71ST WESTERN FOREST INSECT WORK CONFERENCE

RESILIENCE AND RESTORATION: POST-DISTURBANCE AND POST-PANDEMIC

KIMPTON HOTEL MONACO SEATTLE
1101 4TH AVE, SEATTLE, WA 98101

APRIL 24-28, 2023

PROGRAM AGENDA

PROGRAM COMMITTEE:
PATRICK TOBIN (CHAIR), ALLAN CARROLL, DARCI DICKINSON, MELISSA FISCHER, RYAN GARRISON, GLENN KOHLER, ROBBIE FLOWERS, JOHN FORMBY, IRAL RAGENOVICH, KAREN RIPLEY, AND SKY STEPHENS

THE WESTERN FOREST INSECT WORK CONFERENCE WOULD LIKE TO THANK OUR 2023 SPONSORS:

SPONSORSHIP FOR THE WESTERN FOREST INSECT WORK CONFERENCE BY MARCIA WAKARCHUK JONES AND THE SYNERGY SEMIOCHEMICALS CORPORATION IS MADE IN THE LOVING MEMORY OF DAVID ALEXANDER WAKARCHUK.

DAVID WAS A LONG STANDING MEMBER OF AND CONTRIBUTOR TO WFIWC THROUGHOUT HIS CAREER.

DAVEY®

VALENT BIOSCIENCES®
Forest Health. Protecting Our Home.

ARBORJET® | Ecologel®
PARTNERS IN PLANT CARE

MONDAY, APRIL 24, 2023

15:00-19:30	**Registration**	*Paris Foyer (Lower Lobby)*
16:00-17:00	**Executive Committee Meeting**	*Tokyo Boardroom*
17:00-18:00	**Kimpton Social Hour** *Complementary Wine/Beer*	*Hotel Lobby (near the fireplace)*
18:00-20:00	**Welcome Mixer** *Appetizers and Cash Bar*	*Outlier Restaurant*

TUESDAY, APRIL 25, 2023

7:00-10:00	**Registration Open**	*Paris Foyer (Lower Lobby)*
8:00-8:15	**Welcome to Seattle** *Patrick Tobin, University of Washington* **In Memoriam for Those We Have Lost** *John Formby, USDA Forest Service*	*Paris Ballroom*
8:15-9:00	**Opening Keynote Presentation** **Western Science and Indigenous Knowledge:** **Two different ways of knowing about trees and forests** *Tom Hinckley, University of Washington*	*Paris Ballroom*
9:00-10:00	**Memorial Scholarship Presentations** **Darrell Ross, Moderator** **2021 Memorial Scholarship Awardee** **Wild bee responses to natural and anthropogenic disturbances in montane forests of the western United States** *Gabe Foote, University of California – Davis* **2022 Memorial Scholarship Awardee** **Oystershell scale: an invasive insect threatening sustainability of aspen ecosystems in the Southwest** *Connor Crouch, Northern Arizona University*	*Paris Ballroom*
10:00-10:30	**BREAK**	

10:30-12:00 **Concurrent Session 1:** *Paris Ballroom*
The rise of invasive sap-sucking insects I:
Occurrence, phenology and range expansion
Iral Ragenovich, Moderator

Spruce aphid population response to montane temperatures
Ann Lynch

History of balsam woolly adelgid in the Pacific Northwest
Iral Ragenovich

Balsam woolly adelgid population trends in recently invaded fir forests of Utah
Barbara Bentz

Mapping the severity of Balsam woolly adelgid infestations in Northern Utah
Justin Williams, Michael J. Campbell, and Erin M. Berryman

10:30-12:00 **Concurrent Session 2: Forest pollinators** *Athens*
Patrick Tobin, Moderator

Intensively managed timber plantations provide ephemeral habitat for native bees
James Rivers, Rachel A. Zitomer, Sara M. Galbraith, Matthew G. Betts, Andrew R. Moldenke, and Robert A. Progar

Spatial patterns of plant-pollinator interaction rewiring
Kaysee Arrowsmith, Victoria Reynolds, Annie Schiffer, Madeleine Strait, Manogya Chandar, Connor Morozumi, Xingwen Loy, and Berry Brosi

Restoration via prescribed fire and replanting increase resilience of plant-pollinator communities to species losses
Susan Waters, Rachel M. Mitchell, Emily R. Brown, and Ethan M. Taber

Effects of mixed severity wildfire on native pollinator communities in ponderosa pine forests of eastern Washington
Autumn Maust and Patrick C. Tobin

12:00-13:30 **LUNCH ON YOUR OWN**

13:30-15:00 **Concurrent Session 3:** *Paris Ballroom*
The rise of invasive sap-sucking insects II:
Impacts and management
Amanda Grady, Moderator

Prospects on managing aphids, spider mites and scales with bio-pesticide *Beauveria bassiana* and natural enemies
Richard Hofstetter, Cliff Bradley, Danielle Malesky, and Amanda Grady

Developing an Integrated Pest Management system for oystershell scale in aspen
Kristen Waring, Amanda Grady, Connor Crouch, Richard Hofstetter, Marissa Kuntz, Elizabeth McCarty, Mark Nabel, Jessi Ouzts, Mary Price, and Nicholas Wilhelmi

Urban heat islands awaken sleeper species and predict effects of climate change
Steve Frank

Balsam woolly adelgid in Alaska: how it got there and how we can prevent it from happening again
Elizabeth Graham and Jason Moan

13:30-15:00 **Concurrent Session 4: Novel approaches to big data** *Athens*
Michael Howe, Moderator

Using large datasets to study forest insect outbreaks
Jeffrey Hicke

A dynamic outbreak distribution model (DODM): proof of concept using an irruptive folivore, the western spruce budworm
Vivek Srivastava and *Allan Carroll*

Lessons from working with big data, part I: using ensemble models to describe outbreaks of defoliators in the temperate coastal rainforest
Michael Howe and Kellen Nelson

Lessons from working with big data, part II: using ensemble and logistic models to explore disturbance interactions of western spruce budworm and Douglas-fir beetle
Michael Howe, Amy Trowbridge, and Sarah Hart

15:00-15:30 **BREAK**

15:30-16:30 **Graduate Symposium 1** *Paris Ballroom*
Karen Ripley, Moderator

Seasonal history of the invasive balsam woolly adelgid in northern Utah
Liz Rideout, Barbara J. Bentz, and Diane G. Alston

Metabolome response of Engelmann spruce to bark beetle attack
Ehsan Khedive, Saeideh Fathi Moghanloo, and Seth Davis

Arthropod recolonization of mulch-treated understory habitat after fire in northern Arizona
Chrissy Mott, Rich Hofstetter, and Anita Antoninka

More fuel for the fire? Bark beetle and fire synergisms in the Cascadia region of North America
Holden Payne, Sigrid Netherer, and Allan Carroll

16:30-17:00 **Business Meeting** *Paris Ballroom*

17:00-18:00 **Kimpton Social Hour** *Hotel Lobby (near the fireplace)*
Complementary Wine/Beer

17:30 **WFIWC Fun Run** *Meet in Hotel Lobby*

19:00-21:00 **Poster Session and Silent Auction** *Paris Ballroom*
Cash Bar

Posters

Improving ratios of eastern larch beetles to predators captured in pheromone-baited funnel traps in tamarack forests in Minnesota
Emily Althoff, Brian T. Sullivan, and Brian H. Aukema

Western Forest Insect Work Conference Founder's Award: Walking with giants
Katherine Bleiker, Joel McMillin, Steve Cook, Celia Boone, and Matt Hansen

How are complex spatial patterns affecting bark beetle-caused tree mortality in northern Arizona?
Alyssa Cherow, Gia Landis, Jose Negron, and Kristen Waring

***Nepytia janetae*: A once innocuous species brings novel defoliation and appetites to the Santa Fe National Forest**
Peggy De'Scoville, Jennifer Klutsch, Andy Graves, Anna Schoettle, and John Formby

Two grant programs that help monitor and control invasive species in the west
Darci Dickinson

Cerambycid pheromone (3-hydroxyhexan-2-one) attracts woodborer *Phymatodes aeneus* and predator *Thanasimus undatulus* in the Pacific Northwest (USA)
Darci Dickinson, Dan Miller, Chris Crowe, and Beth Willhite

Monitoring drought induced juniper dieback and mortality in Arizona
Isaac Dell, Joel Mcmillin, Monica Gaylord, Amanda Grady, Nick Wilhelmi, Dan Ryerson, Ryan Hanavan, Aaron Kamoske, and Rowan Moody

Western monarch caterpillar performance on native and exotic milkweed species
Emma Elsner, John Campodall'Orto, Mike Wagner, and Richard Hofstetter

Roundheaded pine beetle as an emerging problem in southwest Colorado ponderosa pine forests
Matthew Ethington, Amy Lockner, Suzanne Marchetti, and John Nelson

Carbon stored in live Sierran ponderosa pines will not return to pre-drought (2012) levels during the 21st century due to bark beetle outbreaks
Christopher J. Fettig, Zachary J. Robbins, Chonggang Xu, Alex Jonko, Rutuja Chitra-Tarak, Jennifer Costanza, Leif A. Mortenson, Brian H. Aukema, Lara M. Kueppers, and Robert M. Scheller

Testing of fungal bioinsecticide on two species of adelgids, *Pineus similis* and *Pineus pinifoliae* in a western white pine-Englemann spruce seed orchard
Melissa Fischer, Darci Dickinson, and and Cliff Bradley

Biology, ecology, and morphological analysis of *Phloeosinus* bark beetles associated with giant sequoia in Yosemite and Sequoia-Kings Canyon National Parks, California
Nathaniel E. Foote, Thomas Seth Davis, and Gabriel G. Foote

Efficacy of trunk injection and bole spray treatments against spotted lanternfly and associated sooty mold production
Don Grosman

Evaluation of systemic fungicide and insecticide for management of pitch canker and insect vectors on Monterey pine
Don Grosman

Pinyon ips develops fast, unless attacking great basin bristlecone pine
Matt Hansen, Jim Vandygriff, Monica Gaylord, Andy Graves, Joel McMillin, Steve Souder, and Barbara Bentz

dfoliatR: An R package for tree-ring detection and reconstruction of forest defoliator outbreak chronologies
Ann M. Lynch, Christopher H. Guiterman, and Jodi N. Axelson

Research concerning new methods of control for spruce beetle in Utah and Wyoming
A. Steven Munson, Christopher J. Fettig, Jackson P. Audley, Darren C. Blackford, Donald M. Grosman, Leif A. Mortenson, A. Mafra-Neto

Pre-pupal diapause in the eastern larch beetle, *Dendroctonus simplex* LeConte
Rose Picklo and Brian Aukema

Fuels change quickly after California drought and bark beetle outbreaks
Charlotte Reed, Sharon Hood, Daniel Cluck, and Sheri Smith

Effective management of thousand cankers disease of walnut through disruption of insect vector behavior
Megan A. Siefker, Corwin M. Parker, Ali E. McClean, Steven J. Seybold, and Richard M. Bostock

WEDNESDAY , APRIL 26, 2023

7:00-9:00 **Registration Open** *Paris Foyer (Lower Lobby)*

8:15-8:30 **Announcements and Housekeeping** *Paris Ballroom*
Patrick Tobin

8:30-9:15 **Keynote Presentation** *Paris Ballroom*
Pathways of species invasions
Yolanda Inguanzo, USDA APHIS-PPQ

9:15-10:00 **Keynote Presentation** *Paris Ballroom*
Northern giant hornet survey and eradication: more than just hope and mimosas
Chris Looney, Washington State Department of Agriculture

10:00-10:30 **BREAK**

10:30-11:30 **Concurrent Session 5: Drought, wind and fire: investigating the role of abiotic disturbances on insect population dynamics** *Paris Ballroom*
Katherine Kitchens and Anna Tobiaz, Moderators

Session Introduction
Katherine Kitchens and Anna Tobiaz

Warming, droughts, bark beetles, and wildfires: A Story from the Sierra Nevada
Christopher J. Fettig

Two's a crowd: interspecific competition by woodborers can prevent bark beetle outbreaks after wildfires
Katherine Kitchens, Lori Daniels, and Allan Carroll

Temperature driven moisture stress affecting B.C. forests and the response of weevils and wood borers
Lorraine Maclauchlan, Celia Boone, and Marnie Duthie-Holt

10:30-11:30 **Concurrent Session 6: Seed and cone insects** *Athens*
Beth Willhite, Moderator

Production of forest tree seed for a diverse and changing landscape
Dan Cress

Seed orchard insect pest IPM – Emerging issues and the future
Alex Mangini and *Melissa Fischer*

Assessment of cone and seed insects and damage in *Pinus strobiformis*
Kristen Waring, Alejandro Leal-Sáenz, Daniel DePinte, Rebeca Álvarez-Zagoya, Monica Gaylord, José Ciro Hernández-Díaz, Carlos A. López-Sánchez, José Hugo Martínez-Guerrero, and Christian Wehenkel

11:30-13:00 **LUNCH ON YOUR OWN**

13:00 **Field Trip to the Washington Park Arboretum** *Hotel Lobby*
Meet in hotel lobby or front of the hotel
Buses will depart from the Valet Lane

13:30-15:45 **Washington Park Arboretum**
The Washington Park Arboretum is a welcome oasis on the shores of Lake Washington. Jointly managed by the University of Washington Botanic Gardens and the City of Seattle, its 230 acres contain a dynamic assortment of plants, some found nowhere else in the Northwest. Learn about the Park's efforts to make green spaces more inclusive, management of its collections, its role in the detection and management of invasive species, and its use in supporting research and conservation.

15:45 **Free time at the Seattle Japanese Garden, Washington Park Arboretum**
The Seattle Japanese Garden is a 3.5 acre urban sanctuary. Winding gravel paths and stone benches invite you to view the garden slowly and mindfully, in all of its detail - rock, water, lanterns, bridges, buildings, plants and animals.

