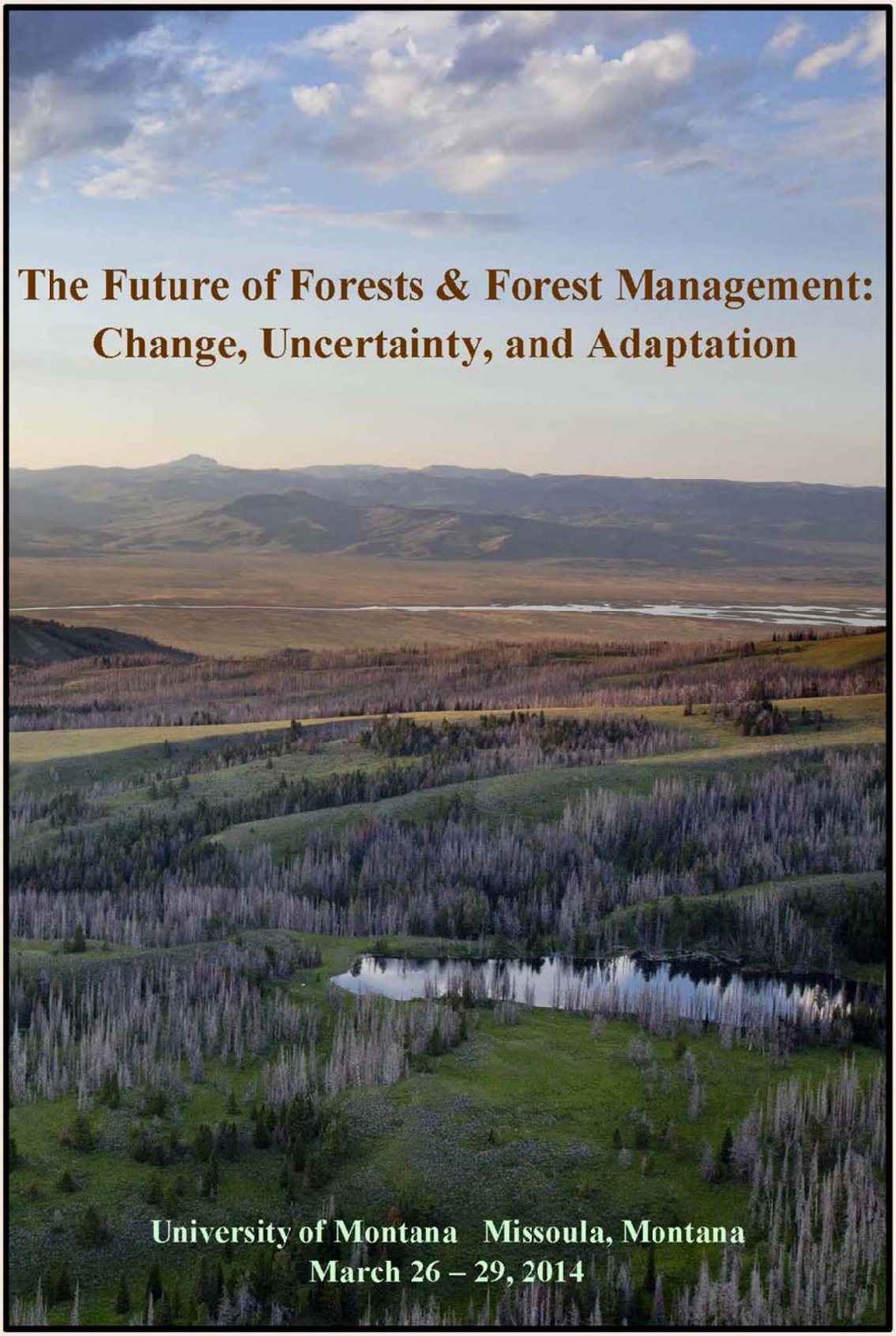
85th Annual Meeting of the **Northwest Scientific Association**

with **The University of Montana Plum Creek Distinguished Lecture Series**



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updated March 21, 2014

A WELCOME FROM THE PRESIDENT

Northwest Scientific Association

… promoting scientific research and disseminating scientific knowledge since 1923.

Welcome to the 85th Annual Meeting for the Northwest Scientific Association (NWSA), co-hosted with The University of Montana College of Forestry and Conservation Distinguished Plum Creek Lecture Series. Thank you for supporting the Association and your community of scientists in northwestern North America. Our conference organizers, Andrea Pipp and Dr. Andrew Larson, have put together an exciting program to consider the future of forest management and to reflect on the diversity of scientific research in the northwest. We are especially honored and fortunate to have plenary and banquet speakers Drs. Richard Waring and Steve Running who will share wisdom gained from long and distinguished careers studying and modeling forests and climate. Complementing the technical sessions, our field trips invite participants to experience forest management at the urban interface; restoration following dam removal, stream re-naturalization, and road modification; and the role that natural areas play as references for detecting the effects of climate change. We also offer the opportunity to discover the diversity of lichens and mosses living on limestone cliffs. Through offering a variety of technical and poster sessions, workshops, field trips, and conversations we hope that this conference provides inspiration and fosters collaboration.

If you are not a member of NWSA, I strongly encourage you to join. We welcome anyone interested in science in the northwestern United States and western Canada, and we strive to be inclusive. Through our diverse membership, annual conference, peer-reviewed journal, and website we seek to connect scientists in the natural and applied sciences and provide a means for spreading scientific knowledge. Our Association is a great means to connect with others, look for job opportunities, seek student grants, publish research, and identify mentors.

Our journal, *Northwest Science,* can be viewed on-line at the BioOne website, http://www.bioone.org/loi/nwsc. Full content is available to NWSA members. Given our worldwide accessibility via BioOne (since 2007), *Northwest Science* is a great place to publish your work! Explore our website http://www.northwestscience.org for NWSA events and to sign-up/ renew your membership.

Please take a look on pages 3-9 to learn about NWSA and how to get involved, who to thank for the conference, and more. It is through the dedication and hard work of many that NWSA is sustained.

This year's conference has benefited from the support of generous sponsors: University of Montana College of Forestry & Conservation, Plum Creek Distinguished Lecture Series, Montana Wetland Council, U.S.D.A. Forest Service-Region 1, Northwest Lichenologists, The Center for Riverine Science and Stream Re-naturalization, Montana Natural Resource Damage Program, Montana Department of Natural Resources and Conservation, Kestrel Aerial Services, Inc., and RESPEC Consulting & Services. On behalf of the board, I am truly grateful for their backing.

I hope you enjoy the meeting and have a chance to see old friends and make new connections.
Thank you for your support of the NWSA through your membership and/or conference attendance.

Sincerely,

Andrea Woodward

President - Northwest Scientific Association

Thank You!!

This event would not be possible without the generous support of our planners, volunteers, & sponsors.

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Department of Environmental Quality

Steve Shelly
U.S. Forest Service, Region 1

Tim Wheeler
Northwest Lichenologists
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The Center for Riverine Science & Stream Re-naturalization (The River Center)
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Natural Resource Damage Program
https://doj.mt.gov/lands

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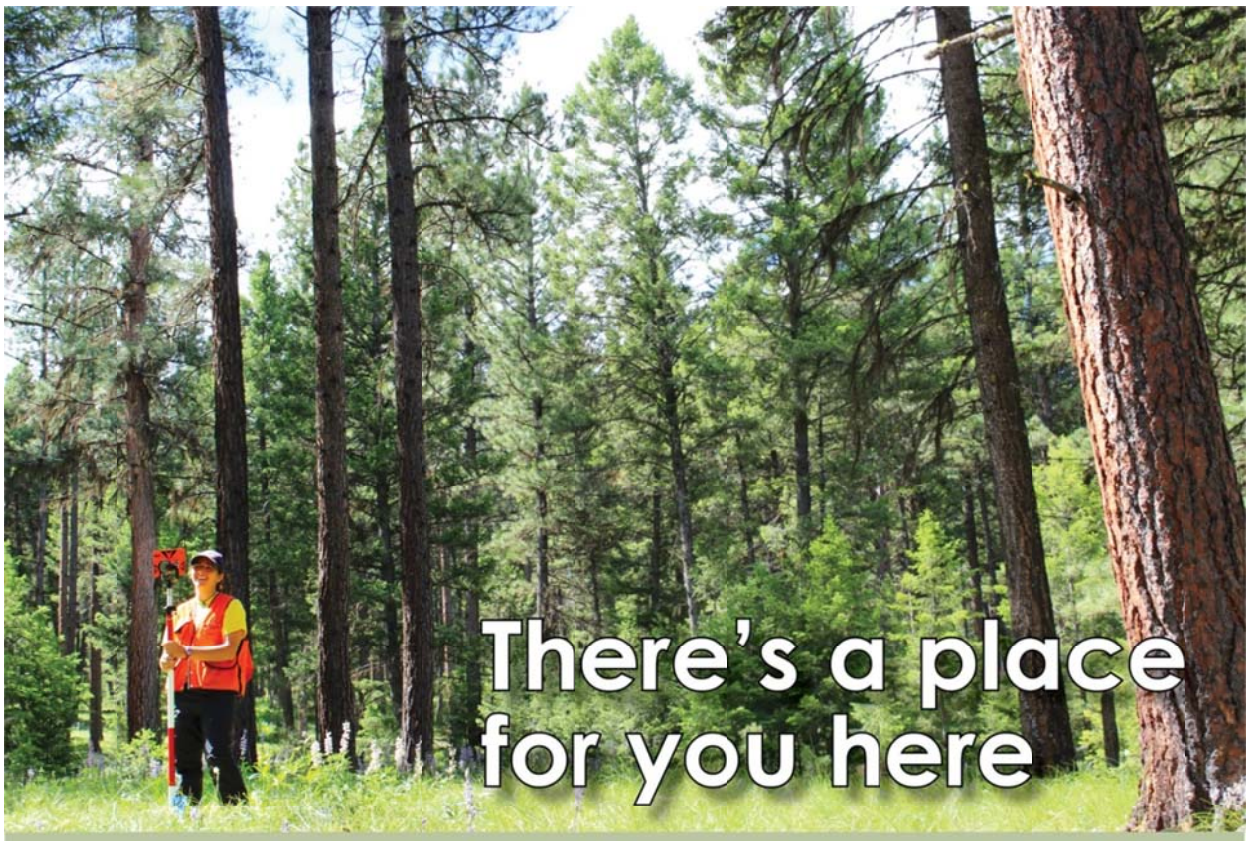

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The College of Forestry and Conservation at the University of Montana ranks in the top ten of academic institutions in North America for research productivity in natural resource and conservation science.

We also train the nation's finest natural resource leaders. Nearly 1,000 undergraduate and graduate students come to Missoula from 47 states, 12 countries, and tribal communities to study in one of 19 degree options.

Our programs get you outside to bring to life classroom learning, from wildlife surveys, to prescribed burns on our 28,000-acre experimental forest, to trekking in the Himalaya.

Whether you're from a ranch in southeastern Montana here to study wildland fire, a music major-turned resource conservation graduate student looking at hydrology's influence on tree growth, or a Chicagoan graduating this spring to work for a forestry company, there's a place for you in the College of Forestry and Conservation.

PLUM CREEK LECTURE SERIES

The Plum Creek Distinguished Lecture Series was funded through a gift to the College of Forestry and Conservation from the Plum Creek Timber Company in 1994. We host outstanding visiting lecturers to discuss relevant natural resource topics and train a PhD fellow to conduct innovative research and excel in their field.

UNIVERSITY OF MONTANA

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Linking Scientists throughout Northwestern North America

Since 1923, the **Northwest Scientific Association (NWSA)** has existed for the purpose of promoting scientific research and disseminating scientific knowledge in the region of northwestern USA and western Canada.

Our membership of professional and amateur scientists represent the array of basic, applied, and social scientists and work for academic, federal, state, tribal, private, and non-profit institutions.

NWSA and its members service the scientific community by publishing a peer-reviewed journal, *Northwest Science*, and hosting an Annual Scientific Meeting (conference). Refer to "Welcome from Our President" for details.

This year marks our 91st year &
our 85th Scientific Meeting!

Would you like to get involved?

Membership provides the foundation for supporting our journal and serving the scientific community in our region.

More substantial ways to be involved include:

Serving on the Board of Directors: The board has 9-21 directors who serve a 3-year term.

Serving as an Officer: President, Vice-President, Treasurer, & Secretary.

Our Standing (permanent) Committees:

- *Nominating*: Seeks Board Members and Officers. If interested inquire with Chair, Katherine Glew, kglew@uw.edu
- *Student Grant*: Solicits, reviews, & awards student research grants.
- *Awards & Honors*: Recommends special awards and honors.
- *Program*: Organizes the annual conferences.

Our current positions & temporary committees:

- *Associate Editors for* Northwest Science
- *Membership*
- *Board Member / Program Handbooks*
- *Website Strategy*
- *Financial Strategy*
- *2015 Conference in Richland, WA*: Much help is needed and many roles are available. You can pick your level of participation. Inquire with:
  Bax Barton, baxqrc@u.washington.edu
  Gary Kleinknecht, res20jii@frontier.com
  George Last, george.last@pnnl.gov
  Janelle Downs, jl.downs@pnnl.gov

A Special Thank you is extended to our Board of Directors

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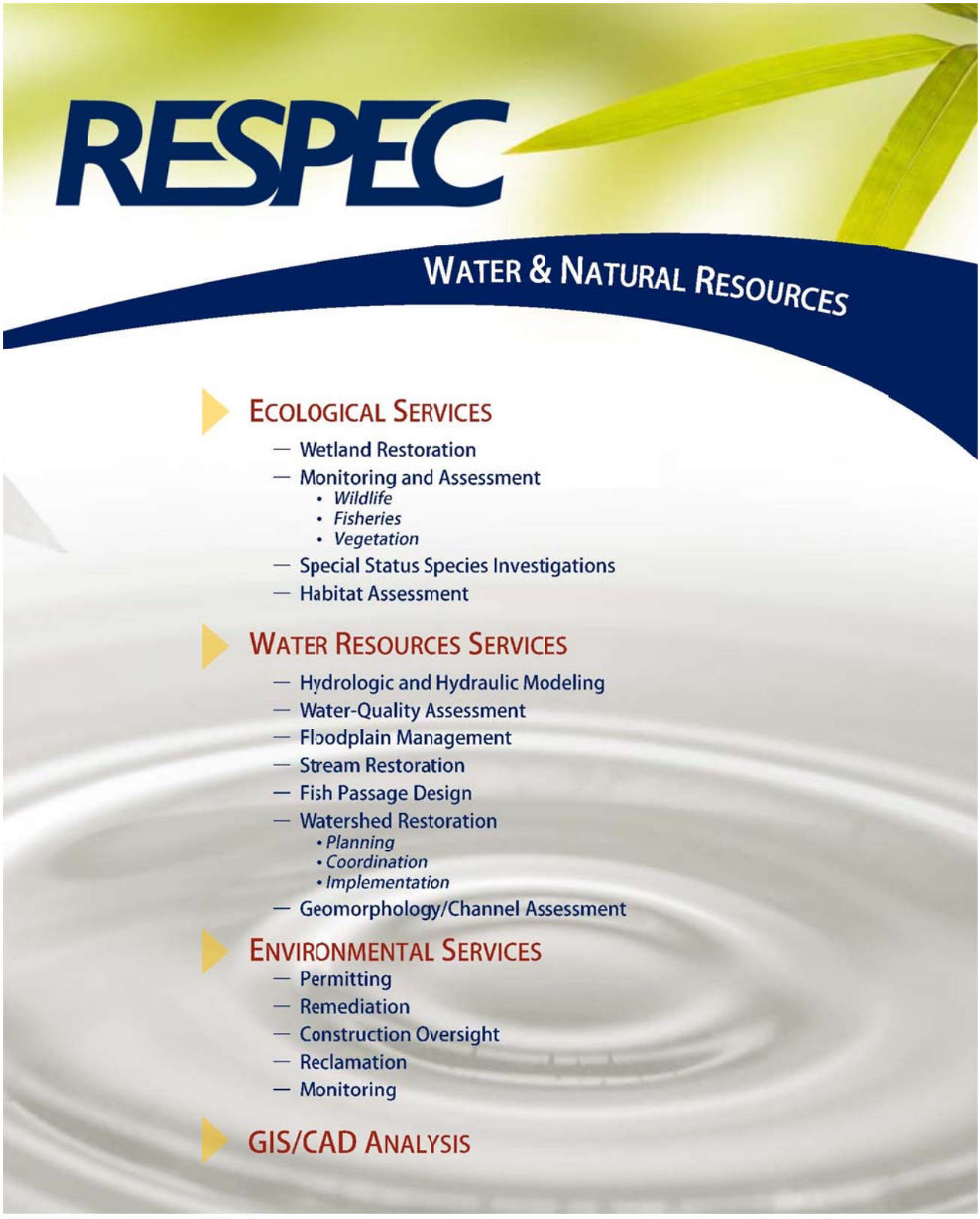
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GIS/CAD ANALYSIS

UNIVERSITY OF MONTANA, MISSOULA – CAMPUS MAP

to Madison Street Bridge

to footbridge/East Gate Shopping Center

Day parking pass can be purchased at Physical Plant or UC Bookstore. Ask clerk for map on where you can park. Also refer to Parking Map in Appendix.

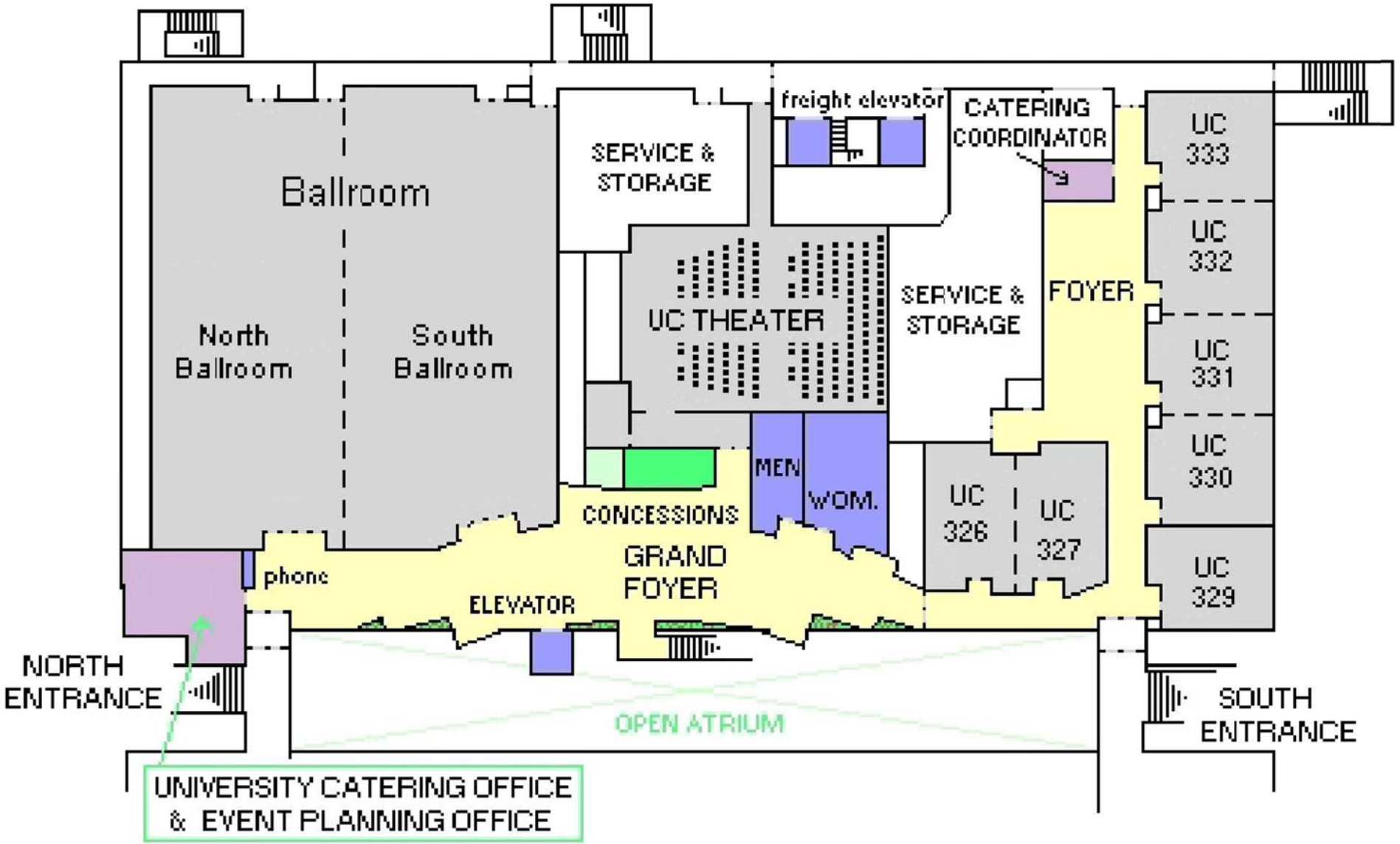
For Registrants who Pre-Paid for parking:

Your parking spot is available in this lot from 7:30am - 9:30am on March 27, 28, and/or 29. Please do not arrive later than 9:30am. An attendant will give you the pass.

M: Metered parking is available and machines take dollars or coin. It costs $1 per hour.

FT: Field Trip meeting location for Saturday March 29. All Field trips leave promptly at 8:30am. Check registration table for field trip updates. Day parking on evenings & weekends is free.

UNIVERSITY CENTER – 3RD FLOOR
FLOOR PLAN FOR CONFERENCE EVENTS



CONFERENCE PROGRAM LAYOUT

Wednesday March 26, 2014 Montana Wetland Council	
Location	UC 330/331
8:45 - 9:00	Gathering: Coffee/Conversation
9:00 - 10:20	**Ecology & Management of Forest Wetlands**
10:20 - 10:50	Break
10:50 - 12:10	**Ecology & Management of Forest Wetlands**
12:10 - 1:10	Lunch (on your own)
1:10 - 2:40	**Ecology & Management of Forest Wetlands**
2:40 - 3:00	Break
3:00 - 4:15	**Ecology & Management of Forest Wetlands**
6:00-8:30	**NWSA/PC Wednesday Evening Social** (food & no-host bar for all NWSA/PC registrants)

Thursday March 27, 2014				
Location	UC Theater			
8:30-10:00	**Welcome & Introduction (NWSA/PC)** **Plenary Keynote Address: Dr. Richard Waring (NWSA/PC)**			
10:00-10:30	Break (South Ballroom)			
Location	UC Theater	UC 330/331	UC 332/333	
10:30-12:30	**Plum Creek Distinguished Lecture Series**	**Aquatic Ecology technical session**	**Community Ecology technical session**	
12:30-1:40	Lunch (on your own)			
Location	UC Theater	UC 330/331	UC 332/333	Health Science 102
1:40-3:00	**Plum Creek Distinguished Lecture Series**	**Research Natural Areas technical session**	**Soils & Geology technical session**	**Rock-loving Microlichens Workshop 13:30-15:45pm**
3:15-5:30	**Poster Session and Break** (South Ballroom)			
6:00-6:30 (social) 6:30-9:30	**Big Sky Banquet & Entertainment** UC 332/333			

Friday March 28, 2014			
Location	UC Theater	UC 330/331	UC 332/333
8:00-9:40	**Forest Ecology I technical session**	**Riverine Science I technical session**	**Forest Management technical session**
9:40-10:10	Break (South Ballroom)		
10:10-12:10	**Plum Creek Distinguished Lecture Series**	**Riverine Science II technical session**	**Plant Ecology technical session**
12:10-1:30	Lunch (on your own or NWSA Business Luncheon)		
1:30-2:50	**Fire Ecology I technical session**	**Natural Resource Management technical session**	**Lichens & Bryophytes technical session**
2:50-3:20	Break (South Ballroom)		
3:20-4:40	**Fire Ecology II technical session**	**Forest Ecology II technical session**	**Lichens & Bryophytes technical session**

Saturday March 29, 2014 - Field Trips Meeting Location: UC Parking Lot. Depart 8:30am. Check Registration Table for Updates.
Milltown Dam Removal & Restoration
Lichens & Mosses of Limestone Cliffs
Timber Harvesting in an Urban Interface & Ashby Creek Road & Stream Restoration
Bitterroot River Research Natural Area

PROGRAM AT A GLANCE

Wednesday 26 March

8:00 am – 10:00 am	Registration Table Open, Grand Foyer
8:45 am – 9:00 am	Gathering: Coffee & Conversation, Room UC 330/331
9:00 am – 10:20 pm	Ecology & Management of Forest Wetlands – Montana Wetland Council, Room UC 330 / 331
10:20 am – 10:50 am	Morning Break, South Ballroom
10:50 am – 12:10 pm	Ecology & Management of Forest Wetlands – Montana Wetland Council, Room UC 330/331
12:10 pm – 1:10 pm	Lunch (on your own)
1:10 pm – 2:40 pm	Ecology & Management of Forest Wetlands – Montana Wetland Council, Room UC 330/331
2:40 pm – 3:00 pm	Afternoon Break, South Ballroom
3:00 pm – 4:15 pm	Ecology & Management of Forest Wetlands – Montana Wetland Council, Room UC 330/331
4:00 pm – 6:00 pm	NWSA Board Meeting, Room UC 329
5:00 pm – 6:00 pm	Registration Table Open, Grand Foyer
6:00 pm – 8:30 pm	NWSA/PC Evening Social (complimentary hors d'oeuvres and no-host bar), Room UC 330/331

Thursday 27 March

7:30 am – 12:00 pm	Registration Table Open, Grand Foyer
8:30 am – 10:00 am	Welcome & Introduction Plenary Session - Keynote Address by Dr. Richard Waring, Room UC Theater
10:00 am – 10:30 am 10:00 am – 9:30 pm	Morning Break, South Ballroom Historical Displays & Information Tables
10:30 am – 12:30 pm	Plum Creek Distinguished Lecture Series technical session, Room UC Theater Aquatic Ecology technical session, Room UC 330/331 Community Ecology technical session, Room UC 332/333
12:30 pm – 1:40 pm 12:30 pm – 2:00 pm	Lunch (on your own) Set-up Time for Poster Presenters, Room South Ballroom

PROGRAM AT A GLANCE (continued)

Thursday 27 March (continued)

1:40 pm – 3:00/3:20 pm	Plum Creek Distinguished Lecture Series technical session, Room UC Theater Research Natural Areas technical session, Room UC 330/331 Soils & Geology technical session, Room UC 332/333
1:30 pm – 3:45 pm	Workshop: An Intro to the Major Genera of Saxicolous Microlichens, Health Science building, Room 102
3:15 pm – 5:30 pm	Poster Session & Social, South Ballroom
6:00 pm – 6:30 pm	Social Before Banquet, Room UC 332/333
6:30 pm – 9:30 pm	Big Sky Banquet featuring ... "Who taught whom? The Steve & Dick Show" by Dr. Steve Running & Dr. Richard Waring *Northwest Landscapes* (a musical slide show)

Friday 28 March

7:30 am – 11:00 am 8:00 am – 5:00 pm	Registration Table Open, Grand Foyer Historical Displays & Information Tables
8:00 am – 9:40 am	Forest Ecology I technical session, Room UC Theater Riverine Science I technical session, Room UC 330/331 Forest Management technical session, Room UC 332/333
9:40 am – 10:10 am	Morning Break, South Ballroom
10:10 am – 12:10 pm	Plum Creek Distinguished Lecture Series technical session, Room UC Theater Riverine Science II technical session, Room UC 330/331 Plant Ecology technical session Room UC 332/333
12:10 pm - 1:30 pm	NWSA Business Luncheon **or** Lunch (on your own)
1:30 pm – 2:50 pm	Fire Ecology I technical session, Room UC Theater Natural Resource Management technical session, Room UC 330/331 Lichens & Bryophytes I technical session, Room UC 332/333
2:50 pm – 3:20 pm	Afternoon Break, South Ballroom
3:20 pm – 4:40 pm	Fire Ecology II technical session, Room UC Theater Forest Ecology II technical session, Room UC 330/331 Lichens & Bryophytes II technical session, Room 332/333
4:40 pm – 5:00 pm	Poster Presenters: Take down posters.

PROGRAM AT A GLANCE (continued)

Saturday 29 March *	**Field Trips** *
8:30 am – 1:30 to 2:30 pm	Lichens & Mosses of Limestone Cliffs * - Northwest Lichenologists
8:30 am – 12:30 to 1:00 pm	Milltown Dam removal & Restoration * - Montana Natural Resource Damage Program
8:30 am – 2:00 pm	Timber Harvesting in an Urban Interface and Ashby Creek Road & Stream Restoration * - Montana Department of Natural Resources & Conservation
8:30 am – 1:00 pm	Bitterroot River Research Natural Area * - U.S. Forest Service, Region 1

*** Please check Registration Table for updates regarding field trips.**

Session Schedule
Wednesday, 26 March 2014

Technical Session: Ecology and Management of Forest Wetlands
Sponsor: Montana Wetland Council
Time: 8:45 am - 4:15 pm
Room: UC 330 / UC 331
Moderator: Lynda Saul

8:45 - 9:00 Gathering: Coffee and Conversation

9:00 - 10:20 **PRICELESS RESOURCES: MONTANA'S STRATEGIC FRAMEWORK FOR WETLAND AND RIPARIAN AREA CONSERVATION AND RESTORATION 2013-2017**
Lynda Saul, Montana Department of Environmental Quality, Helena, MT

OVERVIEW OF STATE WETLAND TIMBER HARVEST REGULATIONS ON STATE, PRIVATE AND FEDERAL FOREST LANDS IN MONTANA
Gary Frank, Montana Department of Natural Resources and Conservation, Missoula, MT.

WETLAND AND RIPARIAN MAPPING IN MONTANA
Karen Newlon, Montana Natural Heritage Program, Helena, MT

10:50 - 12:10 **NON-LETHAL BEAVER MANAGEMENT AND HABITAT RESTORATION PLANNING IN THE UPPER CLARK FORK RIVER BASIN**
Amy Chadwick, Great West Engineering, Missoula, MT

BEAVERS CAN FACILITATE INVASIVE TREES ON MAJOR RIVERS IN EASTERN MONTANA
Peter Lesica, Conservation Biology Research, Missoula, MT

FLUVIAL- AND PLUVIAL-ORIGIN COTTONWOODS ALONG A PRAIRIE STREAM: IMPLICATIONS FOR COTTONWOOD RECRUITMENT EXPECTATIONS
Michael Merigliano, University of Montana, Missoula, MT

1:10 - 2:40 **EXTREMELY RICH FEN MERITS PROTECTION AND MOTIVATES STATEWIDE PLANT CONSERVATION STRATEGIES**
Tara Luna, East Glacier Park, MT; Peter Lesica, Conservation Biology Research, Missoula, MT; Loren Bahls, Montana Diatom Collection, Helena, MT

Session Schedule
Wednesday, 26 March 2014

Technical Session: Ecology and Management of Forest Wetlands (continued)
Sponsor: Montana Wetland Council
Time: 8:45 am - 4:15 pm
Room: UC 330 / UC 331
Moderator: Lynda Saul

1:10 - 2:40 **MANAGEMENT RECOMENDATIONS TO PROTECT WESTERN MONTANA FORESTED WETLANDS AND PEATLANDS FOR WILDLIFE CONSERVATION**
Kristi L. DuBois, Montana Fish, Wildlife & Parks, Missoula, MT

GROUNDWATER DEPENDENT ECOSYSTEMS POLICY AND INVENTORY IN THE U.S. FOREST SERVICE
Meredith Webster, U.S .Forest Service, Missoula, MT

DISTRIBUTION AND CHARACTERISTICS OF GROUNDWATER-DEPENDENT WETLANDS IN WESTERN MONTANA FORESTS
Jennifer Chutz, DCI West Biological Consulting, LLC, Whitefish, MT; Linda Vance, Montana Natural Heritage Program, Helena, MT

3:00 - 4:15 **UNITED STATES FOREST SERVICE-MONTANA COMPACT: WATER RIGHTS FOR NATURAL WETLANDS AND INSTREAM FLOW PROTECTION**
Thor Burbach, U.S. Forest Service, Missoula, MT

THE ROLE OF WETLAND, RIPARIAN, AND FLOODPLAIN WATER STORAGE IN MONTANA'S WATER SUPPLY INITIATIVE
Bruce Sims, U.S. Forest Service, Missoula, MT; Lynda Saul, Montana Department of Environmental Quality, Helena MT

Session Schedule
Thursday, 27 March 2014

Plenary Session:
Time: 8:30 am - 10:00 am
Room: UC Theater

8:30 - 10:00 **WELCOME AND INTRODUCTION**
Andrea Woodward, President - Northwest Scientific Association
Andrew Larson, Chair - Plum Creek Distinguished Lecture Series, The University of Montana
James Burchfield, Dean - College of Forestry & Conservation, The University of Montana

FORESTS IN TRANSITION
Richard Waring, Oregon State University, Corvallis, OR

When I entered the field fifty years ago, we assumed that the future yields and composition of forests could be predicted based on long-term empirical studies. Those assumptions are a lot harder to make today with unparalleled outbreaks of fire, insects, and disease under a changing climate. What underlying changes have occurred to set forests into transition? What changes in growth and composition might we expect across the Pacific Northwest and beyond? My presentation illustrates an approach using process-based models, field surveys, and remote sensing designed to help chart the future of forests in different parts of western North America. The key to recognizing shifts in the productive capacity of forests is to follow trends in the layers of leaves that can be supported. Which species are most vulnerable? Which species are most likely to persist or to migrate? Vulnerability, persistence, and migration can be predicted based on a species' differential response to drought, humidity deficits, and temperature variation throughout the year. The potential exists to decrease the vulnerability of forests to fire, insects, and disease through management, using techniques of selective thinning, shorter rotations, and by increasing biodiversity. The approach will be illustrated with examples.

