lures that are rotated through various years and locations may be more fruitful in the future.

Kate Hrinkevich described her collaborative work with Rob Progar on the climate risk modelling of balsam woolly adelgid (BWA) damage in subalpine fir, which was recently published in *PLoS ONE* (see below). She chronicled the establishment history of BWA in western North America and detailed the establishment of survey sites in nearly 50 subalpine fir stands infested with BWA in Oregon, Washington, Idaho, and western Montana. One question that was raised was why the insect had spread to these sites from west coast locations and had not re-invaded the West from eastern populations of high elevation fir and firs in Christmas tree plantations. Kate described the development of a technique to quantify BWA damage to subalpine (dominant species) and grand (minor species) fir from severity index values that were based on a comprehensive set of typical symptoms of infestation such as gout, crown deformity, branch dieback and mortality in the canopy and subcanopy of fir stands. She described the difficulty in acquiring some of these data and the potential for confusion with other health issues with fir. The severity indices from the plots were used in a two-step process to explain BWA damage in the context of a spatial climate risk model. Thirty-year monthly climate "normal" from the sites were used in a regression model to significantly explain the damage.

In 2015 and 2016 there was a major detection and eradication program for Asian gypsy moth (AGM) in Oregon and Washington. Karen Ripley described the effort conducted by the states of Oregon and Washington with cooperation and support of the USDA FS Pacific Northwest Region (Iral Ragenovich and Rob Flowers). Asian gypsy moth and European gypsy moth (EGM) are both *Lymantria dispar*, but AGM is of greater concern because its host list is broader and includes conifers and because the female moth can fly, enabling more challenging and rapid dispersal if introduced. In 2014, large populations of AGM were observed in Russia and Asia. Adults laid eggs during summer. Smooth surfaces are preferred egg laying sites and can commonly include structures, ships, and cargo. Eggs hatch in spring and larvae can move to available vegetation and mature into summertime moths. In summer 2015, 29 gypsy moth were captured in Washington (10 were AGM in seven locations; 19 were EGM at one location) and 12 gypsy moth were captured in Oregon (two were AGM at two locations; 10 were EGM in four locations). A Science Panel recommended that three aerial applications of *Bacillus thuringiensis kurstaki* (B.t.k.) be conducted to eradicate all gypsy moth at seven Washington sites (totaling 10,500 acres) and one 7923-acre Oregon-Washington cross-border site. These areas encompassed all the AGM capture areas. The applications occurred between April 16 and May 2, 2016. Oregon used a UH1-H helicopter. Washington used an 802 Air Tractor (fixed wing) plane. In summer 2016, Oregon placed 15,873 detection traps and Washington placed about 34,000 detection traps. Zero gypsy moths were caught in the treatment areas. Several European gypsy moth were caught in 2016 (25 in WA; 6 in OR). No eradication treatments are planned for 2017.

Rob Flowers briefly described cooperative monitoring and ship inspection programs for AGM and other *Lymantria* spp. in the Russian Far East, Japan, South Korea, and China. Since 1994, a cooperative agreement with the Russian government has focused on annual AGM detection surveys near several high risk ports in the Russian Far East to determine population levels. Analyses of the population levels helps determine, on a seasonal basis, the risk of introduction by ships and cargo coming from or transiting within the Russian Far East. Other monitored lymantriids include the nun moth, *L. monacha* and the pink or rosy gypsy moth, *L. mathura*. AGM is not currently established in North America due in large part to swift regulatory and control actions that have been in place as Karen described above. As a result of continued AGM detections, the USDA has developed a map of high-risk areas in cooperation with the governments of Russia, Japan, China, and South Korea. These programs minimize the risk of AGM introductions into North America through inspections and certifications of vessels entering U.S. ports from these locations. Program goals include: 1) continuing to improve communications among stakeholders, the shipping industry, and accredited bodies like the National Plant Protection Organization (NAPPO); 2) increasing the number of maritime vessels arriving

with compliance certificates; and 3) developing best regulatory options for increasing program compliance and reducing potential introductions of AGM into North America. Meetings among the various government agencies that oversee these programs are ongoing and included visits by U.S. and Canadian representatives to the Russian Far East in 2016, as well as planned visits by Russian and South Korean representatives to the U.S. and Canada in 2017. Rob will provide FS leadership for these programs now that long term contributor Steve Munson (USDA FS Ogden) has retired.

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Biomimicry: Adapting Insect Behavior and Biotic Interactions to Help Manage their Impact to our Forests *Moderator: Javier Mercado*

- *Improved tools that exploit bark beetle chemical communication and protect individual trees and forest stands.* **Christopher J. Fettig**, Pacific Southwest Research Station, USDA Forest Service, Davis, CA; A. Steven Munson, Forest Health Protection, USDA Forest Service, Ogden, UT (retired); Dezene P.W. Huber, Ecosystem Science and Management Program, University of Northern British Columbia, Prince George, BC; and Agenor Mafra-Neto, ISCA Technologies Inc., Riverside, CA.
- *Adapting bark beetle acoustic communication to protect trees.* **Richard W. Hofstetter**, Northern Arizona University; David D. Dunn, Music Department, University of California Santa Cruz; Nicholas (Nick) Aflitto, Entomology Department, Cornell University; Kasey Yturralde, Urban Forestry, Portland Parks and Recreation, Oregon.
- *Developing Spruce Beetle Mycoinsecticide: Discussing natural entomopathogenic fungi in forest habitats and field trials of fungal pathogen isolates against spruce beetle*. Clifford Bradley, Egan Jankowski and Janina Bradley, Montana BioAgriculture Inc., Missoula, MT; Danielle Malesky, Forest Health Protection, USDA Forest Service, Ogden, UT, USDA-FHP; Seth Davis, Colorado State University, Ft. Collins, CO.
- *Lessons learned about natural enemies of bark beetles: current and future needs.* **Lawrence Haimowitz**, University of Wyoming; Scott Richard Shaw, University of Wyoming.

We have acquired a vast knowledge of chemical communication and the semiochemicals used by important insect pests and we have learned to mimic these compounds to not only capture and study these insect but to also influence their behavior to protect trees. Dr. Chris Fettig discussed some of the risks and efforts involved in the process of developing semiochemicals, including difficulty in their preparation, population specificity to

certain volatiles, and the chemical synthesis of pure versus chiral compounds. Dr. Fettig discussed two principal products: Verb Plus for western pine beetle and SPLAT® Verb for mountain pine beetle. Verbenone is the principal antiaggregation pheromone of western and mountain pine beetles. Although several formulations of verbenone are registered for tree protection, failures in efficacy are not uncommon. The development of Verb Plus [acetophenone, (E)-2-hexen-1-ol + (Z)-2-hexen-1-ol, and (-)-verbenone] followed years of research combining verbenone with other semiochemicals (e.g., nonhost volatiles) in hopes of increasing levels of inhibition. In short, adding nonhost volatile compounds from angiosperms to verbenone (NAV+V) results in a significant reduction in western pine beetle attacks and levels of tree mortality attributed to western pine beetle compared to verbenone alone. Fettig et al. (2015) developed SPLAT® Verb (ISCA Technologies Inc., Riverside, CA, USA; EPA Reg. No. 80286−20; 10.0% a.i.), a novel formulation of (–)-verbenone, that rather than a single release device is a flowable emulsion that allows the user to adjust the size of each release point (dollop) according to desired rates and distributions. SPLAT® Verb was registered by the U.S. Environmental Protection Agency for use on pines in 2013, and was first used operationally in 2014. The development of the current formulation was discussed from its initial forms in 2011. SPLAT® Verb is effective for protecting lodgepole pine, sugar pine and whitebark pine from mortality attributed to mountain pine beetle.

Part of bark beetle communication involves the production of sound. Auditory cues used by bark beetles are investigated by Dr. Richard Hofstetter and his collaborators where their goal is to reveal ways in which a desired change in behavior can be caused by reproducing sounds recorded in nature. A history of bark beetle sound production that including interesting remarks on early studies (Rudinsky and Michael 1972) describing a relationship between sound and chemical communication was presented. Sound production in bark beetles can also influence pair formation, aggregation, competition, and defense. As it related to Biomimicry, we were presented with ways in which his research exploits acoustic communication to manage bark beetles. Simply as a detection tool to actively looking into ways of altering normal insect behavior. Sound reproduction of specific and non-specific insects is used to cause behavioral changes in bark beetles in which these can cease gallery making or egg laying or in which some species may attack other species. Presented limitations in the application of this technology included the need to attach multiple unites to trees and their power requirements. Researchers are looking into optimizing available equipment using sustainable energy sources and to further incorporate artificial intelligence into devices.

Cliff Bradley presented ways in which we can mimic processes intrinsic to all bark beetles. By identifying naturally occurring strands (isolates) of *Beauveria bassiana*, a well-known insect pathogen, Bradley and his colleagues aim to use it for the control of bark beetles. A discussion was provided regarding remaining questions about the species dissemination and vectoring into the beetles in nature, it is particularly intriguing whether the species is adapted to its insect host or particular habitats. He discussed that a particular strain has been selected which is effective in several bark and ambrosia beetles of economic importance including mountain pine beetle and spruce beetles in western USA. A single strain that is not specific to a single target insect is preferred given cost related to the approval of its use and the related cost of producing these bio-insecticides. Utilization of these types of products mimics natural processes and is more consonant with nature with potentially lesser undesired effect than, for example, chemical insecticides. Up to 86% effectiveness has been achieved in some trials spraying the spores of the fungi in solution to trap trees aimed to control the spruce beetle. *Beauveria bassiana* spray was shown to be more effective in killing adult beetles, but research is still ongoing. Nevertheless, it is exciting to learn about new and nature sensitive ways to control these insects.

Larry Haimowitz began by discussing the current state of knowledge about natural enemies of bark beetles and emphasized the difficulty of studying them in standing trees. Current theory suggest that natural enemies

may be responsible to maintain endemic levels of the beetles until unknown factors cause a population increase and after this happen these again may contribute to getting epidemic populations back to endemic ones, perhaps through the synergy of other unknown factors. During epidemics, natural enemies reduce the ratio of increase, but this has been very difficult to quantify. A discussion followed on improving the methods used to study natural enemies. The first of these are emergence traps for standing trees that provide more complete containment than current traps. The second method discussed was a predator exclusion experiment that can be conducted on standing trees to directly measure the effect of natural enemies on bark beetle survival. Predator exclusion is easier than previous methods used for determining the effect of natural enemies. Mr. Haimowitz concluded with discussion of possible applications, which include testing the validity of older methods, and quantifying the effect of natural enemies on epidemic phase bark beetles. By measuring that effect he considers we can answer many important questions such as: Do natural enemies limit the severity of epidemics? Are natural enemies less effective outside the beetles' historic range? Are natural enemies less effective in jack pine forests than in lodgepole forests?