16:30 **Buses depart from the Washington Park Arboretum**

17:00-18:00 **Kimpton Social Hour** *Hotel Lobby (near the fireplace)*
Complementary Wine/Beer

18:00-21:00 **Banquet Dinner** *Paris Ballroom*
2022 Founder's Award Recipient: Iral Ragenovich

THURSDAY , APRIL 27, 2023

7:00-9:00 **Registration Open** *Paris Foyer (Lower Lobby)*

8:00-8:15 **Announcements and Housekeeping** *Paris Ballroom*
Patrick Tobin

8:15-9:00 **Keynote Presentation** *Paris Ballroom*
Using remote sensing to study detection, attribution, impacts, and recovery of tree damage from insects
Jeff A. Hicke

9:00-10:00 **Graduate Symposium 2** *Paris Ballroom*
Iral Ragenovich, Moderator

Native bee response to fire disturbance in ponderosa pine forests of the Colorado Front Range
Ryleigh V. Gelles, Seth Davis, and Camille Stevens-Rumann

Interactions between stand characteristics and balsam woolly adelgid in the interior west
Grayson B. Jordan, Diane G. Alston, Barbara J. Bentz, and R. Justin DeRose

Intra-stand dispersal of the balsam woolly adelgid (*Adelges piceae* (Ratz.)) in Utah
Mike Wayman, R. Justin DeRose, Barbara J. Bentz, and Kezia R. Manlove

After the collapse: predicting the distribution of post-epidemic mountain pine beetle populations
Lucas Peng and Allan Carroll

10:00-10:30 **BREAK**

10:30-12:00 **Concurrent Session 7: Current issues in hardwoods – scolytines and wood borers I** *Paris Ballroom*
Debra Wertman, Moderator

David vs. Goliath
Celia Boone

Go girls: Investigating drivers of female-biased sex ratios in the alder bark beetle system
Taylor Holt and Allan Carroll

Ecological and evolutionary implications of symbiosis between the alder bark beetle and *Neonectria bordena* sp. nov.
Debra Wertman and Allan Carroll

Current status of the walnut twig beetle, *Pityophthorus juglandis*, and thousand cankers disease
Jackson Audley

10:30-12:00 **Concurrent Session 8: Ecological consequences of 21st-century mountain pine beetle outbreaks: Forest structure and composition** *Athens*
Christopher J. Fettig, Moderator

How we got here and the evolution of the Evaluation Monitoring Program-Mountain Pine Beetle Project
Christopher J. Fettig, A. Steven Munson, and Jackson P. Audley

Impacts of historic mountain pine beetle, *Dendroctonus ponderosae*, outbreaks on lodgepole pine forest structure and composition in the Intermountain West, U.S.
Jackson P. Audley, Christopher J. Fettig, A. Steven Munson, Justin B. Runyon, Leif A. Mortenson, Brytten E. Steed, Kenneth E. Gibson, Carl L. Jørgensen, Stephen R. McKelvey, Joel D. McMillin, and Jose F. Negrón

Changes in understory vegetation, including invasive weeds, following mountain pine beetle outbreaks
Justin B. Runyon, Christopher J. Fettig, Jared A. Trilling, A. Steven Munson, Leif A. Mortenson, Brytten E. Steed, Kenneth E. Gibson, Carl L. Jørgensen, Stephen R. McKelvey, Joel D. McMillin, Jackson P. Audley, and Jose F. Negrón

Beetle-killed lodgepole pine snag demography following the 2004–2012 regional mountain pine beetle outbreak
Leif A. Mortenson, Jackson P. Audley, Christopher J. Fettig, A. Steven Munson, Justin B. Runyon, Brytten E. Steed, Kenneth E. Gibson, Carl L. Jørgensen, Stephen R. McKelvey, Joel D. McMillin, and Jose F. Negrón

12:00-13:30 **LUNCH ON YOUR OWN**

13:30-15:00 **Concurrent Session 9: Current issues in hardwoods – scolytines and wood borers II** *Paris Ballroom*
Robbie Flowers, Moderator

Sudden apple decline in British Columbia: a potential link between fungal cankers, invasive Sesiidae moths, and abrupt hydraulic failure
Jesse MacDonald, Kirsten Hannam, Hao Xu, and Dan O'Gorman

The Mediterranean oak borer (MOB, *Xyleborus monographus* Coleoptera: Curculionidae: Scolytinae) a new invasive species infesting valley and blue oak in Northern California
Curtis Ewing, Michael Jones, Akif Eskalen, Albre Brown, and Sheri Smith

Woodboring beetle pests of concern in the PNW
Christine Buhl, Wyatt Williams, and Max Ragozzino

Influence of forest uniformity and holobiont associations on the apparency of hardwood-killing bark beetles: Ohmart (1989) revisited
Debra Wertman, Sam Bacon, and Allan Carroll

13:30-15:00 **Concurrent Session 10: Ecological consequences of 21st-century mountain pine beetle outbreaks: Fuels, fungi, carbon, and water** *Athens*
Jackson P. Audley, Moderator

Changes in fuel loads following mountain pine beetle outbreaks in lodgepole pine forests of the Intermountain West
Crystal S. Homicz, Christopher J. Fettig, A. Steven Munson, Justin B. Runyon, Leif A. Mortenson, Jackson P. Audley, Brytten E. Steed, Kenneth E. Gibson, Carl L. Jørgensen, Stephen R. McKelvey, Joel D. McMillin, and Jose F. Negrón

Assessing how mountain pine beetle outbreaks compare to other disturbances in terms of how they affect ectomycorrhizal fungal communities and pine health
Nadir Erbilgin, Justine Karst, John A. Cale, and James F. Cahill

Effects of mountain pine beetle outbreaks on carbon cycling
Jeffrey A. Hicke

How does water yield respond to mountain pine beetle infestation in a semiarid forest?
Jianning Ren, Jennifer Adam, Jeffrey Hicke, Erin Hanan, Christina (Naomi) Tague, Mingliang Liu, Crystal Kolden, and John Abatzoglou

15:00-15:30 **BREAK**

15:30-17:00 **Concurrent Session 11: Contributed Presentations** *Paris Ballroom*
Allan Carroll, Moderator

Best practices for tree injection
Don Grossman and Joe Doccola

Response of Engelmann spruce and blue spruce to inoculation with spruce beetle fungal symbionts
Seth Davis, Dan Ott, and Javier Mercado

Large-scale outbreak of spruce spider mite in Douglas-fir
Erika Eidson, Tom Eckberg, and Isabella Valdez

Influence of semiochemicals on interactions between the South's only two *Dendroctonus*: the southern and black turpentine beetles
Brian Sullivan, Holly Munro, Will Shepherd, and Kamal Gandhi

Concurrent Session 12: Contributed Presentations *Athens*
John Formby, Moderator

Community engagement can enhance biosurveillance for invasive forest pests
Joseph Hulbert

Predators of the hemlock woolly adelgid in the Pacific Northwest: Implications for biological control in eastern North America
Darrell Ross and Kimberly Wallin

Evaluating the unprecedented success of the anti-aggregation pheromone, 3-Methylcyclohex-2-en-1-one, for protecting live Douglas-fir: Implications for future development of bark beetle pheromone treatments
Darrell Ross

17:00-17:15 **Conference Adjournment** *Paris Ballroom*

17:00-18:00 **Kimpton Social Hour** *Hotel Lobby (near the fireplace)*
Complementary Wine/Beer

FIELD TRIP TO THE WASHINGTON PARK ARBORETUM, WEDNESDAY , APRIL 26, 2023

The Washington Park Arboretum (WPA) is a component of the University of Washington Botanic Gardens, and is managed through the University of Washington, Seattle Parks and Recreation, and the nonprofit Arboretum Foundation. The plant collections include >14,500 accessioned specimens and >4,000 different types of trees, shrubs and other plants native to 98 countries, spread out over 230 acres. Click here for an interactive map of the Washington Park Arboretum.

Field Trip Schedule

13:00 *Meet in hotel lobby or front of hotel. Buses will depart from the Valet Lane.*

13:20 *Approximate arrival time at the Pacific Connections Garden of the WPA;*
Location 1 on map on next page.

13:30 ***Christina Owen, Director of the University of Washington Botanic Gardens***
Welcome, history and facts about the WPA, and efforts being made to make the WPA more inclusive.

13:50 *Divide into three groups, with each group walking to one of three stations*
Locations 2a, 2b, and 2c on map on next page.

Location 2a (Rhododendron Glen): Ray Larson, Associate Director of the University of Washington Botanic Gardens and Curator of Living Collections
Collection and conservation at the WPA

Location 2b (Camellias): Ryan Garrison, Plant Health Specialist, WPA
Use of the WPA in research and in the management of invasive species

Location 2c (Lookout): David Zuckerman, Manager of Horticulture and Plant Records, University of Washington Botanic Gardens
Management of the plant resources of the WPA

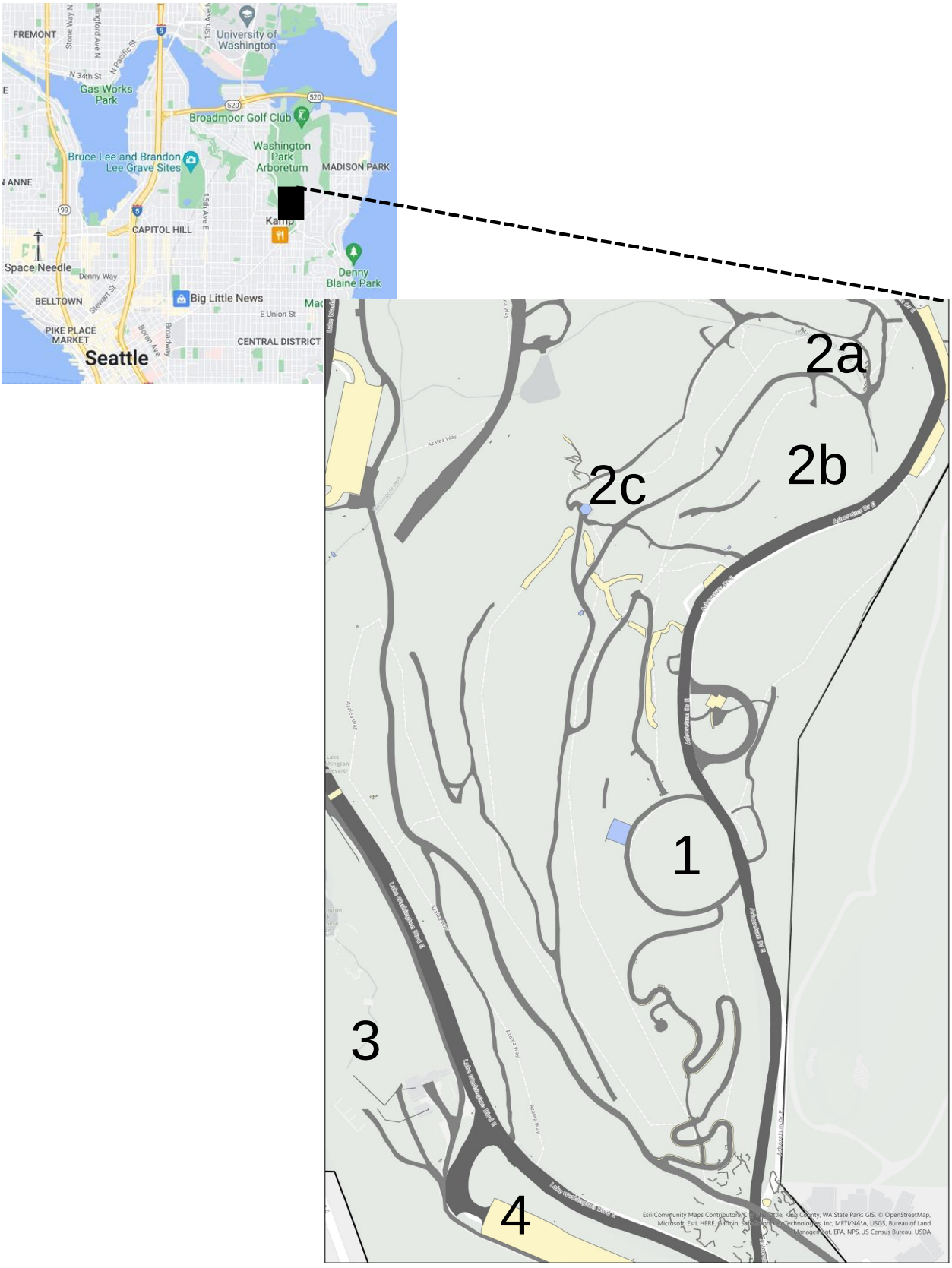
Rotation Schedule

14:00 *Station 1*
14:25 *Conclude Station 1 and walk to Station 2*
14:35 *Station 2*
14:55 *Conclude Station 2 and Walk to Station 3*
15:05 *Station 3*

15:30 Walk to *the Seattle Japanese Garden for free time*; *The Seattle Japanese Garden is a 3.5 acre garden located in the southern end of the WPA. It is regarded as one of the oldest and most authentic Japanese Gardens in North America.*
Location 3 on the map on the next page.

16:30 *Buses depart from the parking lot next to the Seattle Japanese Garden for return to the Kimpton Hotel Monaco Seattle.*
Location 4 on the map on the next page.

FIELD TRIP TO THE WASHINGTON PARK ARBORETUM, WEDNESDAY , APRIL 26, 2023



71ST WESTERN FOREST INSECT WORK CONFERENCE

PRESENTATION ABSTRACTS

TUESDAY, APRIL 25, 2023

Western Science and Indigenous Knowledge:
Two different ways of knowing about trees and forests

Tom Hinckley, University of Washington

Abstract

This is a story of how I have approached the study of trees (and forests). Graduate school at the University of Washington gave me an outstanding foundation in all things involved in the physiology of water and carbon in plants, especially trees. In addition, I became enamored with a wide variety of devices to measure photosynthesis, transpiration, xylem sap flux, water potential, stomatal opening, and the associated micrometeorological techniques and tools. This path continued for almost the next 40 plus years at the University of Missouri, University of Natural Resources and Applied Life Sciences (Vienna, Austria), and the University of Washington. Two events caused moderate to major changes in focus. The May 18, 1980, eruption of Mt. St. Helens occurred 4.5 months after I began at the University of Washington – my approach continued to focus at the organ level (i.e., leaf or needle); however, there was increasing pressure to scale to the whole tree and stand! I learned a wide range of new approaches the use of remote sensing and stable isotopes were just two examples, but my fall back were the tools of my youth. The second event was the May 21, 2001, arson fire at the Center for Urban Horticulture. As a result of the fire, I underwent a considerable transformation. My momentum in physiological ecology ended and two new foci emerged: undergraduate and graduate instruction and learning that involved interdisciplinarity and a 20-year partnership with tribal members from the Yakama Nation. The latter was an endeavor initiated by tribal members and entitled “Papuchan Papasapsikw’at ku Papatmaakte (to teach and respect each other). My efforts with a 3.5-million-dollar NSF IGERT for training Ph.D. students and the annual overnight field trip for UW students to the Yakama Nation led to me learning about an entirely different way of knowing. I will end by reflecting on the advantages of using these two approaches to knowing.