Richard Waring has been with Oregon State University since 1963, where he remains active as a Distinguished Professor Emeritus of Forest Ecology. His current research interest is to forecast disturbance in forests and the subsequent compositional changes associated with climate change. This builds on his earlier research in tree physiology, entomology, and forest growth modeling. Dr. Waring has been a guest professor/scientist at the Botanical Institute in Innsbruck, Austria, The University of Edinburgh, Scotland, The University of Waikato in Hamilton, New Zealand, Woods Hole Ecosystem Center in Massachusetts, and University of South Australia and CSIRO Centre for Environmental Mechanics in Australia. He served 18 months at NASA Headquarters in Washington, DC as a senior visiting scientist. As a leader in the International Biological Program and he helped build the Long-term Ecological Research Program established by NSF. He has published over 170 scientific articles and 4 books (2 co-authored with Dr. Running). Dr. Waring is most respected for the quality of graduate students that he attracted and mentored, including Dr. Running.

Session Schedule
Thursday, 27 March 2014

Technical Session: Plum Creek Distinguished Lecture Series
Sponsor: University of Montana College of Forestry & Conservation
Time: 10:30 am - 12:30 pm
Room: UC Theater
Moderator: Andrew Larson

10:30 - 11:10 **IMPLICATIONS OF CLIMATE CHANGE FOR TURNOVER IN FOREST COMPOSITION: A CASE STUDY FROM MT. RAINIER NATIONAL PARK**
Janneke HilleRisLambers, Ian Breckheimer, Kevin R. Ford, Steve J. Kroiss, University of Washington, Seattle. WA

11:10 - 11:50 **THE VALUE OF OBSERVATION: LONGITUDINAL DATA AND ECOSYSTEM CHANGE**
James A. Lutz, Utah State University, Logan, UT

11:50 - 12:30 **CLIMATE DRIVERS OF FOREST PATTERN: DEVELOPMENT OF WILDFIRE REFUGIA**
Crystal A. Kolden, University of Idaho, Moscow, Idaho

Session Schedule
Thursday, 27 March 2014

Technical Session: Aquatic Ecology
Sponsor: The Center for Riverine Science and Stream Re-naturalization
Time: 10:30 am - 12:30 pm
Room: UC 330/331
Moderator: Gary Frank

10:30 - 10:50 **MOVEMENT PATTERNS AND GROWTH RATES OF TROUT IN THE BIG HOLE RIVER, MONTANA.**
Michael A. Bias, Big Hole River Foundation, Butte, MT; Jim Olsen, Montana Department of Fish, Wildlife & Parks, Bozeman, MT

10:50 - 11:10 **DISTRIBUTION, RELATIVE ABUNDANCE, AND CATCH PER UNIT EFFORT OF FISHES IN THE COLVILLE RIVER WATERSHED, STEVENS COUNTY, WASHINGTON**.
Aaron J. Mettler, Jenna Hatem, Bryan Witte, Jessica Walston, Raymond Ostlie, Allan T. Scholz, Eastern Washington University, Cheney, WA

11:10 - 11:30 **RELATIVE INFLUENCE OF WATER QUALITY AND PHYSICAL HABITAT FACTORS ON SALMONID DISTRIBUTION AND ABUNDANCE IN A SUPERFUND-REMEDIATED MONTANA STREAM.**
Joe P. Naughton, RESPEC Inc., Missoula, MT; Robert E. Gresswell, U.S. Geological Survey, Bozeman, MT; Thomas E. McMahon, Montana State University, Bozeman, MT; Trevor Selch, Montana Fish, Wildlife and Parks, Helena, MT

11:30 - 11:50 **ALBENI FALLS DAM RESTRICTS MOVEMENTS OF BULL TROUT TO NATAL TRIBUTARIES.**
Shawna B. Warehime, Mark Paluch, Allan T. Scholz, Eastern Washington University, Cheney, WA; Brian Bellgraph, Pacific Northwest National Laboratory, Richland, WA; Jason Connor, Kalispell Tribe of Indians, Usk, WA

11:50 - 12:10 **EFFECTIVENESS OF FLOW MANAGEMENT AND RAINBOW TROUT HARVEST ON LONG-TERM VIABILITY OF NATIVE YELLOWSTONE CUTTHROAT TROUT IN THE SOUTH FORK SNAKE RIVER.**
Laurie Battle, Montana Tech, Butte, MT; Rob Van Kirk, Department of Mathematics, Humboldt State University, Arcata, CA; Bill Schrader, Idaho Department of Fish and Game, Nampa, ID

12:10 - 12:30 **EVALUATING BENTHIC MACROINVERTEBRATE ASSEMBLAGES IN THE BIG HOLE RIVER AND TRIBUTARIES, MONTANA.**
Michael A. Bias, Big Hole River Foundation, Butte, MT

Session Schedule
Thursday, 27 March 2014

Technical Session: Community Ecology
Time: 10:30 am - 12:30 pm
Room: UC 332/333
Moderator: Chantelle Delay

10:30 - 10:50 **IMPACTS OF SPOTTED KNAPWEED ON PLANT-POLLINATOR INTERACTIONS**
Christina R. Herron-Sweet, Jane M. Mangold, Erik A. Lehnhoff, Jeffrey L. Littlefield, Montana State University, Bozeman, MT; Laura A. Burkle, Montana State University, Bozeman, MT

10:50 - 11:10 **EVALUATING THE EFFECTS OF A GRASS-SPECIFIC HERBICIDE ON THE SILVERY BLUE BUTTERFLY IN AN OREGON PRAIRIE**
Rachel Glaeser, Cheryl Schultz, Washington State University Vancouver, WA

11:10 - 11:30 **THE DISTRIBUTIONS, ACTIVITY PATTERNS, AND FEEDING HABITS OF COMMON WESTERN OREGON GROUND BEETLES, AND THEIR RELATION TO PEST PREDATION RISK ACROSS AGRICULTURAL LANDSCAPES**
Michael Russell, Oregon State University, Corvallis, OR

11:30 - 11:50 **INFLUENCE OF THE FUNGAL PATHOGEN *PYRENOPHORA SEMENIPERDA* ON DOWNY BROME (*BROMUS TECTORUM*) AND ASSOCIATED GRASSY SPECIES**
Krista A Ehlert, Fabian Menalled, Jane Mangold, Zachariah Miller, Alan Dyer; Montana State University, Bozeman, MT

11:50 - 12:10 **TROPHIC COMPLEXITY AND THE SUCCESS OF FUNGAL BIOLOGICAL CONTROL AGENTS**
Guy R. Knudsen, Louise-Marie Dandurand, Yeoung-Seuk Bae, Tae Gwan Kim, and Ruben Garcia De la Cruz, University of Idaho, Moscow, ID

12:10 - 12:30 **THE IMPACT OF COMMON MYCORRHIZAL NETWORKS ON ECTO-, ENDO-, AND DUAL MYCORRHIZAL HOST PLANTS**
Kira D. Taylor, Rebecca Bunn, Western Washington University, Bellingham, WA

Session Schedule
Thursday, 27 March 2014

Technical Session: Plum Creek Distinguished Lecture Series
Sponsor: University of Montana College of Forestry & Conservation
Time: 1:40 pm - 3:00 pm
Room: UC Theater
Moderator: Andrew Larson

1:40 - 2:20 **DOES AVAILABLE ENERGY INFLUENCE AVIAN RESPONSE TO KEY FOREST STAND HABITAT FEATURES?**
J.P. Verschuyl, J. Giovanini, J. Jones, D. B. McWethy, A. J. Kroll**;** National Council for Air and Stream Improvement, Anacortes, WA

2:20 - 3:00 **HEDGING AGAINST AN UNCERTAIN FUTURE: FOREST PRESERVATION AND CONSERVATION IN THE ANTHROPOCENE**
Travis Belote, The Wilderness Society, Bozeman, MT

Session Schedule
Thursday, 27 March 2014

Technical Session: Research Natural Areas
Sponsor: U.S. Forest Service, Region 1
Time: 1:40 pm - 3:20 pm
Room: UC 330/331
Moderator: Karen Shelly

1:40 - 2:20 **RESEARCH NATURAL AREAS IN THE NORTHERN REGION OF THE U.S. FOREST SERVICE: ISSUES AND RESEARCH OPPORTUNITIES IN A FEDERAL PROTECTED AREAS NETWORK**
Steve Shelly, Mary Manning, U.S. Forest Service, Missoula, MT; John Byrne, U.S. Forest Service, Moscow, ID

2:20 - 2:40 **WHAT THE...MY RNA IS ON FIRE...AGAIN??!**
Gregg Riegel, U.S. Forest Service, Bend OR; Todd M. Wilson, U.S. Forest Service, Corvallis, OR

2:40 - 3:00 **VULNERABILITY OF OREGON AND WASHINGTON'S NATURAL AREAS TO CLIMATE CHANGE**
Margaret Massie, Dr. Anita Morzillo, Oregon State University, Corvallis, OR; Todd Wilson, U.S Forest Service, Corvallis, OR; Emilie Henderson, Institute of Natural Resources, Portland, OR

3:00 - 3:20 **HISTORICAL FOREST STRUCTURE, COMPOSITION, AND SPATIAL PATTERN IN DRY CONIFER FORESTS OF THE SOUTHERN BLUE MOUNTAINS, OREGON: USING RESEARCH NATURAL AREAS TO DESIGN MODERN FOREST RESTORATION TREATMENTS**
Gunnar C. Carnwath, U.S. Forest Service, OR; Derek J. Churchill, University of Washington, Seattle, WA; Sean M. A. Jeronimo, University of Washington, Seattle, WA; Andrew J. Larson, University of Montana, Missoula, MT

Session Schedule
Thursday, 27 March 2014

Technical Session: Soils & Geology
Time: 1:40 pm - 3:00 pm
Room: UC 332/333
Moderator: Gary Frank

1:40 - 2:00 **THE USE OF X-RAY FLUORESCENCE SPECTROSCROPY TO REFINE STRATIGRAPHIC INTERPRETATION OF THE COYOTE CANYON MAMMOTH SITE**
George V. Last, Eirik Krogstad, Pacific Northwest National Laboratory, Richland, WA

2:00 - 2:20 **A CLIMO-, LITHO-, AND PYRO-SEQUENCE APPROACH TO SOIL PROCESSES ACROSS SOUTHWESTERN MONTANA**
John Sugden, *Tony Hartshorn*, Montana State University, Bozeman, MT

2:20 - 2:40 **GEOMORPHIC HAZARDS IN GLACIALLY CONDITIONED BASINS AND IMPLICATIONS FOR RECREATIONAL TRAILS IN GLACIER NATIONAL PARK, MONTANA**
Kari E. Nielsen, Central Washington University, Ellensburg, WA

2:40 - 3:00 **DEEP SOIL: SAMPLING, MODELING, AND SIGNIFICANCE OF CARBON IN SUBSURFACE LAYERS**
Jason James, Warren Devine, Rob Harrison, University of Washington, Seattle, WA; Thomas Terry, Sustainable Solutions, Olympia, WA

Session Schedule
Thursday, 27 March 2014

The Big Sky Banquet
Time: 6:00 pm - 6:30 pm, Social
6:30 pm - 9:30pm, Banquet
Room: UC 332/333

THE DICK & STEVE SHOW: WHO TAUGHT WHOM?
Presented by Dr. Richard Waring & Dr. Steve Running

dinner

NORTHWEST LANDSCAPES
A Slide Show by Chris Boyer with music by Stuart Weber

STEVEN W. RUNNING

Dr. Running has been with the University of Montana, Missoula since 1979, where he is a University Regents Professor of Ecology. His primary research interest is the development of global and regional ecosystem biogeochemical models integrating remote sensing with bioclimatology and terrestrial ecology. Dr. Running is a Team Member for the NASA Earth Observing System, Moderate Resolution Imaging Spectroradiometer, and chairs the MODIS Land Working Group. He is responsible for the EOS global terrestrial net primary production and evapotranspiration datasets. He has published over 260 scientific articles and two books. Dr. Running has recently served on the standing Committee for Earth Studies of the National Research Council and on the federal Interagency Carbon Cycle Science Committee. He has served as a Co-Chair of the National Center for Atmospheric Research Community Climate System Model Land Working Group, a Member of the International Geosphere-Biosphere Program Executive Committee, and the World Climate Research Program, Global Terrestrial Observing System. He currently serves on the advisory NASA Earth Science Subcommittee, and the NOAA Science Advisory Board Climate Working Group. Dr. Running shared the Nobel Peace Prize in 2007 as a chapter Lead Author for the 4th Assessment of the Intergovernmental Panel on Climate Change. Dr. Running is an elected Fellow of the American Geophysical Union and is designated a Highly Cited Researcher by the Institute for Scientific Information. In the popular press, his essay in 2007, "The 5 Stages of Climate Grief" has been widely quoted.

RICHARD H. WARING

Dr. Waring has been with Oregon State University in Corvallis since 1963, where he remains active as a Distinguished Professor Emeritus of Forest Ecology. His current research interest is to forecast disturbance in forests and the subsequent compositional changes associated with climate change. This builds on his earlier research in tree physiology, entomology, and forest growth modeling. During his career, Dr. Waring was a guest professor/scientist at the Botanical Institute in Innsbruck, Austria, The University of Edinburgh, Scotland, The University of Waikato in Hamilton, NZ, University of South Australia in Perth, Woods Hole Ecosystem Center in Massachusetts, and CSIRO Centre for Environmental Mechanics, Canberra, Australia. He also served 18 months at NASA Headquarters in Washington, DC as a senior visiting scientist. Dr. Waring was a leader in the International Biological Program and helped build the Long-term Ecological Research Program established by NSF. He has published over 170 scientific articles and four books, two co-authored with Dr. Running. His paper "Land of the giant conifers" published in Natural History in 1982 is widely cited, as was its precursor published in "Science" with J.F. Franklin in 1979. Dr. Waring is most respected for the quality of graduate students that he attracted and mentored, including Dr. Running.

Session Schedule
Friday, 28 March 2014

Technical Session: Forest Ecology I
Time: 8:00 am - 9:40 am
Room: UC Theater
Moderator: Eryn Schneider

8:00 - 8:20 **ADAPTIVE CAPACITY OF ECOSYSTEMS: CONCEPTS AND APPLICATIONS**
Klaus J. Puettmann, Oregon State University, Corvallis, OR

8:20 - 8:40 **USE OF CLIMATIC WATER BALANCE METRICS AS SITE PRODUCTIVITY PREDICTORS**
Matthew Perry; David Affleck, University of Montana, Missoula, MT; Zachary Holden, University of Montana, Missoula, MT

8:40 - 9:00 **A CONTINTENTAL SCALE APPROACH TO UNDERSTANDING CLIMATE SENSITIVITY IN DOUGLAS-FIR**
Christina Restaino, University of Washington, Seattle, WA; David L. Peterson, U.S. Forest Service, Seattle, WA; Jeremy Littell, United States Geological Service, Anchorage, AK

9:00 - 9:20 **MAPPING MORTALITY IN MONTANA'S WHITEBARK PINE FORESTS**
Linda Vance, Claudine Tobalske, Montana Natural Heritage Program, University of Montana, Missoula, MT; Steve Brown, U.S. Forest Service, Missoula, MT

9:20 - 9:40 **WHITEBARK PINE COMMUNITY DYNAMICS OF THE OLYMPIC MOUNTAINS**
David H. Peter, Timothy B. Harrington, U.S. Forest Service, Olympia, WA

Session Schedule
Friday, 28 March 2014

Technical Session: Riverine Science I
Sponsor: The Center for Riverine Science and Stream Re-naturalization
Time: 8:00 am - 9:40 am
Room: UC 330/331
Moderator: Andrew Wilcox

8:00 - 8:20 **NUMERIC NUTRIENT CRITERIA FOR 18 MONTANA ECOREGIONS.**
Vicki Watson, University of Montana, Missoula, MT; Mike Suplee, Montana Department of Environmental Quality, Helena, MT

8:20 - 8:40 **A COMPARISON OF DIATOM ASSEMBLAGES BETWEEN PRESENT AND HISTORIC PRE-MINING WETLAND SEDIMENTS FROM THE BUTTE MINING AREA.**
Diane Winter, Algal Analysis, LLC, Missoula MT; Nicholas J. Tucci, Montana Bureau of Mines and Geology, Butte, MT

8:40 - 9:00 **A UNIQUE EXTREMELY RICH FEN FROM THE PLAINS OF THE BLACKFEET RESERVATION, MONTANA.**
Tara Luna, East Glacier Park, MT; Peter Lesica Conservation Biology Research, Missoula, MT; Loren Bahls Montana Diatom Collection, Helena, MT

9:00 - 9:20 **CLOSED BASIN WETLAND POND FLUCTUATIONS ON THE WATERVILLE PLATEAU, WASHINGTON.**
Karl Lillquist, Anthony Gabriel, Central Washington University, Ellensburg, WA; Ben Sainsbury, Oregon-Metro, Portland, OR

9:20 - 9:40 **FLOW AND SEDIMENT TRANSPORT CONSTRAINTS ON UPROOTING THRESHOLDS FOR PIONEER WOODY SEEDLINGS.**
Sharon Bywater-Reyes, Andrew C. Wilcox, University of Montana, Missoula, MT; John Stella, Li Kui, State University of New York, Syracuse, NY; Anne Lightbody, University of New Hampshire, Durham, NH

Session Schedule
Friday, 28 March 2014

Technical Session: Forest Management
Time: 8:00 am - 9:40 am
Room: UC 332/333
Moderator: Clayton Marlow

8:00 - 8:20 **THE EFFECTS OF SOIL PARENT MATERIAL AND FERTILIZATION TREATMENT ON THE WOOD QUALITY OF DOUGLAS-FIR IN THE PACIFIC NORTHWEST**
Luyi Li, Eric C. Turnblom, University of Washington, WA

8:20 - 8:40 **INNOVATION AND EVOLUTION OVER 10 YEARS OF COLLABORATIVE ECOSYSTEM RESTORATION EFFORTS ON THE MOUNT HOOD NATIONAL FOREST, OREGON**.
Jeffrey Gerwing, Portland State University, Portland, OR

8:40 - 9:00 **THE LONG-TERM EFFECTS OF FUEL TREATMENTS ON ECOSYSTEM PROCESSES: REVISITING THE LUBRECHT FOREST FIRE AND FIRE SURROGATES STUDY.**
Peter Ganzlin; Dr. Cory Cleveland, University of Montana, Missoula, MT

9:00 - 9:20 **CHANGES IN UNDERSTORY VEGETATION 28 YEARS AFTER OVERSTORY THINING AT YELLOW BAY POINT, FLATHEAD LAKE, MONTANA**.
Patricia S. Muir, Bruce McCune, Oregon State University, Corvallis, OR

9:20 - 9:40 **QUAKING ASPEN RESPONSE TO MECHANICAL TREATMENT IN SOUTHWEST MONTANA.**
Jarrett M. Payne, Twin Bridges, MT; Clayton B. Marlow, Montana State University, Bozeman, MT

Session Schedule
Friday, 28 March 2014

Technical Session: Plum Creek Distinguished Lecture Series
Sponsor: University of Montana College of Forestry & Conservation
Time: 10:10 am - 12:10 pm
Room: UC Theater
Moderator: Andrew Larson

10:10 - 10:50 **INTEGRATING SILVICULTURE & LANDSCAPE ECOLOGY: A FRAMEWORK FOR MULTI-SCALE FOREST MANAGEMENT**
Derek Churchill, University of Washington, Seattle, WA

10:50 - 11:30 **PAST, PRESENT, AND FUTURE IN THE FORESTS OF CALIFORNIA'S SIERRA NEVADA: VARIABILITY IN FOREST RESPONSE TO ENVIRONMENTAL CHANGE, AND THE ROLE OF MANAGEMENT IN PROMOTING ECOSYSTEM RESILIENCE**
Hugh D. Safford, University of California, Davis, CA

11:30 - 12:10 **ACCELERATING CLIMATE CHANGE ADAPTATION IN FOREST ECOSYSTEMS: PRINCIPLES AND PARADIGM SHIFTS**
David L. Peterson, U.S. Forest Service, Seattle, WA

Session Schedule
Friday, 28 March 2014

Technical Session: Riverine Science II
Sponsor: The Center for Riverine Science and Stream Re-naturalization
Time: 10:10 am - 12:10 pm
Room: UC 330/331
Moderator: Andrew Wilcox

10:10 - 10:30 **DOWSTREAM SPATIAL AND TEMPORAL RESPONSE TO DAM REMOVAL, WHITE SALMON RIVER, WASHINGTON**
Erika J. Colaiacomo, University of Montana, Missoula, MT

10:30 - 10:50 **MIMICKING NATURE: RESTORATION OF THE CLARK FORK RIVER AT MILLTOWN, MONTANA**
Diana Hammer, U.S. Environmental Protection Agency, Helena, MT; *Amy Sacry*, Geum Environmental Consulting, Hamilton, MT

10:50 - 11:10 **MERCURY CONTRIBUTIONS FROM FLINT CREEK AND OTHER TRIBUTARIES TO THE UPPER CLARK FORK RIVER IN NORTHWESTERN MONTANA**
Heiko Langner, Matthew Young, Molly Staats, University of Montana, Missoula, MT; Ute Langner, Montana Natural Heritage Program, University of Montana, Missoula, MT

11:10 - 11:30 **LONG-TERM WATER QUALITY DATA AND BIOGEOCHEMICAL FILTERING ALONG THE UPPER CLARK FORK RIVER, MONTANA**
H. Maurice Valett, Marc Peipoch, Mike DeGrandpre, Vicki Watson, University of Montana, Missoula, MT; Mike Suplee, Montana Department of Environmental Quality, Helena, MT; Rob Payn, Montana State University, Bozeman, MT

11:30 - 11:50 **VARIATION IN BIOTIC FORM AND FUNCTION AMONG AQUATIC HABITATS OF RIVERINE FLOODPLAINS**
Marc Peipoch, Katey P. Driscoll, Ric F. Hauer, Maury H. Valett, University of Montana, Missoula, MT

11:50 - 12:10 **HYDROLOGIC MODELING OF IMPACTS OF CLIMATE CHANGE ON STREAMFLOW AND SEDIMENT TRANSPORT FOR SNOWMELT-DOMINATED RIVERS IN THE INTERIOR PACIFIC NORTHWEST**
Sarah Praskievicz, University of Oregon, Eugene, OR

Session Schedule
Friday, 28 March 2014

Technical Session: Plant Ecology

Time: 10:10 am - 12:10 pm
Room: UC 332/333
Moderator: Chantelle Delay

10:10 - 10:30 **A FIELD AND MODELING APPROACH TO PREDICTING A COASTAL WETLAND RESPONSE TO SEA LEVEL RISE**
Katrina L. Poppe, John M. Rybczyk, Western Washington University, Bellingham, WA

10:30 - 10:50 **COMMUNITY-SPECIFIC BIOGEOCHEMICAL RESPONSES TO ATMOSPHERIC NITROGEN DEPOSITON IN SUBALPINE MEADOW ECOSYSTEMS OF THE CASCADES**
Justin Poinsatte, Washington State University, Pullman, WA; Regina Rochefort, North Cascades National Park Service Complex, Sedro-Woolley, WA, 98284; Lou Whiteaker, Mount Rainier National Park, Ashford, WA; R. Dave Evans, Washington State University, Pullman, WA

10:50 - 11:10 **SIMILARITIES AND DIFFERENCES IN PLANT COMMUNITY RESPONSE TO ABIOTIC CONDITIONS WITHIN 30 VARIABLY AGED GRAZING EXCLOSURES IN BRITISH COLUMBIA, CANADA**
W.F. Preston Cumming, Gary Bradfield, University of British Columbia, Vancouver, BC; Reg Newman, Ministry of Forests, Kamloops, BC

11:10 - 11:30 **APPLYING COMMUNITY ASSEMBLY RULES TO UNDERSTAND INVASION - THE SEED PREDATION FILTER**
Dean Pearson, U.S. Forest Service, Missoula, MT; Jose Hierro, Universidad Nacional de La Pampa, Uruguay, Argentina; John Maron, University of Montana, Missoula, MT; Nadia Icasatti, Universidad Nacional de La Pampa, Uruguay, Argentina; Ray Callaway, University of Montana, Missoula, MT; Justin Runyon, U.S. Forest Service, Bozeman, MT; Yvette Ortega, U.S.Forest Service, Missoula, MT

11:30 - 11:50 **EVALUATING THE IMPACT OF TALL BUTTERCUP (*RANUNCULUS ACRIS*) ON FORAGE PRODUCTION, SPECIES RICHNESS AND PLANT DIVERSITY**
Hally Strevey, Jane Mangold, Montana State University, Bozeman, MT

11:50 - 12:10 **EXOTIC PLANT INVASION DISRUPTS HOST-PARASITOID INTERACTIONS: INVISIBLE PARASITOID WASP BECOMES VISIBLE TO SPIDER HOST**
Jennifer N. Smith, Douglas J. Emlen, University of Montana, Missoula, MT; Dean E. Pearson, U.S. Forest Service, Missoula, MT

Session Schedule
Friday, 28 March 2014

Technical Session: Fire Ecology I
Time: 1:30 pm - 2:50 pm
Room: UC Theater
Moderator: Eryn Schneider

1:30 - 1:50 **HISTORICAL FIRE HETEROGENEITY IN A SIERRA NEVADA MIXED-CONIFER FOREST**
Molly A.F. Barth, Andrew J. Larson**,** University of Montana, Missoula, MT; James A. Lutz, Utah State University, Logan, UT

1:50 - 2:10 **CHARACTERIZING FOREST STRUCTURE OF THE SIERRA NEVADA: AN EXAMINATION OF FIRE, CLIMATIC WATER BALANCE, AND LARGE-DIAMETER TREES**
Kendall M.L. Becker, James A. Lutz, Utah State University, Logan, UT

2:10 - 2:30 **HISTORICAL FIRE REGIME AND FOREST COMPOSITION IN THE SOUTHERN BLUE MOUNTAINS OF OREGON**
Sean M. A. Jeronimo, Derek J. Churchill, University of Washington, Seattle, WA; Gunnar C. Carnwath, U.S. Forest Service, Baker City, OR; Andrew J. Larson, University of Montana, Missoula, MT

2:30 - 2:50 **EVIDENCE OF HIGH-SEVERITY FIRE IN A 1915-1925 INVENTORY OF APPROXIMATELY 200,000 FORESTED HECTARES IN EASTERN OREGON**
Keala Hagmann, Jerry F. Franklin, University of Washington, Seattle, WA

Session Schedule
Friday, 28 March 2014

Technical Session: Natural Resource Management
Time: 1:30 pm - 2:50 pm
Room: UC 330/331
Moderator: Clayton Marlow

1:30 - 1:50 **A FORTY YEAR ODYSSEY WITH WOLVES IN MONTANA**
Robert Ream, University of Montana, Missoula, MT

1:50 - 2:10 **EMERGING RESEARCH IN NATURAL RESOURCE MANAGEMENT THROUGH A CONSORTIUM OF REGIONAL UNIVERSITIES AND FEDERAL AGENCIES**
Pei-Lin Yu, Lisa Gerloff, Kathy Tonnessen, University of Montana, Missoula, MT

2:10 - 2:30 **TRADITIONAL NATIVE AMERICAN METHODS FOR HARVESTING BARK DOES NOT CHANGE SECONDARY GROWTH RATES IN WESTERN RED-CEDAR**
David A. Hooper, University of Montana, Missoula, MT

2:30 - 2:50 **INTEGRATION OF SHEEP AND CROP PRODUCTION: EFFECTS ON COVER CROP TERMINATION, WHEAT EMERGENCE, AND SHEEP LIVE WEIGHT GAINS**
Jasmine Westbrook, Craig Carr, Patrick Hatfield, Molly Butler, Montana State University, Bozeman, MT; Perry Miller, Fabian Menalled, Montana State University, Bozeman, MT

Session Schedule
Friday, 28 March 2014

Technical Session: Lichens & Bryophytes I
Time: 1:30 pm - 2:50 pm
Room: UC 332/333
Moderator: Tim Wheeler

1:30 - 1:50 **MANY THINGS YOU CAN DO, NOVICES CAN DO TOO: SAMPLING ERROR ASSOCIATED WITH NOVICE TECHNICIANS IN A LARGE-SCALE, LONG TERM BIODIVERSITY MONITORING INITIATIVE**
Diane L. Haughland, Alberta Biodiversity Monitoring Institute at the Royal Alberta Museum, Edmonton, AB

1:50 - 2:10 **A METHOD FOR ASSESSING CARBON STORAGE AND FUNCTIONAL IMPORTANCE IN MOSS AND LICHEN GROUND LAYERS**
Robert J. Smith and Bruce McCune, Oregon State University, Corvallis, OR; Sarah Jovan, U.S. Forest Service, Portland, OR

2:10 - 2:30 **MONTANA LICHEN BIODIVERSITY – AN UPDATE**
Bruce McCune, Oregon State University, Corvallis, OR; Roger Rosentreter, Boise, ID; Toby Spribille, University of Graz, Austria; Othmar Breuss, Naturhistorisches Museum Wien, Wien, Austria; Tim Wheeler, Arlee, MT

2:30 - 2:50 **MOSS FRAGMENTS TO RESTORE VEGETATIVE COVER TO ARID ECOSYSTEMS**
Roger Rosentreter, Boise State University, Boise, ID

Session Schedule
Friday, 28 March 2014

Technical Session: Fire Ecology II
Time: 3:20 pm - 4:40 pm
Room: UC Theater
Moderator: Kelsey Jencso

3:20 - 3:40 **HOW QUICKLY DOES BIG SAGEBRUSH RECOVER FOLLOWING FIRE?**
Peter Lesica, Conservation Biology Research, Missoula, MT; Stephen V. Cooper, Montana Natural Heritage Program, Helena, MT

3:40 - 4:00 **THE POST GLACIAL FIRE AND VEGETATION HISTORY OF SUNRISE RIDGE, MOUNT RAINIER NATIONAL PARK, WASHINGTON**
Megan K. Walsh, Central Washington University, Ellensburg, WA; Michael Lukens, Central Washington University, Ellensburg, WA

4:00 - 4:20 **DEFINING NEW FUEL MAPS FOR MOUNT RAINIER NATIONAL PARK FROM A FUSION OF FIELD, LIDAR, AND ENVIRONMENTAL DATA**
Van R. Kane, University of Washington, Seattle, WA; Karen Kopper, North Cascades National Park, Marblemount, WA 98267; Catharine Copass, Olympic National Park, Port Angeles, WA

4:20 - 4:40 **FIRE ACTIVITY AND SEVERITY VARY ALONG PROXY GRADIENTS REPRESENTING FUEL AMOUNT AND FUEL MOISTURE IN THE WESTERN UNITED STATES**
Sean A. Parks, U.S. Forest Service, Missoula, MT; Marc-André Parisen, Canadian Forest Service, Edmonton, Alberta; Carol Miller, U.S. Forest Service, Missoula, MT; Solomon Z. Dobrowski, University of Montana, Missoula, MT

Session Schedule
Friday, 28 March 2014

Technical Session: Forest Ecology II
Time: 3:20 pm - 4:40 pm
Room: UC 330/331
Moderator: Andrew Larson

3:20 - 3:40 **MAPPING A HISTORIC BITTERROOT VALLEY, MONTANA LANDSCAPE USING GENERAL LAND OFFICE SURVEYORS' FIELD NOTES**
Karen Shelly, University of Montana, Missoula, MT

3:40 - 4:00 **INFLUENCE OF TREE AGREGATION ON MORTALITY IN PRE-FIRE SUPPRESSION FORESTS IN THE SOTHERN BLUE MOUNTAINS OF OREGON**
Miles LeFevre, Derek J. Churchill, University of Washington, Seattle, WA; Gunnar C. Carnwath, U.S. Forest Service, Baker City, OR; Andrew J. Larson, University of Montana, Missoula, MT

4:00 - 4:20 **WESTERN WHITE PINE SEEDLINGS COMPENSATE FOR AN AMMONIUM DEFICIENCY WITH INCREASED AMINO ACID UPTAKE**
Beau Larkin, MPG Operations, Missoula, MT

4:20 - 4:40 **RATES AND SPATIAL PATTERNS OF TREE MORTALITY DIFFER STRONGLY BETWEEN YOUNG AND OLD-GROWTH FORESTS**
Andrew J. Larson, University of Montana, Missoula, MT

Session Schedule
Friday, 28 March 2014

Technical Session: Lichens & Bryophytes II
Time: 3:20 pm - 4:40 pm
Room: UC 332/333
Moderator: Tim Wheeler

3:20 - 3:40 **CYANOBACTERIAL IDENTITY IN STEREOCAULON OF THE NORTH AMERICAN ARCTIC AND HOW IT INFLUENCES BOTH CEPHALODIAL MORPHOLOGY AND SPECIES DEFINITION**
Elisa Alphandary, Bruce McCune, Oregon State University, OR

3:40 - 4:00 **UNTANGLING *LEPTOGIUMS: LEPTOGIUM SATURNINUM* AND *L. BURNETIAE***
Daphne Stone, Eugene, OR; Frances Anderson, Nova Scotia Museum, Halifax, NS, Canada; James Hinds, University of Maine, Orono, ME; James Lendemer, New York Botanical Garden, Bronx, NY

4:00 - 4:40 **A BRYOPHYTE AND LICHEN FLORA FOR THE SOUTH PUGET SOUND PRAIRIES**
Lillian M. Hynson, Abigail Arnold, Evan Charatz, Gregory Eide, Griffin Jackmond, Joseph Nannes, Kate Petersen, Lalita M. Calabria, Evergreen State College, Olympia, WA

Poster Session Schedule
Thursday, 27 March 2014

Room: South Ballroom
Poster Set-Up Time: 12:30 pm - 2:00 pm
Attended Poster Session Time: 3:15 pm – 5:30 pm, Authors will be available to discuss and answer questions.
Poster Take-Down Time:: FRIDAY 28 March 2014, 4:40-5:00pm

Listed in order of presenting author [italicized]:

THE INFLUENCE OF FIRE ON HERBACEOUS COMMUNITY COMPOSITION OF SUBALPINE PARKLAND IN THE NORTH CASCADES.
Justine Andreychuk, C. Alina Cansler, University of Washington, Seattle, WA; Donald McKenzie, U.S. Forest Service, Seattle, Washington

TEST OF THE EFFECTIVENESS OF BOKASHI AMENDMENT FOR A CAMPUS COMPOSTING PILOT STUDY.
Talinna Appling, M. Departee, Z. Eddy, P. Rychener, A. Hartshorn, Montana State University, Bozeman, MT

GROUND BEETLE (COLEOPTERA: CARABIDAE) POPULATIONS IN WESTERN WASHINGTON PRAIRIES AND GARRY OAK STANDS.
Rachel L Bietz, Evergreen State College, Olympia WA; Chris Maynard, Washington State, Lacey, WA

PLANT-POLLINATOR INTERACTIONS IN A NORTHWEST ARUM ARE INFLUENCED BY PLANT TRAITS, NOT RIPARIAN FOREST MANAGEMENT.
Matthew R. Brousil, Chris Humann, and Dylan Fischer, Evergreen State College, Olympia, WA

CHARACTERIZING STREAMFLOW RESPONSE TO IRRIGATION USING COUPLED HYDROLOGIC AND AGROECONOMIC MODELS.
Douglas R. Brugger, Marco P. Maneta, University of Montana, Missoula, MT

THE EFFECT OF LAND USE AND LAND MANAGEMENT ON CARBON SEQUESTRATION AT CABIN CREEK RANCH IN SHEPHERD, MONTANA.
Hailey Buberl, Clayton Marlow, Montana State University, Bozeman, MT; Stephanie Ewing, Montana State University, Bozeman, MT

A COMPARISON OF THE PARKER POINT INTERCEPT AND DAUBENMIRE CANOPY COVER VEGETATION SAMPLING METHODS USED AT THE LOST TRAIL NATIONAL WILDLIFE REFUGE, MARION, MONTANA.
Joshua Buckmaster, Clayton Marlow, Montana State University, Bozeman, MT

CAN ZIRCONIUM SERVE AS AN INDICATOR OF POST-FIRE SOIL BURN SEVERITY?
Russell Callahan, Tony Hartshorn, Montana State University, Bozeman, MT

POSTER SESSION SCHEDULE

Listed in order of presenting author [italicized].