Mountain Pine Beetle's Changing Range and Challenges for Forest Management Decision-Making *Moderators: Kathy Bleiker, Brian Aukema*

- *Cold tolerance of mountain pine beetle in novel hosts*. **Brian Aukema**, Rob Venette, Derek Rosenberger.
- *Mountain pine beetle and climate: Implications for continued range expansion in Canada.* **Kathy Bleiker**, Greg Smith
- *Pushing North: some model predictions for how temperatures may affect northward range expansions.* **Devin Goodsman**, Chonggang Xu, Brian Aukema.
- *Forest management on the front lines: assessing the efficacy of mountain pine beetle spread and control in Alberta*. **Allan Carroll**

This workshop addressed the impact of climate and novel host tree species on the potential range of mountain pine beetle in North America, and how this knowledge is being used both to predict areas at risk in the future under climate change and to assist managers making operational decisions on where best to focus control efforts. Brian Aukema began the session by discussing the cold tolerance of mountain pine beetle in red, jack, eastern white, and Scots pines vs. historical hosts such as lodgepole and ponderosa pines. He showed how novel hosts such as red pine may confer greater cold tolerance to larvae and that lower lethal temperatures are a more reliable indicator of winter mortality than supercooling points. Kathy Bleiker showed that mountain pine beetle larvae from northern Alberta were more cold hardy than insects from southern British Columbia by at least 7 degrees Celsius. Variation in acclimation, deacclimation, and resumption of development following cold exposure suggests that a cold-associated larval diapause may be critical for maintaining an adaptive seasonality of populations in the southern boreal forest, which receives 40% more degree days than needed for a one-year life cycle. Next, Devin Goodsman presented data supporting the idea that higher reproductive output of mountain pine beetles at middle elevations is likely driven by their thermal biology and specifically by requirements for adaptive seasonality. Models of mountain pine beetle thermal biology predict that with warmer climates the climatic suitability of low elevations for mountain pine beetles may decrease, forcing them back up into the mountains where they belong. Finally, Allan Carroll explained how population survey data is being used by the province of Alberta to make science-based decisions regarding where to focus control efforts. It was an excellent example of how science can inform, enhance, and quantify the efficacy of control efforts.

Field Trip Summary

Organized by: Matt Hansen, Darren Blackford and Ryan DeSantis

The field trip was blessed with spectacular weather, a picture perfect day that allowed incredible views of the Teton Mountains. We drove past Jenny Lake at the base of the Tetons then stopped along the shores of Jackson Lake to view the 2016 Berry fire. National Park Service employees Nancy Bockino and Mack McFarland met us there and discussed the history of recent wildfires in Grand Teton National Park, including management concerns and forest recovery. We drove through a section of the Berry fire which also re-burned a portion of forest burned during the 1988 fires. We stopped for a quick lunch at Flagg Ranch then made our way to Teton Village, viewing moose, bear, bison, swans, pelicans, and many other wildlife species along the way. A quick stop at Glacier View Turnout allowed Bill Ciesla to photograph the group with the Tetons as a back-drop.

In Teton Village, Jackson Hole Mountain Resort manager Bill Schreiber arranged a presentation of vegetation management issues on the ski hill as well as a tram ride to the top of Rendezvous Mountain (10,450', 3,185 m). JJ Markman gave us an overview of management concerning whitebark pine, which provides valuable ecosystem services and is an iconic aesthetic species along the resort's higher ridges. Mountain pine beetle and white pine blister rust have been major concerns within local whitebark pine and Markman described management including the deployment of verbenone and plantings using blister rust-resistant stock from local seed sources. The literal *high*light of the day was the tram ride which afforded views of beetle-killed and rust-infected whitebark pines and a spectacular, if alpine-chilled, view of Jackson Hole, the Tetons, and several other western Wyoming (and eastern Idaho) mountain ranges.

Poster Session

Organized by Carl Jorgensen

Effect of trap height on catches of bark and wood boring beetles in a stand of white oak and shortleaf pine in Georgia

D.R. Miller[1], C.M. Crowe[1], and J.D. Sweeney[2]

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Detection programs for non-native, potentially invasive species of bark and wood boring beetles typically employ traps placed at breast height. Species composition of insects inhabiting forest canopies are known to differ from those closer to the ground (Dodds 2014 *Can. Ent.* 146: 80-89). Our objective was to determine the effect of trap height on catches of common species of bark and wood boring beetles, and their associates, in a stand of white oak and shortleaf pine in north-central Georgia. In 2014, we conducted two experiments in a mature stand of white oak and shortleaf pine in northcentral Georgia (Jasper Co.). In both experiments, twelve 10-unit modified multiple-funnel traps were set in six replicate blocks of two traps per block. In each block, one trap was positioned at breast height (Ground) and one trap positioned 18-22 m above ground (Canopy). Traps were spaced > 8m apart horizontally. Each trap in Expt. 1 was baited with lures releasing a hardwood borer blend (EKD) of ethanol, 3,2-hydroxyketones and 2,3-hexanediol, whereas each trap in Expt. 2 was baited with lures releasing a pine borer blend (ASD) of α-pinene, ipsenol and ipsdienol. Cups contained a solution of propylene glycol. Expt. 1 was conducted 30

May to 9 October 2014 with lure changes on 2 July, 31 July and 1 September, whereas Expt. 2 was conducted 6 August to 9 October without any lure changes. We found that among Cerambycidae, canopy traps were preferred over ground traps by *Acanthocinus obsoletus*, *Monochamus titillator*, *Neoclytus jouteli*, *N. scutellaris* and *Xylotrechus sagittatus*. The reverse was true for *N. acuminatus* and *Xylotrechus colonus*. *Cnestus mutilatus*, *Hylocurus rudis* and *Ips avulsus* were more common in canopy traps whereas *Dendroctonus valens*, *Dryoxylon onoharaenses*, *Hypothenemus rotundicollis*, *Stenoscellis brevis*, *Xyleborinus saxesenii* and *Xylosandrus crassiusculus* were more common in ground traps. Similar patterns were shown by predators and associates.

Comparing bottle traps to multiple-funnel traps for ambrosia beetles

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Ambrosia beetles (Curculionidae: Scolytinae) are an important target group in detection programs for invasive and exotic insects. To date, >25 species of ambrosia beetles have invaded the USA with several species such as *Xylosandrus crassiusculus* (Motschulsky) and *X. germanus* (Blandford) causing economic damage in fruit orchards and horticultural nurseries. Detection programs for exotics typically employ multiple-funnel traps while orchards and nurseries typically employ plastic bottle traps. Bottle traps are easy to make and considerably cheaper than multiple-funnel traps. Our objective was to determine the effect of trap type on catches of three common species of ambrosia beetles in eastern USA: *X. crassiusculus*, *X. germanus* and *Xyleborinus saxesenii* (Ratzeburg). In 2015, we conducted the same experiment at four locations across the USA: (1) Greene Co., Georgia (1 April – 23 June); (2) Tippecanoe Co., Indiana (6 May-30 June); (3) Wayne Co., Ohio (14 May – 8 July); and (4) Virginia Beach, Virginia (1 April – 27 May). 4-Unit multiple funnel traps (Synergy Semiochemicals Corp., Burnaby BC) were compared to clear, plastic bottle traps for efficacy in trapping ambrosia beetles. Funnel traps were modified by increasing the center hole of each funnel from 5 cm to 12 cm, allowing placement of all lures within the trap. Each trap was baited with ethanol and conophthorin lures from Contech Enterprises (Victoria BC), releasing at 0.25 g/d and 0.5 mg/d, respectively. Conophthorin can enhance catches of some species to traps baited with ethanol. At each location, we deployed 10 bottle and 10 funnel traps, in ten replicate blocks of two traps (one bottle and one funnel) per block. Traps were spaced > 8m apart. Cups contained a solution of propylene glycol. Means with different letters are significantly different at $P = 0.05$ (*t* test). We obtained larger catches of *X. germanus* in bottle traps than in funnel traps in Ohio but not Indiana and Georgia. Catches of *X. saxesenii* were larger in funnel traps than in bottle traps in Georgia, Indiana and Virginia but not Ohio. Similarly, catches of *X. crassiusculus* were larger in funnel traps than in bottle traps in Georgia and Virginia but not Indiana. Additionally, bottle traps were preferred by two more species whereas funnel traps were preferred by five more species.

Attraction of non-cerambycids to cerambycid pheromones in southeastern USA

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Numerous hardwood borers (Coleoptera: Cerambycidae) are broadly attracted to blends of hydroxyketones and hexanediols (Hanks et al. 2012, Can. J. For. Res. 42: 1050-1059). Our objective in this

study was to determine if these compounds had any effect on the responses of other species, particularly ambrosia beetles. We conducted the same experiment once near Eatonton, GA during the spring of 2012 (22 March – 17 May) and again near Staffordville, GA during the summer of 2013 (10 July – 20 August). Ethanol lures and lures of racemic hexanediol (C6-diol), racemic 3-hydroxy-2-hexanone (C6-ketol) and racemic 3-hydroxy-2-octanone (C8-ketol) were supplied by ConTech Inc. (Delta, BC). The hydroxyketones were provided by Bedoukian Research Inc. (Danbury CT) whereas hexanediols were synthesized in Fredericton NB. The release rates of the diols and ketols ranged from 10-40 mg/d depending on temperature whereas ethanol released at about 0.6 g/d. In both experiments, we used 10-unit multiple-funnel traps that were modified by increasing the center hole of each funnel from 5 cm to 12 cm, thereby allowing placement of all lures within the confines of the trap. At each of the two locations, we deployed 40 funnel traps, set in 10 replicate blocks of 4 traps each. Traps and blocks were spaced 8-12m apart. One of the following treatments was allocated to a trap within each block: (1) ethanol alone; (2) ethanol + C6-diol; (3) ethanol + C6-ketol; and (4) ethanol + C8-ketol. Lures were replaced once after three weeks. All cups contained a solution of propylene glycol. The bark beetle predators, *Temnoscheila virescens* (Trogossitidae) was attracted to 3-hydroxy-2-hexanone whereas *Chariessa pilosa* (Cleridae) was attracted to the hexanediols. The bee assassin bug, *Apiomerus crassipes* (Hemiptera) was attracted to both hydroxyketones. Attraction of the ambrosia beetles, *Dryoxylon onoharaensis* (Curculionidae: Scolytinae) to ethanol was interrupted by 3-hydroxy-2-octanone. Catches of four other species were unaffected by the hexanediols and hydroxyketones. The red-shouldered bostrichid, *Xylobiops basilaris* was attracted to the hexanediols. Catches of *Buprestis* spp. (Buprestidae) and *Hylobius pales* (Curculionidae) were unaffected by the cerambycid pheromones. The bark beetle, *Hypothenemus rotundicollis* (Curculionidae: Scolytinae) was attracted to 3-hydroxy-2-octanone.