Wild bee responses to natural and anthropogenic disturbances in montane forests of the western United States

Gabriel Foote (University of California, Davis), Andrew Graves (USDA Forest Service, Forest Health Protection, Southwestern Region), Christopher Fettig (USDA Forest Service, Southwest Pacific Research Station), Darrell Ross (North Dakota State University, Dept. of Entomology), Hugh Safford, (University of California, Davis, Dept. of Environmental Science & Policy) Justin Runyon (USDA Forest Service, Rocky Mountain Research Station), Nathaniel Foote (Colorado State University, Dept. of Forest and Rangeland Stewardship)

Abstract

Ongoing declines in North American bee populations stress the need for a greater understanding of how ecological disturbances affect their abundances and overall diversity in both anthropogenic and natural landscapes. Here we summarize past and ongoing research on the responses of wild bee communities to various types of habitat disturbance (bark beetle outbreaks, wildfire, fuels reduction treatments) in montane forests of California, Idaho, and New Mexico. We further discuss how post-disturbance relationships between wild bee species diversity and forest stand structure can vary along both disturbance-severity and elevational gradients. Broadly, our results indicate that wild bee communities inhabiting montane forests of the western United States benefit from disturbances that create or promote open stand conditions. We conclude that restoration and management practices that prioritize ameliorating the effects of past and ongoing fire suppression efforts throughout the region likely also create ideal habitat for forest-associated bee communities.

Oystershell scale: an invasive insect threatening sustainability of aspen ecosystems in the Southwest

Connor D. Crouch (School of Forestry, Northern Arizona University), Amanda M. Grady (USDA Forest Service, Southwestern Region), Nicholas P. Wilhelmi (USDA Forest Service, Southwestern Region), Richard W. Hofstetter (School of Forestry, Northern Arizona University), Kristen M. Waring (School of Forestry, Northern Arizona University)

Abstract

Invasive herbivores that kill foundation tree species pose a major threat to forest ecosystem sustainability. One important foundation species in the western United States is quaking aspen (*Populus tremuloides*), which is threatened by recent outbreaks of an invasive insect, oystershell scale (*Lepidosaphes ulmi*; OSS). OSS outbreaks were first reported outside of Flagstaff, Arizona in 2016, and since then, OSS has been observed causing dieback and mortality of aspen throughout Arizona and in other western states, including Utah, Nevada, and Idaho. Because these are the first known OSS invasions of aspen ecosystems, we set out to understand the extent, impacts, and drivers of this high-impact invasive insect. We found that OSS invasions are widespread in Arizona, have an outsized negative influence on recruiting stems, and are strongly influenced by climate. We conclude by discussing how our findings can inform monitoring and management of OSS.

Spruce aphid population response to montane temperatures

Ann M. Lynch (USDA Forest Service, Rocky Mountain Research Station)

Abstract

Spruce aphid, *Elatobium abietinum*, originated in eastern European montane spruce forests, probably on Norway spruce. It established in U.S. Southwestern Engelmann spruce forests in the 1970s. Much of what is known about spruce aphid is from European maritime systems, where outbreaks occur in Sitka spruce plantations in spring after mild winters. Southwestern outbreaks occur in autumn and early winter and are much more severe. The insect feeds on phloem fluid through needle stomata when trees are dormant and weather is mild. I conducted field studies to determine what conditions lead to population growth and decline in Arizona. Seasonal population declines are associated with abrupt and/or prolonged cold events, with population cold-hardiness and survival of cold events increasing as autumn progresses. Population densities rarely develop to damaging levels in the high-elevation spruce-fir, reach modest levels in warm, long autumns, but persist at the highest levels when weather in late autumn is relatively cooler and without extreme events.

History of balsam woolly adelgid in the Pacific Northwest

Iral Ragenovich (USDA Forest Service, Pacific Northwest Region)

Abstract

The balsam woolly adelgid (BWA) was first detected in the Pacific Northwest in the late 1950's. The initial infestation quickly spread killing millions of susceptible host true firs primarily along the Cascade Crest. After the initial wave of mortality, BWA impacts were primarily crown damage and deformity which would often result in mortality or make trees susceptible to other insect agents or pathogens. In more recent years the infestation has continued to spread, but at a much slower rate, into previously uninfested areas of WA and OR, but with less dramatic effects. Long term plots established in the 1960's after the initial mortality waves tracked BWA on individual trees in those plots. They were measured annually for the first decade and then less frequently for additional mortality. After over 50 years of infestation, some trees within the initial infestation areas continue to survive.

Balsam woolly adelgid population trends in recently invaded fir forests of Utah

Barbara Bentz (USDA Forest Service, Rocky Mountain Research Station)

Abstract

The invasive balsam woolly adelgid (*Adelges piceae*) (BWA) was first reported in Utah in 2017. In the fall of 2020, we began monitoring BWA lifecycle timing in multiple northern Utah subalpine fir forests with a goal to develop a degree day model (see Liz Rideout presentation in Graduate Student session). Samples were collected on a regular basis from early summer through late fall, and at one accessible site sampling continued through the winter and spring. I compare our field-based seasonality data to previous data collected in other states/regions and evaluate how summer and winter temperatures affected population trends.

Mapping the severity of balsam woolly adelgid infestations in Northern Utah

Justin Williams (USDA Forest Service, Intermountain Region), Michael J. Campbell (Department of Geography, University of Utah), and Erin M. Berryman (USDA Forest Service, Rocky Mountain Research Station)

Abstract

Balsam woolly adelgid (*Adelges piceae*; BWA) is an invasive insect that has caused extensive tree mortality in North America. Despite BWA's lengthy presence in this country, wide geographic spread since introduction, and potential for devastating ecological effects, there have been few attempts to map the extent and severity of infestation in a consistent and reliable manner using remote sensing. To map the current extent and severity of BWA infestation in subalpine fir forests of Northern Utah, a forefront of recent BWA spread in the western US, we compared three different modeling approaches: (1) using a satellite imagery time series (to quantify vegetation change over time); (2) using terrain and climate data (to assess abiotic influences); and (3) using a combination of imagery, terrain, and climate data. By combining spectral, terrain, and climate data, we produced a map of infestation severity that captures both regional and local trends in infestation severity.

Intensively managed timber plantations provide ephemeral habitat for native bees

James Rivers (Department of Forest Engineering, Resources, and Management, Oregon State University), Rachel A. Zitomer (Department of Forest Ecosystems and Society, Oregon State University), Sara M. Galbraith (Center for the Environmental Management of Military Lands, Colorado State University), Matthew G. Betts (Department of Forest Ecosystems and Society, Oregon State University), Andrew R. Moldenke (Department of Botany and Plant Pathology, Oregon State University), Robert A. Progar (USDA Forest Service, Sustainable Forest Management Research, Washington Office)

Abstract

Despite widespread concern about pollinator declines, little is known about the extent to which intensively managed timber plantations support wild bee populations. In 2018-2019 we assessed bee communities and habitat characteristics across a chronosequence of n=60 intensively managed Douglas-fir (*Pseudotsuga menziesii*) stands in the Oregon Coast Range. Bee abundance and richness declined rapidly with stand age with bee diversity measures being lowest in stands after canopy closure. Changes in bee community composition across the stand age gradient were driven by species loss rather than turnover and did not relate to bee life history traits. Bee abundance – but not richness – was positively associated with floral resource density, and neither was associated with floral richness. Additionally, landscape context had a limited effect on early seral bee communities. Our study demonstrates that intensively managed timber plantations support diverse wild bee communities shortly after harvest, but those communities erode rapidly as forest canopies close.

Spatial patterns of plant-pollinator interaction rewiring

Kaysee Arrowsmith (University of Washington), Victoria Reynolds (New South Wales Department of Planning and Environment), Annie Schiffer (Utah State University), Madeleine Strait (University of Washington), Manogya Chandar(University of Washington), Connor Morozumi (University of Louisville), Xingwen Loy (Atlanta Botanical Garden), and Berry Brosi (University of Washington)

Abstract

Plant-pollinator communities frequently experience interaction rewiring, in which plant-pollinator interactions shift despite the maintenance of the plants and pollinators involved in those interactions. Theory suggests that rewiring is influenced by the biotic and abiotic contexts in which interactions occur – for instance, community composition and temperature variation. In this study, I empirically test the effects of these proposed drivers of rewiring in a subalpine plant-pollinator system over four years (2020-2023). Using a geographic and elevational gradient, I evaluate plant-pollinator rewiring across 17 sites that comprise a consistent pool of plant and pollinator species but different abiotic conditions. With this site setup, I am able to distinguish between geographically driven rewiring and rewiring attributable to environmental or biological differences between sites.

Restoration via prescribed fire and replanting increase resilience of plant-pollinator communities to species losses

Susan M. Waters (Quamash EcoResearch, Olympia, WA), Rachel M. Mitchell (School of Natural Resources and the Environment, University of Arizona, Tucson, AZ), Emily R. Brown (Quamash EcoResearch, Olympia, WA), and Ethan M. Taber (School of Natural Resources and the Environment, University of Arizona, Tucson, AZ)

Abstract

Restoration efforts often aim to alter the composition of plant communities, assuming that (1) restoring plant communities will restore important animal interactors, such as pollinators; (2) restored communities will be resilient to future stressors. However, the effects of restoration on pollinator diversity and plant-pollinator community robustness are poorly understood. We examined the effects of restoration-focused prescribed fire (pyrodiversity) and native forb replanting on plant-pollinator networks in Washington prairies. We then explored robustness to plant species losses by simulating removal of an abundant exotic forb, a noxious weed, or the rarest native forb, and measuring secondary coextinctions of plants and pollinators. Pyrodiversity and replanting increased pollinator diversity and visitation, restructured networks, and buffered networks against secondary extinctions. Rare native forbs contributed disproportionately to network robustness in less-restored prairies, while removal of typical "problem" plants like exotic and noxious species had relatively small impacts, particularly in prairies with a longer restoration history.

Effects of mixed severity wildfire on native pollinator communities in ponderosa pine forests of eastern Washington

Autumn Maust (University of Washington) and Patrick Tobin (University of Washington)

Abstract

Fire is a major driver of biodiversity and structural integrity in fire prone ecosystems. Due to fire suppression and pressure from climate change, fires are predicted to shift landscapes outside their historical range of variability, threatening the resilience of ponderosa pine dominated landscapes in eastern Washington. In these landscapes, pollination can be critical for vegetation recovery post fire. Because pollination services can vary by species and across spatial and temporal scales, understanding the effect of fire on pollinator populations informs conservation management and ecosystem restoration efforts. In this study, we examined the effects of mixed fire severity on bee species abundance and diversity, and on the foraging success of native cavity nesting bees. Preliminary results suggest that landscapes 1-3 years post fire have higher rates of abundance, diversity, and fecundity in native wild bee species.

Prospects on managing aphids, spider mites and scales with bio-pesticide *Beauveria bassiana* and natural enemies

Richard Hofstetter (School of Forestry, Northern Arizona University), Cliff Bradley (Montana BioAgricutulture Inc.), Danielle Malesky (USDA Forest Service, Intermountain Region), Amanda Grady (USDA Forest Service, Southwestern Region)

Abstract

The increase in sap-sucking arthropods in forests is damaging tree growth, reproduction, and survival. To address this issue, researchers investigated the effectiveness of *Beauveria bassiana*, an entomopathogenic fungus, against spruce green aphids and plan to use it for oystershell scale on aspens in Arizona and spider mites in Montana's Douglas-fir orchards. Biocontrol agents, such as natural enemies, will also be explored as a potential solution to controlling spider mites and OSS in the field. Results from greenhouse tests showed that commercial *B. bassiana* had a mortality rate of over 90% for spruce aphids on young spruce trees, but field trials were inconclusive due to low aphid numbers. The ultimate goal of these projects is to develop a best management practice guide for controlling these invasive pests. The research will present findings on the pathogenicity of *B. bassiana* and the potential use of natural enemies that could be utilized for biocontrol.

Developing an Integrated Pest Management system for oystershell scale in aspen

Kristen Waring (School of Forestry, Northern Arizona University, Flagstaff, AZ), Amanda Grady (USDA Forest Service, Southwestern Region), Connor Crouch (School of Forestry, Northern Arizona University, Flagstaff, AZ), Richard Hofstetter (School of Forestry, Northern Arizona University, Flagstaff, AZ), Marissa Kuntz (USDA Forest Service Coconino National Forest), Elizabeth McCarty (Warnell School of Forestry and Natural Resources, University of Georgia, Tifton, GA), Mark Nabel (USDA Forest Service Coconino National Forest), Jessi Ouzts (USDA Forest Service Kaibab National Forest), Mary Price (USDA Forest Service Coconino National Forest), and Nicholas Wilhelmi (USDA Forest Service, Southwestern Region)

Abstract

Oystershell scale (OSS; *Lepidosaphes ulmi*) is a regional invasive and emergent insect pest affecting aspen (*Populus tremuloides*) in the Interior West. Rapid climate change has likely contributed to the emergence of OSS, which now threatens aspen sustainability in the Southwest and Intermountain West. We are developing an Integrated Pest Management (IPM) system for OSS in aspen ecosystems using silviculture, insecticide, and prescribed fire. Our work is in the initial stages: In 2019, we installed permanent plots in northern Arizona, prior to any treatment implementation. Silviculture treatments (clearfelling, sanitation thinning) were implemented beginning in late 2019. Limited experimental use of insecticide will occur in late 2023, and prescribed fire will be included as resources and opportunities allow. Through continued permanent plot, natural enemy, insecticide movement and non-target arthropod monitoring, we will develop the initial IPM system, which will be refined as new data are collected and interpreted and new sites added.

Urban heat islands awaken sleeper species and predict effects of climate change

Steve Frank (North Carolina State University)

Abstract

Cities are typically hotter than surrounding areas. These urban heat islands subject trees and arthropods to conditions predicted to occur this century under climate change. Some arthropod tree pests, particularly scale insects, become very abundant in urban heat islands exhibiting characteristics associated with exotic invasive species. These 'sleeper species' may become future forest pests. Urban heat islands provide a glimpse into the future of arthropod tree interactions and may predict invasive species.