TREE REGENERATION AFTER FIRE IN *ABIES LASIOCARPA-LARIX LYALLII-PINUS ALBICAULIS* SUBALPINE PARKLAND IN THE NORTH CASCADES, WASHINGTON.
C. Alina Cansler, University of Washington, Seattle, WA; Donald McKenzie, U.S. Forest Service, Seattle, Washington

MANAGING FOR RESILIENCE IN ROCKY MOUNTAIN LODGEPOLE PINE: EFFECTS OF HETEROGENEOUS STAND TREATMENTS ON WOODY SURFACE FUELS DYNAMICS AND POSTULATED FIRE BEHAVIOR.
Justin S. Crotteau, Christopher R. Keyes, University of Montana, Missoula, MT; David K. Wright, Elaine K. Sutherland, U.S. Forest Service, Missoula, MT

DETERMINATION OF BIOAVAILABLE PHOSPHORUS IN STORM WATER ENTERING LAKE WHATCOM, WASHINGTON FROM FORESTED AND DEVELOPED WATERSHEDS USING THE DUAL CULTURE DIFFUSION APPARATUS REACTOR.
Jonnel Deacon, Dr. Robin Matthews, Western Washington University, Bellingham, WA

RIPARIAN-ASSOCIATED GASTROPODS IN WESTERN WASHINGTON: COMMUNITY COMPOSITION AND THE EFFECTS OF FOREST MANAGEMENT.
Alex D. Foster, U.S. Forest Service, Olympia, WA; Joan Ziegltrum, Shelton, WA

VEGETATION CLASSIFICATION AND FIRE ACTIVITY IN THE BLUE MOUNTAINS OF OREGON.
Christopher R. Goodner, Central Washington University, Ellensburg, WA; Megan K. Walsh, Central Washington University, Ellensburg, WA

PRELIMINARY STABLE ISOTOPE ANALYSIS OF SELECTED SAMPLES FROM THE COYOTE CANYON MAMMOTH SITE, KENNEWICK, WASHINGTON.
Max Guettinger, Nicholas Jared McMillan, Peter Larson, Washington State University, Pullman, WA; George Last, Pacific Northwest National Laboratories, Richland, WA; Scott Boroughs, Washington State University, Pullman, WA

LICHEN BIOMONITORING RESULTS FROM 20 YEARS OF SAMPLING IN PACIFIC NORTHWEST WILDERNESS AREAS.
Amanda Hardman, Linda Geiser, U.S. Forest Service, Corvallis, OR

SYSTEMATIC ANALYSIS OF CARBON STOCKS IN A SMALL CATCHMENT OF THE KOLYMA WATERSHED.
Kathryn E. Heard, Andrew Bunn, Western Washington University, Bellingham, WA; Sue Natali, Woods Hole Research Center, Falmouth, MA

LITHIC ANALYSIS OF COYOTE CANYON MAMMOTH SITE SEDIMENTS.
Kaitlin M. Hill, Central Washington University, Ellensburg, WA; George V. Last, Pacific Northwest National Laboratory Richland, WA 99352;

POSTER SESSION SCHEDULE

Listed in order of presenting author [italicized].

ETHANOL ACCUMULATION DURING SEVERE DROUGHT MAY SIGNAL TREE VULNERABILITY TO DETECTION AND ATTACK BY BARK BEETLES.
Rick G. Kelsey, USDA Forest Service, OR; D. Gallego, F. J. Sánchez-García, Universidad de Murcia, Murcia, Spain; J. A. Pajares, University of Valladolid, Palencia, Spain

EPIDEMIOLOGICAL POTENTIAL OF WHITE-NOSE SYNDROME IN THE NORTHWEST: AN INDIVIDUAL-BASED SIMULATION MODEL EXPLORES DISEASE PARAMETERS. *Guy R. Knudsen*, University of Idaho, Moscow, ID; Sybill K. Amelon, U.S. Forest Service, Columbia, MO; Rita D. Dixon, Idaho Department of Fish and Game, Boise, ID

USE OF A TROPHIC SIMULATION MODEL TO DEVELOP PALE CYST NEMATODE ERADICATION STRATEGIES.
Guy Knudsen, Louise-Marie Dandurand, University of Idaho, Moscow, ID

INTRA- AND INTER- SPECIFIC VARIABILITY OF TRANSPIRATION ON MONTANE HILLSLOPES.
Nathaniel Looker, Justin Martin, Jia Hu, Montana State University, Bozeman, MT; Zachary Hoylman, Kelsey Jencso, University of Montana, Missoula MT

FIRST RECORD OF CHEANOTHECOPSIS OREGANA IN CANADA.
Mireille Martel, Diane L. Haughland, Alberta Biodiversity Monitoring Institute at the Royal Alberta Museum, Edmonton, Alberta

SURVEY OF BIOLOGICAL SOIL CRUSTS ON BLM LANDS IN WYOMING.
Tyrell Perry, Peter Stahl, University of Wyoming, Laramie, WY

THE EFFECTS OF LITTERFALL ON SNOW ABLATION RATES IN NORTHERN ROCKIES MIXED-CONIFER FORESTS.
Michael S. Schaedel, Andrew J. Larson, University of Montana, Missoula, MT

PREDATORY LURING AS A MEANS OF PREY ACQUISITION IN *ARGIA VIVIDA*: A BEHAVIORAL STUDY.
Sharol A. Schmidt, Michael Edgehouse, Lewis-Clark State College, Lewiston, ID

THE INFLUENCE OF TREE SPECIES AND CANOPY POSITION ON SNOW DISAPPEARANCE DATE IN WESTERN MONTANA MIXED-CONIFER FOREST.
Eryn E. Schneider, Andrew J. Larson, University of Montana, Missoula, MT; Zachary A. Holden, U.S. Forest Service, Missoula, MT

EVALUATING STREAMFLOW TRENDS USING RUNOFF SENSITIVITY TO LAND USE AND CLIMATE CHANGE.
Nicholas L. Silverman, Marco P. Maneta, Johnnie N. Moore, University of Montana, Missoula, MT

POSTER SESSION SCHEDULE

Listed in order of presenting author [italicized].

UNCERTAINTY IN ESTIMATING EVAPOTRANSPIRATION AT THE REGIONAL SCALE: A REMOTE SENSING ANALYSIS AND COMPARISON OF LANDSAT SATELLITE DATA IMPROVEMENTS.
Aiden V. Johnson, Paul C. Stoy, Elizabeth Harris, Stephanie E. Ewing Montana State University, Bozeman, MT

SEASONAL DIET OF A POPULATION OF WESTERN TERRESTRIAL GARTER SNAKES, *THAMNOPHIS ELEGANS*, ALONG THE GRANDE RONDE RIVER, SOUTHEASTERN WASHINGTON.
Michael A. Skinner, Michael Edgehouse, Christopher Brown, Brigette S. Schwimmer, Lewis-Clark State College, Lewiston, ID

SOIL CONTROLS ON VEGETATION IN HYALITE CANYON.
John Sugden, Tony Hartshorn, Montana State University, Bozeman, MT

COMPARATIVE REACTION ANALYSIS OF *P*-PHENYLENEDIAMINE IN STEINER'S SOLUTION VS. ETHANOL ON COMMON LICHEN SUBSTANCES.
Darcie Thauvette, Diane L. Haughland, Royal Alberta Museum, Alberta Biodiversity Monitoring Institute, Edmonton, AB, Canada

PREDICTING EPIPHYTIC LICHEN BIODIVERSITY FROM LIDAR DERIVED CANOPY STRUCTURE.
Levi W. Travis, Harmony D. Counsellor, Tim W. Henry, Danny D. Barker, Allison C. Swan, James S. Parker, and Dylan Fischer, Evergreen State College, Olympia, WA

ECOLOGICAL IMPACTS OF BLADED FIRE LINES IN THE NORTHERN MIXED GRASS PRAIRIE.
Samdanjigmed Tulganyam, Craig A.Carr, Montana State University, Bozeman, MT

HOLOCENE BIOTIC SHIFTS IN THE INTERIOR RAINFOREST OF BRITISH COLUMBIA.
Ariana L. White, Daniel G. Gavin, University of Oregon, Eugene, OR

EFFECTS OF NATIVE VEGETATION AND AGRICULTURE ON SOIL CARBON OF MONTANA'S GALLATIN VALLEY.
Edward Wierda, Tony Hartshorn, Montana State University, Bozeman, MT

THE UNIVERSITY OF MONTANA ALGAE AND DIATOM COLLECTION OF DR. FRED A. BARKLEY.
Diane Winter, Algal Analysis, LLC, Missoula MT; Dennis Vander Meer, Rhithron Associates, Inc., Missoula, MT

FIELD TRIPS

Milltown Dam Removal & Restoration

Day / Time: Saturday March 29, 2014; 8:30am to 12:30pm
Pick-Up Location: UC parking lot (see page 10)
Leader: Doug Martin (Montana Natural Resource Damage Program)

About 8 miles upstream from Missoula on the Clark Fork River, Milltown Dam was removed in 2008. Come hear the history of the dam site and its designation as a superfund site, learn about the remediation and restoration activities, and witness the restoration efforts from several locations. Doug Martin, Restoration Project Manager, will guide participants on an interesting tour of this site.

Site History: Milltown Dam was built in 1906 at the confluence of the Clark Fork River and Blackfoot River, eight miles east of Missoula, Montana. During the Clark Fork River flood of record in 1908, the reservoir filled with approximately 6.6 million cubic yards of sediment including tailings from mining operations near Butte, Montana. Between 2005 and 2012 the Milltown Dam and some of the contaminated sediments were removed and a floodplain was re-constructed to near pre-dam conditions allowing the Clark Fork River to flow freely for the first time in over 100 years. Integrated planning efforts for the remediation and restoration of the post-dam Clark Fork River floodplain began in 2000, and implementation of this project was completed in 2012. The integrated remediation and restoration plan goals were to address adverse impacts of this site on human health and the environment by the removal of contaminated sediments and removal of the dam structure, thus cleaning up groundwater, limiting scour of sediments downstream, and reconstruction of the floodplain near the former Milltown Dam into a naturally functioning, self-maintaining floodplain system. To accomplish these goals the project addressed nearly 3 million cubic yards of contaminated sediment, removed the entire dam structure, constructed three miles of the Clark Fork River channel, and completed over 250 acres of floodplain development.

The Lichens and Mosses of Dry, Limestone Canyons

Day / Time: Saturday March 29, 2014; 8:30am to 1:30-2:30pm
Meeting Location: UC parking lot (see page 10)
Leader: Tim Wheeler (Consulting Lichenologist & Geologist)

About 40 miles east of Missoula (on Interstate 90 near Drummond) there is a band of limestone cliffs that house fossilized animals and living mosses and lichens. Come join Tim Wheeler as he leads us on short walks into easily accessible walls of limestone so that we may explore the diversity of lichens and mosses inhabiting this area.

Site Description: The Madison Limestone was deposited 350 million years ago in a shallow sea, and as we explore the cliffs you will notice the fossilized remains of many species of marine creatures. As the Rocky Mountains were forming this area was uplifted, folded, and faulted, resulting in a series of beautifully complex canyons. Mulkey Gulch, Rattler Gulch, and the Helmville Road near Drummond are three south draining canyons that empty into the Clark Fork River. Rattler Gulch is a BLM designated ACEC (Area of Critical Environmental Concern) due to canyon's unique geology. These drainages are also a favorite among rock climbers. Vertical dipping beds of limestone create interesting terrain with steep cliff walls and sharp spires.

Timber Harvesting in an Urban Interface & Ashby Creek Road Stream Restoration

Day / Time: Saturday March 29, 2014; 8:30 am to 2:00 pm*
Meeting Location: UC parking lot (see page 10)
Leader: Gary Frank (Montana DNRC)

We will travel up the Blackfoot River to the Lower Gold Creek drainage and Potomac area to examine two recently completed forest management projects on state trust lands.
Our first stop is the McNamara Timber Sale. This timber sale represents the challenge of logging in an urban interface. Situated on State land and surrounded by Plum Creek timber land that is being subdivided for home sites, we will discuss the State Forest Land Management Plan, the DNRC Forested Lands Habitat Conservation Plan (HCP), and other guiding standards used to design and implement Forest Management Activities. We will discuss the final environmental assessment, silvicultural prescriptions, and the process for designing the sale and contracting the harvest. We will look at the harvest operations and the Best Management Practices implemented to prevent, minimize, or reduce damage to other resources. These will include implementation of soil protection measures, installation of a stream crossing structure designed for fish passage, use of Streamside Management Zones, and wildlife mitigation measures.
Our second stop is Ashby Creek Road and Stream, located on previously owned industrial forest land in the Garnet Range near Potomac. The DNRC acquired this area along with 30,000 acres in 2011 under the Montana Forest Legacy Project. Since this acquisition DNRC has aggressively worked with partners to repair and restore the existing historic road and the stream crossing structures that had negatively impacted water quality, fish passage, and aquatic habitat. Our tour will see how the road was moved upslope and out of the floodplain and how it had channelized the stream, caused flooding, and released sediment into the creek. The old roadbed was reclaimed, several stream structures were removed, and about 1000 feet of stream was reconstructed to restore habitat and stream functions. This project was completed in the fall of 2013. During the tour, we will discuss forest road standards, road construction methods, bridge design, stream restoration, cattle grazing management, erosion control and re-vegetation.

The Bitterroot River Research Natural Area

Day / Time: Saturday March 29, 2014; 8:30am to 1:00pm*
Pick-Up Location: UC parking lot (see page 10)
Leaders: Steve Shelly &Mary Manning (USFS), Karen Shelly (MT Native Plant Society)

The U.S. Forest Service (FS) has established over 480 Research Natural Areas (RNAs) on our National Forests and Grasslands in the USA. These protected sites are selected to represent the range of plant communities and habitats found on our FS lands, and are designated for research, education, and the conservation of biological diversity. To date 64 RNAs have been established in Montana. Participants will learn about the RNA program in detail and discuss the ecological processes that have shaped this particular RNA, the potential for restoration management in protected areas, and the importance of reference sites for assessing the effects of climate change. Beaver activity in and near the RNA is evident, and some effects of that activity will be examined during the field tour. We will also see where areas have been invaded by non-native plants giving us an opportunity to discuss invasive plant management in protected areas.

Site Description: The Bitterroot River RNA is a small preserve in the scenic Bitterroot Valley of west-central Montana, approximately 24 miles south of Missoula. One of the assigned ecosystem "targets" for the RNA network on the Bitterroot National Forest was a riverine ecosystem. This 40-acre site, while small in size, represents that ecosystem in a landscape that is predominantly private land. But it is contiguous with the Lee Metcalf National Wildlife Refuge and contributes to a larger conservation site in this broad riverine valley bottom setting. There are 8 riparian vegetation types represented in this RNA, including herbaceous and shrub-dominated plant communities as well as riverine cottonwood and old-growth ponderosa pine stands.

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ABSTRACTS

ORAL AND POSTER PRESENTATIONS ARE
ARRANGED BY LAST NAME OF PRESENTING AUTHOR

CYANOBACTERIAL IDENTITY IN STEREOCAULON OF THE NORTH AMERICAN ARCTIC AND HOW IT INFLUENCES BOTH CEPHALODIAL MORPHOLOGY AND SPECIES DEFINITION. Elisa Alphandary; Bruce McCune, Department of Botany and Plant Pathology, Oregon State University, 1098 Cordley Hall, Corvallis, OR 97331; *alphande 'at' onid.orst.edu*

Stereocaulon is mainly a fruticose, nitrogen-fixing, rock and ground dwelling genus of lichenized fungi. It is widespread throughout the world, and in many areas has a high biomass. Among lichenized fungi *Stereocaulon* frequently receives minimal attention by lichenologists in the Pacific Northwest. Some explanations are that it is not epiphytic, it can be a frustrating genus to identify, and finally it is a tripartite genus which adds further complexity to its species definitions. Historically it was often necessary to observe the cephalodia under a compound microscope to distinguish the genus of cyanobiont. Under a compound microscope one would either see *Nostoc*, which has chains of small bead-like cells, or *Stigonema,* which has two or more rows of large cells within a filament. In order to facilitate identification we sought differences in the external morphology of the cephalodia among species and between cyanobionts themselves. From our observations *Nostoc*-containing cephalodia tended to be < 1 mm in diameter, spherical and subspherical, brown to white colored externally and somewhat tomentose. *Stigonema*-containing cephalodia tended to be greater than 1 millimeter in diameter, botryose or in bristly clusters and often darker in color-brown to black. Finally we also wished to address some inconsistencies in the importance of the third partner and whether its identity is sufficient reason to separate species. For that reason we also present some key problems within the genus *Stereocaulon* from the North American Arctic so as to encourage further work on the taxonomy of this complex and diverse genus.

THE INFLUENCE OF FIRE ON HERBACEOUS COMMUNITY COMPOSITION OF SUBALPINE PARKLAND IN THE NORTH CASCADES. Justine Andreychuk, C. Alina Cansler, School of Environmental and Forest Sciences, University of Washington, P.O. Box 352100, Seattle, WA 98195-2100; Donald McKenzie, Pacific Wildland Fire Sciences Lab, USDA Forest Service, Seattle, Washington 98103; *justinea 'at' uw.edu*

We examined the impacts of fire on herbaceous community composition within the *Abies lasiocarpa* (subalpine fir) vegetation zone in the northern Cascade Range of Washington. We used plant functional groups, classified based on growth form, to investigate how the ecological role and physiological niches of plants in burned and unburned subalpine parkland may differ, and how the pre-fire setting (closed forest, open forest, alpine woodland, krumholtz, alpine treeless vegetation) interacts with the severity of fire to affect the abundance of plant functional groups. We addressed these questions using field data collected in 2012, 17 years after the Butte Creek fire. We sampled 68 plots in the subalpine parkland ecotone, within or near the burn perimeter, in sites ranging from closed forest to treeless alpine vegetation (1800 meters to 2250 meters). We found significantly more cushion plants in unburned sites than burned sites. Sites that burned with high and very high severity had significantly more graminoids, herbaceous perennials, and tall shrubs. Likewise, closed forest and open forests had significantly more graminoids in burned than unburned areas. Although high intra-site variability and a lack of pre-fire data limit our inferences, our results support the hypothesis that fire influences the composition and function of herbaceous alpine and subalpine vegetation. Climate change may increase area burned and frequency of fire in high-elevation ecosystems, so our results serve as a starting point for future inquiry into the effects of fire on herbaceous vegetation in subalpine parkland.

TEST OF THE EFFECTIVENESS OF BOKASHI AMENDMENT FOR A CAMPUS COMPOSTING PILOT STUDY. **Talinna Appling**, M. Departee, Z. Eddy, P. Rychener, A. Hartshorn, Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT 59717; *soildoc 'at' gmail.com.*

As universities work to reduce their carbon footprints to meet Climate Action Plan emissions targets, campuses are composting, rather than landfilling, their food waste. Unfortunately, few studies of composting outcomes exist, and there are even fewer studies of the effectiveness of amendments such as Bokashi. Here we report the results from a three-phase composting study of pre-consumer food waste (mostly lettuce). We first fermented the food waste in five-gallon buckets; we then outplanted compost to the field; and finally, we recovered, dried, and ground that compost, using it as an amendment to grow lettuce. Five food waste treatments included a single or multiple layer(s) of Bokashi, a single or multiple layer(s) of soil, and a no-amendment control. For Phase 1, headspace measurements of carbon dioxide (CO_2) showed few differences between treatments, with the treatment:soil control ratios declining from approximately 300 to approximately 100 over 4 weeks. For Phase 2, measurements of soil respiration rates showed a large initial spike (greater than 150 micromoles CO_2 per square meter per second), small treatment differences, and a decline over 6 weeks. For Phase 3, clear weight gains for lettuce were observed for all amended (vs. unamended) pots, and surprisingly, the largest gain (150%) was found for the food-only compost amendment. Taken together, our results suggest that Bokashi or soil amendments provide little additional benefit compared with food-only compost that is first fermented, then outplanted, then used as a soil amendment. Future work should assess emissions produced through these types of composting efforts, in order to more quantitatively evaluate the benefits of composted food waste versus potentially avoided greenhouse gas emissions (e.g., methane and nitrous oxide) associated with landfilled food waste.

HISTORICAL FIRE HETEROGENEITY IN A SIERRA NEVADA MIXED-CONIFER FOREST. **Molly A.F. Barth**, Andrew J. Larson**,** Department of Forest Management, College of Forestry and Conservation, The University of Montana, Missoula, MT 59812; James A. Lutz, Wildland Resources Department, Quinney College of Natural Resources, Utah State University, Logan, UT 84322; *molly.barth 'at'umontana.edu*

We characterized the fire history of the Yosemite Forest Dynamics Plot (YFDP), a 25.6 ha long-term forest dynamics research site in Yosemite National Park, California, USA. We collected cross-sections from dead trees with visible fire scars to assess past fire frequency, seasonality, and size. The last fire recorded prior to widespread fire suppression occurred in 1899, but localized fires occurred in the early and mid-20th century. The mean point fire return interval (PFRI) prior to the 1900s was 29.5 years, but increased to 65.4 years during the fire suppression era. Fires occurred most frequently during the late season after dormancy. Most fires on the YFDP were small, as evidenced by a few samples experiencing scars during the same years. Our results are consistent with several fire history studies in the Sierra Nevada. However, when compared to Big Oak Flat, a different study site in the same watershed, our results demonstrate high local variation in historical fire regimes. Big Oak Flat (BOF), a drier site located downslope and north of the YFDP, historically experienced fires nearly twice as frequently. This suggests that the YFDP fire return interval departure is less than BOF and that contemporary vegetation structure and composition may be less altered by fire suppression than similar, less productive sites. Managers seeking to restore natural fire regimes in forests that historically experienced mixed-severity fire should consider the importance of historical fire heterogeneity across a landscape during the design and implementation of prescribed burning and silvicultural treatments.

EFFECTIVENESS OF FLOW MANAGEMENT AND RAINBOW TROUT HARVEST ON LONG-TERM VIABILITY OF NATIVE YELLOWSTONE CUTTHROAT TROUT IN THE SOUTH FORK SNAKE RIVER. **Laurie Battle**, Department of Mathematical Sciences, Montana Tech, 1300 W. Park Street, Butte, MT 59701; Rob Van Kirk, Department of Mathematics, Humboldt State University, 1 Harpst Street, Arcata, CA 95521; Bill Schrader, Idaho Department of Fish and Game, 3101 S. Powerline Road, Nampa, ID 83686;
LBattle 'at' mtech.edu

The South Fork Snake River supports one of the last remaining large-river populations of Yellowstone cutthroat trout *Oncorhynchus clarkii* (YCT). Rainbow trout *O. mykiss* and rainbow × cutthroat hybrid trout (collectively, RHT) established a self-sustaining population there in the mid-1980s. Since 2001, all RHT entering tributaries to spawn have been removed via weirs to ensure hybridization does not occur in tributaries, and we assume that this continues. In 2004, U.S. Bureau of Reclamation began delivering a spring "freshet," a high flow to mimic the natural snowmelt, in the main river, and Idaho Department of Fish and Game removed harvest limits on RHT. We evaluated effectiveness of these management actions with a stochastic simulation model parameterized with observed data from 1988-2003. The model incorporates hybridization in the main river based on observed spawn timing distributions between female YCT and male RHT and a competition scheme based on an experimentally determined proportion of juvenile RHT-YCT competitions won by RHT. Higher winter flows are correlated with higher total recruitment, and higher spring freshet flows are correlated with lower RHT recruitment. Parameters for harvest exploitation rate and flow rates are included to analyze the effect of various management strategies. The model explains observed RHT growth rates and suggests that increased percentage and abundance of YCT since 2004 has resulted from implementation of the freshet and harvest programs. The model suggests about 20% RHT exploitation is required to maintain YCT in equal abundance with RHT. Increased percentage of YCT requires higher RHT harvest and/or higher spring freshet flows, and increased abundance of YCT requires higher winter flows.

CHARACTERIZING FOREST STRUCTURE OF THE SIERRA NEVADA: AN EXAMINATION OF FIRE, CLIMATIC WATER BALANCE, AND LARGE-DIAMETER TREES. **Kendall M.L. Becker**, James A. Lutz, Department of Wildland Resources, Quinney College of Natural Resources, Utah State University, 474 E 700 N, Logan, UT 84321; *becker.kendall 'at' gmail.com*

We defined the realized structural and distributional niches of nine 15-centimeter (cm) tree diameter classes in Yosemite and Sequoia & Kings Canyon National Parks by applying techniques traditionally used to describe the structural and distributional attributes of tree species. We sampled 97 plots (46 unburned since 1930; 51 burned at undifferentiated to moderate severity) that spanned six forest alliances. We used ordination and generalized additive models to assess patterns of basal area and tree density and to quantify relationships among forest structure, recent fire occurrence, and climatic water balance. Tree density declined as a power function with increasing diameter class ($a = 1726.1$; $b = -1.747$), from the 2.5-15.0 cm diameter at breast height (dbh) maximum of 1642 trees per hectare (ha^{-1}) to the greater than 120.0 cm dbh maximum of 40 trees ha^{-1}. Trees greater than 120 cm dbh dominated basal area when present (40 plots), while density patterns were primarily shaped by trees less than 15 cm dbh. Snag abundances suggested that lower-severity fire affected tree density by inducing mortality of small-diameter trees but only marginally affected basal area via the same mechanism. Water balance parameters were related to distribution of density among diameter classes ($p < 0.05$), but no significant relationship emerged between water balance parameters and the basal area proportion attributed to each diameter class ($p > 0.22$). These results suggest that (1) reintroducing lower-severity fire alters forest structure but has a minimal effect on carbon sequestration, and (2) configuration of basal area is heterogeneous along biophysical gradients.

HEDGING AGAINST AN UNCERTAIN FUTURE: FOREST PRESERVATION AND CONSERVATION IN THE ANTHROPOCENE. Travis Belote, The Wilderness Society, 503 W. Mendenhall, Bozeman, MT 59715; *travis_belote 'at' tws.org*

Historically, conservation strategies to preserve forested ecosystems included designating lands into a protected area network, such as the National Wilderness Preservation System. As conservation science has developed, protected areas have repeatedly been shown to effectively sustain forest values including native biological diversity, large old trees and old-growth stands, wildlife habitat, and clean water. However, invasive species, atmospheric deposition, and altered disturbance regimes are increasingly recognized as threatening the biodiversity and ecological processes we value from protected areas. Given these compounding impacts, as well as the predicted exacerbating effects of climate change, some conservation scientists have begun to question the appropriateness of protected areas, such as wilderness, in such a profoundly altered world. In some cases, human trammeling in the form or restoration or innovative management may be required to sustain ecological values of forests we hope to protect and convey into the future. Uncertainty about how forested ecosystems will respond to synergistic impacts of the "Anthropocene" precludes our ability to know which strategy will best sustain ecological values on federally-managed lands. Conservation scientists at The Wilderness Society and elsewhere are increasingly viewing this uncertainty as a problem of risk management that requires a portfolio approach where diverse strategies are implemented and adaptive learning adjusts future decisions. I will discuss how this portfolio approach to conservation can be used to guide both management and science in forested ecosystems, while also discussing the ever-relevant role wilderness will play alongside other active management strategies in the age of global change.

EVALUATING BENTHIC MACROINVERTEBRATE ASSEMBLAGES IN THE BIG HOLE RIVER AND TRIBUTARIES, MONTANA. Michael A. Bias, Big Hole River Foundation, PO Box 3894, Butte, MT 59702; *mikebias 'at' 3rivers.net*

Macroinvertebrate-based surveys are often conducted to assess a stream's biological health. We monitored and evaluated benthic macroinvertebrate (BMI) assemblages from 2007 until 2013 in the Big Hole River and important tributaries to assess whether BMI assemblages were correlated with observed seasonal grayling distributions and whether implemented conservation measures improved stream biological health. Techniques used to collect, process, and analyze macroinvertebrate samples followed guidelines established in the Montana Rapid Bioassessment Protocols (RBP). We sampled three times per year (April, June, and September) from at least 19 locations (14 mainstem and 5 tributary sites). Snow pack and water quality conditions steadily improved from 2007 through 2010. Improving water conditions over this time were reflected in steadily increasing *Ephemoptera*, *Plecoptera*, and *Trichoptera* (EPT) relative abundance. The EPT relative abundance for all the years sampled for every site was greatest during 2010. Arctic grayling exhibit strong seasonal use of tributaries in the upper Big Hole River basin. However, we did not detect any significant differences from any of the BMI metrics between tributary and mainstem locations suggesting that seasonal use of tributaries may have been from some factor other than food resource abundance. Steadily increasing EPT relative abundance and EPT relative abundance being greatest during 2010, revealed improved stream biological health. However, we could not determine from this project whether increasing BMI metrics were a result of implemented conservation measures or improved water conditions over this time. Continued site-specific monitoring will be required to tease these apart.

MOVEMENT PATTERNS AND GROWTH RATES OF TROUT IN THE BIG HOLE RIVER, MONTANA. **Michael A. Bias**, Big Hole River Foundation, PO Box 3894, Butte, MT 59702; Jim Olsen, Montana Department of Fish, Wildlife & Parks, Region Three Fisheries, 1400 S. 19th Avenue, Bozeman, MT; *mikebias 'at' 3rivers.net*

The Montana Department of Fish, Wildlife & Parks (MFWP) has been conducting biennial trout population estimates on the Big Hole River since 1969. Because fish are not permanently marked during these surveys, movement patterns and growth rates of fish cannot be determined reliably. From 2009 to 2012 during the electrofishing surveys, we tagged 7,351 trout with individually-numbered Floy tags among four reaches of the Big Hole River, Montana and used capture-recapture methods to quantify their movement patterns and growth rates. Tag-return information was obtained from anglers (n = 371) and recaptured fish during electrofishing surveys (n = 1,610). Most recaptures for brown (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*), 61% and 68% respectively, occurred within the same reach in which they were tagged. There were no significant difference in upstream or downstream movement distances between rainbow and brown trout. Further, there was no significant difference in average distance moved between brown (4.54 miles) and rainbow (3.76 miles) trout. Three of the four sections provided enough fish recaptures to accurately estimate growth rates. Average specific growth rate for brown trout (0.07%) was significantly greater than rainbow trout (0.04%). Average specific growth rates were not significantly different among reaches for brown or rainbow trout. Although not significantly different, rainbow trout grew at a slower rate in the upper Jerry Creek reach than either the Melrose or Hogback sections. This reduced growth rate corresponds to increasing trout densities in the upper reaches of the Big Hole River.

GROUND BEETLE (COLEOPTERA: CARABIDAE) POPULATIONS IN WESTERN WASHINGTON PRAIRIES AND GARRY OAK STANDS. **Rachel L Bietz**, The Evergreen State College, 2700 Evergreen Parkway, Olympia WA 98505; Chris Maynard, Washington State Department of Ecology, 300 Desmond Drive, Lacey, WA 98503; *rachelbietz 'at' gmail.com*

Ground beetles (Coleoptera: Carabidae) are often studied in agricultural, grassland, and forest ecosystems as an indicator of overall ecosystem health. However, there is little research on ground beetles in Pacific Northwest prairies or Garry oak stands. From April 2005 to April 2006, ground beetles were collected in pitfall traps from three glacial outwash prairie sites and two Garry oak stands in Thurston County, Washington. The goal of this study was to investigate diversity, distribution, and activity density in these unique ecosystems. Over the year-long collection period, 12,464 beetles were captured, comprising 24 species. Three introduced species were collected, making up 2,882 individuals. The remaining 21 species were native to the region. Species composition varied between sites, with nine of the 24 species found at only one location. Each site contained at least one unique species, and only three species were observed at all five sites. Grassland species were more consistently found in the prairie sites and forest species were more consistently found in the oak sites. Activity density was highest during summer months, with an average 13 species collected per month in June, July, and August. Activity persisted during the winter, with an average of 3 species collected per month in December, January and February. This study provides baseline data for Carabidae in prairie and oak habitats in Washington, which can help reserve managers detect long-term changes in community composition and evaluate impacts of management activities.