Detection of bark- and wood-boring beetles is increased by using a diversity of trap colors and heights and decreased by Z-3-hexenol

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Our objective was to determine the effect of trap color, trap height, and *Z*-3-hexenol on efficacy of detecting species of bark and wood borers, and to improve the efficacy of detecting *Agrilus* spp. and other buprestids. We conducted two field experiments in 2015: 1) a 3 x 2 factorial testing the effects of trap color (black *vs.* green *vs.* purple) and trap placement (tree canopy *vs.* understory) with all traps baited with a "superlure", conducted at four sites (New Brunswick, Canada; Poland; Georgia, USA; and China); and a 3 x 2 factorial testing the effects of the same three trap colors and lure (superlure *vs.* superlure + *Z*-3-hexenol), with all traps in the canopy, conducted at three sites (New Brunswick, Massachusetts, and Ontario). Treatments were replicated 8x in randomized blocks at each site and all traps were coated with Fluon®. The superlure was a multi-lure combination of racemic 3-hydroxyhexan-2-one, racemic hydroxyoctan-2-one, *R*R**-2,3-hexane diols, *E/Z*-fuscumol, *E/Z*-fuscumol acetate, and UHR ethanol. In terms of species richness, the number of buprestid species detected per trap was significantly affected by trap color and trap height but not by *Z*-3-hexenol. Green traps in the tree canopy detected the greatest

number of buprestid species, followed by purple canopy traps. Mean catch per trap and/or detection rate of individual buprestid species was significantly greatest in: green traps for 10 species, purple traps for 4 species black traps for 0 species, canopy traps for 10 species, and understory traps for only 1 species. Cerambycid species richness per trap was not significantly affected by trap color or height but was significantly reduced by *Z*-3-hexenol. However, mean catch per trap and/or detection rate of several individual cerambycid species was significantly affected by trap color and/or trap height and was greatest in: green traps for 16 species, black traps for 12 species purple traps for 8 species canopy traps for 16 species, and understory traps for 19 species. The addition of *Z*-3-hexenol lures to traps baited with the superlure significantly affected detection of 18 cerambycid species, decreasing catches of 15 species and increasing catches of only 3 species. Species richness of Scolytinae in traps was not affected by trap color but was significantly greater in the understorey than in the canopy. Trap height significantly affected mean catch per trap and/or detection rate of six species, three species that were caught mainly in the canopy, and three species caught mainly in the understory. *Z*-3-hexenol significantly affected detection of only two species, increasing catch of *Polygraphus rufipennis* and decreasing catch of *Anisandrus sayi.* Because species composition differed between traps in the canopy and the understorey, the mean total number of species detected per trapping effort was increased by placing half of the traps in the canopy and half in the understorey. We conclude that efficacy of detecting exotic and potentially invasive bark- and wood boring beetles at survey sites would be improved by using more than one color of trap and by placing traps in both the canopy and the understory.

Western Forest Insect Work Conference Founder's Award: An Amazing Legacy

Founder's Award Committee (Joel McMillin, Chair)

The Founder's Award is bestowed to an individual who has significantly advanced forest entomology in western North America. The award recognizes contributions in the areas of pest management, extension-consultation, research, and teaching. We highlight the amazing legacy of the award and include pictures of prior recipients. From 1991 through 2017, there have been 24 recipients who embody the evolution of western forest entomology. For more information concerning Founder's Award recipients and how to submit a nomination please visit the WFIWC website (http://www.wfiwc.org/awards/founders-award). We acknowledge and appreciate the assistance of the Technology Committee in recording and uploading recent Founder's Award presentations.

Tree mortality in the central and southern Sierra Nevada: Causes, extent, severity and impact.

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In 2015, USDA Forest Service Aerial Detection Survey (ADS) reported extensive tree mortality in the central and southern Sierra Nevada of California, and estimated >22 million trees had been killed. As a result, Governor Jerry Brown (California) declared a state of emergency on 30 October 2015, establishing a task force to help address the issue (http://www.fire.ca.gov/treetaskforce/). In 2016, ADS estimated an additional 62 million trees died, bringing the total to at least 102 million trees in the last 10 years. We

discuss causal agents and rates of tree mortality, and associated impacts based on a network of plots installed in the most heavily-impacted areas.

SPLAT® Verb and "SPLAT® Repel", a prototype formulation containing (+)-verbenone, for management of mountain and southern pine beetles.

Christopher J. Fettig[1], A. Steven Munson[1,2], Stephen R. Clarke[3], Beverly M. Bulaon[4], Daniel R. Cluck[5], Monica L. Gaylord[6], Sandy Kegley[7], James R. Meeker[8], Leif A. Mortenson[9], John T. Nowak[10], Robert A. Progar[11], Cynthia L. Snyder[12], Lia Spiegel[13], Brytten E. Steed[14], and Agenor Mafra-Neto[15]

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Verbenone is the principal antiaggregation pheromone of mountain and southern pine beetles. Although several formulations of verbenone are registered for tree protection, failures in efficacy are not uncommon. Fettig et al. (2015) developed a novel formulation of (–)-verbenone (SPLAT® Verb, ISCA Technologies Inc., Riverside, CA, USA; EPA Reg. No. 80286−20; 10.0% a.i.) that rather than a single release device is a flowable emulsion that allows the user to adjust the size of each release point (dollop) according to desired rates and distributions. SPLAT® Verb was registered by the U.S. Environmental Protection Agency for use on pines in 2013, and was first used operationally in 2014. We review the development and efficacy of SPLAT® Verb for protecting pines from mountain pine beetle, and early efforts using a similar prototype formulation containing (+)-verbenone for disrupting southern pine beetle infestations (spots).

Monitoring and ship inspection program for Asian gypsy moth and other Lymantria in the Russian Far East, Japan, South Korea, and China.

A. Steven Munson, USDA Forest Service- FHP, Ogden, UT (ret.), Robbie W. Flowers, USDA Forest Service - FHP, Bend, OR, and Brendon J. Reardon, USDA APHIS Plant Protection & Quarantine, Riverdale, MD.

The genus Lymantria (Hübner) contains some of the most destructive forest pests in the world. Asian gypsy moth (AGM), *Lymantria dispar asiatica* Vnukovskij larvae are known to feed on over 500 plant species, including a variety of conifers and hardwoods. In the early 1990's AGM was introduced into the Pacific Northwest by infested ships originating from ports in the Russian Far East. Unlike the flightless female European gypsy moth, AGM females are capable of flying distances of up to 32 km (20 miles). Since 1994, a cooperative agreement with the Russian government has focused on annual AGM detection surveys near high risk ports in the Russian Far East to determine population levels. Analyses of the population levels helps determine, on a seasonal basis, the risk of introduction by ships and cargo coming from or transiting within the Russian Far East. Other monitored lymantriids include the Nun moth, *L. monacha* and the pink or rosy gypsy moth, *L. mathura*. Although AGM is not established in North America, monitoring and trapping programs continue to detect AGM annually. Swift regulatory and control actions are in place such that localized populations have been eradicated. As a result of these detections, the

USDA developed a map of high-risk areas in cooperation with the governments of Canada, Russia, Japan, China, and South Korea. Programs were then developed to minimize the risk of AGM introductions into North America through inspections and certifications of vessels entering North American ports from these locations. Meetings and program discussions among the respective agencies from each country are ongoing and included visits by U.S. and Canadian representatives to the Russian Far East in 2016, as well as planned visits by Russian and South Korean representatives to the U.S. and Canada in 2017.

Evaluation of Systemic Insecticide and Fungicide for Protection of Sycamore from Polyphagous Shot Hole Borer / *Fusarium* Dieback.

Donald Grosman, Akif Eskalen, Joey S. Mayorquin, Joseph D. Carrillo, and David Cox.

Abstract not submitted.

Evaluation of Systemic Fungicide and Insecticide for Management of Pitch Canker and Insect Vectors on Monterey Pine.

Don Grosman, Bryndie Birch, and Tom Zoller.

Abstract not submitted.

Nuclear Polyhedrosis Virus as a Biological Control Agent for *Malacosoma americanum* (Lepidoptera: Lasiocampidae)

R.A. Progar, M.J. Rinella, D. Fekedulegn and L. Butler

In addition to damaging trees, the eastern tent caterpillar is implicated in early fetal loss and late-term abortion in horses. In a field study, we evaluated the potential biological control of the caterpillar using eastern tent caterpillar nuclear polyhedrosis virus (ETNPV), a naturally occurring virus that is nearly species-specific. Egg masses were hatched and second instar larvae were fed virus-inoculated foliage to propagate the virus *in vivo*. Then, a viral pesticide was formulated at concentrations of 10^4, 10^6 and 10^8 polyhedral inclusion bodies ml^{-1}. The pesticide was applied to foliage on which second, third and fourth instar caterpillars were feeding. When the majority of surviving larvae reached the sixth instar, colonies were collected and the surviving caterpillars counted. Mean numbers of surviving caterpillars per treatment were compared via 95% bootstrap confidence intervals. The data indicate second instar caterpillars were highly susceptible to the virus, but only at the highest concentration tested. Third instar caterpillars were also somewhat susceptible to high virus concentrations, while fourth instar caterpillars were fairly resistant. Our data provide the strongest evidence to date that ETNPV can be propagated, harvested and refined for formulation as a biological control agent for eastern tent caterpillar. Its use on this insect may be merited in circumstances where landowners and managers need to protect trees and horses.