Balsam woolly adelgid in Alaska: how it got there and how we can prevent it from happening again

Elizabeth Graham (USDA Forest Service, Alaska Region) and Jason Moan (Alaska Division of Forestry and Fire Protection)

Abstract

Balsam woolly adelgid was found infesting ornamental true fir in Juneau, AK in 2019, which was the first known detection in Alaska. Firs do not occur naturally in the Juneau area but are popular ornamental trees. Subalpine fir and Pacific silver fir are native to other parts of Southeast Alaska. It is likely that balsam woolly adelgid was introduced to the state on wild harvested seedlings from National Forest in the Pacific Northwest. We'll discuss the response to the infestation and how it could have been prevented.

Using large data sets to study forest insect outbreaks

Jeffrey A. Hicke (University of Idaho)

Abstract

Large data sets are useful for increasing our understanding of forest insect outbreaks. They are complementary to field observations in that they can cover larger areas and extend backward in time. In this talk I will describe several examples of using large data sets. The first example is a gridded data set from aerial surveys and the second example describes remote sensing data sets, both used to assess bark beetle-caused tree mortality in western North America. A final example will discuss modeled susceptibility of lodgepole pine to mountain pine beetle attack from forest inventory data from the USDA Forest Service.

A dynamic outbreak distribution model (DODM): proof of concept using an irruptive folivore, the western spruce budworm

Vivek Srivastava (University of British Columbia, Department of Forest & Conservation Sciences and Office of the Chief Forester, Ministry of Forests, Victoria, BC, Canada) and **Allan L. Carroll (University of British Columbia, Department of Forest & Conservation Sciences)**

Abstract

The frequency and severity of forest insect outbreaks has increased due to climate warming favouring insect survival, and forest management practices increasing host tree availability; however, our capacity to predict outbreak occurrences in space and time remains limited. Long-term, systematic aerial detection surveys provide valuable data regarding the presences/absences of epidemic insect populations. Using aerial overview survey data for British Columbia, we adapted a species distribution modelling approach to create dynamic outbreak distribution models (DODMs) that incorporate critical environmental and biological predictors for the western spruce budworm (WSB). DODMs provided robust projections of the distribution of epidemic WSB populations. They were also capable of identifying high-risk areas for future outbreaks, along with anticipated range expansions/contractions under different climate change scenarios. Our study highlights the value of presence-absence data from long-term forest health surveys and emphasizes the importance of incorporating temporal trends in environmental variables to predict irruptive insect outbreak distributions.

Lessons from working with big data, part I: using ensemble models to describe outbreaks of defoliators in the temperate coastal rainforest

Michael Howe (USDA Forest Service, Pacific Northwest Research Station) and Kellen Nelson (USDA Forest Service, Pacific Northwest Research Station)

Abstract

Regional outbreaks of the hemlock sawfly and western blackheaded budworm have recently defoliated forests across the pacific coastal temperate rainforest at a magnitude not previously reported in Canadian and United States aerial detection surveys. We developed multiple ensemble machine learning models at a 1 km^2 resolution to explore how climate and host availability drive A) the spatial extent of defoliation, B) the temporal dynamics of defoliation, and C) how spatial and temporal dynamics interact to drive outbreak activity in each species. Our results demonstrate the overarching importance of climate in driving the biogeography and irruptive dynamics of these insect species and lay the groundwork for future studies investigating insect population dynamics, ecosystem effects, and the potential impacts of climate change. We discuss our findings and lessons we have learned from applying ensemble models to challenging questions.

Lessons from working with big data, part II: using ensemble and logistic models to explore disturbance interactions of western spruce budworm and Douglas-fir beetle

Michael Howe (USDA Forest Service, Pacific Northwest Research Station), Amy Trowbridge (University of Wisconsin), and Sarah Hart (Colorado State University)

Abstract

Outbreaks of western spruce budworm and Douglas-fir beetle have caused significant mortality to Douglas-fir forests across the western United States. Recent work has shown that Douglas-fir beetle outbreaks occur more frequently than expected following western spruce budworm defoliation at a ecoregion scale despite differences in each species response to climate. However, it remains unknown how bioclimatic drivers modulate interactions among these species, whether such interactions are unidirectional (i.e., Douglas-fir followed by western spruce budworm), or how these biotic interactions compare to abiotic disturbances such as fire. We developed multiple ensemble machine learning models at a 1 km^2 resolution to: A) explore the spatial overlap between Douglas-fir beetle and western spruce budworm outbreaks; B) determine the short-term temporal drivers of both species; and C) given these spatial and temporal dynamics, we explored whether prior western spruce budworm defoliation modulated the likelihood of Douglas-fir beetle and whether prior Douglas-fir beetle defoliation modulated the likelihood of western spruce budworm. We discuss our findings and how we employed a mix of machine learning and simple logistic models to explore disturbance interactions.

Seasonal history of the invasive balsam woolly adelgid in northern Utah

Liz Rideout (Utah State University), Barbara J. Bentz (USDA Forest Service, Rocky Mountain Research Station), Diane G. Alston (Utah State University, Department of Biology)

Abstract

The balsam woolly adelgid (BWA) is a true fir pest that has recently expanded its invasive range into the U.S. Intermountain West. In northern Utah, subalpine fir is highly susceptible to BWA. Dependent on climate and habitat, understanding of BWA's regional phenology is imperative in supporting effective management. Bark samples of BWA-infested subalpine fir were regularly collected from five sites in northern Utah from August to November, 2020 and January to December, 2021 and 2022. BWA life stages were enumerated and data prepared as cumulative proportions for assessing voltinism using a Weibull distribution. Optimal lower developmental threshold (LDT) and biofix were estimated for use in degree day model development. Results support a bivoltine life history with adult peaks occurring at 351-684 DD and 1,389-2,392 DD (0°C LDT and 1 April biofix). These findings will inform further regional phenology research and timely pest management decisions to support the region's forest health.

Metabolome response of Engelmann spruce to bark beetle attack

Ehsan Khedive (Colorado State University), Saeideh Fathi Moghanloo (Colorado State University), Seth Davis (Colorado State University)

Abstract

Many studies during past decades focused on secondary metabolites as the defense chemicals of conifers against bark beetles. In this study I focused not only on secondary metabolites, but also on organic acids, amino acids and hormones, using a new technique to detect these compounds in GC/MS. Samples were collected from 5 different Engelmann spruce (*Picea engelmannii*) stands with different climate regimes which were baited to initiate *Dendroctonus rufipennis* attack. Results showed that some key free amino acids along with primary metabolites and hormones have different concentration patterns. These patterns show how suitable the host is for the bark beetle rather than how strong is the defense response against bark beetle. Total metabolome profile could be a useful tool to understand the outbreak regime of bark beetles in Rocky Mountain spruce forests.

Arthropod recolonization of mulch-treated understory habitat after fire in northern Arizona

Chrissy Mott (Northern Arizona University), Rich Hofstetter (Northern Arizona University), and Anita Antoninka (Northern Arizona University)

Abstract

Increasing size, severity, and human proximity to fires in the western US drives a need for more effective ecosystem restoration in the immediate post-fire period. Surface treatments such as masticated logging slash reduce erosion and improve soil nutrient and water retention on steep slopes. However, few studies have investigated the impact of these treatments on arthropod communities over time. We surveyed arthropod abundance in mulch treatments on a landscape scale fire near Flagstaff, Arizona and a controlled split-plot experiment outside of the larger fire footprint. Predatory beetles were more abundant in mulch in the large landscape treatment, with no differences in abundance in the split plots. Fungivores had no significant mulch preference, and several native bark beetles were more abundant on the untreated sites. We were unable to fully evaluate vegetation recovery, but further work will allow us to understand how surface treatments impact the interaction of arthropods and vegetation.

More fuel for the fire? Bark beetle and fire synergisms in the Cascadia region of North America

Holden Payne (University of British Columbia, Department of Forest and Conservation Sciences), Sigrid Netherer (Department of Forest and Soil Sciences, Institute of Forest Entomology, Forest Pathology and Forest Protection, University of Natural Resources and Life Sciences, BOKU, Vienna, Austria), and Allan Carroll (University of British Columbia, Department of Forest and Conservation Sciences)

Abstract

Forests in North America are under threat from stressors relating to climate change and historic management approaches. Of those threats, severe wildfire activity and bark beetle outbreaks have been particularly disruptive. Current projections suggest that both disturbance agents will increase in their impacts in the coming decades. Given this, there is acute concern that bark beetles, with their ability to contribute to wildfire fuel loading, will exacerbate subsequent fire behavior. Prior studies have explored this relationship at the event scale or modeled it at the stand level and have been unable to come to a consensus regarding potential synergistic interactions. Using data on bark beetle outbreaks and fire events for the entire Cascadia region (Oregon, Washington and British Columbia) over the past 6 decades this study will determine whether there exists a synergistic relationship between fire likelihood and bark beetle outbreaks at broad spatial scales and across multiple time lags.

71ST WESTERN FOREST INSECT WORK CONFERENCE

PRESENTATION ABSTRACTS

WEDNESDAY, APRIL 26, 2023

Pathways of species invasions

Yolanda Inguanzo (USDA Animal and Plant Health Inspection Service,
Plant Protection and Quarantine)

Abstract

Many invasive species pathways are known and usually thought to be understood. Some exotic forest pests in North America have been introduced through known and common pathways. There are examples of atypical pathways. Analysis of risk data and pest interceptions can identify pathways and help direct pest detection surveys.

Northern giant hornet survey and eradication: more than just hope and mimosas

Chris Looney (Washington State Department of Agriculture), Brant Carmen (Washington State Department of Agriculture), Jenni Cena (Washington State Department of Agriculture), Cassie Cichorz (Washington State Department of Agriculture), Shawn M. Cleveland (Pacific Lutheran University), Vikram Iyer (University of Washington), Jessica Orr (WSDA), Nathan Roueché (Washington State Department of Agriculture), Karla Salp (Washington State Department of Agriculture), Jacqueline M. Serrano (USDA-Agricultural Research Service), Landon Udo (Washington State Department of Agriculture), Telissa M. Wilson (Washington State Department of Agriculture), Rian Wojahn (Washington State Department of Agriculture), Sven-Erik Spichiger (Washington State Department of Agriculture)

Abstract

Multiple sightings of the hornet *Vespa mandarinia* Smith, 1852 (Hymenoptera: Vespidae) in British Columbia and Washington State in 2019 spurred a multi-year project to prevent its establishment in North America. From 2020 through 2022, traps were placed by WSDA personnel and cooperating agencies. WSDA also developed a program to promote public trapping and encourage reports of suspected sightings, incorporating social media and traditional press outlets. Trapping results and public reports were used to locate and capture live hornets, which were tagged with radio transmitters and followed to nests. We removed four *V. mandarinia* nests in the United States, one in 2020 and three in 2021. No hornets were detected in 2022. The program has also led to research to better understand hornet behavior and ecology, including analyzing the prey base in North America and studying hornet foraging activity in the Republic of Korea.

Warming, droughts, bark beetles, and wildfires: a story from the Sierra Nevada

Christopher J. Fettig (USDA Forest Service, Pacific Southwest Research Station)

Abstract

In montane and subalpine forests of California, recent warming and droughts have contributed to widespread bark beetle outbreaks, extensive tree mortality, reduced tree growth, and wildfires, all of which in turn affect biogeochemical cycling and hydrologic processes. While these disturbances have direct effects on forests, they also have indirect effects on other stressors and disturbances that collectively shape these forests over time. In the future, it is likely that more frequent extreme weather events will increase the frequency and magnitude of severe ecological disturbances driving rapid and often persistent changes in forest structure, composition, and function across large landscapes. As a result, natural resource managers will be increasingly challenged to maintain resilient and productive forests. Effective management requires knowledge of the effects of climate change on forests, of the effects of climate change on other stressors and disturbances, and of the institutional, social, and environmental factors that limit our adaptive capacity. I will discuss these relationships drawing examples from the Sierra Nevada.

Two's a crowd: interspecific competition by woodborers can prevent bark beetle outbreaks after wildfires

Katherine Kitchens (Department of Forest and Conservation Sciences, Faculty of Forestry, University of British Columbia), Lori Daniels (Department of Forest and Conservation Sciences, Faculty of Forestry, University of British Columbia), and Allan Carroll (Department of Forest and Conservation Sciences, Faculty of Forestry, University of British Columbia)

Abstract

In dry coniferous forests, wildfires and insects have historically interacted to create diverse and resilient landscapes, but there is increasing concern that alterations in one or more disturbance regimes by climate change could create novel, and potentially harmful disturbance synergies. Bark beetle populations can respond quickly to wildfires, outbreaking and causing significant mortality due to a sudden resource pulse of wounded trees. However, outbreaks aren't always observed, and recent work has demonstrated that other subcortical insects (Buprestidae, Cerambycidae) are also ubiquitous and aggressively attack conifers post-fire. Using Douglas-fir beetle (*Dendroctonus pseudotsugae*) as an example system, we will investigate the hypothesis that high populations of woodboring species can outcompete and cause significant mortality to Douglas-fir beetles, preventing outbreaks from occurring, even if other factors are conducive for one to arise. Results will be discussed within the context of future management strategies for changing disturbance regimes in a warming environment, and the potential for ecological surprises after disturbance interactions.

Temperature driven moisture stress affecting B.C. forests and the response of weevils and wood borers

Lorraine Maclauchlan (Ministry of Forests, British Columbia), Celia Boone (Ministry of Forests, British Columbia), and Marnie Duthie-Holt (Ministry of Forests, British Columbia)

Abstract

Temperature driven moisture stress leads to vegetation impacts and increased biotic agent response. In recent years the interior of British Columbia (B.C.) has experienced severe and prolonged droughts, and a record breaking "heat dome" in 2021. These abiotic (climate) events have notably affected attack incidence, host choice, and adaptation of insect development in four species of *Pissodes* and various wood borers. We will describe situations where *Pissodes schwarzi* and *P. striatulus*, typically considered secondary invaders associated with primary mortality agents such as comandra blister rust and western balsam bark beetle, respectively, switch to primary invader status due temperature driven moisture stress on host trees. We will also describe climate-mediated host shifts of *P. strobi* to attack a less preferred species, increased attack levels and shortened life history of *P. terminalis* as well as other examples of abiotic disturbance and insect interactions in B.C. forests.