PLANT-POLLINATOR INTERACTIONS IN A NORTHWEST ARUM ARE INFLUENCED BY PLANT TRAITS, NOT RIPARIAN FOREST MANAGEMENT. Matthew R. Brousil, Chris Humann, and Dylan Fischer, Evergreen Ecological Observation Network (EEON) Laboratory, The Evergreen State College, 2700 Evergreen Parkway NW, Olympia, WA 98505; *fischerd 'at' evergreen.edu*

Studies in Pacific Northwest riparian forests highlight the role of management in conserving target species, but rarely consider impacts on interspecies relationships such as pollination. We investigated plant-pollinator interactions among a native species of rove beetle, *Pelecomalius testaceum,* and a widespread native wetland species in the Pacific Northwest, *Lysichiton americanus* (western skunk cabbage), in an experimental framework comparing three riparian forest management regimes. While plant-pollinator interactions with other arum species have been well studied, we know of no studies investigating pollinator abundance on *L. americanus.* First, we compared the effect of riparian buffer treatments on pollinating beetle abundance to determine if logging management has a predictable effect. We measured *P. testaceum* abundance on skunk cabbages in three riparian treatments in a managed forest: (1) an unlogged riparian zone, (2) a logged riparian zone with a limited buffer corridor, and (3) a clear-cut riparian zone with no remaining corridor. Second, across a diversity of forest treatments, we examined the influence of inflorescence temperature, foliar damage, and plant sex on the abundance of *P. testaceum*. Beetle abundance was significantly influenced by geographic site, plant sex, and foliar damage to plants, but not by riparian buffer treatment. In a simple linear regression, spadix and ambient temperatures were positively correlated. Changes in spadix temperature did not follow patterns seen for thermogenic Araceae. Based on these results, we conclude that riparian forest management does not have a clear effect on plant-pollinator interactions between these species unless it results in decreased populations of *L. americanus*.

CHARACTERIZING STREAMFLOW RESPONSE TO IRRIGATION USING COUPLED HYDROLOGIC AND AGROECONOMIC MODELS. Douglas R. Brugger, Marco P. Maneta, Department of Geosciences, The University of Montana, Missoula, MT 59812-1269; *douglas.brugger 'at' umontana.edu*

The reservoirs, diversions, and wells used for irrigation in a watershed form a network that substantially alters the timing and magnitude of surface water flows. If the irrigation network in a watershed is not adequately represented in a computational hydrologic model, the model might not accurately forecast surface water response to climate forcing. This is notably important during periods of drought, when irrigation demand is high and water availability is low. The behavior of irrigators depends on more than just water availability; other factors include market prices of inputs and commodities, policies and regulations, and the feasibility of alternative crops. We address this by coupling a rainfall-runoff and water distribution model (HEC-HMS) to an economic model of agricultural production, which both simulates irrigator behavior (namely allocation of inputs such as land, water, and labor) and quantifies yields and revenues. The coupled model simulates the impact of farming decisions in the hydrologic network, such as reduced water availability for downstream irrigators due to upstream water use. The result is a spatial depiction of both streamflow response and irrigation network response to climate forcing. We present a case study of drought conditions for the Bitterroot River watershed in Montana that quantifies 1) the economic effects on irrigators, 2) the effect of irrigation on the water budget, and 3) the sensitivity of the system to variations in climate forcing. The case study shows that reductions in agricultural productivity do not scale proportionally with reductions of available water.

THE EFFECT OF LAND USE AND LAND MANAGEMENT ON CARBON SEQUESTRATION AT CABIN CREEK RANCH IN SHEPHERD, MONTANA. **Hailey Buberl**, Clayton Marlow, Animal and Range Sciences, Montana State University, Bozeman, MT 59717; Stephanie Ewing, Land Resources and Environmental Sciences, Montana State University, Bozeman, MT 59717; *hailey.buberl 'at' msu.montana.edu*

Carbon storage in soils is a direct reflection of plant community type, varying with both landscape position and land management. In the semi-arid west, soil carbon storage includes both inorganic and organic components. To understand storage of carbon in soils regionally in central Montana, we investigated the distribution of carbon in 10 soil pits in native and introduced plant communities, managed to support livestock grazing on a seasonally deferred rotation. We found that inorganic carbon is a substantial component of total soil carbon (30-90%) on stable landforms, which reflects long term plant productivity and decomposition of plant material in semi-arid soils (30-40 cm precipitation) where leaching is limited. Inventories of aboveground biomass are used to estimate total biomass carbon; this combined with soil organic and inorganic carbon inventories provide a complete evaluation of sequestration potential and grazing management strategies for carbon storage in these landscapes. Carbon inventories for the soil profiles show a ratio of inorganic to organic carbon of 4:1. Vegetation inventories for three analyzed locations show that coniferous needles hold the highest amount of carbon (0.5 gram carbon per gram plant tissue), where coniferous branches and cores contain 0.48 gram carbon per gram of plant tissue. The amount of carbon found in the coniferous vegetation is consistent with published literature. We hypothesize that the soils and vegetation have a direct relationship with one another through translocation of carbon.

A COMPARISON OF THE PARKER POINT INTERCEPT AND DAUBENMIRE CANOPY COVER VEGETATION SAMPLING METHODS USED AT THE LOST TRAIL NATIONAL WILDLIFE REFUGE, MARION, MT. **Joshua Buckmaster**, Clayton Marlow, Animal and Range Sciences, Montana State University, Bozeman, MT 59717; *mtngt32 'at' gmail.com*

The U.S. Fish and Wildlife Service hired Montana State University scientists to record baseline vegetation data, and develop a survey technique that can detect a change in species composition greater than or equal to 20%, with a 90% confidence level at the Lost-Trail National Wildlife Refuge. We used the Daubenmire Canopy Cover method and a modified Parker Three-Step (Point Intercept) method to record species composition. We recorded 86 species with the Parker method and 96 species with the Daubenmire method. More species were recorded with the Daubenmire method because every species within the sample frame was recorded, whereas only the first species intercepted by the Parker method was recorded. The numbers of "top-five" species recorded by the Parker and Daubenmire methods were similar, 20 and 21, respectively. The three most common species were the same using both methods. The Parker method recorded 16 non-native species, whereas the Daubenmire method recorded 15 non-natives; 13 of these were common to both methods. Overall, the Daubenmire method recorded greater species richness in 82% of the community types, greater levels of litter, rock, bare ground, and water, and fewer non-native species. Species area curves were used to determine sample adequacy for both methods. These curves indicate that more sampling would be needed to detect vegetation changes at the desired levels. To detect a change in species composition greater than or equal to 20%, 300 to 2,500 Parker intercept points or 40 to 60 Daubenmire sample frames would be needed per community type, based on the homogeneity of the vegetation.

UNITED STATES FOREST SERVICE-MONTANA COMPACT: WATER RIGHTS FOR NATURAL WETLANDS AND INSTREAM FLOW PROTECTION. **Thor Burbach**; USFS Region 1; 200 E. Broadway; Missoula, MT 59801; thorburbach 'at' fs.fed.us

After many years of negotiations, the State of Montana and the Forest Service finalized a water rights compact in 2007, settling for all time any and all claims to federal reserved water rights for National Forest System lands in the State of Montana. A federal reserved water right is a right under federal law for the amount of water necessary to fulfill the purposes of a federal reservation; in this case the National Forests. In lieu of a federal reserved water right, the Forest Service agreed that both the 77 instream flow rights and one wetland right in the Compact, and any future additional rights the Forest Service acquires under the Compact would be recognized under State, not federal law. One of the most challenging aspects of those negotiations was resolving water rights for instream flow and wetlands on National Forest System lands. One of the most compelling questions facing the negotiation team was how those flows would be quantified and characterized. The State of Montana had already developed and successfully implemented the Wetted Perimeter Method for quantifying state instream flow rights. The Forest Service agreed to use this method, developed by Montana FWP Biologists and endorsed by the State, to establish Forest Service instream flows. In the case of wetland rights the protected volume would be based on a simple calculation of wetland volume plus annual evaporation. However, the compact allows for modification of these methods in the future as need to meet the goals of the compact agreement

FLOW AND SEDIMENT TRANSPORT CONSTRAINTS ON UPROOTING THRESHOLDS FOR PIONEER WOODY SEEDLINGS. **Sharon Bywater-Reyes**, Andrew C. Wilcox, Department of Geosciences, University of Montana, 32 Campus Drive #1296, Missoula, MT 59812-1296; John Stella, Li Kui, Department of Forest and Natural Resources Management, State University of New York College of Environmental Science and Forestry, 1 Forestry Dr., Syracuse, NY 13210; Anne Lightbody, Department of Earth Sciences, University of New Hampshire, 56 College Road, Durham, NH 03824; *sharon.bywater-reyes 'at' umontana.edu*

Pioneer woody riparian trees may be uprooted by river flows if they are subjected to drag forces greater than their anchoring force. We measured seedlings' anchoring force by uprooting seedlings (1-5 years old) laterally to simulate flood flows. We tested species (*Populus*, *Salix*, and *Tamarix*), grain size, and river regulation effects by targeting field sites characterized by different hydrology and substrates, including an unregulated gravel-bed (Bitterroot River in Montana), an unregulated sand-bed (Santa Maria River in Arizona), and an impounded sand-bed river (Bill Williams River in Montana). We tested the effect of scour on decreasing anchoring force by excavated seedlings 10 to 40 centimeters (cm) and repeating uprooting tests. We conducted statistical analyses to compare the uprooting force for each species, site, and scour treatment. Although statistically significant species and site differences in anchoring force were found, scour depth was the dominant factor controlling anchoring force. We set driving forces (drag force) equal to resisting forces (anchoring force) and solved for the threshold velocity at or above which seedlings would uproot. The mean uprooting velocity for all species and sites remained above 2.0 meters per second (m/s) until 40 cm of scour, for which the mean uprooting velocity was 2.3 ± 1.1 m/s, within the range of velocities seedlings may experience during flood events. Our findings imply sediment transport must play a major role in dictating seedling uprooting in rivers, and should therefore be considered in river restoration and management.

CAN ZIRCONIUM SERVE AS AN INDICATOR OF POST-FIRE SOIL BURN SEVERITY?
Russell Callahan, Tony Hartshorn, Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT 59717; *rpcallahan10 'at' gmail.com*

Fire severity can be defined using the ratio of mid (approximately 2.2 micrometers (um)) to near (approximately 0.8 um) infrared reflectance values from satellite imagery. We were curious if post-fire soils data could be used for ground truthing. We relied on well-established patterns between soil zirconium (Zr), soil organic matter (SOM), and loss on ignition (LOI). The Zr element is associated with weathering-resistant zircons. Addition of SOM to soils typically dilutes soil Zr, while SOM losses via LOI can increase soil Zr. Results from long-term experimental burn plots in South Africa indicated that triennial burns increased soil Zr by 160% whereas annual burns increased soil Zr by 141% compared to unburned soils. To test our approach, soils were sampled from burned and unburned plots at the Red Bluff Ranch in Norris, Montana, which burned between June 25 and July 2 of 2012, as part of the Beartrap 2 Fire. We simulated differing fire severities on unburned samples from Red Bluff Ranch using a muffle furnace (durations: 5, 15, 30, 45, or 60 minutes; temperatures: 50, 100, 200, 300, 400, or 500ºC). Our results showed little LOI (less than 0.12%) below 200ºC, but order-of-magnitude increases in LOI with increasing durations for temperature greater or equal to 200ºC; for example, LOI values reached 3.0% for the 60-minute duration at 300ºC. By using a ratio of our simulated LOI to maximum LOI, and comparing this ratio to the expected versus observed Zr level, we document the promise of using this novel post-fire burn severity index derived from ground-based, not satellite-based, data.

TREE REGENERATION AFTER FIRE IN *ABIES LASIOCARPA-LARIX LYALLII-PINUS ALBICAULIS* SUBALPINE PARKLAND IN THE NORTH CASCADES, WASHINGTON.
C. Alina Cansler, School of Environmental and Forest Sciences, University of Washington, P.O. Box 352100, Seattle, WA 98195-2100; Donald McKenzie, Pacific Wildland Fire Sciences Lab, USDA Forest Service, Seattle, Washington 98103; *acansler 'at' uw.edu*

It is unknown how climate change and disturbance will interact to influence the subalpine parkland ecotone in the future, despite several decades of research on tree invasion and gradual loss of alpine meadows. We examined the effects of fire on subalpine parkland with dominate tree species of *Abies lasiocarpa, Larix lyallii,* and *Pinus albicaulis,* in the northern Cascade Range of Washington. We used field data collected 17 and 25 years after fire, to investigate relationships between fire severity and tree regeneration abundance and composition across the subalpine parkland ecotone in. Treeless alpine vegetation rarely burned, and when it did, it generally burned with low severity. Alpine woodland (less than 10% tree cover) did burn, usually with low and moderate severity in a patchy mosaic, resulting in heterogeneous survival of overstory trees within our 100 meter square (m^2) plots. Abundance of *A. lasiocarpa* seedlings was negatively correlated with fire severity in open forest (10-40% tree cover), but showed no significant relationship in alpine woodlands. Abundance of *P. albicaulis* seedlings was negatively correlated with fire severity in alpine woodlands but showed no significant relationship in open forest. Previous research documented prolonged periods of low tree regeneration after fire in *A. lasiocarpa-Tsuga mertensiana* parkland in the western Cascades. Our initial results indicate that the dynamics of fire and post-fire succession dynamics may differ in *A. lasiocarpa* forests in the eastern Cascades, with heterogeneous patterns of severity, higher seedling survival, and relatively more immediate seedling regeneration.

HISTORICAL FOREST STRUCTURE, COMPOSITION, AND SPATIAL PATTERN IN DRY CONIFER FORESTS OF THE SOUTHERN BLUE MOUNTAINS, OREGON: USING RESEARCH NATURAL AREAS TO DESIGN MODERN FOREST RESTORATION TREATMENTS. **Gunnar C. Carnwath,** U.S. Forest Service, 1550 Dewey Avenue, Baker City, OR 97814; Derek J. Churchill, School of Environmental and Forest Sciences, College of the Environment, University of Washington, Seattle, WA 98195; Sean M. A. Jeronimo, School of Environmental and Forest Sciences, College of the Environment, University of Washington, Seattle, WA 98195; Andrew J. Larson, Department of Forest Management, College of Forestry and Conservation, The University of Montana, Missoula, MT 59812; *gcarnwath 'at' fs.fed.us*

There is broad scientific agreement that ecological restoration treatments in frequent fire forests should mimic historical stand structure and spatial patterns in order to enhance resilience and maintain ecosystem functions. Yet, reference information describing historical tree spatial patterns at fine scales is limited and there is little understanding of how these patterns may have varied across environmental gradients. We reconstructed historical (circa 1890), stand-level spatial patterns of frequent fire forests within the Dugout and Canyon Creek Research Natural Areas on the Malheur National Forest in northeast Oregon. Tree spatial patterns were quantified in terms of individual trees, clumps, and openings (ICO) using a spatial clump identification algorithm along with a specified inter-tree distance of 6 meters (m) to define when a cluster of trees forms a clump. Sampling was stratified by plant association series to capture the range of variability across an environmental gradient. We estimated that sites in *Abies grandis* plant associations had an average of 33% of trees growing as individuals with 20% growing in large clumps (greater than 10 trees) compared to approximately 23% growing as individuals and 8% in large clumps in both *Pseudotsuga menziesii* and *Pinus ponderosa* plant associations. Reference conditions were compared with a recent variable density thinning project on the Malheur National Forest to assess how well the restoration treatment mimicked reference conditions. We found that 75% of the trees in the treatment area were growing as individuals (greater than 6 m from a neighbor) compared to 12-48% in reference stands. This project demonstrates how Research Natural Areas are being actively used to help guide ongoing restoration treatments in the southern Blue Mountains.

NON-LETHAL BEAVER MANAGEMENT AND HABITAT RESTORATION PLANNING IN THE UPPER CLARK FORK RIVER BASIN. **Amy Chadwick**, Great West Engineering, 111 N. Higgins Ave., Suite 406, Missoula, MT 59806; *achadwick 'at' greatwesteng.com*

Encouraging restoration of beaver pond complexes and associated wetlands is gaining acceptance as a cost-effective restoration tool. While beaver activity provides great benefit to habitat, water supply, and other natural resources, use of beavers in restoration poses challenges associated with the interrelationship among beavers, habitat, and human activity. Recent beaver management projects in the upper Clark Fork River watershed have identified priority restoration sites, demonstrated cost-effectiveness of some non-lethal management techniques, revealed landowner priorities and attitudes regarding beaver in the watershed, and explored new mechanisms for implementing cost-effective wetland restoration and beaver management on public and private land. Beaver habitat suitability modeling for the upper Clark Fork Basin has revealed that beaver complexes are primarily limited by winter food availability, underlining the need for restoration of riparian and wetland habitat. Pilot projects for beaver habitat restoration and non-lethal management, including a beaver complex wetland restoration pilot project and a cost-benefit analysis of three flow devices installed in Butte, MT, are described to demonstrate the cost-effectiveness of using beavers in watershed restoration.

INTEGRATING SILVICULTURE & LANDSCAPE ECOLOGY: A FRAMEWORK FOR MULTI-SCALE FOREST MANAGEMENT. **Derek Churchill**, School of Environmental and Forest Science, College of the Environment, University of Washington, 4000 15th Ave NE, Seattle, WA 98195; *Derekch 'at' uw.edu*

The need to manage for heterogeneity at multiple scales is increasingly being recognized in forest management. Transitioning from a stand-centered to a multi-scale approach has proven challenging, however. Methods to incorporate targets for spatial pattern into treatments are not well developed or widely used. In this lecture, I present a framework for multi-scale management that integrates concepts of scale, patch hierarchy, and pattern-process dynamics from landscape ecology with silviculture. The framework has four basic components. First, the desired pattern of forest structure and composition must be quantified in terms of ranges, which are derived from reference conditions or functional objectives such as fire behavior or wildlife habitat. Second, current patterns of structure and composition are evaluated against targets. Third, prescriptions are developed that include specific, operational guidance to move current pattern towards the desire ranges. Finally, a monitoring system is developed that assesses both desired pattern and process over time. I present three examples where this framework has been applied in eastern Oregon and Washington. The first is a watershed scale (10,000-20,000 hectares (ha)) landscape evaluation and prioritization using methods developed by Dr. Paul Hessburg. I then scale down to a stand neighborhood (500-2,000 ha) and report results from a project seeking to restore patterns associated with mixed severity fire. Lastly, I present a stand-level approach that quantifies within-stand pattern in terms of widely spaced individual trees, tree clumps, and openings. I summarize reference data from over 30 x 4ha plots and show how this information is being used to guide ongoing treatments across multiple National Forests.

DISTRIBUTION AND CHARACTERISTICS OF GROUNDWATER-DEPENDENT WETLANDS IN WESTERN MONTANA FORESTS. **Jennifer Chutz,** DCI West Biological Consulting, LLC, 255 Rice Lane, Whitefish, MT 59937; Linda Vance, Montana Natural Heritage Program. 1515 E. 6th Avenue, Helena, MT 59602; *dciwestbiological 'at' gmail.com*

Peat-rich groundwater-dependent wetlands often have extremely high species diversity, and provide substantial water storage and groundwater recharge/discharge functions. Undisturbed, they may persist for centuries, but once drained or damaged, they do not easily recover. Although several large fens have been identified and documented in Montana, it is only recently that high-resolution imagery has enabled us to extend the inventory and description of smaller fens and other groundwater-dependent wetland types. Over the past several years, we have been able to map over 3,000 of these wetlands, and have conducted detailed, field-based inventories of almost 200 of these. This presentation will cover the identifying features that researchers and land managers can look for in NAIP and Google Earth images to distinguish groundwater-dependent wetlands from other wetland types, and will describe field-based indicators and metrics appropriate for accurate characterization. We will focus on groundwater-dependent wetlands in the Beaverhead-Deerlodge, Lolo, Flathead, and Kootenai National Forests.

DOWSTREAM SPATIAL AND TEMPORAL RESPONSE TO DAM REMOVAL, WHITE SALMON RIVER, WASHINGTON. Erika J. Colaiacomo, Geosciences Department, University of Montana, 32 Campus Drive, Missoula, MT 59812; *erika1.colaiacomo 'at' umconnect.umt.edu*

The sudden nature of the Condit Dam breach on the White Salmon River (WSR) in Washington provided a unique opportunity to study how a bedrock-confined, gravel-bed river responds to a large influx of fine reservoir sediment. On October 26, 2011, a dynamite explosion breached a hole in the base of the 38 meter (m) tall dam, causing rapid reservoir erosion and downstream transport of fine sediment through the 5.3 kilometers (km) separating the reservoir from the mouth of the WSR, where it flows into the Columbia River. In my research, I measured the pre-breach bed and water surface elevations and repeated my measurements 3 and 9 months after the breach to assess downstream geomorphic response through a confined reach (Reach 1) with forced pool-riffle morphology and a less-confined reach (Reach 2) near the river's mouth. I found that reach and bedform morphologies drive bed aggradation, and that fluvial incision of post-breach deposits is approximately uniform throughout the river, although proportionately less over Reach 2 and pools. Three days after the breach, Reach 1 had aggraded by 4.3 ± 1 m compared to the 6.2 ± 0.5 m of aggradation in Reach 2, and riffles had aggraded 3.4 ± 1 m versus the 5.2 ± 1.4 m of aggradation in pools. Nine months after the breach, Reach 1 had incised by 2.6 ± 0.5 m and Reach 2 by 2 ± 0.3 m, and riffles incised by 2.6 ± 0.8 m and pools by 2.6 ± 0.5 m.

MANAGING FOR RESILIENCE IN ROCKY MOUNTAIN LODGEPOLE PINE: EFFECTS OF HETEROGENEOUS STAND TREATMENTS ON WOODY SURFACE FUELS DYNAMICS AND POSTULATED FIRE BEHAVIOR. Justin S. Crotteau, Christopher R. Keyes, Dept. of Forest Management, University of Montana, 32 Campus Dr., Missoula, MT 59812; David K. Wright, Elaine K. Sutherland, Forest and Woodland Ecosystems Science Program, Rocky Mountain Research Station, USDA Forest Service, 5775 Highway 10 W., Missoula, MT 59808; *justin.crotteau 'at' umontana.edu*

Lodgepole pine (*Pinus contorta*) is one of the most abundant vegetation species in the Northern Rockies. Historical management of these forests availed even-aged silvicultural strategies, yet multi-cohort management of lodgepole pine may mitigate external ecosystem stressors such as bark beetles or wildfire by promoting stand vigor and spatial heterogeneity. In the year 2000, an experimental variable retention harvest at the Tenderfoot Creek Experimental Forest established two divergent stand structure patterns, treating 16 of 20 stands. Approximately 50% of the overstory trees within each stand were retained in either an aggregated or dispersed arrangement; two replicates from each treatment were subsequently broadcast burned. We quantify and present surface fuel loadings within these stands immediately after treatment and again in 2012, establishing downed woody debris treatment reference conditions. Furthermore, we fit linear mixed-effects models to describe the effects of treatment over time on an array of surface fuel size-class responses. One key finding that models report is a greater debris reduction in treated versus control stands in the all but the 1000-hr fuel class (p-value range: 0.0003, 0.0778); retention arrangement and burn effects are also reported by fuel size class. Finally, analysis of potential fire behavior suggests more varied fire behavior in both aggregated and dispersed stands than in controls, as per common behavior metrics (e.g., flame length, crowning index). Fire behavior models suggest that control and post-treatment conditions are capable of carrying a crown fire but probability of crown ignition is low. In dense crown conditions common among lodgepole pine stands, we hypothesize that canopy fragmentation within and among stands as created by variable retention harvests may increase stand resilience to wildfire.

SIMILARITIES AND DIFFERENCES IN PLANT COMMUNITY RESPONSE TO ABIOTIC CONDITIONS WITHIN 30 VARIABLY AGED GRAZING EXCLOSURES IN BRITISH COLUMBIA, CANADA. W.F. Preston Cumming, Gary Bradfield, Department of Botany, University of British Columbia, Vancouver, BC V6T 1Z4; Reg Newman, Ministry of Forests, Lands, and Natural Resources, Thompson Okanagan Region - Resource Management, Kamloops, BC, V2C 2T7; *preston.cumming 'at' botany.ubc.ca*

Although increasing in understanding, the effects of climate induced plant community composition change are still relatively misunderstood in managed grassland plant communities. To explore the similarity in vegetation structure under different climatically driven conditions and topographic influences, historical data (1959-2007) from 30 grazing exclosures, across a 300 kilometer range in the Interior British Columbia grassland ecosystem, were analyzed in conjunction with several climate and topographic measures for floristic similarities and differences over time and among sites. All exclosures within the current study responded to climate similarly within a smaller geographic range (10s of kilometers), while coarser scale relationships were less apparent. Principal Component Analysis (PCA) on the 180 available climate indices showed a strong association with temperature, with axis 1 explaining over 40% of the variability in the data. Climate variables were then reduced to 10 distinct temperature and precipitation indicators based on the first two axes. These reduced climate indices combined with cover and composition were further ordinated using Redundancy Analysis, which showed that species composition change within these communities is not directly driven by these temperature and precipitation indicators, but that species and communities react as individuals, based on autecology, local topography, and age of exclosure; to the conditions presented. By combining climatic variables such as summer, spring, and mean annual temperature; seasonal and annual precipitation; species cover and knowledge of individual species ecology we will greatly enhance our ability to forecast possible impacts on managed and unmanaged communities.

DETERMINATION OF BIOAVAILABLE PHOSPHORUS IN STORM WATER ENTERING LAKE WHATCOM, WASHINGTON FROM FORESTED AND DEVELOPED WATERSHEDS USING THE DUAL CULTURE DIFFUSION APPARATUS REACTOR. Jonnel Deacon, Dr. Robin Matthews, Department of Environmental Sciences, Western Washington University, 516 High Street, Bellingham, WA 98225; *deaconj2 'at' students.wwu.edu*

Lake Whatcom is a large monomictic lake located east of Bellingham, Washington. Long-term monitoring has shown a decrease in water quality, and in 1998 the lake was placed on the state's 303(d) list of impaired waters. Recently, a total maximum daily load (TMDL) was issued to limit phosphorus inputs into the lake, with emphasis on storm water mitigation. Not all phosphorus in storm water can be used by algae; the portion that can be used is described as "bioavailable," and includes both inorganic and organic forms of phosphorus. Our research focused on measuring the portion of bioavailable phosphorus that is released from particulate organic matter by algae that produce alkaline phosphatase. Storm water was collected from three major tributaries to the lake and analyzed to measure initial total phosphorus concentrations. A 50 millileter (mL) aliquot of storm water was added to one side of a dual culture diffusion apparatus reactor and 50 mL of *Selenastrum capricornutum* in phosphorus-deficient growth medium was added to the other side, separated by a 0.45 μm membrane filter. The filter maintained physical separation between the cells and storm water, but allowed diffusion of enzymes and dissolved nutrients. The cultures were incubated on a shaker table for 7 days at 23°C under 24-hour light. All samples had an increase in cell density from a baseline of 60,000 cells/mL in the P-starved control to over 100,000 cells/mL and even 200,000 cells/mL at the conclusion of some experiments. Total phosphorus concentrations were reduced by approximately 80% in the storm water side of the reactor, suggesting that alkaline phosphatase was releasing soluble forms of phosphorus that supported algal growth.

MANAGEMENT RECOMENDATIONS TO PROTECT WESTERN MONTANA FORESTED WETLANDS AND PEATLANDS FOR WILDLIFE CONSERVATION. Kristi L. DuBois, Montana Fish, Wildlife & Parks, 3201 Spurgin Rd, Missoula, MT 59804; *kdubois 'at' mt.gov*

Western Montana hosts a high diversity of wetlands, including many unique or rare wetland types. Small wetlands embedded in forested habitats provide critical habitat services for many vertebrate Species of Concern, such as breeding and wintering sites for amphibians, habitat for northern bog lemmings, feeding or nesting areas for songbirds and bats, and unique feeding sites for large mammals such as moose and grizzly bear. Proper management of these wetlands is critical for conserving rare wildlife species, and overall species diversity. Threats to these wetlands include, but are not limited to roads, illegal OHV use, invasive species, poor livestock grazing practices, cabin/housing developments, and climate change. Management recommendations for these wetlands and other critical habitats for fish and wildlife Species of Concern are being developed by MFWP as part of the State Wildlife Action Plan, to be released in 2014. They include buffer zones, road removal and reclamation, monitoring for SOC and invasive species, protection through easements or acquisition, better zoning, and designation as special botanical areas or resource natural areas when appropriate. Peatlands in particular may need special forest management to protect them from wildfires that can burn into peat during periods of drought. Completion of the NWI will help facilitate protection of these wetlands by allowing better planning of monitoring and management efforts.

INFLUENCE OF THE FUNGAL PATHOGEN *PYRENOPHORA SEMENIPERDA* ON DOWNY BROME (*BROMUS TECTORUM*) AND ASSOCIATED GRASSY SPECIES. **Krista A Ehlert,** Fabian Menalled, Jane Mangold, Zachariah Miller, Alan Dyer; Montana State University, PO Box 173120, Bozeman, MT 59717-3120; *krista.ehlert 'at' msu.montana.edu*

Herbicide application is the traditional management approach for downy brome. While herbicides do not affect downy brome's seedbank, a soil-borne fungal pathogen *Pyrenophora semeniperda* causes seed death and reduced seedling vigor. In addition to downy brome, we investigated *P. semeniperda*'s impact on five crop (*Triticum aestivum, Hordeum vulgare, Secale cereal, Avena sativa,* X *Triticosecale*), five non-native forage/pasture (*Agropyron cristatum, Festuca arundinacea, Bromus inermis, Elymus junceus, Dactylum glomerata*), and five native rangeland species (*Koeleria cristata, Festuca idahoensis, Agropyron spicatum, Boutelous gracilis, Schizachyrium scoparium*). In a greenhouse, we established a randomized complete block design with eight blocks. Treatments were a) inoculated and b) non-inoculated (control). Seedling emergence and survivorship were recorded weekly, and aboveground biomass was harvested, dried, and weighed four weeks after seeding. Results suggest that inoculation affects species' emergence ($P < 0.0001$) and biomass ($P = 0.0108$). Four of the five rangeland species were negatively affected by inoculation, which resulted in a 20%-80% reduction in emergence relative to the non-inoculated treatment. Further, inoculation resulted in 25%-30% and 10%-35% reduced emergence for three forage and two crop species, respectively. Inoculation reduced downy brome emergence by 40%; however, its biomass was unaffected. There was little effect of inoculation on non-target plant biomass, with the exception of one crop and two forage/pasture species. These results indicate that *P. semeniperda* is not a silver bullet for downy brome but has potential as an additional tool for management. Integrated management with other tools such as herbicides and fungicides can provide a two-pronged approach that effectively targets both downy brome's seedbank and its seedlings.

RIPARIAN-ASSOCIATED GASTROPODS IN WESTERN WASHINGTON: COMMUNITY COMPOSITION AND THE EFFECTS OF FOREST MANAGEMENT. Alex D. Foster, USDA Forest Service, PNW Research Station, 3625 93rd Avenue SW, Olympia, WA 98512; Joan Ziegltrum, 8310 Lynch Road SE, Shelton, WA 98584; *alexfoster 'at' fs.fed.us*

Little is known about the biology and response to environmental change of endemic mollusks in the Pacific Northwest. As logging is one of the most pervasive disturbance mechanisms in forest lands throughout the region, few studies have assessed the effects on terrestrial mollusks. This is problematic because federal agencies are required to account for impacts to sensitive mollusk species as part of project environmental analysis. In addition, several species are currently being considered for protection under the Endangered Species Act. To help address these knowledge gaps, we evaluated the riparian gastropod communities along headwater streams and their response to logging in southwestern Washington State. Terrestrial mollusks near logged streams with 15 meter fixed-width buffers were compared to logged streams with no buffers and to unlogged control streams. Mollusk communities varied among sites relative to vegetative composition, the amount of understory cover and presence of seeps or small wetland features in the riparian areas. For example, coastal sites on sandstone lithologies had similar mollusk communities, whereas inland sites on basalt were distinctly different. After logging, slug and snail abundance were significantly different between streams with no buffers and control streams ($p \leq 0.002$). Additionally, fixed-width buffers were significantly different from streams with no buffers ($p \leq 0.015$); however the effect size was relatively small suggesting site variability may override the effects of logging. Our findings illustrate that site differences can affect mollusk community structure and influence taxa resiliency to disturbances such as logging.

THE LONG-TERM EFFECTS OF FUEL TREATMENTS ON ECOSYSTEM PROCESSES: REVISITING THE LUBRECHT FOREST FIRE AND FIRE SURROGATES STUDY. Peter Ganzlin, Dr. Cory Cleveland, College of Forestry and Conservation, The University of Montana, 32 Campus Drive, Missoula, MT 59812; *peter.ganzlin 'at' umontana.edu*

As a result of decades of fire suppression, many western forests previously accustomed to frequent low-intensity fire have become exceedingly dense and accumulated excessive amounts of fuels. Fuels reduction treatments such as mechanical thinning and/or prescribed burning are used by forest managers to restore fire-suppressed western forests to pre-settlement density, reduce wildfire risk and enhance biodiversity and pathogen resistance. In a long-term assessment of the Fire and Fire Surrogate (FFS) study, we measured Carbon (C), Nitrogen (N) and Phosphorus (P) pools and rates of nitrogen cycling in summer 2013, eleven years post-treatment, at the FFS site at Lubrecht Experimental Forest in western Montana. Our data show available N pools two to five times less than those seen in prescribed burn treatments from a short-term study at Lubrecht. Forest floor C pools remain 1.5 times lower in the thin+burn treatment due to reduced duff mass, though we saw no difference in N or P pools in forest floor. No significant differences were seen in total C, N, or available P pools mineral soil, pine foliage or litter. Current rates of net N mineralization are 3 to 4 times lower than those seen at one and three years post-treatment in burn treatments, yet current rates show no significant differences between treatments. These data suggest a return to pretreatment conditions at our site. While there is evidence that forest restoration utilizing thinning can improve tree growth and vigor, long-term sustainability of this effect will likely be driven by nutrient availability. Finally, due to restoration cost and logistics, treatment longevity is an important consideration for forest managers. Understanding soil C and N dynamics relates to treatment longevity and success in terms of forest productivity, C sequestration and post-treatment fuel accumulation.