A Severity Rating System for Evaluating Stand-level Balsam Woolly Adelgid (Hemiptera: Adelgidae) Damage in Two *Abies* Species in Western North America

K.H. Hrinkevich, R.A. Progar, and D. Shaw

Severity rating systems are fundamental to understanding the impacts of disturbance agents in forest stands. The balsam woolly adelgid (BWA), *Adelges piceae* (Ratzeburg) (Hemiptera: Adelgidae) is an invasive forest pest in North America that infests and causes mortality in true fir, *Abies* spp. There is currently no single system for evaluating damage caused by BWA in the western United States. Since range

expansion through favored habitat is inevitable, it is imperative to begin long-term monitoring using a unified approach to evaluate changing conditions and hasten management opportunities. We developed a new rating system for two western host species: grand fir and subalpine fir. Unlike other severity scales, our index describes stand-level damage rather than impacts on individual host trees alone. We sampled fifty-eight sites across the current range of BWA in the western United States and compiled severity indices using ten metrics of overstory and understory damage. We used ANOVA analyses to identify five discrete severity classes and translated the results into a descriptive table of damage characteristics for each class. This index is proposed as an improvement over existing rating systems for western North America because of its broader scope, demonstrated ability to distinguish between classes, and identification of the predominant indicators that will improve efficiency and efficacy of field assessments. The adoption of this system will facilitate long-term monitoring through site resurveys that will be directly comparable over time, also allowing future studies to conduct risk assessments and target stands that face the greatest threat to forest health.

Acoustic communication in *Dendroctonus* and *Ips* beetles

Kasey Yturralde[1] and Rich Hofstetter[2]

[1]Portland Parks and Recreation, [2]Northern Arizona University

Bark beetles (Scolytinae: Coleoptera) produce sound via stridulation that functions in mating, competition, and disturbance contexts. Recent studies indicate that in some bark beetle species, both sexes use acoustic signals to choose mates, often associated with large size. However, the relationship between acoustic signals and size of stridulatory structures is poorly understood. We investigated the relationship between acoustic signals, variation in the underlying stridulatory structures, and body size in *Dendroctonus* and *Ips* bark beetle species. Within species, stridulatory structures often scaled positively with body size in some *Dendroctonus* species. Fewer *Ips* species exhibited correlations between body size and stridulatory structures, as well as with chirp characteristics, likely due to the mechanism of sound production, which pairs two ridged structures together. *Dendroctonus* species produced chirps at lower frequencies compared to *Ips* species, while species also differed significantly in chirp characteristics within genera. Across species, but within genera, stridulatory structures positively scaled with body size. *Dendroctonus* species were generally more variable in chirp characteristics than *Ips* and such patterns may reflect differences in life history strategies and mating systems.

Citizen science project reveals vulnerability to pests in Portland street trees

Kasey Yturralde*, Julie Fukuda, Jeff Ramsey, and Angie DiSalvo

Urban Forestry, Portland Parks and Recreation

Urban forests provide ecosystem services, economic benefits, and enhance human health of city residents. However, urban forests are also subject to multiple pressures such as pests, pathogens, habitat fragmentation, and challenges of the built environment. Street trees are particularly susceptible to pests and pathogens because they often experience an additional suite of biotic and abiotic stressors, such as limited growth space, urban warming, and anthropogenic injuries. Unfortunately, some forest pests are capable of attacking even healthy trees, such as the emerald ash borer (*Agrilus planiplennis*).

Given such potential risks, knowing the species composition of urban forests is vital in understanding how to manage for resilience to existing and potential non-native pests. Portland's citizen science-driven street tree inventory afforded the opportunity to assess vulnerability to non-native pests. The street tree

inventory was conducted by Urban Forestry staff with assistance from over 1,400 volunteers organized by neighborhood tree teams. Data collected included tree identification (species or genus), size, health, and site conditions. Over seven years approximately 218, 600 trees were inventoried with greater than 95% accuracy in species identification.

The street tree population was assessed for vulnerability to Emerald ash borer (*Agrilus planipennis*), Asian longhorned beetle (*Anoplophora glabripennis*), Bronze birch borer (*Agrilus anxius*) and Dutch elm disease. Approximately 42% of street trees are vulnerable to one or more of these pests/pathogens. The greatest risk to street trees is due to ALB, with 34.4% vulnerable trees. Indeed, over 25% of street trees belong to the *Acer* genus, a preferred host of ALB. Estimated vulnerability to pests in Portland street trees is likely an underestimate as defoliators, such as Asian gypsy moth (*Lymantria dispar asiatica*), were not included. Recommendations include increasing street tree diversity, improving tree planting compliance, updating tree planting lists, and leveraging citizen scientists in early detection rapid response efforts.

Collecting and storing increment cores: Do's and don'ts for tree-ring objectives

A.M. Lynch and A.H. Arizpe.

Abstract not submitted.

Pine Engraver Adapting in a Time of Warmer Temperatures

Sandra Kegley, USFS; Tom Eckberg, Idaho Dept. of Lands

In northern Idaho, tree mortality due to the pine engraver, *Ips pini*, is associated with fresh pine slash in the spring. Two generations are produced in most years with the first generation emerging from slash to attack standing pines. The 2nd generation overwinters as adults. Three generations were suspected to occur in 2015, a hot, dry year and was also reported in 1994. A logging operation during winter 2015-16 created six processor piles of slash in an attempt to contain beetles and keep them out of standing trees (after Knopf 1982). This technique has been successful in most years. This gave us an opportunity to determine if piles are successful in containing beetles for multiple generations during a warm, dry spring, monitor *Ips pini* flight period with pheromone traps, and determine the number of generations.

Three or 4 funnel traps baited with *Ips pini* attractants were placed around 4 slash piles. Two slash piles served as controls with no traps. Traps were monitored and emptied weekly. Fresh slash was provided at three piles when the current developing generation became pupae or callow adults on June 14 and July 28. The first pine engravers were caught March 31. There were 3 flights from March to late September, with over 750,000 beetles caught. Three full generations were confirmed by beetle development. Tree mortality occurred adjacent to both treated and untreated piles. Trees killed in the 2nd and 3rd flights could be differentiated by crown color by November 2016.

Neither very large slash piles nor pheromone traps kept beetles out of standing trees during a dry spring and summer. If our climate continues to become warmer, three or more generations of pine engravers could become more common in northern Idaho. This would influence recommendations regarding timing of harvest and slash management in pine stands to prevent tree mortality.

Reducing Sequoia Pitch Moth Damage – Transitioning to New Technologies in Tree Improvement Pest Management

Sandra Kegley and Nancy Sturdevant, USFS Forest Health Protection, Northern Region

Genetically improved ponderosa and lodgepole pines from many different seed sources are planted off-site in centrally located tree improvement areas (TIA). These off-site pines are very susceptible to sequoia pitch moth (SPM) feeding. Larvae feed in the cambium causing large pitch masses to form. Heavy infestations cause stem and branch breakage or girdling. Current management involves removing pitch masses and destroying larvae which is time consuming and only partially effective.

New tree protection methods—tree wrap and mass trapping—were tested in lodgepole pine (LPP) at either Bigfork or Plains TIA. In mass trapped plantations, 24 pheromone traps (12 per acre) were placed in LPP blocks using 1 mg commercial lures (Alpha Scents). To find the optimum pheromone dose for future mass trapping, three different dosages (1 mg, 3 mg, and 10 mg of the pheromone (Z, Z)-3, 13-octadecadien-1-ol (ChemTica International)) were tested in bucket traps at Big Creek TIA. Each TIA had chronic SPM infestations for several years.

Wrapping trees up to about 4.5 feet on the main bole resulted in significantly fewer pitch masses than controls ($P = 0.01$). In mass trapped plantations, 120 moths were caught at Bigfork and 175 moths caught at Plains. At Bigfork, there were significantly fewer numbers of new pitch masses in trapped (59) than control blocks (176) after mass trapping ($P < 0.0001$). At Plains, the number of pitch masses pre- and post-trapping declined significantly (from 100 to 58) in the mass trapped block ($P < 0.01$). In the lure dosage test, the 10 mg lure caught the most pitch moths over the flight period (206 compared to 141 in 3 mg baited traps and 129 in 1 mg baited traps) but mean trap catches were not significantly different between the different lure dosages. Our results suggest that both tree wrapping and mass trapping can reduce damage from SPM and any lure dose tested can be used in pheromone traps to catch SPM.

MCH for area and individual tree protection against spruce beetle attack

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We tested 1 g MCH pouches for area and single tree protection against spruce beetle attack at two locations in Utah and one in New Mexico. MCH was applied at 20, 40, and 80 g ha^{-1}. In 80 x 80 m measure blocks, all three MCH treatments significantly reduced the probability of mass attacks by about 50%. The three MCH spacings did not significantly differ in efficacy against spruce beetle attack.

We also tested 1 g MCH pouches and a novel spruce beetle repellent, *Acer* kairomone blend (AKB), as single tree protectants at locations near those used for the area protection study. Compared to spruce with only a spruce beetle bait, the probability of attacks on MCH- or AKB-alone trees was significantly reduced but still at rates considered too high for operational efficacy. Baited spruce treated with both MCH and AKB, however, sustained no attacks whatsoever, a significant difference compared to bait-only trees and indicating treatment success. We plan further study of the AKB components and hope to identify an optimized spruce beetle repellent for area and single tree use.

Testing a novel formulation of 3-methylcyclohex-2-en-1-one (MCH) for managing Douglas-fir beetle (*Dendroctonus pseudotsugae*) in high risk stands and potential implications for associated bee communities

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The Douglas-fir beetle, *Dendroctonus pseudotsugae* (DFB), is the most damaging pest of Douglas-fir (*Pseudotsuga menziesii*) throughout North America. DFB infestations in high-risk stands can be managed successfully using the anti-aggregation pheromone, 3-methylcyclohex-2-en-1-one (MCH), which is widely used in bubble capsule formulation to protect thousands of hectares annually. Despite its wide use, the impacts of MCH on beneficial components of forests (e.g. the associated bee community), is largely unknown. During 2016, we established experimental plots near Socorro, NM and Boise, ID to determine the efficacy of a novel formulation of MCH, SPLAT®-MCH (i.e. SPLAT-MCH), for protecting trees from DFB infestation. We concurrently examined how MCH affects the associated pollinator community, by sampling bees from plots treated with either MCH-bubble capsules, SPLAT-MCH or untreated control plots located near Boise, ID and Bozeman, MT. Mean percentages of mass-attacked Douglas-fir trees ≥ 20.3 cm dbh were significantly reduced on 0.4-ha plots treated with SPLAT-MCH (34.4 % reduction) or MCH bubble capsules (50.7 % reduction) compared to untreated control plots at the New Mexico site. These levels of reduction did not differ significantly between MCH formulations. Furthermore, we found no treatment effect on neither the number of bees nor the number of genera captured per plot. These preliminary results suggest that SPLAT-MCH is an effective option for reducing tree mortality attributed to DFB, and that using MCH for managing DFB should have no negative effects on the associated bee community.