Production of forest tree seed for a diverse and changing landscape

Dan Cress (Regenetics Forest Genetics Consulting)

Abstract

Over 50 years of research has been devoted to the task of developing tree seedlings that are suitable for a broad array of forest environments and land management objectives. Reliable sources of healthy seed are critical to the success of the associated restoration, afforestation and reforestation efforts. Over a billion tree seeds are sown every year in Oregon, Washington and British Columbia, most of which arise from what are known as seed orchards. Seed orchard design, management and management needs are discussed.

Seed Orchard Insect Pest IPM – Emerging Issues and the Future

Alex Mangini (USDA Forest Service, Southern Region)

Abstract

This presentation will review the history of the management of cone and seed insects from the earliest studies to the present. Current insecticide options will be covered with emphasis on the cone and seed insects of the Southern pines. Newly developed chemical families will be covered including RNAi-based insecticides. Opportunities for collaboration will be mentioned.

Assessment of cone and seed insects and damage in *Pinus strobiformis*

Kristen Waring (Northern Arizona University), Alejandro Leal-Sáenz (Universidad Juárez del Estado de Durango, Durango, Mexico), Daniel DePinte (Northern Arizona University, Flagstaff, AZ and USDA Forest Service, Pacific Northwest Region), Rebeca Álvarez-Zagoya (Instituto Politécnico Nacional, Durango, Mexico), Monica Gaylord (USDA Forest Service, Southwestern Region), José Ciro Hernández-Díaz (Universidad Juárez del Estado de Durango, Durango, Mexico), Carlos A. López-Sánchez (Mieres Polytechnic School, University of Oviedo, Mieres, Spain), José Hugo Martínez-Guerrero (Universidad Juárez del Estado de Durango, Durango, Mexico), and Christian Wehenkel (Universidad Juárez del Estado de Durango, Durango, Mexico)

Abstract

Damage to conifer cones and seeds can impact regeneration success by reducing the amount of viable seed available. Forest managers rely on abundant, healthy seed being available to regenerate sites naturally and for seed collections yet little research has been done on most tree species in western North America. We identified insects infesting cones and seeds of southwestern white pine (*Pinus strobiformis*), and quantified damage proportions in the US and Mexico. We developed models to assess whether environmental variables were associated with damage on sites in Mexico. The most frequently occurring insect identified causing damage was *Leptoglossus occidentalis*, but several Lepidopteran species and *Conophthorus ponderosa* were also common. We found a large range of variation in damage level (0-80%). Climate and soils variables along with crown dieback were associated damage caused by two insects, *L. occidentalis* and *Megastigmus albifrons*.

71ST WESTERN FOREST INSECT WORK CONFERENCE

PRESENTATION ABSTRACTS

THURSDAY, APRIL 27, 2023

Using remote sensing to study detection, attribution, impacts, and recovery of tree damage from insects

Jeffrey A. Hicke (University of Idaho), Arjan J. H. Meddens (Washington State University), Benjamin C. Bright (USDA Forest Service), Amanda T. Stahl (Washington State University), Andrew T. Hudak (USDA Forest Service), Abhinav Shrestha (University of Idaho), and Ryan P. Hanavan (USDA Forest Service)

Abstract

Remote sensing is a useful tool for quantifying insect-caused tree damage and its consequences. Studies using aerial and satellite imagery have a long history in forest entomology, beginning decades ago, and the emergence of new technologies has allowed additional capabilities. In this talk I will discuss the use of remote sensing for detecting insect damage, attributing forest disturbances to different causal agents, and quantifying forest impacts and recovery following insect outbreaks. I will focus on bark beetles in the western United States but will include studies of other types of forest insects. I will discuss advances in technology that are leading to improved or expanded applications in forest entomology, such as dense time series, lidar, satellite constellations, and drones.

Native bee response to fire disturbance in ponderosa pine forests of the Colorado Front Range

Ryleigh V. Gelles (Colorado State University, Department of Forest and Rangeland), Seth Davis (Colorado State University, Department of Forest and Rangeland), and Camille Stevens-Rumann (Colorado State University, Colorado Forest Restoration Institute)

Abstract

Native bees are critical components of ecosystems by providing ~85% of pollination services. Recently, evidence of global decline in bee populations have drawn concern from conservationists, compelling the need for insight on the drivers and mechanisms influencing said decline. In ponderosa pine ecosystems, fire suppression policies implemented throughout much of the 19th century stand structures with closed canopies, suppressed understories, and increased surface fuel loadings. To restore desirable forest structure, forest management efforts often focus on reducing stand densities and reintroducing fire disturbance. However, it remains unclear if these practices benefit important insect taxa, including native bees. To address this knowledge gap, bee communities were sampled across the growing season within ponderosa pine- dominant forests of central Colorado to assess effects of fire disturbance on native bee populations. Findings here have implications for forest management and indicate structural elements of ecosystems that can be managed for enhancing bee biodiversity.

Interactions between stand characteristics and balsam woolly adelgid in the Interior West

Grayson B. Jordan (Department of Wildland Resources, Utah State University), Diane Alston (Department of Biology, Utah State University), Barbara Bentz (USDA Forest Service, Rocky Mountain Research Station), Justin DeRose (Department of Wildland Resources, Utah State University)

Abstract

Adelges piceae (Ratzeburg) (Hemiptera: Adelgidae) is an invasive forest insect native to central and southern Europe that has caused extensive damage in true fir populations in North America. Subalpine fir, *Abies lasiocarpa* [Hook] Nutt., has been identified as a host species with a high risk of experiencing high-intensity damage and mortality. With continued range expansion into Utah and Wyoming expected, we are interested in examining the individual tree and stand level characteristics that may influence the observed damage attributed to balsam woolly adelgid. To do so, we collected field data from 42 infested subalpine fir stands within the Interior West. Our findings suggest that the presence of witch's brooms from fir broom rust negatively impact BWA's ability to colonize a tree and that stand structure – specifically, the diameter distribution of host trees – is important in predicting the severity of BWA-associated damage.

Intra-stand dispersal of the balsam woolly adelgid (*Adelges piceae* (Ratz.)) in Utah

Mike Wayman (Utah State University), R. Justin DeRose (Utah State University), Barbara J. Bentz (USDA Forest Service, Rocky Mountain Research Station), Kezia R. Manlove (Utah State University)

Abstract

Balsam woolly adelgid (BWA, *Adelges piceae* (Ratz.)) is an invasive insect of true firs (Abies spp.). BWA spread from initial introductions on the west coast of North America in the 1920s through the Intermountain region and has recently invaded Utah. White fir (*A. concolor*) and subalpine fir (*A. lasiocarpa*) are the two main species of concern in this region, however subalpine fir has been documented as being more susceptible to attack and subsequent damage. While long-range dispersal mechanisms and patterns are of interest for spread across regions and predicting new infestations, very little is known of how BWA moves within a stand once it is present. Fine-scale dispersal patterns and associated tree stand conditions influence management decisions in areas infested by any pest or pathogen. We propose to stem-map seven BWA-infested subalpine fir stands and measure BWA intensity on each tree, stand and tree characteristics, and topographic position. Individual trees in each stand will be monitored for two growing seasons to detect change in infestation levels at the tree- and stand-level. We expect the rate of tree-to-tree spread will be influenced by stand density, stand age structure, the ratio of non-hosts to hosts and presence of other pests and pathogens. By using spatially explicit stand and tree-level data, we aim to identify tree characteristics that influence new infestations, support current infestations, and predict future infestations. Fine-scale dispersal patterns and associated tree and stand conditions will inform our ecological understanding of how sessile insect pests select hosts and disperse in an environment after initial invasion. This knowledge will also inform future management strategies that target stand structural components and tree-level characteristics to more effectively control BWA in the region.

After the collapse: predicting the distribution of post-epidemic mountain pine beetle populations

Lucas Peng (University of British Columbia) and Allan Carroll (University of British Columbia)

Abstract

Epidemic mountain pine beetle (MPB) populations have caused extensive mortality in recent decades within pine forests across western North America. However, the epidemic phase is not normative and populations will collapse as the availability of susceptible pine trees diminishes and/or extreme cold events cause high generation mortality. For MPB populations to persist, they must occupy an endemic niche where they preferentially colonize defensively compromised trees. Recent research suggests that stand density index (SDI), a measure of inter-tree competition, can be used to predict niche availability for endemic MPB. To investigate the potential distribution of endemic MPB populations and the possible source of future eruptions in British Columbia, we calculated SDI from vegetation resource inventory datasets, and intersected endemic habitat with projections of climatic suitability to quantify the distribution of suitable habitat for endemic MPB. Results will be discussed in the context of future MPB irruptions in a warming environment.

David. vs. Goliath

Celia Boone (British Columbia Ministry of Forests)

Abstract

Invasive species can inflict negative direct and indirect economic and ecological effects long after they've been introduced if left unchecked. The poplar-willow borer (PWB) is considered a naturalized invasive species, but it continues to expand its range in northern BC., feeding on native willows and cottonwood with seeming impunity, altering habitat significant to wildlife and First Nations traditional culture. Scouler's willow is not only the preferred host of PWB, but also the preferred forage species of moose in northwestern BC. Moose have been beleaguered by several afflictions that compromise the health of their populations. Efforts have been made to improve moose habitat and increase available winter browse, however, these may be negated if PWB continues to expand its range. I will discuss the current status of PWB and moose in northwestern BC and some options being considered to address the threats PWB poses to sensitive and valuable habitats.

Go girls: Investigating drivers of female-biased sex ratios in the alder bark beetle system

Taylor Holt (University of British Columbia) and Allan Carroll (University of British Columbia)

Abstract

Female-biased sex ratios are common among bark beetle species and are thought to have evolved from local mate competition and sib-mating, sexual size dimorphism, or haplodiploidy. Most investigations of bark beetle life history strategies have focused on conifer infesting species, often overlooking the life history adaptations of angiosperm-infesting bark beetles in relation to the physiology and ecology of their hosts. The alder bark beetle, *Alniphagus aspericollis*, is a univoltine, hardwood-infesting bark beetle with a female-biased sex ratio. The alder bark beetle lifecycle is unique in that a portion of the population overwinters as adults in branch nodes of the host, red alder, *Alnus rubra*, while the remainder overwinters as larvae in the main stems. Through dissections of branch and bole-overwintering adult bark beetles of both sexes, we evaluate the hypothesis that the branch-overwintering habit is a consequence of maturation feeding by mated females that promotes oogenesis.

Ecological and evolutionary implications of symbiosis between the alder bark beetle and *Neonectria bordena* sp. nov.

Debra Wertman (University of British Columbia, Department of Forest and Conservation Sciences), Joey Tanney (Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre), Richard Hamelin (University of British Columbia, Department of Forest and Conservation Sciences), and Allan Carroll (University of British Columbia, Department of Forest and Conservation Sciences)

Abstract

Associations between herbivorous insects and microorganisms range from weak commensal relationships to highly evolved phytopathogenic mutualisms. In mutualistic symbioses with fungi, herbivorous insects may gain access to resources that would be unavailable in the absence of fungal mutualists, while the fungi benefit from insect-vectored dispersal. *Alniphagus aspericollis*, the alder bark beetle, is an unusual bark beetle in that it infests and kills red alder, *Alnus rubra*, a Pacific Northwest hardwood, and unlike most tree-killing bark beetles, is not regularly associated with ophiostomatoid fungi. Instead, we have discovered that *A. aspericollis* vectors *Neonectria bordena* sp. nov. among host trees, marking a heretofore undocumented type of bark beetle–fungus symbiosis. We systematically investigate whether the *A. aspericollis–N. bordena* symbiosis represents a mutualism by critically assessing hypotheses regarding the ecological functions of bark beetle symbiotic fungi, aiming to help to elucidate the processes leading to the formation of evolutionarily stable mutualisms.

Current status of the walnut twig beetle, *Pityophthorus juglandis*, and thousand cankers disease

Jackson Audley (USDA Forest Service, Pacific Southwest Research Station)

Abstract

The walnut twig beetle, *Pityophthorus juglandis* Blackman, and its associated fungal pathogen *Geosmithia morbida* comprise the thousand cankers disease (TCD) complex. Both organisms are native to the southwestern U.S. and northern Mexico but have been spread extensively beyond their native range. Populations of *P. juglandis* and *G. morbida* have been established across U.S. and more recently in Italy and France. *Pityophthorus juglandis* and TCD attack species of walnut, butternut (*Juglans* spp.), and wingnut (*Pterocarya*) and threatens both forest products (primarily *J. nigra*) and agricultural (primarily *J. regia*) industries. Despite more than a decade of research efforts, management strategies remain limited. I will discuss the status of TCD research with a particular focus on efforts to develop a semiochemical interruption tool for protecting *Juglans* spp. from *P. juglandis* attacks.

How we got here and the evolution of the Evaluation Monitoring Program-Mountain Pine Beetle Project

Christopher J. Fettig (USDA Forest Service, Pacific Southwest Research Station), A. Steven Munson (USDA Forest Service), Jackson P. Audley (USDA Forest Service, Pacific Southwest Research Station)

Abstract

Bark beetles are a major disturbance in western forests and often impact an area larger than wildfire. Several recent outbreaks of species such as mountain pine beetle, spruce beetle, western pine beetle, and pinyon ips are among the most severe in recorded history. We discuss factors that contributed to recent outbreaks of mountain pine beetle, impacts to ecosystem goods and service, and the development and evolution of the Evaluation Monitoring Program-Mountain Pine Beetle Project.

Impacts of historic mountain pine beetle, *Dendroctonus ponderosae*, outbreaks on lodgepole pine forest structure and composition in the Intermountain West, U.S.