INNOVATION AND EVOLUTION OVER 10 YEARS OF COLLABORATIVE ECOSYSTEM RESTORATION EFFORTS ON THE MOUNT HOOD NATIONAL FOREST, OREGON. **Jeffrey Gerwing,** Associate Professor of Environmental Science and Management, Portland State University, PO Box 751 – ESM, Portland, OR 97201; jgerwing 'at' pdx.edu

In 2003 the U.S. Congress passed the "Stewardship Contracting Authority" allowing for collaboration among government agencies, local communities, and nongovernmental organizations in the development of ecosystem restoration projects on U.S. National Forests. In 2004 the Clackamas Stewardship Partners (CSP) formed to facilitate the collaboration among diverse stakeholders necessary for successful stewardship contracting implementation on the Clackamas River Ranger District of the Mount Hood National Forest, Oregon. Over 10 years of collaboration, ecosystem restoration projects involving the US Forest Service (USFS) and the CSP have increased in spatial scale, complexity of project elements, and ability to incorporate uncertainties over best management practices. During the first two years, the group focused on defining objectives and developing a framework for the collaborative process. During this "partially-collaborative" phase, CSP provided comments on projects that had been developed by the USFS and management "innovations" were mostly silvicultural and stand-based (e.g., refinement of variable density thinning treatments on 500 acres). Beginning in 2007, CSP and the USFS entered a phase of "co-management" where CSP was involved in the siting, design, and development of projects and project alternatives and innovations increased in spatial scale and complexity (e.g. commercial thinning of 1,200 acres followed by decommissioning of 113 miles of roads in a sub-watershed). More recently, CSP has ventured into "adaptive co-management" by developing management-based research questions and working with the USFS to develop management "experiments" to answer those questions (e.g., comparing different approaches to marking stand for variable density thinning).

EVALUATING THE EFFECTS OF A GRASS-SPECIFIC HERBICIDE ON THE SILVERY BLUE BUTTERFLY IN AN OREGON PRAIRIE. **Rachel Glaeser**, Cheryl Schultz, Environmental Science, Washington State University Vancouver, 14204 NE Salmon Creek Ave, Vancouver, WA 98686; *rachel.glaeser 'at' wsu.edu*

In western Oregon and Washington, over 95% of the historic prairie-oak habitat has been lost or degraded. Exotic tall grasses dominate many remnant swards and obstruct butterfly access to host plants and nectar sources. Selective herbicides that target these grasses are a popular tool for promoting native habitat. However, the benefits of improved habitat must be weighed against any detrimental costs to non-target species. In previous laboratory trials, grass-specific herbicides decreased butterfly larval survivorship and shortened development time. At a site in the Willamette Valley, I tested for an effect of an early spring application of fluazifop-p-butyl and a nonionic surfactant on adult behavior, oviposition, and larval survivorship of the silvery blue butterfly (*Glaucopsyche lygdamus columbia*). In contrast with a previous field study, there was no difference in the amount of time that adult butterflies spent in herbicide and control plots. Additionally, total number of eggs, total larvae, and larval survivorship on lupine host plants (*Lupinus oreganus*) was similar between plot types. I found that in the field, factors such as lupine flowering stalk abundance and height as well as larva-ant associations are more important than herbicide treatment for predicting differences in egg numbers and larval survivorship. These results suggest that applying grass-specific herbicides like fluazifop-p-butyl at a time of low butterfly activity may reduce or completely eliminate potential negative effects. Further research should address the effects of multiple herbicide applications per year as well as repeated annual use especially for species that may be exposed during the larval stage.

VEGETATION CLASSIFICATION AND FIRE ACTIVITY IN THE BLUE MOUNTAINS OF OREGON. **Christopher R. Goodner**, Resource Management, Central Washington University, 1204 North Vista Road, Ellensburg, WA 98926; Megan K. Walsh, Department of Geography, Central Washington University, Ellensburg, WA 98926; *goodnerch 'at' cwu.edu*

In order to help select study sites in the Blue Mountains of Oregon to be used for post-glacial paleofire reconstructions, we used ERDAS Imagine to map the current vegetation cover types of the region. Additionally, ESRI ArcGIS was used to show how the current vegetation distribution is related to 20th century fire activity. Phase one was to classify vegetation cover types of the Blue Mountains based on Landsat 8 imagery captured on July 14, 2013. For our purposes, we used this to show the degree to which vegetation cover varies in both composition and structure between high and low elevation sites. The Forest Inventory and Analysis from the USDA Forest Service (USFS) was used for ground truthing the classification. Phase two involved mapping known fire locations from 1910 to 2012 from the USFS GIS Data Library. This process involved overlaying historic fire polygons on the classified cover types to assess the spatial distribution of recent fires in the Blue Mountains and their possible impact on the current vegetation mosaic. The final product of phase two is a map that displays the vegetation cover classification and fire history. The results of this analysis will be used to determine appropriate study sites for collecting lake sediment cores and completing macroscopic charcoal analysis to determine the Holocene (approximately last 12,000 years) fire history of the region. We expect the results of the paleofire analysis to show how the influence of fire suppression activities have varied between high versus low elevation sites in the Blue Mountains.

PRELIMINARY STABLE ISOTOPE ANALYSIS OF SELECTED SAMPLES FROM THE COYOTE CANYON MAMMOTH SITE, KENNEWICK, WASHINGTON. Max Guettinger, School of the Environment, Washington State University, Pullman, WA 99164-2812; Nicholas Jared McMillan, School of the Environment, Washington State University, Webster 1228, Pullman, WA 99164-2812; Peter Larson, School of the Environment, Washington State University, Pullman, WA 99164-2812; George Last, Pacific Northwest National Laboratories, P.O. Box 999, MSN P7-54, Richland, WA 99352; Scott Boroughs, School of the Environment, Washington State University, Pullman, WA 99164-2812; *max.guettinger 'at' email.wsu.edu*

Oxygen and carbon isotope ratio analyses were conducted on thirteen 3-centimeter diameter depth-discrete sediment samples collected from the Coyote Canyon Mammoth Site south of Kennewick, Washington. These analyses were conducted to hopefully expand our understanding of the paleoclimate history of the mammoth site. Unfortunately, many of the small depth-discrete samples were found to have too low of carbonate concentration to be measureable. However, eight of the samples did yield acceptable data. These were then used to perform preliminary paleotemperature and $\delta^{18}O$ (delta oxygen 18; depository water) calculations. All eight samples were collected from pedogenically altered and/or reworked fine-grained Ice Age flood deposits. Discrepancies between the stable-isotope results from this study and previous results from tests conducted by Cornell University on samples from the site suggest significant differences in the representativeness of the samples and/or analytical techniques, with differences varying on a per sample basis. To further examine the representativeness of the depth-discrete samples, dilute HCl acid tests were conducted to determine potential signal output of the carbonates present in the samples. In addition, variable thickness sediment sections were made from select samples to examine the nature of the carbonates, specifically their location and morphologies in the samples. These tests found that the calcite content and distributions was highly variable, even within some of the small-depth discrete samples, thus leading to variability within the stable-isotope results. These observations indicate that more studies are required for a complete understanding of the site's paleoclimate with the current study allowing us to gain a basic understanding of the isotopic properties of collected samples of the site's carbonates and a greater knowledge of how to proceed in future studies.

EVIDENCE OF HIGH-SEVERITY FIRE IN A 1915-1925 INVENTORY OF APPROXIMATELY 200,000 FORESTED HECTARES IN EASTERN OREGON. **Keala Hagmann**, Jerry F. Franklin, School of Environmental and Forest Sciences, University of Washington, Box 352100, Seattle, WA 98195-2100; *hokulea 'at uw.edu.*

Timber inventories conducted early in the 20th century provide detailed records of forests on the slopes and foothills east of the Cascade Range in Oregon. More than 20% of the area in approximately 200,000 hectares (ha) of mixed-conifer and ponderosa pine forests was sampled in a systematic strip cruise tied to a grid of documented survey points. Cruisers recorded the species and diameter at breast height (dbh) of conifers at least 15 cm dbh on 1.6 ha transects. High-severity fire effects were evident in patches 100-500 ha in size in association with documented burn areas in 1) a fire that burned approximately 80,000 ha in ponderosa pine - lodgepole pine forest and 2) at higher elevations where forests transition to wetter, colder types. Transects in this boundary area differ from the rest of the mixed-conifer habitat in: 1) extent and contiguity of area occupied by few to no trees (less than 25 trees per hectare larger than 15 cm dbh), and 2) lower ponderosa pine and large tree (greater than 53 cm dbh) densities. These landscapes were dominated by predominantly low-density forests dominated primarily by large ponderosa pines and secondarily by large Douglas-fir trees. The nearly ubiquitous presence and abundance of large trees and ponderosa pine in all size classes and the near absence of stands composed solely of small-diameter trees both support an inference that high-severity wildfires with an extensive stand-replacement component were either absent or uncommon on these landscapes for at least several centuries.

MIMICKING NATURE: RESTORATION OF THE CLARK FORK RIVER AT MILLTOWN, MONTANA. **Diana Hammer**, U.S. Environmental Protection Agency, Region 8 Montana Office, 10 West 15th Street, Suite 3200, Helena, MT 59626; **Amy Sacry**, Geum Environmental Consulting, Inc., 307 State Street, Hamilton, MT 59840; *hammer.diana 'at' epa.gov*

The cleanup of the Milltown Reservoir Sediments Superfund Site shows how remediation, restoration, and redevelopment can be integrated and represents a collaborative effort among governments, private industry, and the public to cleanup, restore, and reuse the Clark Fork and Blackfoot Rivers near Milltown, Montana. The presenters will focus on the restoration component of this project. The goal of restoration is to create a naturally-functioning river system along nearly five miles of the Clark Fork River and its floodplain. The restoration considered natural models, such as reference reaches and riparian vegetation succession, to pattern channel and floodplain features and will rely on natural processes for long-term development and function. The presenters will discuss aspects of the restoration design and how the Site has responded since construction including floodplain erosion and deposition and natural recruitment of floodplain vegetation. Ecological restoration projects such as Milltown show how we can look to Nature for solutions. If we consider how many rivers and floodplains Nature has designed and re-designed, vegetated and revegetated, might we not learn even more from these methods? Using Nature as "model, mentor, and measure" is at the heart of the field of Biomimicry. While the Milltown project was not designed explicitly to follow Biomimicry Principles, it does exhibit several - such as *Adapt to Changing Conditions, Be Locally Attuned and Responsive,* and *Integrate Development with Growth*. The presenters will evaluate this project using these Life Principles and discuss how Biomimicry could be further applied to this and other restoration projects.

LICHEN BIOMONITORING RESULTS FROM 20 YEARS OF SAMPLING IN PACIFIC NORTHWEST WILDERNESS AREAS. **Amanda Hardman**, Linda Geiser, USDA Forest Service, Regional Air Resource Management, 3200 SW Jefferson Way, Corvallis, OR 97331; *amandachardman 'at' fs.fed.us*

The Forest Service Air Resource Management program has been gathering lichen data from plots on all 65 Forest Service wilderness areas of the Pacific Northwest (PNW) for the last 20 years. Our goal was to install plots at a density of 1/20,000 acres for each wilderness and revisit those plots every 10 years. We established that baseline goal in 2013 and now have trends data for twenty percent of the wilderness plots. Both community composition and elemental analysis of lichen tissue are used to measure air quality. Air scores are produced for each plot using species composition and abundance. A lichen community that is composed of pollution tolerant or nitrogen dependent species will have a worse air score than one composed mostly of pollution sensitive species. Trend analyses of elemental concentrations in lichens indicate that regionally deposition of Nitrogen is stable, while Lead, Nickel, Copper, and Chromium has decreased, and Zinc, Sulfur, and Cadmium has increased. Areas closest to urban and agricultural interfaces (Hells Canyon, Alpine Lakes, Columbia River Gorge), have the highest Nitrogen and Sulfur deposition. Higher elevation plots in the Cascade and Olympic Ranges (Boulder Creek, Waldo Lake) generally have better air quality scores. Here we will highlight results from selected wilderness areas and show trends in community composition and elemental content where available. We will provide the proportion of nutrient nitrogen indicating species and acid sensitive species for each wilderness plot. And compare current regional elemental thresholds to measured elemental content of lichens collected from wilderness plots.

A CLIMO-, LITHO-, AND PYRO-SEQUENCE APPROACH TO SOIL PROCESSES ACROSS SOUTHWESTERN MONTANA. John Sugden, Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT 59717; David Thoma, National Park Service, Bozeman, MT 59717; **Tony Hartshorn**, Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT 59717; *soildoc 'at' gmail.com*.

How can a state factor approach to soils improve our understanding of soil processes? Here we report on efforts to clarify dominant processes influencing soils across southwestern Montana, with data primarily from a climosequence (9 soil profiles along a an approximate 1400-2900 meter (m) elevational gradient, all on limestone); a lithosequence (5 soil profiles with comparable climate, topographic setting, and estimated residence times, but overlying five distinct rock types); and a pyrosequence (1 soil profile burned in the 2012 Millie Fire; we are quantifying changes in soil properties with time since fire). We characterized all 15 soil profiles by morphologic horizon to bedrock for a suite of field and laboratory measurements, including immobile elements to quantify chemical depletion fractions, or the fraction of total mass loss that can be attributed to chemical weathering (versus physical erosion). Across the climosequence, chemical depletion fractions averaged 79%, consistent with the weatherability of limestone. These fractions ranged from an anomalously low value of 28% (implying 72% physical erosion) at 2100 m to much higher values of 98% at both 2300 m and 2600 m. These high chemical depletion fractions at very high elevations are somewhat surprising given our expectation—derived from a Sierra Nevada climosequence—that physical erosion associated with freezing and thawing would play a greater role in soil development at these elevations. We use these data to explore the potential climate change consequences for chemical weathering along this northern Rocky Mountain climosequence.

MANY THINGS YOU CAN DO, NOVICES CAN DO TOO: SAMPLING ERROR ASSOCIATED WITH NOVICE TECHNICIANS IN A LARGE-SCALE, LONG TERM BIODIVERSITY MONITORING INITIATIVE. Diane L. Haughland, Alberta Biodiversity Monitoring Institute at the Royal Alberta Museum, 12854 102 Avenue NW, Edmonton, AB, T5N 0M6; *diane.haughland 'at' gov.ab.ca*

To combat the biodiversity crisis, many scientists called for long-term, large-scale ecological monitoring in the 1990s. The concurrent increased appreciation of statistical power and detection-related sampling error meant that few jurisdictions took on the experiment. The Alberta Biodiversity Monitoring Institute (ABMI; Alberta, Canada) is one example that has now survived its first decade. The scale and breadth of the ABMI necessitates the employment of mainly novice technicians as well as the use of rapid assessment protocols. This led to the supposition that sampling error was insurmountably high and focused solely on common species. I examined these suppositions in the field and the laboratory. First, in a factorial repeated measures complete-block field experiment, I compared sources of sampling error in floristic surveys of bryophytes and found that a) rare species were detected, b) species detected by experts in similar habitats were also detected by novices, and c) sampling error did not prohibit community-level analyses. Individual species' detection probabilities varied however, making trend detection for many individual species difficult. Second, I analyzed the overlooking and error rates of novices conducting routine identification of common lichens in the laboratory, a taxon for which expertise is limited. The technicians attained ≥ 95% accuracy in their identification of 21 of 23 lichen species. Technicians retained for two field seasons appeared to reduce errors for all technicians in their cohort. I conclude by highlighting rare lichen species, some new to Alberta or to western Canada, that have been collected by novice ABMI technicians since 2009.

SYSTEMATIC ANALYSIS OF CARBON STOCKS IN A SMALL CATCHMENT OF THE KOLYMA WATERSHED. Kathryn E. Heard, Andrew Bunn, Huxley College of the Environment, Western Washington University, Bellingham, WA 98225; Sue Natali, Woods Hole Research Center, 149 Woods Hole Road, Falmouth, MA 02540-1644;*heardk2 'at' students.wwu.edu*

As Arctic terrestrial ecosystems comprise about one-third of the global terrestrial ecosystem carbon total, the response of Arctic systems to accelerated warming is an issue of global concern. Both the identification and quantification of terrestrial carbon stocks is fundamental in determining how terrestrial ecosystems will respond to changing climatic conditions. For this research, above- and belowground carbon stocks were quantified in a small catchment of the Kolyma watershed in northeastern Siberia. The sites were chosen based on four categories of tree density. In total, 20 sites were established. At each site, we obtained six soil cores, estimated woody debris using the line-intercept method, and measured understory biomass, percent cover, thaw depth, diameter-at-breast height of trees and snags, and canopy cover. Solar insolation, slope, densiometry, and leaf area index were analyzed as predictor variables. Preliminary results suggest a significant correlation between densiometry and the two measures of leaf area index: hemispherical photography and LAI 2000. Furthermore, slope and leaf area index are predictor variables for the carbon in aboveground biomass and organic soil, while solar insolation is not. In addition, the carbon pool in mineral soil is significantly related to aboveground shrub biomass. These findings provide insight into the biotic and abiotic factors that mediate carbon pools, and present several alternatives to directly measuring carbon stocks.

IMPACTS OF SPOTTED KNAPWEED ON PLANT-POLLINATOR INTERACTIONS.
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Animals pollinate over 85% of all angiosperms from important agricultural crops to wildflowers. Many weeds rely on pollinators as well, which they may share with native plants resulting in competitive, facilitative or neutral consequences for native plants and their reproduction. We investigated the impacts of spotted knapweed (*Centaurea steobe* L.) on plant-pollinator interactions in Montana rangeland over two years through both observational and experimental studies. We found that spotted knapweed is integrated into the pollinator network of the plant communities it invades; across nine sites in western Montana, spotted knapweed shared pollinators with all other co-flowering plants. Some pollinator taxa appear to prefer spotted knapweed (particularly *Apis meliffera*, which accounted for almost 60% of all visits to spotted knapweed flowers at some sites), whereas others only visited native plants. In an experiment studying pollinator dynamics between spotted knapweed and hairy false goldenaster (*Heterotheca villosa* (Pursh) Shinners), we found that spotted knapweed received an average of 1.1 more visits per flower per 90 minutes than hairy false goldenaster (p-value < 0.01). Despite spotted knapweed's higher visitation rate, neither pollinator visitation nor seed production of goldenaster decreased in the presence of spotted knapweed. These results suggest that although spotted knapweed influences the structure of plant-pollinator networks in the communities it invades, it does not decrease seed production of the common native plant hairy false goldenaster.

LITHIC ANALYSIS OF COYOTE CANYON MAMMOTH SITE SEDIMENTS.
Kaitlin M. Hill, Central Washington University, 400 E University Way, Ellensburg, WA 98926; **George V. Last**, Pacific Northwest National Laboratory P. O. Box 999, MSN K6-81 Richland, WA 99352; *george.last 'at' pnnl.gov*

Previous research at the Coyote Canyon Mammoth Site, located 5 kilometers south of Kennewick, Washington, suggests that the skeletal remains are located within Ice Age flood deposits. These deposits are superimposed by paleosol development, and overlain by eolian sediments and slope wash. Casual observations during excavation activities suggested that the Ice Age flood deposits may have a higher percentage of granitic (felsic) sand grains (presumably ice-rafted in from felsic bedrock near the origin of the floods) than locally derived loess deposits. The research presented here was conducted to test this hypothesis, by using point-counting methodology to quantify the lithologic make-up of the different stratigraphic units. Our study focused on the 1-2 millimeter (very-coarse sand) fraction of wet-screened sediments from excavation unit 2. Point count analysis was conducted on 23 different levels, each representing a 10 centimeter thick layer. Two-gram aliquots of the very-coarse sand fraction, yielding 345 to 512 sand grains, were separated into six different lithic groups (basaltic, caliche, granitic, light-colored translucent, light-colored opaque, and other) based on their visual appearance. Our results (although limited by the small sample size) suggest that indeed the undisturbed portion of the Ice Age flood deposits may have a lower median ratio of basalt-to-granitic sand grains than the other three stratigraphic units. The data also suggest that perhaps with larger sample sizes lithic point counting may allow statistical differentiation of the stratigraphic units based on the lithologic make up of their very coarse sand fractions.

IMPLICATIONS OF CLIMATE CHANGE FOR TURNOVER IN FOREST COMPOSITION: A CASE STUDY FROM MT. RAINIER NATIONAL PARK.

Janneke Hille Ris Lambers, Ian Breckheimer, Kevin R. Ford, Steve J. Kroiss, Department of Biology, University of Washington, Box 351800, Seattle. WA 98195-1800. *Jhrl 'at' uw.edu*.

One of the greatest challenges forest ecologists face is forecasting how global climate change will influence forest community structure. Locally, forests are expected lose cold-adapted trees while warm-adapted trees increase in abundance. However, potential lags due to slow-growing and long-lived trees paired with species-specific climatic sensitivities could add complexity to compositional changes. We use extensive demographic measurements across a large climatic gradient at Mount Rainier National Park (Washington) to ask 1) how rapid recruitment and mortality occurs in these forests; and 2) whether differences among tree species in their climatic sensitivities are likely to result in idiosyncratic changes to forest communities. We found that successful seedling recruitment is rare, sapling growth rates in forest understories are extremely slow, and mortality of adult trees is low, implying forest community composition may not change rapidly with future climate change. Consistent with this finding is the surprisingly low compositional change in forest communities over the last 35 years, despite significant turnover of individuals. However, tree species differ significantly in recruitment, growth and mortality rates. Moreover, tree growth and seedling recruitment of high-elevation trees is especially sensitive to high snowpack and short growing seasons, suggesting the potential for rapid population growth with warming for these species. Additionally, mortality rates may increase precipitously, especially if climate change alters disturbance regimes. In all, we conclude that future climate change could have large and unpredictable impacts on forest composition at Mt. Rainier, despite the resilience showing by forest communities thus far.

TRADITIONAL NATIVE AMERICAN METHODS FOR HARVESTING BARK DOES NOT CHANGE SECONDARY GROWTH RATES IN WESTERN RED-CEDAR.

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The bark of western red-cedar (*Thuja plicata*) is an important basketry resource for the Native Americans of the Pacific Northwest. While the common indigenous approach to bark harvesting does not kill the tree, little attention has been given to the possible affects traditional harvesting has on the tree's fitness. In this study I address the question: does traditional harvesting of western red-cedar affect secondary growth rates? In the spring of 2008, eight western red cedars were peeled within Mount Rainier National Park. The individual that peeled the trees is unknown but the approach to harvesting appears to follow the traditional methods used by the Nisqually Tribe and other local Native Americans. I paired these trees with eight unpeeled trees growing adjacent to them and then used dendrometer bands to measure the increase in diameter over time. These measurements indicate peeled trees have a faster growth rate than the controls. I then cored and measured the ring width of the trees to see if the faster growth rates developed after peeling in 2008. There was no change in the growth rates between 2005 and 2012, indicating that traditional harvesting does not affect secondary growth in cedar trees. The faster growth rates observed in the peeled trees may indicate an association between secondary growth and characteristics that make a tree preferable for harvesting.

A BRYOPHYTE AND LICHEN FLORA FOR THE SOUTH PUGET SOUND PRAIRIES AND THE EFFECTS OF FIRE ON PRAIRIE BRYOPHYTE AND LICHEN COMMUNITIES.
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We present a bryophyte and lichen flora for the south Puget Sound prairies based on field investigations of seven prairie sites conducted over the period of 2012-2014. We report a total of 32 terrestrial bryophyte taxa including 27 mosses and 5 liverworts, representing 20 families and 27 genera. We report a total of 34 terrestrial lichen taxa, representing three families and three genera, several of which are state-ranked species and appear to be rare or uncommon in Washington. Bryophyte species richness was similar between burned and unburned plots (26 species recorded in burn, 23 species in unburned), however growth form and functional group composition was altered significantly. In burned plots short turf, tall turf and mat/weft growth forms comprised 98% of total cryptogam cover. Nitrogen-fixing lichen (*Peltigera*) and forage lichen (Reindeer-type *Cladonia* spp.) functional groups were absent from the burned areas we surveyed. In unburned plots, tall turf, forage lichen (Reindeer (*Cladonia* spp.)) and mat/weft moss growth forms/functional groups totaled 89% of the cryptogam cover, with the remaining 11% cover representing five distinct functional categories. Total bryophyte and lichen cover averaged 62.3% across our study sites. In burned plots, overall lichen covered decreased by 98% ($p = < 0.0041$) and overall moss cover decreased by 19% ($p = < .0001$). Overall liverwort cover was very low (< 1%) and was not significantly different between burned and unburned plots ($p = 0.3249$). Bryophyte and lichen mat depth was significantly reduced in burned areas at 4 out of 5 of our study sites.

DEEP SOIL: SAMPLING, MODELING, AND SIGNIFICANCE OF CARBON IN SUBSURFACE LAYERS.
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Soil is the primary sink for carbon (C) in forest ecosystems, but it is often overlooked in ecosystem C budgets. Efforts to quantify C pools often sample soils to a depth of 0.2 meter (m) despite observations that deep soil C is neither scarce nor entirely stable. This study examined the systematic sampling depth for ecosystem C analyses in the Pacific Northwest, and compared best-fit models of C in deep soil layers with laboratory measurements. Forest floor samples were collected as well as mineral soil bulk density samples at the midpoint of regular depth intervals (bounded by 0-0.1 m, 0.1-0.5m, 0.5-1.0 m, 1.0-1.5 m, 1.5-2.0 m, and 2.0-2.5 m) from 22 sites across the coastal Pacific Northwest Douglas-fir zone. Soil samples were screened to 4.7 millimeters and analyzed for C content. We found that systematic soil sampling shallower than 1.5 m significantly underestimated total soil C. On average, sampling to 2.5 m compared to 0.5 m increased total C by 156% (85.3 Mg per hectare to 132.7 Mg per hectare). On average, 65% of total C was found in the top 0.5 m of soil, 35% of total C was between 0.5 and 2.5 m, and 21% of total C was between 1.0 and 2.5 m (ranging from 6% to 57%). A nonlinear mixed model using an inverse polynomial curve form and predicting total C to 2.5 m given only data to 1.0 m was reliable for 20 of 22 sites; the sites that could not be accurately modeled carried the greatest C at depth and contained noncrystalline minerals. Shallow soil sampling at best provides a biased estimate and at worst leads to misleading conclusions regarding soil C. Researchers seeking to quantify soil C or measure change over time should sample deep soil to create a more complete picture of soil pools and fluxes.

HISTORICAL FIRE REGIME AND FOREST COMPOSITION IN THE SOUTHERN BLUE MOUNTAINS OF OREGON. **Sean M. A. Jeronimo**, Derek J. Churchill, School of Environmental and Forest Sciences, College of the Environment, University of Washington, Seattle, WA 98195; Gunnar C. Carnwath, U.S. Forest Service, 1550 Dewey Avenue, Baker City, OR 97814; Andrew J. Larson, Department of Forest Management, College of Forestry and Conservation, University of Montana, Missoula, MT 59812; *jeronimo 'at' uw.edu*

We investigated the relative importance of fire versus environmental conditions in determining forest composition within the Dugout Creek Research Natural Area on the Malheur National Forest in the Southern Blue Mountains of Oregon. We combined a spatially and temporally explicit fire history by E.K. Heyerdahl with a reconstruction of stand-level structure, composition, and spatial pattern under an active fire regime. Sample sites were established along a productivity gradient to capture the range of variability within the study area. We tested the abilities of environmental variables (elevation, slope, aspect, topographic position, and potential evapotranspiration) and fire regime attributes (median and maximum return interval) to distinguish between plant associations. Median fire return interval was the only attribute to differ significantly between associations ($p < 0.05$). Shorter return intervals (median 12 years) were correlated with dominance of *Pinus ponderosa* (greater than 84% of basal area) while more mesic sites with longer return intervals (median 20 years) had sizable proportions of *Abies grandis* (greater than 30% of basal area). Our analyses suggest that the ecological process of fire historically acted as a stronger driver of forest composition than environmental conditions alone. This study demonstrates the importance of Research Natural Areas as rich bases for forest science over the long term.

UNCERTAINTY IN ESTIMATING EVAPOTRANSPIRATION AT THE REGIONAL SCALE: A REMOTE SENSING ANALYSIS AND COMPARISON OF LANDSAT SATELLITE DATA IMPROVEMENTS. **Aiden V. Johnson**, Paul C. Stoy, Elizabeth Harris, Stephanie E. Ewing; Department of Land Resources & Environmental Science, Montana State University, PO Box 173120, Bozeman, MT 59717; j*ohnson.aiden 'at' ymail.com*

Accurate measurements or estimates of evapotranspiration (ET) are critical for water resource management especially in water limited areas. The factors that control ET include leaf and canopy conductance of water, plant and surface available water, and available energy. These factors are dynamic across space and time; thus, integrating plot-scale measurements from eddy covariance or similar measurements across landscapes is not a simple task. Remotely sensed data provides the spatial extent to bridge site measurements to regional scales of interest. We compared estimates of ET factors generated from two different satellites, Landsat ETM (Enhanced Thematic Mapper for) and Landsat 8 over a dryland wheat producing region in the Judith Basin of central Montana. Our results suggest that both satellites successfully distinguish the seasonality of the factors that control ET. However, Landsat 8 provides more reliable estimates of land surface temperature because of greater radiometric precision in the thermal band. Future work will focus on in situ comparisons of ET via existing and forthcoming eddy covariance towers, as well as comparisons against the landscape-scale water balance.

DEFINING NEW FUEL MAPS FOR MOUNT RAINIER NATIONAL PARK FROM A FUSION OF FIELD, LIDAR, AND ENVIRONMENTAL DATA. **Van R. Kane**, Forest Structure and Dynamics Lab, School of Environmental and Forest Sciences, Box 352100, University of Washington, Seattle, WA 98195-2100; Karen Kopper, North Cascades National Park, 7280 Ranger Station Rd., Marblemount, WA 98267; Catharine Copass, Olympic National Park, 600 E. Park Avenue, Port Angeles, WA 98362; *vkane 'at'uw.edu*

Fuels maps are needed by Pacific Northwest forest managers to model fire behavior and anticipate wildland fire effects on managed lands. Fire ecologists have used broad-scale fuel classes (e.g. meadows verses mixed conifer forest) to classify and compare fire hazards across Mount Rainier National Park. However, the need for finer-scale fuel maps has increased for mesic Pacific Northwest forests due to climate change, particularly with respect to the increased likelihood of longer fire seasons and larger areas burned. Finer-scale fuel classes would enhance fire behavior models and planning for the expected new climate and fuel conditions. Higher resolution fuels maps also would be useful today where fire severity is more variable such as the drier east-side of the park. We used surface fuel and vegetation data from 174 plots to define high/low fuel classes based on median values for organic, 1 to 100 hour, and 1000 hour surface fuels. Random forest modeling with environmental data and canopy structure data from airborne LiDAR mapped these classes across the park with accuracies between 62% and 75%. We used the LiDAR data to define six canopy structure classes that differentiated dominant tree heights and whether canopies were single or multiple layered. The surface fuel and canopy structure classes were combined to define 26 fuel beds that were mapped across the park at much finer scale (0.09 ha) than previous maps. Our work demonstrates the fusion of field, LiDAR, and environmental setting data with machine learning algorithms like random forests to create maps to guide management of forests under a changing climate.

ETHANOL ACCUMULATION DURING SEVERE DROUGHT MAY SIGNAL TREE VULNERABILITY TO DETECTION AND ATTACK BY BARK BEETLES.
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Tree mortality from temperature driven drought is occurring in forests around the world, often in conjunction with bark beetle outbreaks, when carbon allocation to tree defense declines. Physiological metrics for detecting stressed trees with enhanced vulnerability prior to bark beetle attacks remain elusive. Ethanol, water, monoterpene concentrations and composition were examined in the phloem and sapwood of drought stressed Aleppo pine, *P. halepensis,* freshly attacked by Mediterranean pine shoot beetles, *Tomicus destruens,* and in neighboring unattacked trees. The attacked trees were more water stressed and contained on average 2.1 and 2.4 times more ethanol in the phloem and sapwood, respectively, than the neighboring attack free trees. This response is consistent with *T. destruens* known attraction to ethanol. Most monoterpene concentrations in the phloem, but not sapwood, were greater in tissues of attacked trees, whereas compositional differences were minor between the two tree groups for both tissues. Tissue water content explained much of the variation in phloem monoterpene concentrations that increased as water in the phloem declined; suggesting higher constitutive quantities existed in the more stressed trees prior to the attacks. Monoterpenes may have contributed to *T. destruens* host tree selection, but their influence is considered less important than the ethanol based on beetle responses to these compounds in previous trapping studies. This is the first report of elevated ethanol concentrations in tissues of trees experiencing natural drought stress, and suggests that ethanol measurements in severely water stressed trees may allow early detection of those most vulnerable to bark beetle attack.

EPIDEMIOLOGICAL POTENTIAL OF WHITE-NOSE SYNDROME IN THE NORTHWEST: AN INDIVIDUAL-BASED SIMULATION MODEL EXPLORES DISEASE PARAMETERS.
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The fungal disease known as 'white-nose syndrome' (WNS) has devastated bat populations in eastern North America, with losses totaling millions of bats. Relatively little is known about its epidemiology or the pathogen's potential for invasiveness in the Northwest. Framing WNS epidemiology in a predictive context will help to understand the potential for disease spread in western bat populations. We used an individual-based modeling ("IBM") approach; whereby, attributes of individual bats at discrete geographic locations are tracked over time, allowing analysis of processes where events among individuals have emergent metapopulation consequences. With an IBM, the system's spatial structure can be explicitly constructed, with flexibility to accommodate habitats that are spatially heterogeneous for biotic and abiotic conditions, and phenotypic heterogeneity among hosts. For several eastern bat species, large winter populations converge in few hibernacula; whereas, some western species occur in smaller colony assemblages. It is possible that smaller, dispersed colonies may limit the spread of the pathogen. Our model simulates epizootic dynamics in metapopulations of up to 10^7 bats, in up to 50 hibernacula. Pathogen transmission occurs by bat-to-bat contact (or from inoculum on abiotic surfaces). Healthy and latently-infected bats occasionally move between hibernacula, but infectious bats do not. Simulations suggest an interplay between local pathogen transmission efficiency and inter-hibernaculum movement, which may enhance geographic spread of the epizootic, or, conversely, localized extinctions of both host and pathogen populations which limits epizootic spread. Future research will explore the relative contribution of inoculum from abiotic reservoirs on pathogen persistence and initiation of new infections.