Latitudinal Variation in Mountain Pine Beetle Prepupal Diapause

Barbara J. Bentz and E. Matthew Hansen

The range of mountain pine beetle (MPB) spans more than 30° latitude across thermally diverse habitats. Local adaptation has resulted in genetic differences in development time and thresholds among populations. Dormancy strategies used by MPB and variability among populations, however, are unclear. Dormancy strategies used by insects include: 1) Diapause – neurohormonally-mediated suppression of development and growth induced by environmental conditions that are not by themselves limiting, and 2) Quiescence – occurs as a direct result of unfavorable conditions, is not hormonally regulated, and metabolic suppression is reversible upon the return of favorable conditions. A 4th instar developmental threshold (i.e., quiescence) has been hypothesized to drive mountain pine beetle seasonality. The 4th instar relationship between development rate and temperature, however, is similar to that of spruce beetle for which several lines of evidence support a prepupal diapause. Our goal was to explore a potential prepupal diapause in MPB. We also tested for latitudinal variation in dormancy strategies by including northern (northern Utah and southern Idaho) and southern (southeastern Arizona) populations.

We conducted several laboratory studies to test if MPB can pupate below the previously described pupation threshold in the range 15 to 17°C. We also investigated the range of temperatures that induce prepupal diapause. We found evidence of prepupal diapause, rather than simple quiescence, in both the northern and southern MPB populations. Diapause was induced in northern individuals by 12 hr cryophase temperatures ≤ 15°C. Diapause induction in southern individuals required colder temperatures and a longer duration of exposure. Diapause was averted more in southern compared to northern individuals. A few individuals from both populations do not have the diapause phenotype and can develop without completing diapause requirements.

Evaluating the threat of *Dendroctonus ponderosae* to Minnesota pine forests

Kevin D. Chase[1], Mark Abrahamson[2], Angie Ambourn[2], Robert C. Venette[3], Brian H. Aukema[1]

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The mountain pine beetle (MPB), *Dendroctonus ponderosae* Hopkins (Coleoptera: Scolytidae), affects mature pine forests on a landscape scale when populations reach epidemic levels. Cold temperatures previously prevented MPB from northern and eastern range expansion through the Boreal Forest and the Great Plains prairies prevented eastward expansion. However, with increasing minimum winter temperatures and anthropogenic movement of timber, these barriers have been breached. Over the next four years, we will evaluate: 1) the long-distance dispersal capabilities of MPB through the Great Plains of South Dakota and the pine ridges of northern Nebraska; 2) the biotic resistance community of bark beetles and their predators between Minnesota, South Dakota, and Nebraska; 3) the response of living red pine, eastern white pine, and Scots pine to challenge by the MPB fungal associate *Grosmannia clavigera*; 4) how the bark beetle competitor *Ips grandicollis* affects colonization success of MPB. Our experiments aim to classify this threat and better predict the potential impacts of MPB in eastern pine forests.

Optimal attack density of *Dendroctonus ponderosae* in naive lodgepole pine in Alberta

Antonia E Musso, Dr. Maya L. Evenden, Dr. Allan L. Carroll, and Victor Shegelski.

Abstract not submitted.

Forest Health Monitoring: Western Forest Insect Work Conference 2017

Tom Eager and Karen Ripley

National Program Manager, Forest Health Monitoring, Washington DC; Forest Health Monitoring Mega-Region Coordinator. Portland, OR. USDA Forest Service

Forest Health Monitoring is a national program that brings State and Federal cooperators together in order to track the long-term and widespread changes in forest health due to disturbance. Forest Health Monitoring is currently in the process of re-vitalizing the program by utilizing the latest techniques and seeking out new partners to participate in data gathering and reporting.

There are several aspects to the program including: Evaluation Monitoring (EM) Projects provide early follow-up to changes and trends in forest health due to biotic and abiotic causes. Projects sponsored by Forest Health Protection are selected in an annual competitive process to investigate and understand nationally important forest health topics.

Forest Health Highlights are annual reports produced by State Forest Health Monitoring partners that describe state-wide and regional forest health issues

Forest Health Monitoring: National Status, Trends, and Analysis is a National Technical Report that provides an overview of forest health conditions across the nation. Insect and disease impacts, the effects of drought and weather, results from Evaluation Monitoring Projects and special “spotlight” issues are reviewed annually.

Plans are being made for a National Meeting in 2018. We hope to bring together a wide range of cooperators who will work together to detect and record the status and impacts of change occurring within the nation's forests.

Preparing for Forest Entomology Reconnaissance in Mongolia

Karen Ripley, klripley@fs.fed.us

Although mostly grassland and desert, Mongolia has about 30 million acres of forest composed of Siberian larch, Siberian pine, Scots pine, birch and poplar. It also has significant problems with native defoliating caterpillars such as *Lymantria dispar* (gypsy moth), *Dendrolimus sibericus* (Siberian caterpillar), and *Erannis jacobsoni* (Jacobsen's spanworm). Lepidoptera tend to be more damaging in Asia than in North America (oddly, Asian forests don't receive much impact from bark beetles) and the pesticide sprays the Mongolian Forestry Department and industrial lease-holders have been using for decades don't seem to be working effectively.

Mongolia is part of the United Nations "Reducing Emissions from Deforestation and Forest Degradation" (UN-REDD) program. The UN-REDD system for calculating forest degradation has recently changed to include degradation caused by native forest insects. Karen Ripley was invited to spend about 15 days (6 in the field) conducting an "assessment" mission to identify opportunities to reduce forest degradation and improve forest sustainability – with better tools and decisions about when/where/what to spray and how to monitor tree vigor, insect population changes, and the effectiveness of the treatments that occur.

Ripley will also give several presentations on the methods that are used in North America to monitor forest health and tree vigor; how to determine when suppression is needed; and some of the tools that are used for monitoring and treatments. This poster invited comments and conversation among WFIWC participants to generate advice on what kinds of questions to be asking, equipment to take and conditions to be sensitive toward during this assessment effort.

An economic analysis of Mountain Pine Beetle Direct Control in the Cranbrook Timber Supply Area

Clay Allison[1], Bill Riel[2] and Arthur Stock[3]

[1]SR Management Ltd., [2]Canadian Forest Service, Natural Resources Canada, [3]BC Ministry of Forests, Lands, and Natural Resource Operations

This analysis explored the short-term economic impact of mountain pine beetle (MPB) suppression strategies in areas designated for suppression management in the Cranbrook Timber Supply Area (TSA) in southeastern British Columbia.

The analysis was conducted using various data sources available within the province of BC including timber cruise, vegetation resource inventory and aerial overview survey data. Data were collated and input into a model (MPBSIM) which projected stand and harvest values at 5-year intervals up to 15 years, comparing two MPB management scenarios: "direct control" as currently practiced in the TSA and "no management". The resultant gain or loss in forest estate dollar values, estimated annual harvest values and return on investments (ROI) were calculated.

Although there was a decrease in the estimated forest estate value over 15 years in both scenarios, the decrease under direct control was substantially less than under the no management strategy. The gains ranged from 18-26% in different forest types with direct control. Results show that there was a net loss in the estimated annual harvest value of stands in the 0-to 5-year interval under direct control. However,

between years 5-10 and years 10-15, there was a substantial net gain in value. In this study, MPB suppression showed a cumulative ROI of 330% over a 15 year period demonstrating the economic viability of this management program.

State of the Science for Non-Native Invasive Species–A National Assessment

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The USDA Forest Service works with a wide assortment of partners to detect, respond to, and manage non-native invasive species that threaten the Nation's wildland and urban forests and rangelands, but a current comprehensive, and integrated assessment of the state of invasive species science and research is lacking. Increased science focus on quantifying invasive species biology, interactions, and impacts, along with managing invasive species and altered ecosystems were identified as major priorities in a Forest Service Technical Report, *A Dynamic Invasive Species Research Vision: Opportunities and Priorities 2009-2029.* In December 2015, a national stakeholder workshop was held in Phoenix, Arizona with leading experts on invasive pests, climate change, social sciences, and forest and rangeland management to highlight the science and identify knowledge gaps in a diverse array of topics related to invasive species. A major outcome of the workshop will be a USDA FS General Technical Report that synthesizes the available information on invasive species science in one place for reporting and use by multiple stakeholders and decision makers.

Graduate Student Presentation Abstracts

Moderated by Monica Gaylord

Pine engravers carry bacterial communities whose members reduce concentrations of host monoterpenes with variable degrees of redundancy, specificity, and capability.
Michael Howe and Kenneth Raffa. University of Wisconsin.

Bark beetles are eruptive forest insects that have the potential to cause landscape level destruction of conifer forests. The pine engraver, *Ips pini* (Say), is the predominant pest of red pine (*Pinus resinosa* Aiton) plantations throughout the Great Lakes region of North America. Pine engraver attack elicits a localized response by host trees in which concentrations of terpenes rapidly exceed the tolerance levels of beetles and their fungal associates. Here I demonstrate that 1) most pine engravers harbor bacterial communities that reduce monoterpene concentrations *in vivo*; 2) several individual bacterial isolates can reduce monoterpenes at high doses, which are likely lethal to beetles; and 3) bacteria isolated from pine engravers are similar to those found in other bark beetle systems. Bacteria isolated from pine engravers decreased concentrations of α-pinene by an average of 14%, 3-carene by 15%, and myrcene by 12%. Nine out of ten beetles carried at least one bacterial isolate that reduced concentrations of at least one monoterpene. Some bacteria reduced concentrations of monoterpenes even at the highest levels (20 μL), but different bacteria varied in this capability. Bacteria most closely matching *Serratia, Erwinia,* and *Klebsiella* were relatively the most abundant operational taxonomic units capable of reducing monoterpene concentrations. *Serratia* decreased monoterpene concentrations by 25% relative to the nonbacterial controls. The community of bacteria associated with an individual beetle appears to have substantial functional redundancy that could collectively increase the likelihood of successful colonization.

What are mites bringing to the table? Their role in mountain pine beetle – fungal mutualisms.
Sneha Vissa and Rich Hofstetter. Northern Arizona University, School of Forestry, Flagstaff, Arizona.

Mountain pine beetles (*Dendroctonus ponderosae*) have been a focus among forest researchers and managers due to their frequent outbreaks. These beetles are associated with a variety of micro-organisms that cover a range of symbioses (mutualistic to antagonistic). One such interaction involves the mutualism between beetles and 'mycangial fungi', in which the beetles use the fungi as a nutritional resource and the fungi are transported to new habitats. Mycangial fungi are Ophiostomatoid fungi that cause blue-staining of tree tissue and are associated with vascular wilt. Relative abundances of these fungi are highly dependent on abiotic factors such as temperature, elevation and season. However, secondary microorganism may influence the fungal composition of mountain pine beetle-infected trees. Here we examine two southwestern populations of *D. ponderosae*, Utah and Arizona, and their mite and fungal associates. Using genetic tools, we examine and compare the fungal composition associated with mountain pine beetles and phoretic mites. Results indicate that mites carry one of the mycangial fungi (*Ophiostoma montium*) among other Ophiostomatoid propagules, consequently vectoring multiple fungi into trees. We also add 3 new taxa to the list of known mites associated with *D. ponderosae*, and discuss the ecological and evolutionary implications of a mite-mediated fungal environment.