Jackson P. Audley (USDA Forest Service, Pacific Southwest Research Station), Christopher J. Fettig (USDA Forest Service, Pacific Southwest Research Station), A. Steven Munson (USDA Forest Service, Intermountain Region, retired), Justin B. Runyon (USDA Forest Service, Rocky Mountain Research Station), Leif A. Mortenson (USDA Forest Service, Pacific Southwest Research Station), Brytten E. Steed (USDA Forest Service, Northern Region), Kenneth E. Gibson USDA Forest Service, Northern Region, retired), Carl L. Jørgensen (USDA Forest Service, Intermountain Region), Stephen R. McKelvey (USDA Forest Service, Pacific Southwest Research Station), Joel D. McMillin (USDA Forest Service, Southwestern Region), and Jose F. Negrón (USDA Forest Service, Rocky Mountain Research Station)

Abstract

Following historic mountain pine beetle outbreaks in the Intermountain West, U.S. from 2004-2012, we investigated resulting tree mortality and the effects on forest structure and composition. A network of 125, 0.081-ha circular plots was established in lodgepole pine forests in Colorado, Idaho, Montana, Utah, and Wyoming. Plots were installed in 2010 and sampled annually through 2022. 5107 trees died across the network, 98.6% of which were lodgepole pine. Most of the observed tree mortality (68.8%) was attributed to mountain pine beetle. The resulting mortality significantly reduced mean dbh (by 5.3%), quadratic mean diameter (by 8.6%), tree height (by 15.9%), numbers of trees (by 40.8%), basal area (by 52.9%), and stand density index (by 51.8%). Tree density significantly declined for all diameter classes (5-cm classes) except for the smallest (7.5-12.5 cm). Subalpine fir was well represented in the understory regeneration and contributed to the increase in the number of seedlings and saplings observed from 2010-2018.

Changes in understory vegetation, including invasive weeds, following mountain pine beetle outbreaks

Justin B. Runyon (USDA Forest Service, Rocky Mountain Research Station), Christopher J. Fettig (USDA Forest Service, Pacific Southwest Research Station), Jared A. Trilling (USDA Forest Service, Rocky Mountain Research Station), A. Steven Munson (USDA Forest Service, Intermountain Region, retired), Leif A. Mortenson (USDA Forest Service, Pacific Southwest Research Station), Brytten E. Steed (USDA Forest Service, Northern Region), Kenneth E. Gibson (USDA Forest Service, Northern Region, retired), Carl L. Jørgensen (USDA Forest Service, Intermountain Region), Stephen R. McKelvey (USDA Forest Service, Pacific Southwest Research Station), Joel D. McMillin (USDA Forest Service, Southwestern Region), Jackson P. Audley (USDA Forest Service, Pacific Southwest Research Station), and Jose F. Negrón (USDA Forest Service, Rocky Mountain Research Station)

Abstract

An important but little understood way that bark beetle outbreaks can change forests is by affecting understory vegetation. We assessed changes in non-tree vegetation from ca. 2–10 years after recent mountain pine beetle outbreaks in lodgepole pine forests of Colorado, Idaho, Montana, Utah and Wyoming, U.S. Total plant cover and cover of shrubs and graminoids did not change but forb cover generally increased. Forb cover was negatively correlated with canopy cover. Approximately 20% of plots contained invasive plants, mainly Canada thistle. The abundance of weeds increased from 2014 to 2018. Presence of weeds was positively related to percent of dead and fallen trees. Weed abundance was positively correlated with percent dead and fallen trees. The disturbance created when trees uproot and fall appears to act as sites of weed invasion and proliferation. Lastly, we provide a global review of the effects of bark beetle outbreaks on non-tree vegetation.

Beetle-killed lodgepole pine snag demography following the 2004–2012 regional mountain pine beetle outbreak

Leif A. Mortenson (USDA Forest Service, Pacific Southwest Research Station), Jackson P. Audley (USDA Forest Service, Pacific Southwest Research Station), Christopher J. Fettig (USDA Forest Service, Pacific Southwest Research Station), A. Steven Munson (USDA Forest Service, Intermountain Region, retired), Justin B. Runyon (USDA Forest Service, Rocky Mountain Research Station), Brytten E. Steed (USDA Forest Service, Northern Region), Kenneth E. Gibson (USDA Forest Service, Norther Region, retired), Carl L. Jørgensen (USDA Forest Service, Intermountain Region), Stephen R. McKelvey (Forest Service, Pacific Southwest Research Station, USDA), Joel D. McMillin (USDA Forest Service, Southwestern Region), and Jose F. Negrón (USDA Forest Service, Rocky Mountain Research Station)

Abstract

Snags are important components of forest ecosystems that provide habitat for many species of wildlife while simultaneously being a safety concern for forest workers, recreationalists, and firefighters. We present the fall rates of 3789 bark beetle-killed lodgepole pines from the severe 2004–2012 regional-scale outbreak of mountain pine beetle. Data were collected annually (2010–2019) across 107 0.081-ha plots installed in lodgepole pine-dominated forests in Colorado, Idaho, Montana, Utah, and Wyoming. The greatest proportion of snag fall events occurred 4–8 years since death (YSD), yet by 2019 only 24.7% of snags had fallen. Slope aspect had the strongest influence on fall rates. We modeled snag fall using a Cox's proportional-hazards model to extend past our 14 years of monitoring and found the predicted YSD to reach 50% snag fall was ~16. These results, their context, and their implications to management of lodgepole pine forests are discussed.

Sudden apple decline in British Columbia: a potential link between fungal cankers, invasive Sesiidae moths, and abrupt hydraulic failure

Jesse MacDonald (Agriculture and Agri-Food Canada), Kirsten Hannam (Agriculture and Agri-Food Canada), Hao Xu (Agriculture and Agri-Food Canada), Dan O'Gorman (Agriculture and Agri-Food Canada)

Abstract:

Sudden apple decline (SAD) is a little understood disorder, resulting in rapid death of apple trees. We investigated the signs and symptoms, biotic and abiotic stressors, fruit quality impacts and internal tree hydraulics of afflicted trees. Field surveys showed the presence of a necrotic stem canker to be correlated with declining trees. Across orchards, there appeared to be an association between infestation of *Synanthedon myopaeformis*, the size of necrotic stem lesions, and incidence of SAD. Assessment of stem water transport showed a water limiting bottleneck at the graft union. Grid (5-m) sampling of soils in four affected orchards showed a correlation between SAD-associated tree mortality and a given soil's ability to retain water. We propose that impaired water transport across the graft union, due in part to the impacts from *Cytospora* canker and associated *S. myopaeformis* infestations, may be a contributing factor to the incidence of SAD in this region.

The Mediterranean oak borer (MOB, *Xyleborus monographus* Coleoptera: Curculionidae: Scolytinae) a new invasive species infesting valley and blue oak in Northern California

Curtis Ewing (California Department of Forestry and Fire Protection), Michael Jones (University of California), Akif Eskalen (University of California, Davis), Albre Brown (California Department of Food and Agriculture), and Sheri Smith (USDA Forest Service)

Abstract

The Mediterranean oak borer (MOB), *Xyleborus monographus*, is an invasive ambrosia beetle native to the Mediterranean region. The first North American infestations were confirmed in valley oaks in Napa County, California in late 2019, followed by Lake and Sonoma Counties in early 2020, and Sacramento County in September 2020. MOB has also been detected in 4 counties in Oregon in 2019-2022. MOB attacks at least 12 species of oaks in its native range. In California, it has been found infesting two species of white oak: most commonly valley oak and, to a lesser extent, blue oak and the third, Oregon white oak, is a suspected host in Woodburn OR. MOB grows fungi inside galleries and use it as food for larvae and adults. Some fungi can be pathogenic and cause disease that may lead to tree decline and, sometimes, death. Six species of fungi have been found associated with MOB in Napa County, with three shown to be mildly aggressive wilt pathogens. Oak trees infested with MOB are most easily identified by damage caused by the beetle's tunneling activity in the xylem. MOB galleries are often trellis-like, crowded and intersecting, fan out in a single plane and 1.2-1.5 mm in diameter. Other signs and symptoms of MOB include boring dust in cracks of the tree bark, and sometimes oozing sap. In addition to looking at the associated pathogens, cooperative investigations have: 1) provided information regarding the origin, distribution, and age of the infestations, 2) estimated rate of spread, 3) evaluated flight periodicity, flight height, lure efficacy and mode of attack, 4) evaluated the efficacy of verbenone splat as a deterrent, and 5) provided training to a variety of audiences regarding MOB identification and management. For more information and a MOB pest alert can at https://www.ucanr.edu/sites/mobpc/.

Woodboring beetle pests of concern in the PNW

Christine Buhl (Oregon Department of Forestry), Wyatt Williams (Oregon Department of Forestry), and Max Ragozzino (Oregon Department of Forestry)

Abstract

Overview of the first detection of emerald ash borer (*Agrilus planipennis*) in Oregon in 2022 and multiagency response. Also discussing diagnosis and management of a native, biologically similar tree-killing *Agrilus*, bronze birch borer (*A. anxius*).

Influence of forest uniformity and holobiont associations on the apparency of hardwood-killing bark beetles: Ohmart (1989) revisited

Debra Wertman (University of British Columbia, Department of Forest and Conservation Sciences), Sam Bacon (University of British Columbia, Department of Forest and Conservation Sciences), and Allan Carroll (University of British Columbia, Department of Forest and Conservation Sciences)

Abstract

Tree-killing by bark beetles is generally associated with coniferous forests of the northern hemisphere while tree mortality associated with hardwood-infesting bark beetles is largely overlooked. In a 1989 paper synthesizing potential biosystematic, environmental, and physiological constraints on the evolution of phloeomycetophagous scolytines, Clifford Ohmart argued that tree-killing bark beetles are almost exclusively constrained to conifer systems. We propose that bark beetles, when considered with their fungal mutualists as singular holobionts, have similar propensity to exhibit pulse-driven irruptive dynamics in coniferous and hardwood forests under permissive environmental and resource availability conditions. Inherent differences in forest uniformity and tree-species diversity between conifer and hardwood forests influence the apparency of tree-killing events. Under future global change scenarios that are expected to increase forest uniformity, invasive species dispersal, and climatic conditions conducive to forest pest outbreaks, it is critical to recognize increasing apparency of bark beetle tree-killing events in coniferous and angiosperm forests.

Changes in fuel loads following mountain pine beetle outbreaks in lodgepole pine forests of the Intermountain West

Crystal S. Homicz (University of California-Davis), Christopher J. Fettig (USDA Forest Service, Pacific Southwest Research Station), A. Steven Munson (USDA Forest Service, Intermountain Region, retired), Justin B. Runyon (USDA Forest Service, Rocky Mountain Research Station), Leif A. Mortenson (USDA Forest Service, Pacific Southwest Research Station), Jackson P. Audley (USDA Forest Service, Pacific Southwest Research Station), Brytten E. Steed (Forest Health Protection, USDA Forest Service), Kenneth E. Gibson (USDA Forest Service, Northern Region, retired), Carl L. Jørgensen (USDA Forest Service, Intermountain Region), Stephen R. McKelvey (USDA Forest Service, Pacific Southwest Research Station), Joel D. McMillin (USDA Forest Service, Southwestern Region), and Jose F. Negrón (USDA Forest Service, Rocky Mountain Research Station)

Abstract

Surface and ground fuels are important components of forest structure and accurate measures are needed when making management decisions. Surface and ground fuels create wildlife habitat and may influence wildfire behavior and severity. Previously, there has been little work monitoring the rate of change of fuel loads over a long time period following mountain pine beetle outbreaks in lodgepole pine forests. We monitored these changes following mountain pine beetle outbreaks utilizing a 125-plot network spread throughout Colorado, Idaho, Montana, Utah, and Wyoming. We measured ground and surface fuels on each plot using modified Brown's transects, as well as the torching potential for standing live study trees, in 2010, 2014, 2018, and 2022. We will determine through statistical analysis what variables are the best predictors of fuel loads. Some variables to be analyzed and presented include basal area, trees per hectare, plot aspect, snag fall rates, and tree species composition.

Assessing how mountain pine beetle outbreaks compare to other disturbances in terms of how they affect ectomycorrhizal fungal communities and pine health

Nadir Erbilgin (Department of Renewable Resources, University of Alberta), Justine Karst (Department of Renewable Resources, University of Alberta), John A. Cale (Department of Renewable Resources, University of Alberta), and James F. Cahill (Department of Biological Sciences, University of Alberta)

Abstract

The rapid eastward expansion of mountain pine beetle into lodgepole pine forest ecosystems that lack a co-evolutionary history with the beetle in western Alberta has created cascading impacts on above ground plant communities and below ground ectomycorrhizal fungal communities. We examined the effects of changes in composition and structure of ectomycorrhizal fungal communities in response to the beetle outbreak. We also compared the impacts of mountain pine beetle and other disturbances. We conducted field and greenhouse experiments to determine (1) changes in the fungal communities in response to various disturbances, and (2) how these changes affect plant health. Overall, we found that stand mortality caused by prior beetle attacks of mature pines have cascading effects on seedling secondary chemistry, growth, and survival which is probably mediated through effects on below-ground mutualisms; single (beetle outbreak) vs cumulative (salvage harvesting following beetle outbreak) disturbances have different impacts on the structure of fungal communities, changes due to beetle outbreak and other landscape level disturbances in the root-associated fungal communities can affect primary and secondary metabolites of pine seedlings. Overall, these results have important implications for the survival of pine seedlings in disturbed forest stands because both changes in the composition of fungal communities and loss of fungi may result in establishing pine seedlings with reduced primary and secondary metabolites. Currently we are investigating the interaction between pathogenic fungi and ectomycorrhizal fungi, and the role of ectomycorrhizal fungi in drought resistance in pines.

Effects of mountain pine beetle outbreaks on carbon cycling

Jeffrey A. Hicke (University of Idaho)

Abstract

Forest insects are major disturbances in western North America, killing billions of trees in recent decades. This mortality affects forest carbon cycling in several ways. First, the reductions in trees within a stand decrease photosynthesis, the input of carbon into the ecosystem. Second, the killed trees decompose and release carbon back into the atmosphere. The effect on the net carbon balance, or whether a stand is a carbon sink or a source, is the sum of these changes, and varies with time from immediately following the outbreak through forest recovery. I will describe the effects of mountain pine beetle outbreaks on carbon stocks and fluxes. I will draw on theoretical understanding as well as studies that document impacts across a range of spatial and temporal scales.

How does water yield respond to mountain pine beetle infestation in a semiarid forest?