TROPHIC COMPLEXITY AND THE SUCCESS OF FUNGAL BIOLOGICAL CONTROL AGENTS.
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Fungal biocontrol agents (BCA) against plant pathogens or weeds operate within physically, biologically, and spatially complex systems, by means of various trophic and non-trophic interspecific interactions. The biocontrol agent *Trichoderma harzianum* is a mycoparasite of several fungal plant pathogens, including *Sclerotinia sclerotiorum*, causal agent of white mold disease of potato, bean, and other crops. *T. harzianum* has been used to control the pathogen in the greenhouse and field. However, in a non-agricultural setting, *Sclerotinia* is being evaluated as a BCA against certain invasive weeds, such as spotted knapweed. BCA are themselves subject to trophic interactions with parasites or predators that may affect their biocontrol efficacy. Several tools are available to help characterize these ecologically complex trophic webs. We investigated soil systems including crop or weed plants, the phytopathogen *S. sclerotiorum*, the mycoparasite *T. harzianum*, and fungivorous nematodes in the genus *Aphelenchoides*. We engineered *T. harzianum* to express green fluorescent protein (GFP) for visualization using epifluorescence and confocal microscopy, and for detection and quantification of the GFP gene in soil, using polymerase chain reaction (PCR) amplification. Presence of *Aphelenchoides* decreased growth and activity of *T. harzianum*, reducing its efficacy as a BCA against the crop pathogen *Sclerotinia sclerotiorum*. However, when *S. sclerotiorum* was used as a BCA against spotted knapweed, hyperparasitism by *T. harzianum* reduced its biocontrol efficacy, so that predation of *Trichoderma* by *Aphelenchoides* had the effect of enhancing biocontrol of knapweed. Factoring in trophic complexity will help reduce the uncertainty that has plagued biological control efforts in the field.

USE OF A TROPHIC SIMULATION MODEL TO DEVELOP PALE CYST NEMATODE ERADICATION STRATEGIES. **Guy R. Knudsen**, Louise-Marie Dandurand, Department of Plant, Soil, & Entomological Sciences, University of Idaho, Moscow, Idaho 83844; *gknudsen 'at' uidaho.edu*

Intensive efforts are underway to eradicate the pale cyst nematode (PCN), *Globodera pallida*, from Idaho potato fields. To date, in the USA, this invasive plant pathogen has been found only in Idaho. Fumigation with methyl bromide has reduced but not eradicated PCN populations. Biologically-based control methods, including fungal biocontrol agents (*Trichoderma* and *Plectosphaerella* spp.) and trap crops, show promise for eradication or management of PCN. However, quarantine considerations preclude comprehensive field testing of these methods, and a quantitative modeling framework to predict and optimize their efficacy is needed. The system is ecologically complex, involving a trophic web that includes potato, PCN, solanaceous trap plants, and the nematophagous biocontrol fungi. We used a simulation model to identify susceptible points in the nematode life cycle, and to predict effects of the biological control strategies at those points. The model was implemented using the systems dynamics software package VENSIM, with additional code in C++. Simulation results suggest that an optimal eradicative outcome would be achieved by using combinations of control strategies, such as trap crops or chemical hatching factor to stimulate emergence of J2 larvae that survive chemical fumigation, in combination with nematophagous fungi that are able to colonize cysts containing unhatched eggs. Sensitivity analysis of simulation results was used to estimate levels of control achievable with the different control methods, individually or in combination. This quantitative approach should provide a useful tool to optimize strategies to eradicate or manage this important plant pest.

CLIMATE DRIVERS OF FOREST PATTERN: DEVELOPMENT OF WILDFIRE REFUGIA. **Crystal A. Kolden**, University of Idaho, McClure Hall 401B, Moscow, Idaho 83844-3021; *Ckolden 'at' uidaho.edu*

It is hypothesized that climate variability and change impacts forest mosaics through ecological disturbances such as wildfires. However, climate-fire research has primarily focused on understanding drivers of fire frequency and area burned, primarily due to scale mismatches and limited availability of data and computing power. Recent new datasets, however, allow for the characterization of ecological patch metrics cross regions broad enough to investigate climate linkages. One area of particular interest is the occurrence of fire refugia within wildfire perimeters. While much recent research emphasis has been placed on high severity patches within wildfires, it is the unburned patches and low severity refugia that provide critical remnant habitat and serve as seed sources to initiate colonization and succession in recently burned landscapes. These patches also may yield insights into approaches for developing fire resilient landscapes by forest managers and communities seeking to reduce wildfire hazard. Recent efforts to begin characterizing fire refugia across landscapes have yielded some surprising results, including the absence of a temporal trend in unburned proportion even as research and anecdotal information suggests fires are becoming larger and more severe. These efforts also reveal challenges related to classifying refugia from remotely-sensed data. Here, I present results from nascent efforts to characterize climate drivers and patterns of fire refugia across recently-burned forests in the western United States, and contextualize these results in a suggested framework for addressing climate change impacts on forest pattern more broadly.

MERCURY CONTRIBUTIONS FROM FLINT CREEK AND OTHER TRIBUTARIES TO THE UPPER CLARK FORK RIVER IN NORTHWESTERN MONTANA. Heiko Langner, Matthew Young, Molly Staats, Geosciences Department, University of Montana, 32 Campus Drive, #1296, Missoula, MT 59812; Ute Langner, Montana Natural Heritage Program - Spatial Analysis Lab, 32 Campus Drive, University of Montana, Missoula, MT 59812; *heiko.langner 'at' umontana.edu*

Mercury levels in biota are a major factor diminishing the environmental quality of the Upper Clark Fork River (CFR), e.g. by triggering human consumption limits on fish. However, Superfund remediation so far has focused on other mining-related contaminants (As, Cu, Zn, Pb, Cd), which may be counterproductive with respect to the bio-availability of mercury. A legacy of precious metals mining caused elevated total mercury concentrations in many tributaries to the CFR. However, the relative effect of these sources on total mercury levels in the watershed is not known. This work is an attempt to quantify relative contributions of various mercury sources. We obtained fine sediment samples from 56 sites along a 430 kilometer (km) reach of the CFR and major tributaries. While sediment mercury levels were elevated throughout the main stem CFR, we discovered an extremely large increase from 0.7 to 4 milligram/kilogram at the mouth of Flint Creek, suggesting this stream to be the largest contributor of mercury to the CFR watershed. Relative mercury contributions of each tributary were estimated based on concentrations in fine sediment and the mean annual flow rate. We conducted another sampling campaign (48 sites) to further confine mercury sources within the Flint Creek watershed. We identified a historic mill site along Fred Burr Creek as the largest mercury source, with less extensive contributions from Lower Willow Creek and Douglas Creek. Elimination of these point sources may be an economical and effective way of remediating mercury levels throughout the CFR watershed.

WESTERN WHITE PINE SEEDLINGS COMPENSATE FOR AN AMMONIUM DEFICIENCY WITH INCREASED AMINO ACID UPTAKE. Beau Larkin, MPG Operations, 1001 South Higgins Ave, Suite A3, Missoula MT, 59801; *blarkin 'at' mpgranch.com*

Disturbance mediated shifts from ammonium to nitrate can increase mortality of planted conifer seedlings. Conifer root discrimination against nitrate, poor constitutive uptake of nitrate, and poor performance on nitrate have been documented, but potential compensatory uptake of organic nitrogen sources during ammonium starvation remains untested. We used stable isotope labeled nutrient salts in a greenhouse and laboratory experiment to test the ability of non-mycorrhizal western white pines from two genotypes to take up the nitrogen sources arginine, glycine, ammonium, and nitrate. With the use of dual-labeled (^{13}C, ^{15}N) arginine, we confirmed intact amino acid uptake by analysis of *in planta* carbon-nitrogen (C-N) ratio. Arginine constituted 60% of total recovered labeled N in the control group, followed by ammonium (33%), glycine (6%) and nitrate (2%). In seedlings starved of ammonium for one year, labeled nitrate recovery did not change, but glycine uptake increased more than 37%. Despite the observed compensation, white pines starved of ammonium attained less mass than did controls that were given ammonium. With hybrid genotype seedlings, the mass reduction was not significant, but wild type seedlings' mass was 16% less under ammonium starvation. These results support previous evidence that coniferous species rely little on nitrate.

RATES AND SPATIAL PATTERNS OF TREE MORTALITY DIFFER STRONGLY BETWEEN YOUNG AND OLD-GROWTH FORESTS. **Andrew J. Larson**, Department of Forest Management, The University of Montana, 32 Campus Drive, Missoula, MT 59812; *a.larson 'at' umontana.edu*

Tree death is a complex ecological process and the modes and spatial patterns of tree mortality are thought to change during forest structural development. In young even-aged forests mortality is expected to be primarily density-dependent due to competition, leading to increasingly spatially uniform pattern of surviving trees. In contrast, tree mortality in old-growth forests is thought to be primarily density-independent and caused by contagious and spatially autocorrelated agents (e.g., root pathogens and gap-phase disturbance) which should maintain or increase spatial heterogeneity of surviving trees. I used a three decade record of tree mortality based on replicated permanent stem map plots located in young (stand age 23 to 54 years) and old-growth (stand age 300 to 1000+ years) *Abies amabilis* forests to test these predictions. Trees in young forests died at a rate of 4.42 per year, while trees in old-growth forests died at 0.60% per year. The spatial context, spatial pattern, and spatial outcome of tree mortality in young forests differed significantly from the null model of random mortality. In young forests, strongly density-dependent mortality caused a transition to increasingly uniform live tree patterns. Mortality in old-growth forests rarely differed from spatial randomness, maintaining spatial heterogeneity in the population of surviving trees. This long-term study demonstrates that the dominance of density-dependent competitive mortality leading to increasingly homogenous tree spacing in young forests ultimately gives way to a more even mixture of density-dependent and density-independent mortality processes that generate and maintain spatial heterogeneity in old-growth forests.

THE USE OF X-RAY FLUORESCENCE SPECTROSCROPY TO REFINE STRATIGRAPHIC INTERPRETATION OF THE COYOTE CANYON MAMMOTH SITE. **George V. Last**, Eirik Krogstad, Pacific Northwest National Laboratory P. O. Box 999, MSN P7-54, Richland, WA 99352; *george.last 'at' pnnl.gov*

Mammoth remains at the Coyote Canyon Mammoth Site, located five kilometers south of Kennewick, Washington, are located within fine-grained Ice Age flood deposits, some of which have been pedogenically altered, and in turn are overlain by loess deposits. Differentiating individual flood beds from each other and from paleosol and loess deposits is visually difficult in higher elevation back-flooded canyon areas. During the summer of 2013, we tested the use of a portable energy-dispersive X-Ray Fluorescence (XRF) spectrometer to collect in-situ elemental signatures to help differentiate the various stratigraphic units. Sediment samples were also collected and analyzed in the laboratory using wavelength-dispersive XRF spectrometry. Although actual concentrations varied, the field and laboratory results for Ca, Fe, Mn, and Ti, were well correlated (correlation coefficients ranging between 0.80 and 0.92). Depth-discrete elemental plots, elemental-ratio plots, and cross plots of the portable XRF data showed good agreement with the perceived stratigraphic units. Refinements to the stratigraphic contact depths improved cross-plot separation between the various stratigraphic units. In particular, a cross plot of Ba and Ti elemental concentrations proved most diagnostic. Our preliminary results suggest that portable XRF analysis is a useful tool for differentiating between the major stratigraphic units at the Coyote Canyon Mammoth Site. More detailed analyses are planned to examine the lateral heterogeneity at the site. We also plan to test the ability of this methodology to differentiate between Ice Age flood events, weak paleosols, and/or loess deposits in other high elevation back-flooded valleys.

INFLUENCE OF TREE AGREGATION ON MORTALITY IN PRE-FIRE SUPPRESSION FORESTS IN THE SOUTHERN BLUE MOUNTAINS OF OREGON. Miles LeFevre; Derek J. Churchill, School of Environmental and Forest Sciences, College of the Environment, University of Washington, Seattle, WA 98195; Gunnar C. Carnwath, U.S. Forest Service, 1550 Dewey Avenue, Baker City, OR 97814; Andrew J. Larson, College of Forestry and Conservation, The University of Montana, Missoula, MT 59812;
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Stand level spatial heterogeneity is increasingly being recognized as a key component in improving ecological resilience. Patterns of widely spaced individual trees, clumps, and openings characteristic of frequent fire forests are being used to guide thinning operations. Major concerns with leaving clumps of large and old trees are increased rates of mortality and competitive stress. It is well established that density is a major driver of mortality during early stages of forest development in stand replacement systems. However, relationships between density and mortality are not well understood in low density forests with heterogeneous spatial patterns, particularly for old trees. No empirical evidence linking higher mortality in clumps of old trees versus widely spaced individuals exist to our knowledge. Our goal in this study was to describe the relationship of tree clumping and density with mortality. We mapped and reconstructed pre-settlement conditions for multiple plots covering three plant association series within the Dugout Research Natural Area on the Malheur National Forest in the southern Blue Mountains of Oregon. Trees were described in terms of clump size, clump density, tree position within clumps, as well as variable area density and neighborhood index. Results from the Wilcoxon rank-sum test showed no significant shift in the distributions of live and dead trees for clump size in five plots ($p < 0.92$) while one plot showed a significant shift toward smaller clumps for live trees ($p = 0.05$). No plot showed a significant shift in respect to variable area density ($p < 0.96$). The use of point pattern statistics showed no significant difference in the initial neighborhoods of dead versus live trees in five plots ($p < 0.87$) and a significant difference in one plot ($p = 0.04$). These findings indicate that mortality may be spatially random, and that retaining clumps of trees in thinning treatments is not likely to increase risk of mortality.

BEAVERS CAN FACILITATE INVASIVE TREES ON MAJOR RIVERS IN EASTERN MONTANA. Peter Lesica; Conservation Biology Research, 929 Locust, Missoula, MT 59802;
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Beavers can play an important role in Russian olive and tamarisk invasion by removing the cottonwood trees while having little impact on the invaders. Beaver foraging damaged the majority of cottonwood trees within 50 m of most river channels sampled, but only 21% of stands farther away were affected. Russian olive and tamarisk suffered little damage regardless of location. Cottonwood establishment and dominance will not be precluded on unregulated rivers where flooding events reinitiate primary succession beyond the zone of beaver activity. However, cottonwood establishment is often restricted to lower terrace sites along regulated rivers, and here beaver prevent cottonwood from developing a mature canopy close to the river while having little effect on the continued invasion of Russian olive.

HOW QUICKLY DOES BIG SAGEBRUSH RECOVER FOLLOWING FIRE?

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Big sagebrush (*Artemisia tridentata*) provides habitat for numerous species; however, sagebrush steppe has declined across the semi-arid west. Prescribed fire is often used to control conifer encroachment in sagebrush steppe, but, there is disagreement on the ability of big sagebrush to recover following fire. We sampled 38 burned-unburned paired sites in southwest Montana dominated by three subspecies (ssp. *wyomingensis*, ssp. *vaseyana*, ssp. *tridentata*) of big sagebrush and 24 sites in eastern Montana dominated by ssp. *wyomingensis*. At each site we subjectively located one sample macroplot representing the burned area and a second macroplot in a similar, adjacent, unburned location for comparison. Post-fire time to full recovery of big sagebrush canopy cover differed among subspecies in southwest Montana. Recovery time averaged 32 years for ssp. *vasseyana*. Recovery rate for ssp. *vaseyana* was ten times greater than for ssp. *wyomingensis* ($P<0.001$) but less than for ssp. *tridentata* ($P=0.01$). There was no difference in recovery rates between prescribed fires and wildfires in stands of ssp. *vaseyana* ($P=0.15$). In eastern Montana where only ssp. *wyomingensis* occurs, prescribed burns and wildfires typically resulted in complete mortality. We found no sagebrush recovery for 17 of the 24 sites after burning had occurred, and the oldest burned stand (67 years) was only 8% recovered. Our results indicate that the speed of post-fire recovery of big sagebrush depends on subspecies (or associated habitat). The majority of ssp. *vaseyana* stands will recover in about three decades, but only long fire-return intervals will allow stands dominated by ssp. *wyomingensis* to persist.

THE EFFECTS OF SOIL PARENT MATERIAL AND FERTILIZATION TREATMENT ON THE WOOD QUALITY OF DOUGLAS-FIR IN THE PACIFIC NORTHWEST.

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The influence of soil parent material (SPM) and nitrogen treatment on wood quality of middle age Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) has been studied in the Pacific Northwest (PNW). Douglas-fir is the predominant plantation species native to the PNW. Nitrogen is consistently the most limiting factor to the growth of forests in the PNW as well as in the rest of the world. Fertilization practices have been developed to cope with insufficient nitrogen availabilities and stimulate tree growth. This study intends to address the needs in updating wood property models for different stand conditions and environmental variables. Experiments would be conducted both in the field and laboratory, measurements include: (1) Time-of-flight Acoustic Velocity (largely determined by wood stiffness) measurements would be conducted on logs and standing trees separately; (2) Disks and increment cores would be extracted from sampled trees to measure the proportion of juvenile/mature wood and earlywood/latewood; and (3) Specific Gravity (density), one of the most important wood physical properties, would be determined on disks and increment cores. Datasets shall be combined to test the effect of stand conditions along with silvicultural treatments. Wood quality models would be instituted for different stand conditions and environmental variables for a better understanding of the influences of these variables on each wood property (stiffness, density, earlywood/ latewood proportion). The outcomes would inform forest managers, wood scientists and forest modelers of the effect of silvicultural treatment on several important wood properties.

CLOSED BASIN WETLAND POND FLUCTUATIONS ON THE WATERVILLE PLATEAU, WASHINGTON. Karl Lillquist, Anthony Gabriel, Geography Department and Resource Management Program, Central Washington University, 400 East University Way, Ellensburg, WA 98926; Ben Sainsbury, Oregon-Metro, 600 NE Grand Avenue, Portland, OR 97232-2736; *lillquis 'at' cwu.edu*

Washington State's Waterville Plateau occupies the northwestern corner of the Columbia Plateau, a semi-arid, winter-wet area of rolling to hummocky topography, agricultural land uses, and ample waterfowl. We used Thematic Mapper to monitor area fluctuations of 52 hydrologically closed basin wetland ponds there from 1986 to 2007. Pond data sets were analyzed cumulatively and stratified (moraine vs. scabland geomorphology; large vs. small watershed area; high vs. low watershed relief; moderate vs. slow vs. very slow water infiltration into soils; and farmland vs. rangeland land use). Pond areas generally reached their maxima at the end of the wet season in March and April. Pond minima were more dispersed throughout the year. Pond areas were large in 1986, the mid- to late- 1990's, and again beginning in 2006. Small pond areas occurred around 1994 and 2005. Pond area fluctuations correlate best with the Palmer Hydrological Drought Index (0.4478 to 0.6702, $p < 0.05$) and with the precipitation:potential evapotranspiration ratio (0.4557 to 0.5570, $p < 0.05$) indicating that they depend on inflow from precipitation and outflow from evaporation. Overall precipitation correlated in about half of the possible situations while snowfall correlated in very few possible situations. Correlations improved with water year data suggesting that a several month lag-time exists in pond responses to weather. Pond areas of stratified data sets showed little difference in their response to weather. However, scablands, small watersheds, slowly infiltrating soils, and rangelands were more strongly correlated to weather variables than their counterparts. These results suggest that these variables are secondary to weather in their impacts on pond area fluctuations.

INTRA- AND INTER- SPECIFIC VARIABILITY OF TRANSPIRATION ON MONTANE HILLSLOPES. Nathaniel Looker, Justin Martin, Jia Hu, Department of Ecology, Montana State University, P.O. Box 173460, Bozeman, MT 59717-3460; Zachary Hoylman, Kelsey Jencso, College of Forestry and Conservation, 32 Campus Drive, The University of Montana, Missoula, MT 59812; *ntlooker 'at' gmail.com*

Estimation of transpiration is critical to understand plant growth-climate relationships and resolve water balances. Sap-flow methods measure transpiration in individual trees but may not capture spatial heterogeneity in water fluxes. To identify patterns in transpiration associated with topography and species, we measured sap-flow rates in *Pseudotsuga menziesii* and *Pinus ponderosa* at 1450 meters (m) and in *Pseudotsuga menziesii* and *Picea engelmannii* at 1800 m in the Lubrecht Experimental Forest of western Montana. At the two elevations, we chose four individual trees for each tree species, with two individuals of each species growing in a convergent hollow and two individuals growing on an adjacent slope. In each tree, we installed two sap-flow sensors on the eastern and western sides of the tree. The maximum mean daily sap flux per sapwood area (i.e., amount of water transpiring per unit area of conducting tissue) was 26.8 cm^3 cm^{-2}, in *P. engelmannii* growing in a hollow, and the minimum mean daily rate was 4.36 cm^3 cm^{-2}, in *P. ponderosa* growing on a slope. Variability of sap flux within *P. menziesii* provided preliminary evidence of the interaction of elevation and topographic convergence, with greater contrasts between hollow and slope at 1800 m (63% difference) than at 1450 m (4% difference). Future efforts will link variation in transpiration to plant hydraulic architecture across topographic gradients.

EXTREMELY RICH FEN MERITS PROTECTION AND MOTIVATES STATEWIDE PLANT CONSERVATION STRATEGIES. **Tara Luna,** P.O. Box 447, East Glacier Park, MT; 59434, Peter Lesica, Conservation Biology Research, 929 Locust, Missoula, MT 59802; Loren Bahls, Montana Diatom Collection, 1032 12th Avenue, Helena, MT 59601; *tluna 'at' 3rivers.net*

Extremely rich fens are considered the rarest of all peatland types in North America and are considered to be highly endangered in Europe. Extreme chemistry creates conditions for unusually high species richness and provides habitat for specialist species that can withstand, adapt, or thrive in such environments. The Connelly fen occurs within the semi-arid and glaciated northwestern plains, with precipitation at only 37 centimeters per year. All plant taxa and diatoms presently known in the site are boreal and cordilleran in their distribution. Of the 18 unknown diatom species, at least 3 are new to science. Six rare boreal plant taxa have been found; all are either peripheral or isolated from other known populations. All taxa are vulnerable to climate change and hydrologic alteration. Today, the site has been a focal point for developing restoration and conservation efforts on the Blackfeet Reservation in Montana, in light of recent threats that affect this site, and serves as an impetus for developing plant conservation strategies throughout the state.

A UNIQUE EXTREMELY RICH FEN FROM THE PLAINS OF THE BLACKFEET RESERVATION MONTANA. **Tara Luna,** P.O. Box 447, East Glacier Park, MT; 59434, Peter Lesica, Conservation Biology Research, 929 Locust, Missoula, MT 59802; Loren Bahls, Montana Diatom Collection, 1032 12th Avenue, Helena, MT 59601; *tluna 'at' 3rivers.net*

An eight-hectare, extremely rich fen, surrounded by saline wet meadows, occurs on the western edge of a mixed grass prairie in the northwestern Great Plains, 47 kilometers from other fens located along the Montana Rocky Mountain Front. The site occurs on an outwash plain near the junction of Pleistocene continental and mountain glaciers and on the western edge of former glacial Cut Bank Lake. Five wetland plant communities have been described from this site. Analysis with Sorenson's coefficient reveals floristic similarity with extremely rich fens in the northwestern Great Plains of Minnesota (45%), Rocky Mountain Front of Montana (78.5%), and high elevation sites in Colorado (49%). A total of 66 vascular plant and 65 diatom species have been found. Eighteen diatom taxa could not be identified with available floras and three have presently been confirmed as new to science. Vascular plants include six rare boreal species that largely have highly restricted geographic ranges, are peripheral, or are widely separated from other known populations. One rare vascular plant species relies strictly on clonal reproduction, two species may rely mainly on clonal reproduction, and two species have specialist breeding systems, which may limit seed production and seedling recruitment. Both diatoms and vascular plants indicate a post-glacial assemblage found in boreal and mountainous habitats, adapted to alkaline waters with moderate conductivity and low concentrations of nutrients. Isolated boreal species, restricted to extremely rich fens occurring within a semi-arid climate, are rare and are especially vulnerable to climate change and hydrologic alteration.

THE VALUE OF OBSERVATION: LONGITUDINAL DATA AND ECOSYSTEM CHANGE.
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When forest ecosystems develop over millennia, trees live five centuries, and mortality unfolds over decades, direct repeated observation – longitudinal data – may be the only way to understand the fate of organisms. Longitudinal data sets have contributed greatly to our understanding of forests, complementing experimental, modeling, and chronosequence approaches. In western forests, longitudinal data have provided insights into the mechanisms of early seral colonization, tree mortality, and relationships between overstory and understory. Changing climate is changing forests – particularly through altered mortality – and the elusive nature of integrated mechanistic understanding requires refinements to historically productive protocols. The combination of the longitudinal protocols developed by the Smithsonian Center for Tropical Forest Science – originally for examination of tropical species diversity – and those developed by the US Geological Survey for annual tree mortality assessment allows investigation of climate-mediated temperate forest change. The etiologies of the different factors contributing to tree mortality are unique, and only some are expected to respond to climate variability and change. Because tree mortality rates are low (1-5%), large numbers of individuals (greater or equal to 10,000) must be tracked to understand changing mortality rates, particularly those of less common species or important large-diameter sub-populations. And because mortality factors can be spatially aggregated and density-dependent, the causes and rates of tree mortality depend on the specific relationships between climate and forest spatial structure. If spatial heterogeneity within forests creates pockets of instability where trees experience elevated sensitivity to climate-induced mortality, local spatial structure would modulate the effects of interannual climatic variation on tree mortality rates and causes.

FIRST RECORD OF CHEANOTHECOPSIS OREGANA IN CANADA.
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Calicioid lichens and non-lichenized fungi are under-reported in North American forests. To address this deficit regionally, calicioid expert Dr. Steve Selva was invited to the Royal Alberta Museum (Edmonton, Alberta, Canada) to provide training on identification and field collection methods. During field surveys in the Lower Foothills region of Lesser Slave Lake, Alberta, the first Canadian record of the recently described resinicolous *Chaenothecopsis oregana* Rikkinen was discovered. The specimen was collected from balsam fir (*Abies balsamifera*) resin and resin-impregnated wood in an old growth forest in the Marten Mountains. We present the first scanning electron microscope images of this species. Originally found in coastal Oregon, its taxonomy has been in flux and the species was temporarily split into *Cheanothecopsis diabolica* and *Ch. zebrana*. In 2012 the original name was reinstated. *Chaenothecopsis oregana* apparently requires old-growth forests, presumably for the unique microhabitats found therein. As currently documented the species has a disjunct distribution (Europe and western North America), but it was hypothesized to be circumboreal, at least historically; this specimen supports that hypothesis. As this was the sole resinicolous specimen found during 20 hours of searching by four lichenologists, it is clear more field surveys are required to document the range of calicioid species.

VULNERABILITY OF OREGON AND WASHINGTON'S NATURAL AREAS TO CLIMATE CHANGE. **Margaret Massie**, Dr. Anita Morzillo, College of Forestry, Oregon State University, Corvallis, OR 97330; Dr. Todd Wilson, U.S Department of Agriculture, Forest Service, Pacific Northwest Research Station, Corvallis, OR 97331; Dr. Emilie Henderson, Institute of Natural Resources, Portland, OR 97202; *Margaret.Massie 'at' oregonstate.edu*

Natural areas are tracts of land set aside for research, education, and conservation. There are currently more than 580 natural areas in Oregon and Washington managed by 20 federal, state, local, and private agencies and organizations. The natural areas network is unparalleled in its representation of the diverse ecosystems found in the region and may be the best collection of sites for monitoring long-term ecological responses to climate change. The primary goal of this research was to build a climate change monitoring program for the Pacific Northwest based on natural areas to (1) better understand the relative strengths of the existing natural areas network for representing effects of climate change, and (2) determine which subset of natural areas have the best potential to detect change over the long term. We conducted a proportionality assessment that compared natural areas with the PNW region based on elevation and modeled vegetation from the Landscape Ecology, Modeling, Mapping & Analysis group and the USGS GAP Vegetation Program. Vulnerability of the natural areas to climate change was evaluated using13 future climate models from the ClimateWNA and the Random Forest Method. Three future projection periods (2020s, 2050s, and 2080s) were compared to current distribution of vegetation formation class types across the region. Projection consensus illustrated a substantial range increase in suitable climate for warmer adapted forest types coupled with a contraction in cooler forest types. The results highlight the potential stress of climate change on many ecosystems across the region and the need for management strategies that can address this uncertainty and change.

MONTANA LICHEN BIODIVERSITY – AN UPDATE.
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The lichen flora of Montana reflects its topographic, geologic, and climatic diversity. We are preparing a list of the lichen flora of the state and annotating the list to indicate the ecological context for each species. Sources for the records (literature and herbarium collections) will be identified for each species. So far, a total of 1,002 species of lichenized fungi are documented from Montana. Of these, 213 species are new for the state and 12 are new to North America. An additional 434 species are listed as reported from nearby states and provinces and are likely to occur in the state. Previous reports based on 570 synonyms of currently accepted names are also given, as well as 38 questionable reports. One hundred reports are considered erroneous and excluded from the flora. Collecting in the state has been decidedly uneven. Based on the combined databases of McCune, Rosentreter, and Wheeler, the counties with the most collections are Lake, Ravalli, Flathead, and Missoula, each with over 1,400 collections. The areas of the state with the fewest collections are central, east central, and the northern tier of counties east of Glacier County. Counties with no known lichen collections are Blaine, Custer, Daniels, Dawson, Garfield, Golden Valley, Liberty, Musselshell, Prairie, Toole, and Wheatland.

FLUVIAL- AND PLUVIAL-ORIGIN COTTONWOODS ALONG A PRAIRIE STREAM: IMPLICATIONS FOR COTTONWOOD RECRUITMENT EXPECTATIONS.

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The cottonwood forest along the Redwater River in northeastern Montana is nearly all mature, and concerns about its future motivated an investigation into constraints on establishment of young trees. This retrospective study determined the age structure of the forest as well as drivers and constraints on cottonwood establishment. The streamflow record reveals a mixture of snow-melt and rain-driven flood events, and scars on trees along the channel and in-channel features indicate periodic ice jams or drives. The floodplain shows relic channels remaining from past migration, and most of the cottonwoods are of fluvial origin. Most of the groves were established in the 1880's and early 1900's, and a significant portion is older than 150 years. Cottonwoods on dune surfaces that far exceed flood stages indicate rainfall as an agent of seedling survival rather than streamflow alone. Snowmelt occurs several weeks before cottonwood seed dispersal, while peak summer rain generally coincides with seed dispersal and early establishment. The Redwater River gage is one of the oldest for a prairie river in eastern Montana, but nearly all the cottonwood establishment occurred before the streamflow record began. Paleohydraulic techniques reveal historic flood estimates that were at least three times the flood of record. Cottonwood recruitment is especially episodic on small streams, where large events are more widely spaced and sediment storage and supply is typically less than for large basins, so expected frequency of cottonwood establishment needs to be adjusted accordingly for the Redwater River system.

DISTRIBUTION, RELATIVE ABUNDANCE, AND CATCH PER UNIT EFFORT OF FISHES IN THE COLVILLE RIVER WATERSHED, STEVENS COUNTY, WASHINGTON.

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This is the first study to report on the fish assemblage of the Colville River watershed, Stevens County, Washington. Sixty-nine sites were sampled from May – November of 2013, 19 in the Colville River and 50 in its tributaries: Blue Creek (n=2), Chewelah Creek (n=6), Cottonwood Creek (n=2), Deer Creek (n=2), Gold Creek (n=3), Haller Creek (n=2), Huckleberry Creek (n=3), Jump Off Joe Creek (n=2), Little Pend Oreille River (n=11), Mill Creek (n=8), Paye Creek (n=1), Sheep Creek (n=2), Sherwood Creek (n=2), Stensgar Creek (n=2), Stranger Creek (n=1), and Thomason Creek (n=1). Sites were sampled using backpack electrofishing, seine nets, and minnow traps. A total of 4,314 fish were captured representing six families and 28 species. The species (relative abundance) were: carp (3.5%), peamouth (>0.1%), northern pikeminnow (0.3 %), longnose dace (3.4 %), Umatilla dace (3.8 %), speckled dace (14.7%), redside shiner (13.7%), tench (0.3 %), longnose sucker (1.7 %), bridgelip sucker (>0.1%), largescale sucker (1.2%), lake whitefish (>0.1%), mountain whitefish (0.3 %), westslope cutthroat trout (>0.1%), coastal rainbow trout (8.0%), interior rainbow trout (14.1%), brown trout (8.0%), brook trout (11.0%), prickly sculpin (2.9%), mottled sculpin (2.6%), slimy sculpin (>0.1%), shorthead sculpin (1.1%), torrent sculpin (7.6%), green sunfish (>0.1%), pumpkinseed (1.1%), bluegill (>0.1%), largemouth bass (>0.1%), and yellow perch (0.5%). Presence/ absence, relative abundance, and catch-per-unit-effort (CPUE) data were compared to evaluate patterns of distribution in relation to 1) barrier falls, 2) stocking records, and 3) influence of water quality on distribution.