Ant functional group changes along elevational gradients in northern Arizona: a baseline measure of a possible bioindicator.
Derek Uhey, Northern Arizona University

Ecosystem health is often measured indirectly by proxy taxonomic groups, or 'bioindicators'. These groups consist of taxa sensitive to environmental change and are indicative of a wide range of other taxa. Ants are commonly used in Australia as bioindicators, and a system of functional group designations has provided a simplistic tool for measuring disturbance. Typically, disturbance is measured as the proportion of opportunistic species in relation to other functional groups, with higher ratios of opportunists indicating disturbance. Limited studies in the United States show that this system may be applicable in North America as well. However, more work is needed to establish a "baseline" of what ant functional groups should look like without disturbance across a multitude of habitats. Our study seeks to describe ant community patterns in undisturbed sites across a range of habitat types, to show the natural variation from environmental conditions to be expected. We found that ant functional groups follow distinct elevational patterns, with distinct partitions between life zones. Hot climate specialists and dominant dolichoderinae functional groups were confined to pinyon-juniper and lower habitats. Cold climate specialists were only found in the Ponderosa life zone. The only groups to reach the highest life zone, mixed conifer, were opportunists and subordinate Camponotini. Additionally, subordinate Camponotini showed a strong preference for forest habitats over meadow habitats. These results show a changing "baseline" for ant functional groups, with certain groups being indicative of each life zone and habitat. Using the proportion of opportunists as a bioindicator measure seems possible in all but mixed conifer and higher life zones, as these are naturally composed of primarily opportunists.

Response to multiple stressors in *Pinus pinaster* Ait.: conflicts between drought and herbivory stress with *Hylobius abietis*

Estefanía Suárez-Vidal[1*], Jennifer Klutch[2], Nadir Erbilgin[2], Luis Sampedro[1] and Rafael Zas[1]

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Climate models predict an increase in temperatures and a decrease in precipitation, resulting in longer and more intense periods of drought. Associated to global change, an increase of the incidence of pests and pathogens has also been predicted. Pines are isohydric species whose mechanism to prevent water losses is the closure of stomata, implying a decrease in the carbon uptake needed for growth, reproduction and defenses. Hormonal cascading in response to biotic and abiotic threats may also interact among each other altering the ability to tolerate each single stress. The aim of this study is to test how drought stress can constrain pine defensive responses to insect herbivory. For this purpose Maritime pine (*Pinus pinaster* Ait.) originating from three different populations, known to differ in their tolerance to drought, were submitted to three levels of water scarcity (control, moderate and severe drought stress) and then subjected to herbivory (control and the pine weevil *Hylobius abietis* L.). After that, seedlings were harvested and biomass allocation, water potential, ^{13}C concentration, non-structural carbohydrates and chemical defensive composition were studied.

Water treatments promoted drought stress, measurable by a less discrimination to ^{13}C, a decrease in water potential and reduced seedling dry weight in all populations. Moreover, the insect herbivore inflicted less damage on water-stressed than on well-watered plants. Pine responses to insect damage included alterations of the concentration of particular chemical defenses but these responses largely varied depending on the water treatment. Interactions between the experimental treatments and the population factor also revealed

different strategies among pine populations to cope with the biotic and abiotic stressors. Overall, the results provide valuable information to understand how pines are able to tolerate at the time biotic and abiotic stressful conditions. These results will be helpful for forest management in a global change scenery.

Synchronous resurgence of larch casebearer in eastern and western larch forests
Samuel J. Fahrner, Brian H. Aukema, University of Minnesota, Saint Paul

Larch casebearer *Coleophora laricella* Hübner (Lepidoptera: Coleophoridae) is an invasive defoliator native to Europe. Since 2000, after decades of successful importation biological control, large scale defoliation has been mapped via aerial surveys in geographically isolated forests of eastern and western larch. We sought to determine whether climatic variables such as minimum winter temperatures were associated with enhanced larch casebearer activity. We quantified the spatial synchrony of defoliation from 1997-2014 within and between eastern larch forests of Minnesota and western larch forests of Oregon and Washington. The spatial synchrony of minimum temperatures in select months (September, January, April and June from 1995-2014) was also quantified. We found that defoliation is synchronous up to 330 km within and up to 2,240 km between eastern and western larch forests. Minimum temperatures for January were positively correlated at the same scales as defoliation (> 2300 km), while no other synchronous weather patterns emerged. Given that cold temperatures are implicated in regulating populations of larch casebearer and that minimum winter temperatures are increasing across the study region, our findings suggest that the resurgence of larch casebearer may be facilitated by a warming climate.

Naturalization of a native invasive: endemic mountain pine beetle in novel pine habitats
Stanley Wolf Pokorny, Allan Carroll, Faculty of Forestry, Department of Forest and Conservation Sciences, University of British Columbia, BC, Canada
One of the most dramatic and destructive examples of a response by a native organism to recent climate change is the ongoing outbreak range expansion of mountain pine beetle (*Dendroctonus ponderosae,* MPB) in Canada. However, observations from the native range indicate that to persist long term in pine forest ecosystems mountain pine beetles must establish and maintain low density, endemic phase, populations after epidemic source populations have collapsed. To assess the potential for MPB to persist as endemic phase populations in novel pine habitats, endemic niche conditions in six western boreal jack pine (*Pinus banksiana)* stands and four Albertan lodgepole pine (*Pinus contorta*) stands were quantified and compared to equivalent data from six BC lodgepole pine stands. Significantly less endemic susceptible host material per hectare was detected in jack pine stands than in native range and Albertan lodgepole pine stands. No difference was detected between lodgepole pine populations. This data suggests that although MPB is likely to integrate into recently invaded lodgepole pine landscapes, the relative dearth of susceptible host material in jack pine stands may prove to be a biological barrier to endemic persistence and spread in the boreal forest.

Response of mountain pine beetle and its fungal mutualists to simulated climate change: preliminary results from a reciprocal translocation experiment
David Soderberg, Wildland Resources Department, Utah State University; Barbara Bentz, Research Entomologist, Rocky Mountain Research Station, Logan, Utah; Karen Mock, Professor, Utah State University, Department of Wildland Resource, Logan, Utah.

Understanding how native species will respond to climate change is important for management of future forests. Population persistence depends on dispersal to suitable environments, phenotypic plasticity, and capacity for adaptation. Mountain pine beetle (*Dendroctonus ponderosae*, MPB) has recently responded to a

warming climate with range expansion northward and population persistence at high-elevations, although the potential for population expansion southward and future adaptation to changing conditions is unclear. Warming temperatures increase survival and impact generation times in ways which promote synchronous emergence and successful mass attacks on host trees. The duration of MPB life-cycle completion, larval cold tolerance, and beetle size are proxies for MPB fitness, but the plasticity and speed of adaptive responses of these traits have not been investigated in the field. Moreover, although considerable variability is known to exist in regional adaptation among MPB populations, the plasticity of fungal community composition in different climates is uncertain. We are conducting a reciprocal MPB population translocation experiment in the Coconino National Forest near Flagstaff, Arizona and the Cache National Forest near Logan, Utah to simulate changing climate and assess the response of MPB and its mutualistic fungal community. Preliminary data confirms genetic differences in development time and provides new information on genetic differences in cold hardening capacity between locally adapted Arizona and Utah MPB populations. To identify and quantify relative abundances of MPB's fungal associates, we are developing high-throughput sequencing approaches that will have benefits over the traditional approach of morphological identification of fungal cultures grown on selective media.

Modeling phenology of a southern population of mountain pine beetle (*Dendroctonus ponderosae)*

Anne McManis[1], James Powell[2], Barbara Bentz[3]. [1]Department of Biology, Utah State University, Logan, UT , [2]Department of Mathematics and Statistics, Utah State University, Logan, UT, [3]Rocky Mountain Research Station, US Forest Service

Mountain pine beetle (*Dendroctonus ponderosae* Hopkins, Coleoptera: Curculionidae, Scolytinae) (MPB) is a native bark beetle that kills and reproduces in the phloem of several *Pinus* species in western North America. Climate change has expanded the northern edge of MPB's range, but its effect on beetles at the southern range margin is unknown. Developmental response to temperature differs genetically between northern (Idaho, Utah) and southern (Arizona) MPB populations, although the lifestage(s) responsible for the differences have not been investigated. Using phloem sandwiches and a novel combination of x-rays and image analysis to describe oviposition, we describe the influence of temperature on MPB collected from an infested *Pinus strobiformis* in Arizona. These data are being used to better understand lifestage-specific differences across latitudes, and re-parameterize a MPB phenology model originally developed using a northern MPB population. Preliminary data suggest southern MPB have a lower and higher threshold for oviposition than northern MPB, although the mean rate of oviposition for southern MPB is generally lower than northern MPB. Developmental rates of northern and southern MPB were surprisingly similar across all lifestages except teneral adults, which indicates that this lifestage is primarily responsible for the difference in emergence times between populations.

Committee Reports

Memorial Scholarship Committee Submitted by Darrell Ross

The committee received two applications for the 2017 Memorial Scholarship. The committee selected Erika Eidson as the 2017 Scholarship recipient. She is an MS student at Utah State University advised by Drs. Barbara Bentz and Karen Mock. Her thesis research is focused on understanding resistance mechanisms of Great Basin bristlecone pine against the native herbivore mountain pine beetle.

With Steve Munson's retirement, the committee was short one member. Tom Coleman was asked to serve on the committee and he agreed to do so. The committee is now composed of Darrell Ross (Chair), Sandy Kegley, Steve Seybold, and Tom Coleman.

Fundraising Committee Submitted by Monica Gaylord, Dan Miller, Andrea Hefty and Sky Stephens

The 2017 Western Forest Insect Work Conference was held in Jackson Hole, WY during the week of May 1st. The Silent Auction was held Tuesday, May 2nd, in conjunction with the Formal Poster Session. The items were all set up and displayed in the Grand Room. This year, 57 items were donated to the auction by 13 individuals or organizations and 28 individuals purchased items.