Jianning Ren (Department of Natural Resources and Environmental Sciences, University of Nevada-Reno), Jennifer Adam (Department of Civil & Environmental Engineering, Washington State University), Jeffrey Hicke (Department of Geography, University of Idaho), Erin Hanan (Department of Natural Resources and Environmental Sciences, University of Nevada-Reno), Christina (Naomi) Tague (Bren School of Environmental Science & Management, University of California-Santa Barbara), Mingliang Liu (Department of Civil & Environmental Engineering, Washington State University), Crystal Kolden (Management of Complex Systems, University of California-Merced), and John Abatzoglou (Management of Complex Systems, University of California-Merced)

Abstract

Mountain pine beetle outbreaks result in widespread tree mortality, transforming forest structure within watersheds. Previous field studies showed conflicting results on how water yield changes after forest disturbances, with some finding an increase in yield while others report a decrease or no change in yield. To disentangle this problem, we coupled a beetle effects model to an ecohydrological model and applied it to a semiarid watershed in central Idaho. We found that water yield during the red phase is driven by three factors: interannual climate variability, mortality level, and long-term aridity. Specifically, we discovered that the aridity index is a reliable predictor of the hydrological response to beetle outbreaks during dry years. In water-limited areas, water production mainly decreased and was less affected by mortality level. Conversely, in wetter areas, water production changed with mortality. Low to medium mortality decreased water production, while high mortality increased water production. Our model framework can assist researchers in understanding field observations and in predicting extreme events in different locations.

Best practices for tree injection

Don Grosman (Arborjet Inc) and Joe Doccola (Arborjet Inc)

Abstract

Tree Injection is just one of several methods used to apply chemical treatment options for protection of trees against insect and disease pests. This presentation will address 1) the benefits of tree injection 2) types of tree injections 3) tree responses to tree injection treatments, 4) application considerations, such as application timing, pest biology and susceptibility, treatment formulation, residual activity, tree phenology, environmental factors, and time of day and 5) administering injections, which includes measuring tree diameter, mixing and dosing, injection location, drilling injection holes and injecting the tree.

Response of Engelmann spruce and blue spruce to inoculation with spruce beetle fungal symbionts

Seth Davis (Colorado State University), Dan Ott (USDA Forest Service, Intermountain Region), and Javier Mercado (USDA Forest Service, Rocky Mountain Research Station)

Abstract

We evaluated defensive responses of two spruce species to inoculation with the fungal symbiont (*Leptographium abietinum*) of spruce beetle (*Dendroctonus rufipennis*). Blue spruce is largely resistant to spruce beetle and had higher constitutive resin duct densities than Engelmann spruce. Blue spruce exhibited a more rapid defensive response (monoterpene upregulation) than Engelmann spruce, and upregulated a different composition of terpenoids than Engelmann spruce. Blue spruce also has thicker bark and thinner phloem than Engelmann spruce, which may restrict beetle access to phloem resources. We interpret these interspecific phenotypic differences following fungal inoculation to be consistent with resistance-associated traits.

Large-scale outbreak of spruce spider mite in Douglas-fir

Erika Eidson (Idaho Department of Lands), Tom Eckberg (Idaho Department of Lands), Isabella Valdez (Idaho Department of Lands)

Abstract

Spruce spider mite *(Oligonychus ununguis)* is a native pest of many conifers in western North America. Infestations are common in landscape trees and Christmas tree plantations throughout Idaho, but large-scale outbreaks in natural forested settings are rare. In 2022, a large-scale outbreak of spruce spider mite was observed in Douglas-fir forests near Council, Idaho. Severe foliage bronzing was visible from major highways, and defoliation occurred on some of the most heavily infested trees. The outbreak area is under continued monitoring to assess tree survival following this outbreak.

Influence of semiochemicals on interactions between the South's only two *Dendroctonus*: the southern and black turpentine beetles

Brian Sullivan (USDA Forest Service, Southern Research Station), Holly Munro (NCASI, Athens GA), Will Shepherd (USDA Forest Service, Southern Research Station), Kamal Gandhi (University of Georgia, Athens, GA)

Abstract

The southern pine beetle, *Dendroctonus frontalis* Zimmermann, and the black turpentine beetle, *D. terebrans* (Olivier), often colonize the same trees and share components of their respective aggregation/sex pheromones. Our research group investigated commonalities in the responses by these beetle species to pheromone components and resin odors of shared host species. We discovered that southern pine beetle was attracted to a pheromone component produced only by black turpentine beetle males (exo-brevicomin), and that the same host resin constituents increased attraction of both species to attractive pheromone components. Walking southern pine beetle males were arrested by odors of black turpentine beetle frass but significantly longer by conspecific female frass. Our results were consistent with mutually supportive roles for the two species in locating and overcoming the resistance of suitable host trees.

Community engagement can enhance biosurveillance for invasive forest pests

Joseph Hulbert (Washington State University)

Abstract

People are part of ecosystems and biosecurity is a shared responsibility. Protecting our forests from invasive pests requires constant and broad biosurveillance, beyond the capacity of any individual agency or sector. Programs designed to empower more people as guardians can increase capacity for biosurveillance and strengthen the resilience of our communities to respond to forest threats. Many programs exist to empower participants as first detectors and respond to the impacts of invasive species. This presentation will review approaches for engaging the public across the stages of biological invasions and summarize the merit of public engagement within the Forest Health Watch program (https://foresthealth.org/).

Predators of the hemlock woolly adelgid in the Pacific Northwest: Implications for biological control in eastern North America

Darrell Ross (North Dakota State University) and Kimberly Wallin (North Dakota State University)

Abstract

Three specialist predators of the hemlock woolly adelgid have been identified in its native range in the Pacific Northwest (PNW). The first to be identified, *Laricobius nigrinus*, has received by far the most attention over the past 25 years. However, despite being established at well over 100 sites in the eastern US, there is no evidence that the beetle is impacting HWA populations or reducing eastern hemlock mortality. More recent evidence suggests that the two species of silver flies, *Leucotaraxis argenticollis* and *Leucotaraxis piniperda*, are most likely regulating HWA populations in the PNW. This paper will review the current state of knowledge of these predators and their status as biological control agents for HWA in the eastern USA.

Evaluating the unprecedented success of the anti-aggregation pheromone, 3-Methylcyclohex-2-en-1-one, for protecting live Douglas-fir: implications for future development of bark beetle pheromone treatments

Darrell Ross (North Dakota State University)

Abstract

The operational use of MCH to protect live Douglas-fir trees from infestation by the Douglas-fir beetle is unparalleled in its success in comparison to similar efforts with other bark beetle species. This presentation will discuss the likely reasons for the successful development of this treatment and assess implications for the development of future bark beetle pheromone treatments for other species.

71ST WESTERN FOREST INSECT WORK CONFERENCE

POSTER ABSTRACTS

TUESDAY, APRIL 25, 2023

Improving ratios of eastern larch beetles to predators captured in pheromone-baited funnel traps in tamarack forests in Minnesota

Emily Althoff (University of Minnesota), Brian T. Sullivan (USDA Forest Service),and Brian H. Aukema (University of Minnesota)

Abstract

Eastern larch beetle, *Dendroctonus simplex* LeConte, is a native bark beetle whose range is sympatric with its host, eastern larch or tamarack, *Larix laricina*. In Minnesota, the past two decades have witnessed a shift from historically small, sporadic outbreaks to a large, landscape-level outbreak that now affects more than 70% of the state's tamarack cover. This pronounced outbreak has renewed interest in this insect's chemical ecology. In the Great Lakes region, the predominant monoterpenes in tamarack phloem are alpha-pinene and delta-3-carene. While alpha-pinene is currently part of the commercial lure, seudenol parings with delta-3-carene have not received as much attention. We found that traps baited with delta-3-carene + seudenol captured the highest number of eastern larch beetles and fewest natural enemies. This work will be helpful to further elucidate the chemical ecology of eastern larch beetle, which may vary geographically.

Western Forest Insect Work Conference Founder's Award: Walking with Giants

Katherine Bleiker (Canadian Forest Service), Joel McMillin (USDA Forest Service, Southwestern Region), Steve Cook (University of Idaho), Celia Boone (British Columbia Ministry of Forests), and Matt Hansen (USDA Forest Service, Rocky Mountain Research Station)

Abstract

The Founder's Award recognizes individuals who have made an outstanding contribution to forest entomology in western North America. Recipients have made exceptional contributions in the following areas: forest health management, extension-consultation, research, teaching, and mentoring. We highlight the Founder's Award remarkable legacy, recognizing the 27 recipients from 1991 to 2022 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 (https://www.wfiwc.org/awards/project-one-kh576-kbpz6).
We acknowledge and appreciate the assistance of the Technology Committee in recording and uploading recent Founder's Award presentations.

How are complex spatial patterns affecting bark beetle-caused tree mortality in northern Arizona?

Alyssa Cherow (Northern Arizona University School of Forestry), Gia Landis (Northern Arizona University School of Forestry), Jose Negron (USDA Forest Service, Rocky Mountain Research Station), and Kristen Waring (Northern Arizona University School of Forestry)

Abstract

Stand density and spatial patterns of inter-tree competition are important factors to consider when managing to mitigate bark beetle-caused tree mortality. Although higher tree densities are often associated with bark beetle attacks, the effects of variable individual tree competition on mortality are understudied, as are the interactions with site productivity. Site index is a measure of stand productivity where higher site index values correlate with higher stand density, potentially indicating increased stress. Our project aims to determine if there is a relationship between site index and mortality within individual tree competition plots. In this poster presentation, we will present our findings on the relationship between site index and bark beetle-caused mortality, and possible explanations behind this relationship. This research will broaden our knowledge on the effect of spatial patterns on bark beetle-caused mortality in conjunction with site productivity.

Nepytia janetae: A once innocuous species brings novel defoliation and appetites to the Santa Fe National Forest

Peggy De'Scoville (New Mexico Highlands University), Jennifer Klutsch (Natural Resources Canada, Canadian Forest Service), Andy Graves (USDA Forest Service Southwestern Region), Anna Schoettle (USDA Forest Service Rocky Mountain Research Station), and John Formby (USDA Forest Service Southwestern Region)

Abstract

Prior to 50 years ago, Janet's looper moth (*Nepytia janetae*) was an innocuous species in the southwestern US with populations that had not risen to levels of concern. However, global warming has shifted northern New Mexico's climate into one of prolonged drought and rising temperatures, and in these new climatic conditions Janet's looper has emerged as a novel pest. In a recent outbreak between 2017 to 2019, nearly 5000 ha of high-elevation mixed conifers were defoliated in the Santa Fe National Forest of northern New Mexico, which is about 300 km north of any previous outbreak. The geometrid also expanded its diet to include Pinus aristata and *P. flexilis.* From 2018 to 2021, we collected stand data including species composition, mortality, regeneration, and bark beetle attack evidence. Host species were cored to measure growth impact of defoliation. Identifying stand characteristics associated with defoliation will improve monitoring for future outbreaks.

Two grant programs that help monitor and control invasive species in the West

Darci Dickinson (USDA Forest Service, Pacific Northwest Region)

Abstract

The need to control invasive weeds and restore habitat across the west is very important. Each year dozens of new invasive species are introduced. Forest Health Protection sponsors two grant programs to help control Invasive Species; the Forest Service-Pesticide Impact Assessment Program (FS-PIAP), and Biological Control of Invasive Forest Pests (BCIFP) program.

Cerambycid pheromone (3-hydroxyhexan-2-one) attracts woodborer *Phymatodes aeneus* and predator *Thanasimus undatulus* in the Pacific Northwest (USA)

Darci Dickinson (USDA Forest Service, Pacific Northwest Region), Dan Miller (USDA Forest Service, Southern Research Station), Chris Crowe (USDA Forest Service, Southern Research Station), and Beth Willhite (USDA Forest Service, Pacific Northwest Region)

Abstract

In 2012, we evaluated the effects of cerambycid pheromones syn-2,3-hexanediol (D6), 3-hydroxyhexan-2-one (K6), and 3-hydroxyoctan-2-one (K8) on catches of Cerambycidae and associates in ethanol-baited multiple-funnel traps in two field trials in Oregon and Washington, USA. We found that: (1) catches of the woodborer *Phymatodes aeneus* (Cerambycidae) in traps increased with addition of K6 lures or blend of K6+K8; (2) catches of the beetle predator *Thanasimus undatulus* (Cleridae) in traps increased with the addition of K6; (3) the lure blend of K6+K8 decreased trap catches of the ambrosia beetle *Gnathotrichus sulcatus* (Curculionidae: Scolytinae); and catches of *Ptilinus basalis* (Anobiidae) in traps increased with the addition of the K6+K8 blend.

Monitoring drought induced juniper dieback and mortality in Arizona

Isaac Dell (U.S. Forest Service, Forest Health Protection), Joel Mcmillin (USDA Forest Service, Forest Health Protection), Monica Gaylord (USDA Forest Service, Forest Health Protection), Amanda Grady (USDA Forest Service, Forest Health Protection), Nick Wilhelmi (USDA Forest Service, Forest Health Protection), Dan Ryerson (USDA Forest Service, Forest Health Protection), Ryan Hanavan (USDA Forest Service, Forest Health Protection), Aaron Kamoske (USDA Forest Service, Geospatial Technology and Applications Center), and Rowan Moody (USDA Forest Service, Geospatial Technology and Applications Center)

Abstract

Severe and persistent drought has caused severe juniper crown dieback and mortality in Arizona. Various survey methods are being evaluated to document dieback and mortality, such as remote sensing (Delta Viewer), satellite (World View) imagery, and aerial (ADS) and ground-based surveys. Over 350,000 acres of juniper with crown dieback and mortality were observed from ADS with moderate to severe damage intensities in 2021 and nearly 100,000 acres in 2022. Ground monitoring was conducted in October 2021 and November 2022 across three National Forests in northern Arizona. Although this dieback was primarily drought driven, bark beetles (*Phloeosinus* spp.) and possibly wood borers contributed to limited juniper mortality in some areas. Bark beetle activity was more common on alligator juniper than shaggy bark junipers in northern Arizona.

Western monarch caterpillar performance on native and exotic milkweed species

Emma Elsner (Northern Arizona University), John Campodall'Orto (Northern Arizona University), Mike Wagner (Northern Arizona University), and Richard Hofstetter (Northern Arizona University)

Abstract

The monarch is a widely known butterfly in North America, but it's future is at risk. Milkweed leaves are used by adult monarchs for laying eggs and serve as the sole food source for caterpillars. Milkweeds are also a source of nectar for not only monarch butterflies but many other pollinators. Both milkweed and monarch populations are in decline mostly due to habitat loss, and since Arizona is part of the migratory path of the butterflies, it is imperative that there is a substantial population of milkweed for them to utilize here. This project looks at western monarch caterpillar performance on 9 milkweed species both native and non-native to Arizona. We measured caterpillar weights every 5 days, recorded time to chrysalis formation, and weights of chrysalis. Particular milkweed species promote better growth than others, with the monarchs growing best on *Asclepias curassavica*, an exotic species native to the American tropics.