CHANGES IN UNDERSTORY VEGETATION 28 YEARS AFTER OVERSTORY THINING AT YELLOW BAY POINT, FLATHEAD LAKE, MONTANA. **Patricia S. Muir**, Bruce McCune, Department of Botany and Plant Pathology, Oregon State University, Corvallis, OR 97331-2902; *muirp 'at' oregonstate.edu*

Before European settlement, Yellow Bay Point of Flathead Lake likely supported a *Pinus ponderosa*-dominated savannah. Fire suppression allowed tree encroachment, particularly by *Pseudotsuga menziesii*, which probably caused changes in understory species composition. In the summer of 1984, we, with students from the University of Montana's Biological Station, carried out a "simulated burn" on the Point with the goals of reducing tree cover, favoring *P. ponderosa*, removing diseased Douglas-fir, and stimulating release of remnant prairie grasses and herbs. We attempted to mimic effects of a moderate-intensity ground fire, cutting down trees most likely to die during such a fire (e.g., *Juniperus scopulorum* and small diameter *P. menziesii*). Trees were measured before treatment, during the summer of 1985, and again in summer 2012; ground vegetation was sampled concurrently and also in summers of 1986 and 1987. Treatments reduced tree basal area (BA) immediately from 42 meters per hectare ($m^2\ ha^{-1}$) to 32 $m^2\ ha^{-1}$ and tree density from 1,234 trees per ha (tph) to 822 tph. By summer 2012 (after a major windstorm in 2008), BA was 21 $m^2\ ha^{-1}$ and tree density was 460 tph. Total plant cover and cover by *Calamagrostis rubescens* and *Spiraea betulifolia*, open woodland species, increased with time. Species diversity and cover by most other species, however, varied along an axis that was independent of time since treatment and represented a gradient from herb- to shrub-domination. Cover of prairie species did not increase despite the reduction in overstory, but encroachment of forest species may have been arrested by treatment.

RELATIVE INFLUENCE OF WATER QUALITY AND PHYSICAL HABITAT FACTORS ON SALMONID DISTRIBUTION AND ABUNDANCE IN A SUPERFUND-REMEDIATED MONTANA STREAM. **Joe P. Naughton**, RESPEC Inc., 1535 Liberty Lane, Suite 110D, Missoula, MT, 59808; Robert E. Gresswell, Northern Rocky Mountain Science Center, U.S. Geological Survey, 2327 University Way, Suite 2, Bozeman, MT 59715; Thomas E. McMahon, Department of Ecology, Montana State University, P.O. Box 173460, Bozeman, MT 59717-3460; Trevor Selch, Montana Fish, Wildlife and Parks, 1420 East Sixth Avenue, P.O. Box 200701, Helena, MT 59620-0701; *joe.naughton 'at' respec.com*

Uncontrolled disposal of mining wastes near Butte, Montana led to the extirpation of fishes from Silver Bow Creek throughout the 20th century. Superfund remediation has been ongoing in the watershed since 1998. Overall, metals concentrations in Silver Bow Creek have been reduced from pre-remediation levels. However, the stream is influenced by municipal sewage, and during midsummer, hypoxia has been observed at night downstream from the wastewater discharge. Despite the water quality problems, six fish species, including three sensitive salmonids, now inhabit Silver Bow Creek. To evaluate the success of remediation in reestablishing salmonid populations, we conducted spatially-continuous fish abundance and habitat surveys, and assessed synoptic water quality throughout 34 stream kilometers (km) during the summer of 2011. An extensive stream portion (approximately 6 km) had low dissolved oxygen (DO less than 5 milligrams per liter [mg/L]) with minimum DO concentrations less than 2.5 mg/L. Additionally, ammonia and copper concentrations increased sharply below the wastewater effluent. Longitudinal abundance of salmonids closely resembled the longitudinal trend in DO and salmonids were largely absent from hypoxic stream sections. Regression analysis revealed strong associations between water quality factors, particularly DO and copper concentrations, and salmonid abundance or occurrence. By comparison, physical habitat factors had little association with occurrence or abundance. Findings suggest remediation has largely succeeded in the reestablishment of salmonid populations despite ongoing ammonia pollution, hypoxia, and copper toxicity. However, persistently toxic copper concentrations, if not contained, will likely limit abundance of salmonids even if ammonia pollution and hypoxia are alleviated.

WETLAND AND RIPARIAN MAPPING IN MONTANA. **Karen Newlon**, Montana Natural Heritage Program; 1515 East Sixth Avenue, Helena, MT 59620; *knewlon_'at'_mt.gov*

The Montana Natural Heritage Program (MTNHP) has been creating digital wetland and riparian mapping across Montana since 2007. With the help of multiple state, federal, and Tribal partners, the MTNHP has mapped nearly 2.2 million acres of wetland and riparian habitat to rigorous, federally mandated mapping standards. Data can be accessed in several ways, including download of the digital data or data viewing via online map services. Wetland and riparian mapping is also incorporated into the National Wetlands Inventory (NWI). Within the next three years, over 70% of Montana will have digital wetland and riparian mapping created from 2005 or later aerial imagery. Wetland and riparian mapping is used for local and regional land use planning, identifying and prioritizing conservation and restoration targets, natural resource inventories, and assessing the quantity and quality of habitat for wetland-dependent species.

GEOMORPHIC HAZARDS IN GLACIALLY CONDITIONED BASINS AND IMPLICATIONS FOR RECREATIONAL TRAILS IN GLACIER NATIONAL PARK, MONTANA.
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Glacier National Park, like many other mountain areas, is experiencing measurable loss in alpine glaciers. As glaciers recede, over-steepened slopes are left behind subsequently causing instability. A glacially conditioned landscape remains that is then shaped by mass wasting and fluvial processes. These processes become hazards when there is potential harm to people or property. The park is known for its dense trail system, allowing visitors to access alpine environments, putting those who access these trails at risk. The purpose of this study was to identify and map patterns of past mass wasting and their causes to help predict areas with high potential for future hazardous events in the Many Glacier Valley of Glacier National Park. Air photo interpretation, archival research, in-depth fieldwork, and Geographic Information System (GIS) analysis resulted in the identification of 394 debris flows, rockfalls, avalanches, translational slides, and rotational slides and predicted areas prone to future events based on bivariate statistical analysis. The trail system was within 100 meters of 43% of all mapped geomorphic features. Fifty nine percent of all events occurred within 100 meters of lakes, glaciers, or streams. Forty seven percent of events have slope angles above 30 degrees. Control variables found statistically significant are distance to surface water, elevation, slope angle, slope aspect, and underlying geology. Significant control variables were used to create hazard maps in the Many Glacier Valley. With over two million visitors per year and over 700 miles of maintained trails, Glacier National Park visitors are affected by geomorphic processes.

FIRE ACTIVITY AND SEVERITY VARY ALONG PROXY GRADIENTS REPRESENTING FUEL AMOUNT AND FUEL MOISTURE IN THE WESTERN UNITED STATES.
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Numerous theoretical and empirical studies have shown that wildfire activity (e.g., area burned) at regional to global scales may be limited at the extremes of environmental gradients such as productivity or moisture. Fire activity, however, represents only one component of the fire regime, and no studies to date have been conducted that characterize *fire severity* along such gradients. This is a considerable knowledge gap, especially given the importance of fire severity in dictating ecological response to fire. For the western United States (U.S.), we more completely represent the fire regime by empirically describing both fire activity and severity along two climatic water balance gradients that can be considered proxies for fuel amount and fuel moisture. We also concurrently summarize fire activity and severity among ecoregions, providing one of the first empirically based descriptions of the geographic distribution of fire regimes. Our results show that fire activity in the western U.S. increases with fuel amount and has a unimodal (i.e., humped) relationship with fuel moisture; fire severity increases with fuel amount and fuel moisture. The explicit links between fire regime components and physical environmental gradients provides an initial framework for generating an empirically based fire regime map for the western U.S., and as such, can be used with gridded climate-change predictions to anticipate climate-mediated changes in fire recurrence and impacts.

QUAKING ASPEN RESPONSE TO MECHANICAL TREATMENT IN SOUTHWEST MONTANA.
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Land managers concerned with declining aspen cover at the Lutz Farm near Bozeman, Montana studied aspen stand response to mechanical treatment. All aspen stands classified as "poor" with browsing dieback present on all monitored stands. Mature trees were clear-cut on one decadent aspen stand to evaluate if mechanical treatment stimulated sucker growth. A game camera and double electric fence measuring 45 feet by 90 feet was established on the clear-cut stand to evaluate livestock and wildlife browse use on aspen stems. A comparison of two means (alpha=0.05) was used to evaluate browse impacts on stem heights between the fenced and the unfenced portion of the clear-cut. Stems sampled numbered 1,274 within the fenced and 1,160 within the unfenced portion of the clear-cut, which are within 10% of each other for the fall assessment. The clear-cut fenced portion had significantly higher stem heights than the unfenced clear-cut stems (alpha=0.033). A comparison of two means (alpha=0.05) was used to evaluate the total stem heights of the clear-cut's fenced and unfenced portion to each of the untreated aspen stands total stem heights. The clear-cut had significantly higher total stem heights (30,634 inches) than the two untreated aspen stands (940 inches and 437 inches) (alpha<0.01). Results suggest mechanical treatment may be a useful alternative to regenerate decadent aspen stands in southwest Montana. However, wildlife and livestock browsing must be deferred on newly regenerated aspen for successful recovery. Electric fencing may provide the necessary temporary protection for aspen suckers to reach an escapable height of two meters from browsing.

APPLYING COMMUNITY ASSEMBLY RULES TO UNDERSTAND INVASION - THE SEED PREDATION FILTER. **Dean Pearson**, Rocky Mountain Research Station, USDA Forest Service, 800 E. Beckwith Ave., Missoula, MT 59801; Jose Hierro, INCITAP (CONICET-UNLPam) and Facultad de Ciencias Exactas y Naturales, Universidad Nacional de La Pampa, Av. Uruguay 151, 6300 Santa Rosa, La Pampa, Argentina; John Maron, Division of Biological Sciences, University of Montana, Missoula, MT 59812; Nadia Icasatti, Facultad de Ciencias Exactas y Naturales, Universidad Nacional de La Pampa, Av. Uruguay 151, 6300 Santa Rosa, La Pampa, Argentina; Ray Callaway, Division of Biological Sciences, University of Montana, Missoula, MT 59812; Justin Runyon, Rocky Mountain Research Station, USDA Forest Service, 1648 South 7th Ave., Bozeman, MT 59717; Yvette Ortega, Rocky Mountain Research Station, USDA Forest Service, 800 E. Beckwith Ave., Missoula, MT 59801; *dpearson 'at' fs.fed.us*

Exotic plant invasions have devastated native ecosystems since humans began facilitating the movement of species across natural barriers. Yet we still do not fully understand how some invaders accomplish this. Invasion outcomes should be generally predictable based on how individual species traits relate to community filters - independent of species origins. However, exotic species invasions commonly result in virtual monocultures, not normally found in native systems, suggesting that biological invasions challenge the premise of community assembly theory. Here we apply community assembly theory to examine how native and exotic plants respond to a specific biotic filter, seed predation by native rodents and ants, in central Argentina and west-central Montana. Briefly describe how theory was applied to arrive at these conclusions. We found that the *in situ* seed predation filter in central Argentina, a system we show is relatively resistant to invasion, was strongly biased against exotics, while the seed predation filter in Montana, a system relatively susceptible to invasion, was biased in favor of exotics. In both systems seed size largely predicted invader responses to the filter, but we also found that some strongly invasive exotics evaded the filter, possibly via chemical defenses. Applying community assembly theory to exotic plant invasions demonstrates that *in situ* filters can help explain the relative invasiveness of many exotic plants (particularly, weakly to moderately successful invaders) and possibly the differential susceptibility of systems to invasion. However, understanding invasion outcomes for some strong invaders may require deciphering how these species evade *in situ* filters.

VARIATION IN BIOTIC FORM AND FUNCTION AMONG AQUATIC HABITATS OF RIVERINE FLOODPLAINS. Marc Peipoch, Katey P. Driscoll, Ric F. Hauer, Maury H. Valett, Montana Institute on Ecosystems, Division of Biological Sciences, University of Montana, 32 Campus Drive, Missoula, MT 59812; *marc.peipoch 'at' mso.umt.edu*

Riverine floodplains have a complex structure consisting of physically and biologically distinct aquatic habitats (i.e., main channel and off-channel zones) that are continuously modified by flood pulses and geomorphic processes. The Multi-scale Assessment of Riverscape Complexity (MARC) project aims to quantify the relationship between physical complexity and niche diversity (i.e., biotic form and function) across riverine floodplains with different human-environment interactions. Here we present preliminary results of MARC project on the variation in organic matter abundance, biogeochemical composition, and ecosystem function (ecosystem metabolism) among aquatic habitats differing in their hydrologic connectivity and disturbance regime. Particulate and epilithic organic matter was greatest (0.58–2.6 kg dry-mass/m^2) in off-channel habitats including ponds, springbrooks, and backwaters and lowest in main channel environments (0.038–0.096 kg/m^2) like runs and riffles. Among habitats variation in biogeochemical composition was not explained by the landscape position of those habitats (i.e., not spatially auto-correlated; *Mantel-test* $p>0.05$), but associated with the particular ecological characteristics of each aquatic habitat. In main channel habitats, much greater phosphate concentrations (0.04±0.00 parts per million (*ppm*)) than inorganic nitrogen concentrations (0.016±0.01 *ppm*) suggested a likely Nitrogen-limitation of Gross Primary Production (GPP) in these environments. Overall, rates of GPP and ecosystem respiration were greatest in main channel and parafluvial habitats (1.5–6.2 g O_2/m^2d), and lowest in orthofluvial habitats (0.4–0.9 g O_2/m^2d). Lower rates of GPP per unit of biomass in orthofluvial environments may indicate that more mature and undisturbed off-channel habitats are energetically less efficient than main channel environments of riverine floodplains.

USE OF CLIMATIC WATER BALANCE METRICS AS SITE PRODUCTIVITY PREDICTORS.
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Estimates of forest site productivity are needed for diverse management practices including growth and yield assessments, silvicultural planning, and forest biomass/carbon projections. Traditionally, long-term forest productivity has been quantified in the form of site index by measuring the height growth of dominant trees. While suitable for even-aged structures, in mixed uneven-aged stands this approach is impractical owing to the near ubiquitous early height growth suppression. Moreover, this empirical approach provides no linkage to the biophysical determinants of forest productivity and thus no basis to map potential productivity across forested landscapes or across alternative climate scenarios. This research aims to characterize the major physiographic and climatic determinants of site index. Site index estimates were obtained from an extensive data set of over 900 trees stratified across precipitation zones within ecoregions in Montana. These tree-level estimates of site index were linked to terrain descriptors (slope, aspect, elevation), climate normals (min/max temperatures, vapor pressure deficit), and climatic water balance metrics (potential evapotranspiration, actual evapotranspiration, and deficit) derived at a range of spatial resolutions. Results demonstrate that for some species an appreciable proportion of the variation in tree site index can be explained by terrain attributes alone. Climatic water balance metrics provide additional explanatory power for some species under particular growing conditions. The latter effects are discussed in the context of the spatial accuracy of the climatic data products and the observed levels of inter-tree variability in site index at small spatial scales.

SURVEY OF BIOLOGICAL SOIL CRUSTS ON BLM LANDS IN WYOMING.
Tyrell Perry, Peter Stahl, Department of Ecosystem Science and Management, University of Wyoming, Laramie, WY 82072; *tperry5 'at' uwyo.edu*

Biological soil crusts (BSCs) are common and well known in many semiarid environments in the southwestern United States and evidence is accumulating regarding their contributions to critical ecosystem services. Occurrence and importance of these unique communities of organisms in colder and higher elevation semiarid environments in the western U.S. is much less well known. Preliminary surveys of the occurrence of BSCs have been conducted in semiarid Wyoming rangelands in Major Land Resource Area (MLRA) 32 and MLRA 34A, but a comprehensive survey of BSC occurrence and distribution on Wyoming rangelands is missing from the literature. The objective of this project is to carry out a detailed survey of the occurrence of BSCs in Wyoming rangelands using grazed and ungrazed sites represented by BLM grazing exclosures. Surveys are being conducted on Wyoming BLM lands in the Big Horn Basin, Sweetwater Basin, Upper and Lower Green River Basins, Wind River Basin and parts of the Powder River Basin. Results of the survey will include species lists of lichens and mosses, distribution maps, and a field guide bulletin for land managers' use. To date, 354 acres have been intensively inventoried for BSC species presence including the collection of approximately 2,100 lichen and moss specimens. Inventoried acres will be extrapolated geospatially to represent several thousand acres across Wyoming rangelands predicting BSC distribution.

WHITEBARK PINE COMMUNITY DYNAMICS OF THE OLYMPIC MOUNTAINS.
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Whitebark pine (*Pinus albicaulis*), a subalpine stone pine of western North America is highly susceptible to the introduced white pine blister rust (*Cronartium ribicola*). Blister rust susceptibility, a generally seral status, and a changing climate each affect the pine's competitive status. We established 39 randomly located 1/20 ha plots in a 1.25 square km area in the Dungeness River drainage to assess the current status of whitebark pine communities. We collected vegetation, stand structure, light, soil moisture, and temperature data over a two year period and used floristic classification as a framework to study community dynamics. Although blister rust killed many larger whitebark pines and infected trees of all ages, many young trees still reached reproductive age. Whitebark pine and many associated species grew in drier, warmer, more open habitats than subalpine fir (*Abies lasiocarpa*) and many of its associated species. The oldest and densest subalpine fir forests (100-200 years) occurred on northeast slopes with an average annual soil temperature at 20 centimeters that was 2°C cooler than soil temperatures on the more open southwest slopes. Southwest slopes were dominated by alpine and subalpine herbs and subshrubs with scattered younger (30-80 years) subalpine fir and whitebark pine trees. The younger age of the whitebark pine trees on these slopes is only partially due to blister rust mortality of older trees. It appears that subalpine fir was never common on these slopes. We conclude that subalpine fir is expanding into formerly open whitebark pine habitat with possible negative consequences for the whitebark pine population.

ACCELERATING CLIMATE CHANGE ADAPTATION IN FOREST ECOSYSTEMS: PRINCIPLES AND PARADIGM SHIFTS.
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We are on the cusp of significant changes in forest ecosystems in some regions of North America, mediated primarily by ecological disturbance. Because climatic extremes and their secondary effects (wildfire, insect attacks, etc.) will drive changes in ecosystems in future decades, climate change adaptation should focus primarily on functionality and processes across large landscapes, rather than on distribution and abundance of species. Concepts such as potential vegetation, historic range of variation, and restoration will need to be redefined for planning as we transition to a non-analog climate. When large disturbances occur, they will be opportunities to facilitate this transition and modify the occurrence of future disturbances. Climate-smart thinking needs to be quickly mainstreamed to ensure that viable options are available for the long-term experimental approach required by adaptive management. In the western United States, federal agencies are leading the way in building resilience in terrestrial and aquatic systems through active forest management and revised guidelines for planning and management.

COMMUNITY-SPECIFIC BIOGEOCHEMICAL RESPONSES TO ATMOSPHERIC NITROGEN DEPOSITON IN SUBALPINE MEADOW ECOSYSTEMS OF THE CASCADES. **Justin Poinsatte**, School of Biological Sciences, Washington State University, Pullman, WA 99163; Regina Rochefort, North Cascades National Park Service Complex, Sedro-Woolley, WA, 98284; Lou Whiteaker, Mount Rainier National Park, Ashford, WA 98304; R. Dave Evans, School of Biological Sciences, Washington State University, Pullman, WA 99163; *jpoinsatte 'at' wsu.edu*.

Elevated anthropogenic nitrogen (N) emissions result in higher rates of atmospheric N deposition (N_{dep}) that can saturate sensitive ecosystems, such as the subalpine meadows of the Cascades. Consequences of increased N_{dep} include higher soil emissions of greenhouse gases, eutrophication of watersheds, and deterioration of vegetation communities. The capacity of subalpine communities to assimilate N_{dep} remains unknown, especially with rapid release of N during snowmelt. We measured ambient levels of N_{dep} in winter snowpack and determined community-specific impacts of N_{dep} on biogeochemical processes in the lush-herbaceous, heath-shrub, and wet sedge subalpine vegetation communities at Mount Rainier National Park. Ammonium (NH_4^+) was the dominant form of N_{dep} in snowpack and N_{dep} rates were higher than anticipated based upon nearby National Atmospheric Deposition Program (NADP) measurements. Vegetation N uptake was the dominant N sink, with the highest growing season uptake by the wet sedge community. Soil N leaching was the dominant N loss, with the lush-herbaceous community having the highest rates. Nitrous oxide (N_2O) emissions were greatest in the wet sedge community. Our results differed noticeably from previous N_{dep} research, with lower uptake rates and higher N_2O emissions than those of alpine meadows in the Rockies. These results indicate that subalpine communities have distinct responses to N_{dep} that vary throughout the growing season. Thus, biogeochemical modeling efforts to simulate subalpine ecosystem responses to N_{dep} should be parameterized at a community-specific level to capture this variability. Ultimately, this study will provide insight to land managers on how N_{dep} affects ecosystem services in wilderness areas.

A FIELD AND MODELING APPROACH TO PREDICTING A COASTAL WETLAND RESPONSE TO SEA LEVEL RISE. Katrina L. Poppe, John M. Rybczyk, Huxley College of the Environment, Western Washington University, 516 High St. - MS 9181, Bellingham, WA 98225; *poppek 'at' students.wwu.edu*

Estuaries worldwide are facing the possibility of conversion to open water if accretion cannot keep pace with increasing rates of eustatic sea level rise (ESLR) due to climate change. Recent research into sediment elevation dynamics in Padilla Bay, a National Estuarine Research Reserve in Puget Sound, Washington, has revealed a mean bay-wide elevation deficit of -0.39 centimeters per year since 2002. Using field data collected as part of this research (measurements of sediment accretion rates, suspended sediment concentrations, eelgrass stem density, and above- and belowground eelgrass biomass) we modified, initialized, and calibrated a mechanistic and non-linear Marsh Equilibrium Model (MEM) to predict the response of this eelgrass-dominated estuary to rising sea levels. We then coupled the MEM with a Relative Elevation Model (REM) to create a hybrid that combines each model's strengths in simulating above- and below-ground processes, respectively. The hybrid model predicts elevation change under various ESLR and suspended sediment scenarios. We used an 11-year elevation change dataset obtained from an extensive surface elevation table network in Padilla Bay for model validation. Here we present model structure and preliminary results suggesting sediment accretion rates to be primarily determined by stem density instead of plant biomass or water depth, which differentiates this model from its predecessors.

HYDROLOGIC MODELING OF IMPACTS OF CLIMATE CHANGE ON STREAMFLOW AND SEDIMENT TRANSPORT FOR SNOWMELT-DOMINATED RIVERS IN THE INTERIOR PACIFIC NORTHWEST. **Sarah Praskievicz**, Department of Geography, University of Oregon, 1251 University of Oregon, Eugene, OR 97403; *praskiev 'at' uoregon.edu*

Anthropogenic climate change is likely to have significant impacts on river systems, particularly for rivers dominated by flows from seasonal snowmelt. Here, I use a basin-scale hydrologic model to simulate impacts of climate change on streamflow and sediment transport for three snowmelt-dominated rivers in the interior Pacific Northwest: the Tucannon River in Washington and the South Fork Coeur d'Alene River and Red River in Idaho. I generated scenarios of temperature and precipitation change for my study basins and used these scenarios to drive the Soil and Water Assessment Tool (SWAT), a basin-scale semi-distributed hydrologic model developed by the United States Department of Agriculture that simulates runoff depth as a function of climatic, topographic, soil, and land cover input data using the Soil Conservation Service curve number method, in which hydrologic response units are delineated based on land-surface characteristics. I first calibrated and validated the model for both discharge and suspended sediment load using observed gaging station records from all three rivers, and then ran the model using the future climate change scenarios. The results indicate that climate change is likely to increase the seasonal hydrological variability of the study rivers, with higher winter discharge (increases in ensemble mean January discharge ranging from 16.3%-34.4% for the study rivers), an earlier spring snowmelt peak (by approximately one month), and lower summer discharge (decreases in ensemble mean July discharge ranging from 5.2%-47.2%). The simulated changes are particularly large for the Tucannon River, the lowest-elevation of the three study basins. Simulated changes in suspended sediment transport generally follow the changes in streamflow. These results demonstrate the sensitivity of transient basins, those with average winter temperatures near freezing, to temperature increases associated with climate change.

ADAPTIVE CAPACITY OF ECOSYSTEMS: CONCEPTS AND APPLICATIONS. **Klaus J. Puettmann,** Department of Forest Ecosystems and Society, 321 Richardson Hall, Oregon State University, Corvallis, OR 97331; *klaus.puettmann 'at' oregonstate.edu*

The ability of ecosystems to adapt to changing environmental and social condition is crucial for the sustained provision of desired ecosystem goods and services in the face of a variable, uncertain future. To manage for adaptive capacity, it is important to understand that ecosystems respond to changes on a variety of organizational levels, from genomes to organisms, populations, and the biota. Furthermore, these levels interact in determining ecosystem behavior. Complexity science provides a scientific framework for understanding and studying ecosystems, which can facilitate management efforts to increase or restore adaptive capacity. As an example, how adaptive capacity can be quantified, I highlight a thinning study where species were sorted by their effect traits (how they impact food sources for wildlife) and response traits (how they respond to climate change conditions). Analyzing the vegetation response using this approach highlighted that thinning can increase the likelihood that food sources are enhanced or maintained under climate change conditions. These trends are driven by several mechanisms including invasion of new species after thinning, expansion of species that were already dominant before thinning, and by compensation, i.e., expansion of previously rare species that are able to better grow under post-thinning conditions.

A FORTY YEAR ODYSSEY WITH WOLVES IN MONTANA. Robert Ream, Professor Emeritus of Wildlife Biology, College of Forestry and Resource Conservation, University of Montana, Missoula; Current Address: 521 Clarke Street, Helena, MT 59601; *ream 'at' mt.net*

Based on museum specimens and wolf reports from the 1950s and 1960s, the Wolf Ecology Project started in 1973. We collected reports of wolves from state and federal agencies, outfitters, trappers, hunters, and field checking. We concluded there were no resident packs in Montana (MT). Dispersers occasionally moved down from Canada on either side of the continental divide. In 1979, we radio-collared a lone female near Glacier National Park. She was joined by a male two years later, produced five pups, and the population expanded rapidly. By 1995 a minimum count of 67 wolves were scattered across northwestern Montana. In 1995 and 1996 32 wolves were reintroduced into Yellowstone National Park and 37 into central Idaho as "experimental non-essential" populations. By 2000, the recovery goal for the Northern Rocky Mountain wolf was reached, and 2002 marked the first year they could be delisted. But delisting didn't occur until 2009 for Montana and Idaho. They were relisted in 2010 through court action, and delisted again in 2011. Montana and Idaho held public harvest seasons in 2009, 2011, 2012, and 2013, and Wyoming in 2012 and 2013. Montana carried out the first hunt very conservatively and has increased available permits since. However there has not been a corresponding increase in harvest. Since 2008 the population in southwestern and western MT has been relatively stable, while increasing more slowly in northwestern MT. We have perhaps the most complex predator-prey system anywhere in North America with respect to large carnivore and ungulate populations. Despite controversy on both sides wolves are here to stay.

A CONTINTENTAL SCALE APPROACH TO UNDERSTANDING CLIMATE SENSITIVITY IN DOUGLAS-FIR. Christina Restaino, Fire and Mountain Ecology Lab, School of Environmental and Forest Sciences, University of Washington, Box 352100, Seattle, WA 98195-2100; David L. Peterson, Pacific Northwest Research Station, United States Forest Service, 400 N. 34th St. Suite 201, Seattle, WA 98103; Jeremy Littell, United States Geological Service Alaska Climate Science Center, 4210 University Drive, Anchorage, AK 99508; *ltinsley 'at' uw.edu*

Douglas-fir (*Psuedotsuga menziesii*) spans the entire western United States of America mountain system, exhibiting successful occupation of many different climatic and ecological niches. Its occupation of many different growth environments, and its temporal persistence on the landscape, make this species an ideal representative of forest-climate interactions in western mountain ecosystems. To account for variability in top-down and bottom-up controls on growth, we used a multi-scale sampling approach where we stratified plots based on climate domain, geographic variability, and topography. We collected cores from 122 plots distributed across 10 states in the western US, and developed plot-level chronologies using standard dendrochronological procedures. We correlated the chronologies with climate data (1916-2010) produced by the Variable Infiltration Capacity Hydrologic Model (VIC), which includes both standard and "plant-relevant" climate variables. Correlations suggest that Douglas-fir is both energy-limited and water-limited, and that limiting factors to growth change throughout the growing season *and* have changed over time. Variability in growth is tightly coupled to both interannual and decadal climatic variability, with evident linkages to the El Nino Southern Oscillation and Pacific Decadal Oscillation. No other dataset exists that comprehensively covers a continental distribution of a species. Planning for climate change will require understanding entire populations, not just those that inhabit the tails of the distribution.

WHAT THE…MY RNA IS ON FIRE…AGAIN??!

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Fire is an important ecological process for many of the ecosystems represented by the Research Natural Area (RNA) network. In Oregon and Washington, there were 62 large (greater than 1,000 acres) fires in or adjacent to the 38 (30% of total) Forest Service RNAs during the last quarter century. How managers respond to fire, including decisions made for when and how to suppress a fire, can have long-lasting effects on the subsequent ecological functions of these sites. Thus, planning for fire is a critical component of managing for the ecological integrity of RNAs over the long term. There are three important phases to consider: 1) pre-fire planning (e.g., fire management plans), 2) communication and decision processes during a fire (e.g., to allow fire to burn through an RNA versus attempting to line and hold a fire), and 3) post-fire management actions (e.g., mop-up and Burned Area Emergency Response (BAER)). We provide examples from several case studies of large fires, including the 2013 fires in the Metolius and Mill Creek RNAs, that illustrate the complexities involved in managing fires within RNAs. We also describe the efforts on the Ashland RNA to reduce fire fuel loads as part of an effort to return mixed-severity fire to this ecosystem because this RNA is adjacent to the City of Ashland and contributes to its domestic water supply.

MOSS FRAGMENTS TO RESTORE VEGETATIVE COVER TO ARID ECOSYSTEMS.

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Mosses owe their success in arid ecosystems in-part to their ability to reproduce asexually. This reproduction can be by specialized propagules, separation of whole organs, or by unspecialized plant parts that regenerate into new plants. Laboratory experiments indicate that mosses can be expected to reproduce from fragmented gametophyte tissue. More importantly, the experiments indicate future direction for field inoculation experiments and the ease with which inoculation material could be mass produced given appropriate growth conditions. This methodology, aimed at restoring biological soil crusts, would be an important step in restoring functioning vegetation types. Restoration and rehabilitation strategies, such as these, could contribute to autogenic succession and help direct landscape dynamics toward desired objectives, such as conserving and enhancing soil stability, and encouraging normal water and nutrient cycles. These processes are important for preventing desertification. Moss species growth from fragmentation studies suggests that *Bryum argenteum* and *Ceratodon purpureus* are best suited for restoration.

THE DISTRIBUTIONS, ACTIVITY PATTERNS, AND FEEDING HABITS OF COMMON WESTERN OREGON GROUND BEETLES, AND THEIR RELATION TO PEST PREDATION RISK ACROSS AGRICULTURAL LANDSCAPES. **Michael Russell**, Department of Horticulture, Oregon State University, ALS 4017, Corvallis, OR 97331; michaelcaseyrussell 'at' hotmail.com

Ground beetles (Coleoptera, Carabidae) are a diverse family of predatory arthropods that are abundant in western Oregon agricultural landscapes. Several field and laboratory studies were used to help understand the distributions, activity patterns, and feeding habits of common western Oregon ground beetles, and their relation to prey item predation risk. Pitfall traps and Berlese extraction of soil cores were used to sample ground beetle populations. Laboratory trials assessed seasonal changes in prey consumption, seed consumption, activity levels, and breeding state of the common species. The risk to a potential ground beetle prey item in the field was assayed with sentinel prey (*Drosophila melonogaster* pupae). Ground beetle species were grouped according to their observed life histories. Two life history groups were identified. In one, adults emerge from pupation in summer and breed during the late summer or fall. Most of the population will over-winter as larvae. Beetles in the other group emerge from pupae in autumn, over-winter as adults, and are active in the spring when they lay eggs that develop as larvae over the summer. The greatest beetle activity density was in the annual crop fields, but a few species are mostly active in the perennial field margins. Maximum per beetle prey consumption in the lab studies tended to coincide with peak activity levels in the field. The beetles were grouped into predator guilds based on their life histories. Predator guild activity and sentinel prey consumption rates in the field were associated during the peak activity periods of each guild.

PAST, PRESENT, AND FUTURE IN THE FORESTS OF CALIFORNIA'S SIERRA NEVADA: VARIABILITY IN FOREST RESPONSE TO ENVIRONMENTAL CHANGE, AND THE ROLE OF MANAGEMENT IN PROMOTING ECOSYSTEM RESILIENCE.
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California forests face major changes over the next century, but the extent, intensity, and type of change is likely to be variable among different ecosystems. This variability in response will be driven by factors like the ecological tolerances of component species, site histories, the rate and nature of future environmental change, and management policies. In the Sierra Nevada of California, a major ecotone occurs between lower and upper montane forests, at approximately the altitude of deepest winter snowpack and the average freezing elevation in winter storms. Below this line, the Sierra Nevada is dominated by yellow pine and mixed conifer forests, which are mostly moisture-limited systems historically dominated by highly frequent fire; above this line the range is dominated by red fir and subalpine forests, which are mostly energy-limited systems dominated historically by relatively infrequent fire. Additionally, below this line most of the Sierra Nevada is comprised of "working forest", while above it much of the range is included in roadless and wilderness areas and National Parks. I contrast these two different environments with respect to their historical, current, and likely future conditions, focusing on the impacts of three classes of environmental stressors: climate change, wildfire, and invasive species. Vulnerabilities to these stressors differ appreciably between lower montane and upper montane forests, but climate warming and human population growth, among other things, will likely introduce many lower montane afflictions to the upper montane zone in the not-too-distant future. I discuss what sorts of management actions, both active and passive, might be employed in these different environments to increase ecosystem resilience to future change. At the same time, I caution that human expectations and assumptions about these ecosystems, their permanence and the services they provide must eventually be reconciled with the likelihood that the Sierra Nevada of one-hundred years hence may look little like the Sierra Nevada of today.

PRICELESS RESOURCES: MONTANA'S STRATEGIC FRAMEWORK FOR WETLAND AND RIPARIAN AREA CONSERVATION AND RESTORATION 2013-2017.