Joy Brisighella, the conference coordinator from Utah State University, and her assistant were invaluable in helping the auction run smoothly this year, including setup and processing of payments. Dan Miller assisted Joy with setting up the items for the auction. Pat Ciesla, Andy Graves, Robbie Flowers, Sky Stephens, and Andrea Hefty were also available to assist when needed. Jordan Burke assisted with setup and organizing the online auction of the *Ips* carving donated by Ladd Livingston.

Bidding began at 7 pm and ended at 9 pm. Fifty-four of the items were bid upon during that time. The total amount raised from items donated to the silent auction was $1195. In addition, $300 were given in donations, bringing the grand total raised this year to $1495.

The donation that earned the highest bid was the *Ips* beetle wood carving ($195), donated by Ladd Livingston. Because of the uniqueness of this article, and the number of people unable to attend this year's meeting, we decided to try an online auction for this particular item. The carving was available on the website for bidding for several days ahead of the auction until the close of the auction. This online auction was moderately successful in that the price of the item was raised slightly before the auction itself. We are investigating ways to continue to use this online platform for effective fund raising. Special thanks should also be given to the Ogden Field Office. This office donated 30 items, bringing in $431. Pat Ciesla also donated seven items, contributing $84 to our grand total.

The fundraising committee added several new members: Dan Miller, Andrea Hefty and Sky Stephens. We are also seeking new fundraising ideas and appreciate any and all suggestions.

A detailed spreadsheet with items, donors, bidders and money collected/item will also be submitted (see attached).

Founders Award Committee Submitted by Joel Egan

It is with great pleasure that the Founder's Award Committee announces the selection of Steve Munson as the 2017 WFIWC Founder's Award recipient. Liz Hebertson nominated Steve, and he has been notified of his selection.

The 2015 Founder's Award recipient was Nancy Gillette. We have invited Nancy to present her address at the 2017 WFIWC meeting. Craft Trophy in Ft. Collins, Colorado, did a wonderful job once again on creating the plaque that will be bestowed to Nancy at the meeting. Ken Raffa will present the plaque to Nancy and introduce her at the 2017 meeting.

We did not select a Founder's Award recipient in 2016 due to it being a NAFIWC year.

Based on our approved resolution to add a graduate student to the Founder's Award committee, Stacy Hishinuma was extended an offer to join the committee and she graciously accepted the offer in April 2015. This is a two-year term; however, the term will be extended until the spring of 2018 as WFIWC was not held in 2016. We will seek a graduate student replacement for Stacy in 2018.

After serving on the Founder's Award Committee for 10 years, Ken Raffa has decided to step down from the committee. We thank him for his valuable contributions during this decade of service. The committee will work together to appoint a new member to replace Ken.

The Founder's Award Committee updated a poster that displays the amazing legacy of the WFIWC Founder's Award and includes pictures of prior recipients. The poster was presented at the 2016 NAFIWC in Washington, DC and will also be on display again this year in Jackson Hole. Also on exhibit will be the two "traveling" plaques that list all the recipients' names.

As a reminder, information concerning Founder's Award recipients is also on the WFIWC website. We acknowledge and appreciate the Technical Committee's (Jordan Burke, Joel Egan) assistance in our efforts to update the Founder's Award portion of the WFIWC website (http://www.wfiwc.org/awards/founders-award), including recording and uploading videos of Founder's Award presentations.

We encourage WFIWC members to consider nominating one of the many people who have been important in western forest entomology, and to WFIWC, for this prestigious award. Nomination information is available on the WFIWC website.

Committee members: Ken Raffa, Bill Riel, Steve Seybold, Lorraine Maclauchlan, Stacy Hishinuma

COMMON NAMES COMMITTEE REPORT FOR 2015-2017 Submitted by

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

As of March 2017, the Common Names Committee (CNC) included five members: Beverly Bulaon, Bobbe Fitzgibbon, Lee Humble, Iral Ragenovich, Lee Pederson, and Co-Chairpersons Brytten Steed and Bill Ciesla. Several of the Committee members are at or past retirement age. Consequently new members hip in the CNC is desired, especially from younger members of the WFIWC. If interested, contacy either Brtten Steed or Bill Ciesla

No report was submitted in 2016 at the North American meeting in DC; this report covers two years. During the period between the 2015 and 2017 Western Forest Insect Work Conferences, seven proposals were

submitted to the WFIWC membership for review. Three have been accepted by WFIWC and submitted to the Entomological Society of America Common Names Committee for review. They are:

First set approved by WFIWC and submitted to ESA February, 2015:

Hylesinus aculeatus - eastern ash bark beetle

Hylesinus californicus - western ash bark beetle

Hylesinus oregonus - Oregon ash bark beetle

These proposals were submitted to ESA, have been accepted, and now reside on the ESA Common Names database.

A Second set of proposals were submitted to the WFIWC for review, March, 2015 and subsequently to ESA:

Hemileuca nevadensis – Nevada buck moth

Hemileuca eglanterina – elegant buck moth

Neodiprion autumnalis – autumn ponderosa sawfly

Neodiprion fulviceps – spring ponderosa sawfly

The common name "elegant buck moth" for *Hemileuca eglanterina*, has been accepted by ESA and currently resides on the ESA Common Names database. The remaining three have been withdrawn by the proposers after objections were raised.

The proposed common name, Mexican goldspotted oak borer, for *Agrilus coxalis* was dropped from further consideration because of objections raised by several reviewers. The insect that had been referred to as *Agrilus coxalis,* recently introduced into Callifornia*,* but now identified as *A. auroguttatus*, will keep the ESA approved name of "goldspotted oak borer".

The CNC continues to encourage submission of common names for insects discussed in Furniss and Carolin's "Western Forest Insects" that do not have ESA approved common names. Approximately half of the common names used in this classic publication are not sanctioned by either ESA or ESC. We encourage authors who are revising sections of this publication to submit common names for the insects being revised as appropriate. We also encourage proposals of common names for recently introduced and established exotic forest insects in the West. The established review and comment process, using links available on the WFIWC official website, continues to work well.

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.

History Committee Report 2017 Submitted by Co-chairs Mal Furniss, Sandy Kegley, and Boyd Wickman, with contributions from Joel Egan

Several hundred historic forest entomology reports that were located in the Northern Region Coeur d'Alene and Missoula Field Offices and dated from 1905 to the 1990's are currently being scanned. Many of these reports were from the Bureau of Entomology and Plant Quarantine in the early decades of the 1900's. Electronic versions of these reports should be available in the near future.

Historic reports can be useful in conducting analysis of previous insect outbreaks to compare with current outbreaks. Joel Egan, Forest Health Protection staff, Missoula, Montana, assessed a large body of historic literature to facilitate a spatial reconstruction of early 1900s mountain pine beetle (MPB) outbreaks in the Northern Region. Over 65 reports (exceeding 1000 pages of text) from surveys conducted by the Bureau of Entomology and Plant Quarantine, as well as published scientific literature, were reviewed for this effort. Reports included site-specific location information and detailed maps of MPB activity in different hosts from extensive surveys conducted. Spatial data was plotted in ArcGIS resulting in a composite map of areas of mortality by tree species from 1909-1945.

A total of 2.9 million beetle affected acres were identified from the outbreak reconstruction with the vast majority occurring in the decade from 1925-1934. This reconstruction is considered a conservative estimation as some locations may not have been reported and surveys occurred in the larger impact areas relevant to early 1900s forest values, but it is similar to James Evenden's[1] 1944 estimations. Substantial tree mortality that occurred from 1917-1942 resulted in regeneration and growth of 80 year-old lodgepole pine by the early 2000's when severe mortality occurred during the most recent outbreak. Similar to the more current 1980's and 2000's outbreaks, MPB was active historically wherever there were susceptible hosts during periods of beneficial climate. Decline of beetle activity from 1942-1945 was mainly due to host depletion although there were many attempts at direct control. This data and comparisons with more recent outbreaks will be presented by Joel in a workshop at this conference.

Julie Johnson, Information Specialist, R-6, published her two-part GTR on the 70 year history of Aerial Survey in Oregon and Washington, 1947-2016. Furniss was consulted for photos and personal recollections of the surveys in California during 1950-1954, flown by John Wear of the Portland Forest Insect Lab and on the interior Alaska surveys in 1991-1992. He also reviewed her manuscript which may be accessed at https://archive.org/details/AerialForestInsectAndDiseaseDetectionSurveysInORandWA19472016TheSurveyHighRes

Julie also provided an album entitled Bark Beetle Enemies of California Forests, prepared by personnel of the Division of Forest Insect investigations to publicize killing of old growth ponderosa pine in northeastern California by the western pine beetle ca 1920s. Furniss prepared an article for the American Entomologist featuring photos from the album by John Miller and John Patterson showing the fell-peel-burn method taken to preserve inaccessible stands until they could be logged.

[1]Evenden, J. C. 1944. *Montana's Thirty-Year Mountain Pine Beetle Infestation;* U.S. Department of Agriculture, Forest Service, Bureau of Entomology and Plant Quarantine, Coeur d'Alene, ID. 16 p.

Opening/Closing Business Notes

Compiled by Jason Moan (Alaska Division of Forestry) – WFIWC Secretary

WFIWC Opening Business Meeting

May 2, 2017

Topics:

- Diversity Statement was presented to membership for consideration
- *Local Arrangements:*
    - up to 88 registrants

    - Conference would likely have a couple thousand dollar loss
- Work Conference Challenges
    - Even if the name of the meeting were to change, having a registration cost would still require USFS Meetings Management
- *Treasurer*
    - $20,000 in operating; $64,000 in Scholarship fund
    - No tax return required if less than $100,000 earned in a year
- *Program committee*
    - Could work in more time for lunches, but that would require longer conference days as well
- Future Meetings
    - 2018 Meeting: Denver Area
    - 2019 Meeting: Alaska volunteered
- *Common Names*
    - 7 common names were proposed, 5 approved by ESA
    - Common names proposed were in two sets
        - First set were all associates of emerald ash borer
    - Western forest insects book: many insects needing common names
    - Soliciting new members
- *History*
    - USFS Region 1 is scanning many of the historical reports
    - USFS Region 6 produced a summary of their 70-years of aerial detection surveys
    - Soliciting new members
- *Technology*
    - Soliciting grey literature while being careful of copyrights
    - Need to better promote the conference
- *Memorial Scholarship*
    - Erica Eidson announced as 2017 recipient
- *Memorial scholarship funding committee*
    - Soliciting new members
- *Founders Award*

- Steve Munson announced as 2017 recipient
- Soliciting two new members, including one grad student

Moment of Silence – A moment of silence was held to remember former WFIWC members who have passed recently: Charles Dwight Minnemeyer, Dr. John Schenk, Dr. Jean Pierre (Peter) Vite, Frank Yasinki (Yaz), Dr. Boyd Wickman

WFIWC Executive Committee Nominations

Joel opened up the floor for nominations for Secretary and Counselor.