Roundheaded pine beetle as an emerging problem in southwest Colorado ponderosa pine forests

Matthew Ethington (USDA Forest Service, Forest Health Protection), Amy Lockner (USDA Forest Service, Forest Health Protection), Suzanne Marchetti (USDA Forest Service, Forest Health Protection), and John Nelson (USDA Forest Service, Forest Health Protection)

Abstract

Roundheaded pine beetle (*Dendroctonus adjunctus*, RHPB) is a native bark beetle that has historically produced sporadic pine mortality throughout the southwestern U.S. but recently caused significant and sustained mortality of ponderosa pine in southwest Colorado. Affected trees have been colonized by populations of RHPB as well as a complex including mountain pine beetle (*Dendroctonus ponderosae*) and western pine beetle (*Dendroctonus brevicomis*). The current outbreak started in the San Juan National Forest in 2013 and has since increased and spread from that area to other forests in southwest Colorado. One area of interest is in the Uncompahgre National Forest, where the RHPB complex has caused increasing and sustained mortality of pines. This beetle outbreak is currently being managed by removing heavily infested trees and reducing stand densities, but RHPB may continue to expand its active range, especially when working in concert with other aggressive bark beetles.

Carbon stored in live Sierran ponderosa pines will not return to pre-drought (2012) levels during the 21st century due to bark beetle outbreaks

Christopher J. Fettig (USDA Forest Service, Pacific Southwest Research Station), Zachary J. Robbins (Los Alamos National Laboratory), Chonggang Xu (Los Alamos National Laboratory), Alex Jonko (Los Alamos National Laboratory), Rutuja Chitra-Tarak (Los Alamos National Laboratory), Jennifer Costanza (USDA Forest Service, Southern Research Station), Leif A. Mortenson (USDA Forest Service, Pacific Southwest Research Station), Brian H. Aukema (University of Minnesota), Lara M. Kueppers (University of California-Berkeley), and Robert M. Scheller (North Carolina State University)

Abstract

Bark beetle outbreaks are often incited by drought and may result in large transfers of carbon (C) in live trees to C in dead trees. Over time this C will be transferred back to the atmosphere through combustion and/or decomposition. Using an insect phenology and tree defense model, we projected the future likelihood of western pine beetle outbreaks in the Sierra Nevada with climate drivers from different Earth System Models. Projections suggest that by 2100 the C stored in live ponderosa pine will not return to levels that occurred before the 2012–2015 drought. Tree density was the most important factor driving the mortality rate of ponderosa pine followed by drought severity and temperature. While our results indicate that changes in climate may increase the frequency of future western pine beetle outbreaks, they also provide evidence that management directed towards limiting tree densities will increase long-term forest resilience.

Testing of fungal bioinsecticide on two species of adelgids, *Pineus similis* and *Pineus pinifoliae* in a western white pine-Englemann spruce seed orchard

Melissa Fischer (USDA Forest service, Pacific Northwest Region), Darci Dickinson (USDA Forest Service, Pacific Northwest Region), and Cliff Bradley (Montana BioAgriculture Inc.)

Abstract

The goal of this study was to test the efficacy of the fungal bioinsecticide *Beauveria bassiana* (BoteGHA-ES) to control ragged spruce gall adelgid (*Pineus similis*) and pine leaf adelgid (*Pineus pinifoliae*) on their primary [Engelmann spruce (*Picea engelmannii*)] and secondary [western white pine (*Pinus monticola*)] hosts in a seed orchard. These two adelgids are damaging valuable seed trees that have also been affected by drought, foliar pathogens, secondary bark beetles and an aphid. Removing two of the insect agents should help enable seed trees to recover. This study was conducted for two years in the spring, summer, and fall to determine the best application timing to control adelgids. *Beauveria bassiana* was found to significantly reduce the number of live adelgids on western white pine during the study.

Biology, ecology, and morphological analysis of *Phloeosinus* bark beetles associated with giant sequoia in Yosemite and Sequoia-Kings Canyon National Parks, California

Nathaniel E. Foote (Colorado State University), Thomas Seth Davis (Colorado State University), and Gabriel G. Foote (University of California, Davis)

Abstract

Giant sequoia mortality during and following recent droughts and wildfires in the central and southern Sierra Nevada, California has generated concern over an emerging susceptibility of these trees to stressors that potentially include *Phloeosinus* bark beetles. The species originally described as *Phloeosinus rubicundulus* (but currently synonymized with *P. punctatus*, whose host range includes sympatric incense-cedar) reproduces in freshly downed limbs but also attacks the live crowns of mature giant sequoias, implicating elevated beetle activity as a possible stressor. Yet, information on giant sequoia-associated *Phloeosinus* biology and the factors affecting its distribution and abundance is limited, and potentially obfuscated by changes in taxonomic status. Here, we describe the life history, provide a phenological model, and report occurrence of *Phloeosinus* in giant sequoia groves of Yosemite and Sequoia-Kings Canyon National Parks, California. Initial results from morphological analysis support reassessing the current taxonomic synonymy of *P. rubicundulus* with *P. punctatus*.

Efficacy of trunk injection and bole spray treatments against spotted lanternfly and associated sooty mold production

Don Grosman (Arborjet Inc.)

Abstract

The spotted lanternfly (SLF), *Lycorma delicatula*, an invasive planthopper was discovered in Berks County, PA in 2014. It has since spread to 13 additional states. Direct control options for SLF are limited. We were interested in determining the efficacy of systemic insecticides (imidacloprid, azadirachtin and acephate) and an experimental active ingredient, pymetrizine, using trunk injection and/or bole spray techniques against different SLF life stages and associated sooty mold. Imidicloprid injections and pymetrizine bole spray treatments provided the best protection of host trees by causing high levels of mortality, thus reducing numbers on the trunk, feeding on the host, and low levels of sooty mold. The acephate injection did not cause much in the way of direct mortality, but it appears that it deterred nymphs and adults from feeding and/or staying on the host, thus reducing sooty mold production and egg laying. Azadirachtin do not appear to be activity against SLF.

Evaluation of systemic fungicide and insecticide for management of pitch canker and insect vectors on Monterey pine

Don Grosman (Arborjet Inc.)

Abstract

The invasive pitch canker disease, caused by *Fusarium circinatum*, is threatening the health and survival of conifers in 21 coastal California counties. The disease is known to vectored by several pine beetle species. Disease control options for pitch canker were limited to pruning infested branches. From the Tahama Golf Cllub site in the core area (Monterey Co.) of the infestation, we report an investigation of the impact of pitch canker on Monterey pine, *Pinus radiata*, before and after treatment with a systemic insecticide, emamectin benzoate (EB) alone or combined with a systemic fungicide, propiconazole (P). Both trunk injection treatments, EB + P > EB alone were found to be effective in reducing the number of new pitch canker infections on the main stem compared to untreated checks. This indicates that EB and P are preventing success of both the insect vector and pathogen, respectively.

Pinyon ips develops fast, unless attacking great basin bristlecone pine

Matt Hansen (USDA Forest Service, Rocky Mountain Research Station), Jim Vandygriff (USDA Forest Service, Rocky Mountain Research Station), Monica Gaylord (USDA Forest Service, Forest Health Protection), Andy Graves (USDA Forest Service, Forest Health Protection), Joel McMillin (USDA Forest Service, Forest Health Protection), Steve Souder (USDA Forest Service, Forest Health Protection), and Barbara Bentz (USDA Forest Service, Rocky Mountain Research Station)

Abstract

Pinyon ips, *Ips confusus* LeConte, is a native bark beetle with a distribution that follows that of its host tree species. Between 2000-2004 some areas of pinyon pine experienced near total loss of hosts due to water stress and pinyon ips attacks. Pinyon ips is hypothesized to have two to four generations per year, although data are anecdotal. Pinyon ips was recently found attacking drought-stressed Great Basin bristlecone pine (GBBP), *P. longaeva*, a new host record for this insect. GBBP is a long-lived five-needle pine that is found at high elevations, often upslope from pinyon pines. Previous research showed that GBBP is a population sink for mountain pine beetle (*Dendroctonus ponderosae*). We describe results from field and laboratory studies describing lifecycle timing and phenology of pinyon ips populations in Arizona and New Mexico. Also, laboratory studies show that pinyon ips has very low reproductive success in GBBP.

dfoliatR: An R package for tree-ring detection and reconstruction of forest defoliator outbreak chronologies

Ann M. Lynch (USDA Forest Service, Rocky Mountain Research Station), Christopher H. Guiterman (CIRES, University of Colorado), and Jodi N. Axelson (British Columbia Ministry of Forests)

Abstract

dfoliatR is an R package based on the OUTBREAK Fortran program. Building on the OUTBREAK algorithms and robust R and dplR resources, dfoliatR infers, quantifies, analyzes, and visualizes radial growth suppression events in tree-ring series. It performs an indexing procedure to remove climatic signals represented in a non-host series from the defoliator host species' tree-ring series, retaining variance that the two series do not share, noise and the defoliation signal. Individual-tree defoliation growth suppression events are inferred based on user-specified thresholds, and site-level events are inferred based on user-specified numbers or proportions of trees affected. Both tree- and site-level summary statistics and graphics are provided. dfoliatR offers greatly increased ease-of-use, flexibility, graphical capability, and power. Though designed to reconstruct forest defoliator chronologies, it can be applied to other studies where host- vs non-host comparisons are useful, or when individual tree species might respond differently to environmental change.

Research concerning new methods of control for spruce beetle in Utah and Wyoming

A. Steven Munson (USDA Forest Service, Intermountain Region, retired), Christopher J. Fettig (USDA Forest Service, Pacific Southwest Research Station), Jackson P. Audley (USDA Forest Service, Pacific Southwest Research Station), Darren C. Blackford (USDA Forest Service, Intermountain Region), Donald M. Grosman (Arborjet Inc.), Leif A. Mortenson (USDA Forest Service, Pacific Southwest Research Station), and A. Mafra-Neto (ISCA Technologies Inc.)

Abstract

Spruce beetle is a major cause of spruce mortality in the Intermountain West. We describe the results of three studies focused on developing new tools for protecting spruce from mortality attributed to spruce beetle. In Wyoming, we evaluated the effectiveness of two formulations of emamectin benzoate (EB) alone and combined with propiconazole (P) injected into the tree bole. Both formulations of EB significantly reduced levels of tree mortality, however protection was limited to one field season. Protection was increased to two field seasons by combining EB with P In Utah and Wyoming, we evaluated a biodegradable formulation of MCH alone and combined with other repellants with the goal of developing an effective semiochemical-based tool for tree protection. MCH + Acer kairomone blend and MCH + acetophenone + green leaf volatiles were most effective. MCH alone was effective when applied at higher doses per tree than previously considered in the literature.

Pre-pupal diapause in the eastern larch beetle, *Dendroctonus simplex* LeConte

Rose Picklo (University of Minnesota) and Brian Aukema (University of Minnesota)

Abstract

Since the year 2000, an outbreak of eastern larch beetle (*Dendroctonus simplex* LeConte) has affected ~70% of the tamarack in Minnesota, USA. The insect was previously thought to require an adult overwintering reproductive diapause, but laboratory experiments found that some *D. simplex* can reproduce without an overwintering period. Moreover, evidence of a second generation of beetles was observed in the field in summer 2012, demonstrating that bivoltine reproduction is possible under some conditions. Extended growing seasons have prompted further investigation into the life cycle and developmental thresholds for each life stage of the beetle. Utilizing phloem sandwich assays, we identified the developmental rate for each life stage and found evidence of a facultative pre-pupal diapause in late-stage *D. simplex* larvae reared at 11, 14 and 17°C. In conjunction with climate data, this information can be used for population modeling, which may prove useful for evaluating future forest conditions.

Fuels change quickly after California drought and bark beetle outbreaks

Charlotte Reed (USDA Forest Service, Rocky Mountain Research Station), Sharon Hood (USDA Forest Service, Rocky Mountain Research Station), Daniel Cluck (USDA Forest Service, Forest Health Protection), and Sheri Smith (USDA Forest Service, Forest Health Protection)

Abstract

An extreme drought from 2012-2016 and concurrent bark beetle outbreaks in California resulted in widespread tree mortality. We followed changes in tree mortality and fuels over four years after the peak of mortality to examine patterns of mortality, needle retention after death, and snag fall. We also investigated how the tree mortality event affected fuel loading and potential impacts on fire hazard and emissions. Substantial changes to surface fuel loading, stand density, canopy fuel loads, and potential wildfire emissions occurred within four years of peak tree mortality, with the largest changes related to increases in coarse woody debris. Nearly complete needle fall occurred within four years of mortality for all species except red fir. Pine species and incense cedar snags fell more quickly than fir species. Fire behavior modelling suggested that as canopy fuels are transferred to surface fuels, fires will have greater emissions.

Effective management of thousand cankers disease of walnut through disruption of insect vector behavior

Megan A. Siefker (USDA Forest Service, Pacific Southwest Research Station), Corwin M. Parker (Oregon Department of Agriculture), Ali E. McClean (USDA-ARS, Crops Pathology and Genetics Research Unit, University of California, Davis), Steven J. Seybold (USDA Forest Service, Pacific Southwest Research Station; deceased), and Richard M. Bostock (University of California, Davis, Department of Plant Pathology)

Abstract

The walnut twig beetle (WTB), *Pityophthorus juglandis*, and its associated fungal pathogen, *Geosmithia morbida,* cause thousand cankers disease (TCD) which is threatening native and cultivated walnut trees throughout the United States. In commercial orchards in California where the walnut industry is a 1-billion-dollar enterprise, management of this disease is only partially effective and is limited to general cultural practices and sanitation of infested host material. For a more successful and targeted management strategy, it is important to identify highly susceptible host trees and to detect and deter the insect vector. In this study we investigated the presence of crown gall disease (*Agrobacterium tumefaciens*) as a predisposing factor to WTB attack and TCD severity. We also tested the range of inhibition of a repellent mixture (R-(+)-limonene and trans-conophthorin) to WTB. The results of our study aid in assessing tree risk to TCD and deploying the repellent with the goal of reducing walnut tree losses to TCD.