WFIWC Secretary

Jordan Burke nominated Jason Moan (Alaska Division of Forestry)

WFIWC Counselor, replacing Kathy Bleiker

Jordan Burke nominated Caroline Whitehouse (Alberta Agriculture and Forestry)

No other nominations were received. Both nominations were seconded and a vote was held for each position. Jason Moan becomes the WFIWC Secretary and will be the point of contact for WFIWC correspondence. Caroline Whitehouse becomes a Counselor, replacing Kathy Bleiker.

WFIWC Closing Business Meeting

May 4, 2017

Primarily includes only info not specifically documented in the Opening Business Meeting Notes above.

There were three main items:

1) Announcement of the photo salon winners
2) Include a Diversity statement – Passed
    a. Incorporate as stated in the draft version – Passed
3) Location for 2019: Alaska - Passed
    a. Request was made for Anchorage for ease of travel
    b. Some concern was expressed about USFS participation due to cost

Other business:

- 2017 meeting was held during finals week at some universities, which may have impacted university participation
- Memorial Scholarship Fundraising Committee added Andrea Hefty (USFS)
- History Committee added Glenn Kohler (Washington DNR)
- Common Names Committee added Rich Hofstetter (Northern Arizona University)

Back Row: Don Grossman, Dan Miller, Kevin Chase, Samuel Fahrner, Joel Egan
Front Row: Jennifer Watt, Richard Hofstetter, Darek Czokajlo, Jason Moan, Sky Stephens, Bill Riel

Back Row: Erin Shanahan, Jeff Webster, Michael Howe, Dan West, Glenn Kohler, Katelynn Martinez
Front Row: Liz Davy, Antonia Mosso, Bob Rabaglia, Robbie Flowers, Melissa Fischer, Darrell Ross

Back Row: Lorraine Maclauchlan, Darren Blackford, Karen Ripley, Erika Eidson, Jim Vandygriff, Martin Schebeck. Front Row: Matt Hansen, Amy Gannon, Carl Jorgensen, Sandy Kegley, Sylvia Mori, Andrew Graves.

Back Row: Don Bright, Barbara Barr, Javier Mercado, Brian Aukema, Allan Carroll. Front Row: David Wood, Steve Seybold, John Browning, David Soderberg, Anne McManis, Jordan Burke.

Back row: Devin Goodsman, Barbara Bentz, Monica Gaylord. Front Row: Nadir Erbilgin, Ken Raffa, Karen Mock, Amy Lockner, Estafania Suarez-Vidal, Jennifer Klutsch.

Executive Committee Meeting

Wood carving donated to Silent Auction by Ladd Livingston

Andrea Hefty
Memorial Scholarship Recipient

Nancy Gillette (with Ken Raffa)
Founder's Award Recipient

Jennifer Klutsch
Memorial Scholarship Recipient

Grand Teton National Park and Jackson Hole Ski Area Field Trip.

WFIWC 2017 Insect Photo Contest Winners

Forest Insect

1. One Big Hunk of Meat: carpenter ants harvest a spruce budworm pupa; **Ward Strong**
2. Hickory tussock Moth; **Andrea Brauner**
3. Fir Sawyer; **Christine Buhl**

Insect Damage

1. Newly grafted scion killed by Rhyacionia spp—pupal case visible; **Ward Strong**
2. Spruce budworm damage to spruce; **Ward Strong**
3. Beetle vectored black stain root disease; **Christine Buhl**

Series

1. St. Andrews Cotton Stainer; **William Ciesla**
    a. Slide 1: Adult St. Andrew's cotton stainer, *Dysdercus andreae*, on seed pod of seaside mahoe, *Thespesia populnea*
    b. Slide 2: Pair of St. Andrews cotton stainer adults mating
    c. Slide 3: Adults and nymphs of St. Andrew's cotton stainer feeding on seeds of seaside mahoe
2. Winter logging in Northern Idaho in 2015: Unintended consequences; **Tom Eckberg**
    a. Slide 1: Slash pile in July 2015 from pine logging the previous winter. Large processor piles usually contain *Ips pini* through the flight season.
    b. Mortality in nearby lodgepole pine in November 2015 after the pile was burned.
    c. Needles fell off by the following summer and this mortality was not recorded during the 2016 aerial survey.

Other

1. Milky Way over spruce-fir forest in the White Mountains, AZ; **Derek Uhey**
2. Hornets are bad but robber flies are Badass; **Tom Eckberg**
3. Great Basin bristlecone pine (*Pinus longaeva*) highly resistant to mountain pine beetle; **Barbara Bentz**

Entomologists at work

1. Checking a light trap; **Ward Strong**
2. Black Lighting at Highlands Biological Station, North Carolina; **Andrea Brauner**
3. SPLAT Verb crew locked and loaded; **Candee Wilfong**

Humor

1. Men in Black gone wrong; **Ward Strong**
2. Mark-recapture student tries out new marking technology with mixed results; **Ward Strong**
3. Bear damage to insect exclusion bag; **Ward Strong**

People's Choice

1. Fir Sawyer; **Christine Buhl**
2. Hickory Tussock Moth; **Andrea Brauner**
3. Milky Way over spruce-fir forest in the White mountains, AZ; **Derek Uhey**

1st place Winners

Forest Insect

Ward Strong

Insect Damage

Ward Strong

Series

William Ciesla

Other

Derek Uhey

Entomologists at Work

Ward Strong

Humor

Ward Strong

People's Choice

Christine Buhl

Silent Auction donations Item	Donor	Min/start bid	end bid	bid winner
Stag beetle print	Alpha Scents	60.00	62.00	Bill Murry
Weevil print	Alpha Scents	60.00		
Leaf beetle print	Alpha Scents	60.00		
Brown Marmorated stink bunk print	Alpha Scents	60.00		
ski passes for Alta	Mark Pollish, Alta Ski Area	95.00	120.00	Jeff Webster
handwoven Scarf	Anne McManis		34.00	Matt Hansen
Donation	Barbara Bentz		50.00	Barbara Bentz
Guide to Insect Borer in NA	Dan Miller	5.00	20.00	Barbara Barr
Mason Jar Mug/coffee	Darren Blackford	10.00	25.00	Allan Carroll
Insulated coffee mug/coffee	Darren Blackford		40.00	Bill Riel
Donation	David Wood		50.00	David Wood
Bark beetle wine glass	Erika Eidson	5.00	40.00	Jim Vandygriff
Placeholder set, wood	Jordan Burke	15.00	15.00	Karen Ripley
Candleholder set	Jordan Burke		40.00	Kasey Yturralde
Cone Wreath	Karen Ripley	5.00	20.00	Amy Gannon
R2D2 thumbdrive	Karen Ripley	3.00	11.00	Cliff Bradley
Olive Woodbox	Karen Ripley	10.00	22.00	Cliff Bradley
Honey Nut cheerios	Karen Ripley	3.00	3.00	Cliff Bradley
Honey Nut cheerios	Karen Ripley	3.00	3.00	Cliff Bradley
Donation	Karen Ripley		100.00	Karen Ripley
Ips beetle wood carving	Ladd Livingston		195.00	Lorraine Maclauchlan
Donation	Nancy Gillette		100.00	Nancy Gillette
Insect Shopping Bag	Ogden Field Office	10.00	20.00	Amy Gannon
Insect Mug	Ogden Field Office		8.00	Andy Graves
Insect Mug	Ogden Field Office		8.00	Andy Graves
Butterfly necklace-gold	Ogden Field Office		10.00	Andy Graves
Butterfly earrings - aqua	Ogden Field Office		10.00	Andy Graves
Cloissone necklace & earrings	Ogden Field Office		25.00	Andy Graves
dragonfly necklace&earrings red	Ogden Field Office		25.00	Andy Graves
Butterfly necklace & earring	Ogden Field Office		15.00	Binh Munn
Butterfly necklace, aqua gold	Ogden Field Office		17.00	Binh Munn
Insect Mug	Ogden Field Office		5.00	Binh Munn
Ceramic leaf necklace	Ogden Field Office	10.00	17.00	Carl Jorgensen
Insect Scarf	Ogden Field Office	5.00	15.00	Carl Jorgensen
Dragonfly necklace-silver	Ogden Field Office	10.00	22.00	Cliff Bradley
Bear necklace	Ogden Field Office	5.00	14.00	Cliff Bradley
Lady Bug Necklace	Ogden Field Office		8.00	Cliff Bradley
Silver Diamond Shaped earrings	Ogden Field Office		10.00	Don Grosman
gold pine cone earrings	Ogden Field Office		40.00	Jim Vandygriff
Floral bracelet & earrings	Ogden Field Office		10.00	Jordan Burke
Bee and Daisy necklace	Ogden Field Office		10.00	Jordan Burke
Dragonfly necklace-black chain	Ogden Field Office		15.00	Lorraine Maclauchlan
Butterfly necklace & earring, circular top	Ogden Field Office		10.00	Mark Pollish
Dragonfly necklace & earrings-blue	Ogden Field Office		15.00	Matt Hansen
Cube shaped necklace	Ogden Field Office	3.00	5.00	Melissa Fisher
Insect mug	Ogden Field Office		5.00	Monica Gaylord
Dragonfly bracelet	Ogden Field Office	3.00	5.00	Nadir Erbilgin
Dragonfly necklace-gold	Ogden Field Office	5.00	25.00	Nadir Erbilgin
Insect Mug	Ogden Field Office	10.00	12.00	Sandy Kegley
Insect Mug	Ogden Field Office		15.00	Sharon Hood
Dragonfly necklace with pearls	Ogden Field Office		5.00	Sky Stephens
aqua pine cone earrings	Ogden Field Office		30.00	Steve Voelker
Pine beetle runner	Pat Ciesla	10.00	40.00	Bill Murry
Owl Towel	Pat Ciesla	5.00	6.00	Binh Munn
Bird Towel	Pat Ciesla	5.00	6.00	Cliff Bradley
Pumpkin Towel	Pat Ciesla	5.00	5.00	Jordan Burke
Hedgehog Towel	Pat Ciesla	5.00	7.00	Kate Hrinkevich
Mrs. Mouse	Pat Ciesla	5.00	5.00	Stan P
Green Patch Runner	Pat Ciesla	10.00	15.00	Steve Voelker
Insect Food for Humans	Rich Hofstetter	1.00	8.00	Cliff Bradley
Brass Pinning Block	Russ Mitchell	20.00	22.00	Glenn Kohler
TOTAL:			**1,495.00**	