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The Montana Wetland Council recently completed its second five-year wetland and riparian conservation strategy which has been endorsed by the Governor and state agency natural resource directors. Montana's overarching goal is: No overall net loss of the state's remaining wetland resource based (as of 1989) and an overall increase in the quantity and quality of wetlands in Montana. The Council also supports a riparian goal: Maintain, protect, and restore the ecological integrity of riparian areas. Strategic directions provide focused action to help accomplish these goals and include: restoration, protection, and management; mapping; monitoring and assessment; planning and policy; vulnerable and impacted wetlands; public communication and education; and Montana Wetland Council development. The Montana Wetland Council is an active network of diverse interests engaged in the wetland strategy and implementing its priorities. A few of the major accomplishments from the 2008-2012 strategy include creating an aquatic mitigation crediting program; monumental advances in wetland and riparian mapping; linking wetland protection with floodplain management; and integrating wetlands into watershed restoration plans. Highlights from the 2013-2017 wetland strategy, plans for the next few years, and ideas about how you and your organization can help address strategy priorities will be discussed.

THE EFFECTS OF LITTERFALL ON SNOW ABLATION RATES IN NORTHERN ROCKIES MIXED-CONIFER FORESTS.

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Forest litter within a snowpack changes the snow albedo, affecting springtime melt rates. Albedo, the percent of shortwave radiation a surface reflects, is high in snow and low in forest litter. Litter absorbs shortwave radiation and reemits longwave radiation, which should increase snowmelt rates. We are conducting a two-part study to (1) quantify winter litterfall rates in relation to canopy cover and local tree spacing, and (2) to determine the effects of litterfall density on melt rates. We predicted litterfall will be greatest in tree clumps, less near individual trees, and least in canopy openings; and that snow melt rates will increase with litter inputs, but potentially decrease at very high litterfall rates due to an insulation effect. The research takes place at Lubrecht Experimental Forest, at 1260 meters (m) of elevation. To quantify litterfall rates we deployed litter traps (1 m^2) beneath six randomly selected tree clumps, individual trees, and canopy openings (n = 18 traps total). Traps will be collected after melting is complete and litter weighed. We are using a litter addition experiment (randomized block design) to investigate litterfall effects on snow attributes. Experimental blocks are placed in large canopy openings to limit natural litter inputs. Four litter addition amounts (0.1 kg/m^2, 0.4 kg/m^2, 1 kg/m^2, and 4 kg/m^2) and a control treatment are applied at random to 1 m^2 plots, replicated in nine blocks. During melt season we will measure snow depth, snow water equivalent, albedo, percent snow coverage, and date of snow disappearance in each plot.

PREDATORY LURING AS A MEANS OF PREY ACQUISITION IN *ARGIA VIVIDA*: A BEHAVIORAL STUDY. Sharol A. Schmidt; Michael Edgehouse, Department of Natural Science and Mathematics, Lewis-Clark State College, 500 8th Ave, Lewiston, ID 83051. *Saschmidt 'at' lcmail.lcsc.edu*

Recent studies have demonstrated that certain species of larval Odonates (*Aeshna palmata* and *Argia vivida*) will use predatory luring as a means of prey acquisition. Larval Odonates are known to cannibalize conspecifics when food is a limiting factor. We investigated the predatory behavior of *Argia vivida* naiads from Tammany Creek (Hells Gate State Park, Lewiston, Idaho) when in the presence of conspecifics. Observations revealed that *Argia vivida* do not use predatory luring as a means of prey acquisition when with conspecifics. In all conspecific trials there was no lure-in of individuals followed by attempted consumption. However, agonistic behaviors toward conspecifics, as described in previous studies of the Coenigrionidae family but not within this species, were observed in 78% of trials.

THE INFLUENCE OF TREE SPECIES AND CANOPY POSITION ON SNOW DISAPPEARANCE DATE IN WESTERN MONTANA MIXED-CONIFER FOREST.
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Canopy cover influences snow interception and radiation balance within forest stands, which in turn control snow accumulation and ablation. In many western Montana forests, the canopy is composed primarily of Douglas-fir (*Pseudotsuga menziesii*), an evergreen conifer, and western larch (*Larix occidentalis*), a deciduous conifer. We asked if snow disappearance date differed beneath these two species, and across a gradient of increasing distance from the tree bole within each species. One self-recording iButton soil temperature sensor was placed near the bole, just inside the dripline, and beyond the dripline of seventeen overstory Douglas-fir and 15 overstory western larch at a study site near Seeley Lake, Montana. Sensors recorded soil surface temperature every 4 hours for 9 months. The date of snow disappearance was indicated by the transition from a constant freezing temperature (snow covered) to oscillating diurnal temperatures (not snow covered). In 2013, snow disappearance dates ranged from March 29 to April 26 across all species and crown positions. Date of snow disappearance beneath western larch did not depend on crown position ($P = 0.192$). Snow disappearance beneath Douglas-fir depended on crown position ($P = 0.058$), with snow disappearing 4 days earlier near the bole compared to outer crown positions. These data suggest that western larch does not cause the "tree well effect" characteristic of evergreen conifers where local snowpack is decreased by canopy interception and melting promoted by heating from the tree bole. Overall, our results suggest that stand composition and the abundance of western larch influence the timing of snowmelt within mixed conifer stands.

MAPPING A HISTORIC BITTERROOT VALLEY, MONTANA LANDSCAPE USING GENERAL LAND OFFICE SURVEYORS' FIELD NOTES. **Karen Shelly**, Department of Geography, University of Montana, Missoula, MT 59801; *kmshelly 'at' msn.com*

The late 1800s Bitterroot Valley landscape and settlement patterns were summarized and mapped using the General Land Office (GLO) surveyors' field notes. Surveyors' observations of six townships from Hamilton to the Stevensville vicinity were examined in several ways. A total of 3,321 points of ecological and geographic information and 422 miles of vegetation were mapped from the field notes. Vegetation composition, tree abundance, vegetation spatial structure and distribution of vegetation types were characterized in a geodatabase as an assemblage of point, line and polygon feature classes. Aquatic, topographic and cultural aspects recorded by surveyors contributed to the historic landscape configuration. A GLO land cover classification was derived using surveyors' terminology and crosswalked with current land cover classes. The culmination of this research produced historic vegetation maps, summaries of cultural, topographic and aquatic features, and a comparison of GLO vegetation to current land cover. GLO vegetation along section lines compared to current land cover revealed differences between historic and current conditions. Highest differences were decreases in Upland Timber and Prairie-No Timber, and increases in Field and Bottomland Timber near-equivalents. This methodology could be used to map more extensive areas of Montana, providing systematic quantitative and descriptive observations of a pre-satellite landscape that may be useful to researchers, planners and historians. Comprehension of the temporal variability in ecosystems may help identify alternatives for future landscape management, including determining feasability of native vegetation conservation and restoration.

RESEARCH NATURAL AREAS IN THE NORTHERN REGION OF THE U.S. FOREST SERVICE: ISSUES AND RESEARCH OPPORTUNITIES IN A FEDERAL PROTECTED AREAS NETWORK. **Steve Shelly, Mary Manning**, U.S. Forest Service, Northern Region, P.O. Box 7669, Missoula, MT 59807; John Byrne, U.S. Forest Service, Rocky Mountain Research Station, 1221 S. Main Street, Moscow, ID 83843; *sshelly 'at' fs.fed.us*

The Research Natural Area (RNA) program is one of the oldest formal programs in the U.S. Forest Service. Since 1927, these areas have been designated to represent a wide range of habitats, as part of a national network of sites protected in perpetuity for research, education, and the conservation of biological diversity. To date, 482 RNAs have been designated on Forest Service lands, protecting a total of over 570,000 acres. The designation of RNAs on Forest Service lands in the northern Rocky Mountains and Great Plains began in 1935, and 106 RNAs have been established in the Northern Region. As the RNA program has evolved, many issues have arisen related to stewardship of the areas and representation of ecological sites. Historically, RNAs were viewed as 'hands off' reserves intended to protect natural features in a strictly unmanaged state. However, as the ecological effects of fire suppression and invasive species have increased, a philosophical shift has occurred within the Forest Service (and the natural areas profession). Stewardship management in RNAs is now more commonplace as a result, but intervention to restore the vegetation in these protected areas raises a variety of ecological and policy questions, such as: 1) Under what circumstances is management appropriate?; 2) To what degree should ecological processes be allowed or suppressed?; 3) Should sites that are altered by disturbance be disestablished?; and 4) How should disturbance and succession be accounted for in establishing and managing a network of reference areas? Research use in RNAs has been modest to date, but there is outstanding potential for studies regarding climate change and ecological restoration. Ongoing studies utilizing RNAs in the Northern Region are examining the effects of increased atmospheric carbon dioxide (CO_2) on tree growth, and the efficacy of restoration treatments in old growth forests and grasslands.

EVALUATING STREAMFLOW TRENDS USING RUNOFF SENSITIVITY TO LAND USE AND CLIMATE CHANGE. **Nicholas L. Silverman**, Marco P. Maneta, Johnnie N. Moore, Geosciences Department, University of Montana, 32 Campus Drive #1296, Missoula, MT 59812; *nicholas.silverman 'at' umontana.edu*

The majority of watersheds within the United States have been disturbed by anthropogenic land use change. On top of this, there is strong evidence of (historic and projected) climatic changes that affect earth's hydrologic cycle. Streamflow records integrate the effects of land use and climate change on watershed hydrology. Therefore, when temporal trends are present, teasing out the cause is challenging due to the overlying climate and land use signals. In this study, we develop an analytical framework for distinguishing trends in streamflow that are driven by climate change from those that are driven by land use change. This framework is based on the fact that during wetter years runoff is affected more by changes in climate than during drier years. Whereas, the inverse is true for land use change. During wetter years runoff is affected less by land use change than during drier years. This difference can be seen in the quantile regression of the 75th and 25th percentile annual stream flows which represent wetter and drier years, respectively. This creates a defining characteristic in how these two forcing mechanisms manifest within the streamflow record. We empirically test this framework using 290 watersheds across the contiguous United States. These watersheds are characterized by a range of disturbances, such as: irrigation withdrawals, timber harvesting, wildfire regeneration, urbanization, etc. Our results support the analytical framework developed and show that the sensitivity of runoff to climate and land use change vary depending on the spatiotemporal water and energy limitations of a catchment.

THE ROLE OF WETLAND, RIPARIAN, AND FLOODPLAIN WATER STORAGE IN MONTANA'S WATER SUPPLY INITIATIVE. **Bruce Sims**. USDA Forest Service; Northern Region; 200 East Broadway; Missoula MT 59807. *bsims 'at' fs.fed.us*; and Lynda Saul; Montana Department of Environmental Quality; 1520 East 6th Ave; Helena MT 59620; *lsaul 'at' mt.gov.*

Montana is facing increased water resource demands and a relatively fixed supply. The State is currently updating its water plan to "provide up-to-date water resource information essential for planning and estimating future water demand." A major strategy used in the past and currently being investigated is using water storage to offset increasing demands. Over time, earlier snow melt due to global warming will likely make the need for increased water storage even more critical. Traditionally water storage has been met by building infrastructure. These storage projects are expensive to plan, construct, manage, and maintain. The term natural infrastructure has been defined as natural landscapes that are strategically used and managed to provide benefits or services to human population (Allen, 2012). Managing stream and wetland systems to enhance natural channel storage can augment structural measures by reconnecting streams to their floodplain, protecting wetlands, and encouraging healthy riparian vegetation. Functioning stream systems and wetlands will provide for ground water storage, low flow enhancement, and flood flow mitigation. In addition, these areas provide important wildlife and fish habitat and are important focal points for outdoor recreation. A partial literature review will highlight some of the findings and acknowledge limitations.

SEASONAL DIET OF A POPULATION OF WESTERN TERRESTRIAL GARTER SNAKES, *THAMNOPHIS ELEGANS*, ALONG THE GRANDE RONDE RIVER, SOUTHEASTERN WASHINGTON. Michael A. Skinner, Michael Edgehouse, Christopher Brown, Brigette S. Schwimmer, Department of Natural Science and Mathematics, Lewis-Clark State College, 500 8th Avenue, Lewiston, ID 83501; *maskinner 'at' lcmail.lcsc.edu*

Garter snakes (*Thamnophis* spp.) are historically considered generalist predators. However, recent studies have demonstrated that several populations of western terrestrial garter snake (*Thamnophis elegans*) are dietary specialists during certain life stages or particular seasons. We investigated the spring and summer time diet, using forced regurgitation via stomach palpation, of a population of *Thamnophis elegans* along the Grande Ronde River in southeastern Washington. Our data, coupled with previous studies, demonstrate that this population of *Thamnophis elegans* is a dietary specialist. Snakes from this population show a 100% preference for sculpin fish (*Cottus* spp.) as their food source during the spring and summer and a 92% preference for *Cottus* spp. throughout the year. Food preference was calculated by identifying each prey item and classifying according to genus. This is the first known population of *Thamnophis elegans* to consume *Cottus* spp. as their primary food source. The apparent specialization in diet may provide important natural history data for the conservation of the meta-population.

EXOTIC PLANT INVASION DISRUPTS HOST-PARASITOID INTERACTIONS: INVISIBLE PARASITOID WASP BECOMES VISIBLE TO SPIDER HOST. Jennifer N. Smith; Douglas J. Emlen, Division of Biological Sciences, University of Montana, Missoula, MT 59812; Dean E. Pearson, Rocky Mountain Research Station, U.S.D.A. Forest Service, Missoula, MT 59801; *jennifer5.smith 'at' umconnect.umt.edu*

Host-parasitoid interactions are commonly tightly linked. Such interactions may be particularly susceptible to disruption by exotic species invasions, but the effects of biological invasions on such interactions are poorly understood. In grasslands of the northwestern United States, a wasp (*Pteromalus grisselli* Gibson) parasitizes egg sacs of *Dictyna coloradensis* spiders. Early workers in this system documented that these wasps roam freely over *Dictyna* webs, unencumbered by the web and largely unchallenged by the web's host. However, our field observations in spotted knapweed (*Centaurea stoebe*) invaded habitats where these spiders reach extraordinarily high densities, suggest that *D. coloradensis* spiders aggressively attack their parasitoids. To examine this phenomenon, we conducted laboratory and field studies on *D. coloradensis* populations from native-uninvaded and knapweed-invaded grasslands. Laboratory experiments indicated that female *D. coloradensis* spiders from knapweed-invaded populations were over three times more likely to kill parasitoids placed in their webs compared to conspecific spiders from native areas. Moreover, parallel experiments substituting fruit flies as prey items in place of the parasitoids resulted in no difference in kill rates between populations, indicating this response was parasitoid-specific. Field surveys indicated no difference in parasitoid densities between *Dictyna* populations in knapweed-invaded and uninvaded grasslands. In contrast, parasitism rates on *Dictyna* egg sacs tended to be about 33% higher in knapweed-invaded grasslands, though this pattern was marginally significant. Our results suggest that knapweed invasion may be associated with increased parasitoid attack rates on spiders, which may have selected for greater defense against parasitoid attack.

A METHOD FOR ASSESSING CARBON STORAGE AND FUNCTIONAL IMPORTANCE IN MOSS AND LICHEN GROUND LAYERS. **Robert J. Smith** and Bruce McCune, Department of Botany and Plant Pathology, 2082 Cordley Hall, Oregon State University, Corvallis, OR 97331-2902; Sarah Jovan, USDA Forest Service, Portland Forestry Sciences Lab, 620 SW Main, Suite 400, Portland, OR 97205; *smithr2 'at' onid.oregonstate.edu*

Ecosystem functions in many forest and range lands are influenced by mat-forming "ground layers" of mosses and lichens. In boreal systems, these organisms can build deep deposits of peat that sequester one-third of all global terrestrial carbon, while also regulating water tables, cooling soils and slowing decomposition. Because land managers currently lack reliable tools for quantifying terrestrial carbon and functional importance of moss/lichen ground layers in national landscapes, we implemented a new method as part of the Forest Inventory and Analysis (FIA) program of the U.S. Department of Agriculture, U.S. Forest Service. We measured ground layer biomass and elemental content for several functional groups (calibration set: *N*=150 samples), then generated landscape-level estimates based on depth and coverage measurements (implementation set: *N*=81 plots among 8 habitat types in Alaska and Oregon). We also used bootstrap resampling to derive habitat-specific minimum sampling requirements for nationwide implementation of our method. Landscape-level estimates of cover, volume, standing biomass, carbon content and functional richness of ground layers were significantly greater in boreal forest and tundra habitats of Alaska compared to temperate forest and steppe habitats in Oregon; this highlights the need for increased FIA attention to under-sampled areas in Alaska. Fewer samples were required in less-complex vegetation. Our method represents a non-destructive, repeatable and efficient method (mean sampling time: 61 minites per site), and will give resource managers a baseline for gauging changes in ground layers in response to land use and environmental alterations.

UNTANGLING *LEPTOGIUM*S: *LEPTOGIUM SATURNINUM* AND *L. BURNETIAE*. **Daphne Stone,** 30567 Le Bleu Rd., Eugene, OR; Frances Anderson, Nova Scotia Museum, 1747 Summer St., Halifax, NS, Canada B3H 3A6; James Hinds, School of Biology and Ecology, University of Maine, Orono, ME 04473; James Lendemer, New York Botanical Garden, Bronx, NY 10458; *daphstone 'at' gmail.com*

Leptogium saturninum and *L. burnetiae* are macrolichens that are usually identifiable in the field. But in both eastern and western North America, some thalli are difficult to distinguish. We examined type specimens and collections from eastern and western North America. Using DNA sequencing, structure of the medulla and isidia, thallus thickness and other characters, we found that there are previously unrecognized species hidden in these species concepts, both in eastern and western North America. Preliminary results suggest that some *Leptogium saturninum* in the Pacific Northwest and Colorado are similar to the type from Scotland; molecular and morphological work suggests that other collections from Oregon to Alaska fall into a different group of western "*L. saturninum*". *Leptogium saturninum* collections sequenced from Nova Scotia and Ontario appear to fall into a third group. The names *L. burnetiae* and *L. hirsutum* have both been applied to one species concept in North America. The type of *L. burnetiae* has a medullary structure that is very different from collections from North America, while the type of *L. hirsutum* is morphologically similar to those collected in central North America. Collections from southeast Alaska are separated out genetically; some morphological differences were noted by Jørgensen. A typical habitat of hardwoods, often in moist places, is similar across the continent, and is not helpful in distinguishing the species.

EVALUATING THE IMPACT OF TALL BUTTERCUP (*RANUNCULUS ACRIS*) ON FORAGE PRODUCTION, SPECIES RICHNESS AND PLANT DIVERSITY. Hally Strevey, Jane Mangold, Department of Land Resources and Environmental Sciences, 334 Leon Johnson Hall, Montana State University, Bozeman, MT 59717; *hally.berg 'at' msu.montana.edu*

Tall buttercup (*Ranunclus acris*), an invasive perennial forb found in moist fields and sub-irrigated meadows, was listed as a noxious weed in Montana in 2003. Despite its noxious status, little is known about the impact of tall buttercup on forage or plant diversity. To investigate the influence of tall buttercup on plant community composition, two study sites were established in sub-irrigated hayfields near Twin Bridges, Montana. During the study period sites were grazed, sub-irrigated and hayed after sampling occurred. Three 100 meter (m) permanent transects were placed at each site across a gradient of low to high density of tall buttercup. Biomass was sampled by species at 5 m intervals along each transect in late July 2012 and 2013. Plant diversity was calculated using the Shannon-Wiener Diversity Index. Data were analyzed using linear regression to determine the relationship between tall buttercup and perennial grasses, grass-like species, native and exotic forbs (not including tall buttercup), species richness, and plant diversity. Year was analyzed separately. In 2012 and 2013, tall buttercup had no influence on perennial grass biomass, grass-like biomass, native forb biomass, or species richness at either site. However, exotic forbs increased by 0.39 and 0.19 gram per meter squared (g m^{-2}) in 2012 and 2013, respectively, for every g m^{-2} increase of tall buttercup (P=0.01 and 0.04). Plant diversity increased by 0.003 for every g m^{-2} increase of tall buttercup (P=0.007 and 0.03) in both 2012 and 2013. Results indicate diversity and forage production are not negatively correlated with tall buttercup in Montana hayfield meadows.

SOIL CONTROLS ON VEGETATION IN HYALITE CANYON. John Sugden, Tony Hartshorn, Department of Land Resources and Environmental Sciences, 334 Leon Johnson Hall, Montana State University, Bozeman, MT 59717; *john.sugden 'at' msu.montana.edu*

The Langohr Campground lithosequence compares soils on gneiss, sandstone, shale, limestone, and basaltic andesite within a 3.2 kilometer (km) transect, approximately 16 km south of Bozeman, Montana. In this short distance, vegetation fluctuates between grassland meadows and lodgepole pine (*Pinus contorta*) forests. Underlying bedrock weathering may create soil conditions that control vegetative communities. A state factor approach was used to gain insights into soil processes: all other state factors (mean annual precipitation of 76 centimeters (cm), mean annual air temperature of -1.1^{0}Celsius, west to northwest aspects, slopes of 15% to 20%, and estimated soil age approximately 20 ky) are held constant except lithology. Field observations and laboratory analyses for elemental concentrations as well as derivative calculations (e.g., chemical depletion fractions [CDF; the fraction of total mass loss due to chemical weathering versus physical erosion], europium anomalies, and lanthanum ytterbium ratios) of 6 rock, 28 soil, and 4 dust samples were used to compare soils. Soil textures and coarse fragment content varied most: soils over gneiss and sandstone showed coarser textures and higher coarse fragments (up to 80%) compared to the fewer coarse fragments (less than 5%) and clayey textures of the other soil profiles. Geochemical differences were also apparent: CDF ranged from approximately 0.2 for the basaltic andesite soil to approximately 0.9 for the limestone soil. We conclude that underlying rock strongly influences soil properties, but in variable ways across this lithosequence. This influence appears to be both direct and indirect: while chemical weathering of rock leads to compositional changes in overlying soil horizons, it also produces coarse fragments that appear to greatly influence soil hydrology.

THE IMPACT OF COMMON MYCORRHIZAL NETWORKS ON ECTO-, ENDO-, AND DUAL MYCORRHIZAL HOST PLANTS. Kira D. Taylor, Andrew Cortese, Rebecca Bunn Huxley College of the Environment, Western Washington University, Bellingham, WA 98225; *taylo51 'at' students.wwu.edu*

The Elwha Dam removal is the biggest dam removal project in North America and one of the largest restoration projects through the National Park Services. Around 400,000 native seedlings are in the process of being planted across 800 acres of silt exposed from the drained reservoirs. The silt is acidic, nutrient-poor and fine-textured; a medium not conducive to plant growth. The recovery of the soil ecosystem will be essential to establishing plant communities across these sites. The plant-fungal symbiosis, mycorrhizae, may help sustain early colonization of the reservoir silts by redistributing nutrients from sources to sinks through common mycorrhizal networks. We first assessed the reservoir silts for presence of viable arbuscular and ecto- mycorrhizal inoculum through spore extractions, field colonization levels, and infectivity potential experiments. Both arbuscular and ecto-mycorrhizal fungi are present in the silt, albeit at low levels and with a high variability in distribution. Furthermore, mycorrhizal fungal colonization did not differ in willows grown in silt versus potting soil, indicating that the fungi are not inhibited by silt. In our next greenhouse study, we will evaluate (1) if ecto-, arbuscular, and dual mycorrhizal host plants benefit from being connected to a mycorrhizal network and (2) if nitrogen (^{15}N), a limiting nutrient in these environments, can be transferred from ectomycorrhizal networks to arbuscular mycorrhizal networks via dual host plants.

COMPARATIVE REACTION ANALYSIS OF *P*-PHENYLENEDIAMINE IN STEINER'S SOLUTION VS. ETHANOL ON COMMON LICHEN SUBSTANCES. Darcie Thauvette and Diane L. Haughland, Royal Alberta Museum, Alberta Biodiversity Monitoring Institute, 12845 102 Ave, Edmonton, AB, Canada, T5N 0M6; *darcie.thauvette 'at' gov.ab.ca*

Chemical spot tests to identify secondary metabolites are an invaluable asset to lichen taxonomy. Asahina (1934) was the first to suggest the use of *p*-phenylenediamine (PD) dissolved in 95% ethanol. This formulation of PD is notoriously unstable, requires more handling of the potentially carcinogenic PD, and discards more of the expired solution. Steiner (1955) developed a stable solution to facilitate the use of PD in lichen taxonomy. It has been observed that some lichen substances react differently to PD in Steiner's solution when compared to PD dissolved in ethanol, and subsequently some authors caution generally against the use of Steiner's solution. Our goal was to document more specifically which secondary metabolites and subsequently which taxa are amenable to spot testing with the safer, more stable Steiner's solution. We documented the color changes over time of a variety of lichens to both PD solutions. The tests were performed by using a drawn-out glass microcapillary tube to place a drop of each of the respective solutions directly onto the lichen thallus while watching through a dissection microscope and timing any changes. Our preliminary results suggest PD dissolved in 95% ethanol is required for reliably detecting atranorin, norstictic acid, psoromic acid and the stictic acid complex and should be used for genera such as *Stereocaulon*. We recommend Steiner's solution to detect nephroarctin, salazinic acid and fumarprotocetraric acid, particularly for routine testing of many *Cladonia* and *Melanohalea* species.

PREDICTING EPIPHYTIC LICHEN BIODIVERSITY FROM LIDAR DERIVED CANOPY STRUCTURE. **Levi W. Travis**, Harmony D. Counsellor, Tim W. Henry, Danny D. Barker, Allison C. Swan, James S. Parker, and Dylan Fischer**,** Evergreen Ecological Observation Network (EEON) Laboratory, The Evergreen State College, 2700 Evergreen Parkway, Olympia, WA 98505; *tralev20 'at' evergreen.edu*

Variation in vertical stand structure of temperate rainforests has the potential to influence macrolichen species diversity and community composition. We surveyed macrolichens in an array of permanent plots selected along a gradient of structural diversity based on aerial LiDAR surveys to 1) determine if there were predictable relationships between LiDAR-derived structural variation and diversity in lichen communities; 2) determine if there were predictable relationships between structural variation and community composition of macrolichen communities; and 3) to determine if there were predictable relationships between LiDAR-derived structural variation and lichen inputs of carbon (C) and nitrogen (N) to forest ecosystems. Despite our initial hypothesis of a predictive relationship, we found no significant relationship between canopy structure and macrolichen composition or diversity. This is likely a limitation of the data obtained from LiDAR. We did, however, find interesting patterns with individual tree species where Douglas-fir (*Pseudotsuga menziesii*), western red cedar (*Thuja plicata*), and Sitka spruce (*Picea sitchensis*) were predictive of macrolichen community composition in our second-growth forest study system. The r^2 values are 0.68, 0.54 and 0.42, respectively. Additionally, we found some evidence of predictable variation in canopy lichen C and N inputs to the forest floor. These data may suggest that structural diversity within the forest canopy had no direct relationship with the composition or diversity of epiphytic macrolichens, but variation in the forest canopy does affect lichen biomass and C and N inputs, and overstory composition may be predictive of canopy macrolichen communities.

ECOLOGICAL IMPACTS OF BLADED FIRE LINES IN THE NORTHERN MIXED GRASS PRAIRIE. **Samdanjigmed Tulganyam,** Craig A.Carr, Department of Animal and Range Sciences, Montana State University, Bozeman, MT 59717; *samdan.tulga 'at' gmail.com*

Bladed fire line construction is a fire suppression technique that limits fire spread by altering fuel continuity through vegetation removal and mineral soil exposure. Anecdotal evidence suggests bladed fires lines can cause long-term changes in soil and vegetation properties; however, relatively little research has been performed to corroborate these changes. In this study we compared soil and vegetationproperties among burned, unburned, and bladed fire line conditions (treatments) at three locations in north-central Montana and three locations in southwest Montana. Vegetation cover, standing biomass, functional groupabundance, soil bulk density, soil aggregate stability, and infiltration rates were quantified and comparisons made using one-way Analysis of Variance (ANOVA) (alpha equals 0.05 level). Perennial grass and perennial forb cover and standing biomass were lower on fire lines whileannual grasses and annual forbs were higher on fire lines in comparison to the other treatment types. Soil bulk density was higher on fire lines than theother two treatments while soil aggregate stability was lower. Litter cover and standing biomass did not differ among treatment types. These data support the contention that bladed fire lines could cause long-term ecologicalchange associated with altered hydrologic function, potential soil loss, and alteration in successional dynamics associated with substantial increase in dominance on non-native annual species.

LONG-TERM WATER QUALITY DATA AND BIOGEOCHEMICAL FILTERING ALONG THE UPPER CLARK FORK RIVER, MONTANA. **H. Maurice Valett**, Marc Peipoch, Division of Biological Sciences, Mike DeGrandpre, Department of Chemistry and Biochemistry, Vicki Watson, Environmental Sciences Program, University of Montana, 32 Campus Road, Missoula, MT 59812; Mike Suplee, Montana Department of Environmental Quality, Helena, MT 59620; Rob Payn, Department of Land Resources and Environmental Science, Montana State University, Bozeman, MT 59717; *maury.valett 'at' umontana.edu*

Contamination of the Upper Clark Fork River (UCFR), Montana, resulted from a massive flood in 1908 that deposited heavy metals along the stream banks and floodplain for over 150 kilometer (km) downstream, creating one of the nation's largest Superfund complexes. A $100 million remediation effort along the UCFR, including removal of metal contaminated floodplain sediments and lowering of the floodplain, began in 2013 in 'Reach A', a 70-km reach extending downstream from the river's headwaters. Recovery of the river is now occurring under nutrient-rich conditions reflecting point sources and more diffuse inputs associated with agricultural landscapes and natural tributary inputs. Since the early 1980s, and intensely since inception of the Voluntary Nutrient Reduction Program in 1998, bi-weekly measurements of river chemistry, emphasizing nitrogen (N) and phosphorus (P), have been made at 10 UCFR river sites. Epilithic organic matter and attached algae have been collected during August and September of every year since 1996 at four river sites. These data have illustrated the river's enriched character (total N: 150-450 µg/L; total P: 20-50 µg/L; algal chl:100-300 mg/m^2), but also longitudinal declines in nutrient concentration, concomitant decreases in algal abundance, and temporal reduction in some nutrient concentrations. In combination with river discharge records, long-term water quality data assessed using a 'landscape filtering' approach reveal how nutrient transport and retention serve as insightful measures of the biogeochemical behavior of river segments along the UCFR.

MAPPING MORTALITY IN MONTANA'S WHITEBARK PINE FORESTS. **Linda Vance**, Claudine Tobalske, Montana Natural Heritage Program, Spatial Analysis Lab, 310 Natural Science, University of Montana, Missoula, MT 59812; Steve Brown, U.S. Forest Service Northern Region, 200 E. Broadway, Missoula, MT 59807; *livance 'at' mt.gov*

Recent mortality in Montana's forested landscapes has made it increasingly difficult to maintain the kind of geospatial information that scientists and land managers need. Mortality-associated mapping challenges compound the existing difficulties often encountered in developing forest land cover classifications: a lack of reliable reference data, multiple classification schemes, spectral confusion caused both by natural succession and human disturbance, frequent cloud cover in mountainous areas, and persistent issues of scale. In this presentation, we will present and discuss some of our recent experience mapping mortality in whitebark pine and adjacent lodgepole pine forests in western Montana. Using NAIP and Landsat imagery, we have been able to refine both a single-species methodology for this candidate species and broad-scale mapping of live/dead forest cover. This approach provides a semi-automated way to classify imagery and provide a basis for fire managers, research scientists and restoration ecologists to visualize patterns in forest mortality over large landscapes. The presentation will focus on the Beaverhead-Deerlodge National Forest, where our findings indicate that approximately 40% of whitebark pine has been killed by insects and disease since 1992.

DOES AVAILABLE ENERGY INFLUENCE AVIAN RESPONSE TO KEY FOREST STAND HABITAT FEATURES? **J.P. Verschuyl**, J. Giovanini, J. Jones, D. B. McWethy, A. J. Kroll**;** National Council for Air and Stream Improvement, P.O. Box 1259, Anacortes, WA 98221; *jverschuyl 'at' ncasi.org*

Private forest managers are often charged with responsibility for maintaining structural complexity, biological diversity, and ecosystem services on their lands. However, little consideration has been given to potential geographic variation in the nature of relationships between elements of forest structure and biodiversity. Decomposition rates of snags and coarse woody debris are mediated by available energy, and the state of decay in snags and coarse woody debris affects their use by birds and other wildlife. Accordingly, the value of stand level structural components to wildlife species may depend on the amount of energy available at the local scale. We sampled montane avian communities across an energy gradient in the Cascades Mountains of Oregon and Washington. Available energy refers to factors influencing vegetation growth including light, heat and precipitation. We refer to Gross Primary Productivity, a satellite derived index representing a collection of those factors. We predicted avian functional diversity would be positively associated with large snag density in a high energy landscape in Oregon and decrease in a low energy landscape in Washington. We also predicted abundance and richness of species within ground foraging guilds would increase with increasing coarse woody debris in higher energy settings, but that coarse woody debris would not be a significant factor in lower energy locations. We fit a Bayesian multispecies site occupancy model to estimate species level covariate effects as well as population level measures of occupancy, including species richness. For abundance data, we fit a Bayesian multispecies version of the N-mixture model. We found nearly all foraging guilds were represented in each stand. As a result, the strength of association between avian functional diversity, snag and coarse woody debris density was small in both high and low energy landscapes. A large and precise negative response of key foraging guild bird abundance to large snag density was observed in the lower energy site. 95 percent posterior credibility intervals for the community-level hyper-parameters for snag density at the low energy landscape did not include zero, indicating a defined overall population-level trend. Large but less precise negative responses of primary guild bird abundance to coarse woody debris density were observed at both high and low energy landscapes. In this case, 95 percent posterior intervals for the community hyper-parameters included zero at both landscapes, indicating little overall population-level trend with respect to coarse woody debris. We discuss how residual forest structure can be managed across a gradient in available energy to conserve avian diversity in forested settings.

THE POST GLACIAL FIRE AND VEGETATION HISTORY OF SUNRISE RIDGE, MOUNT RAINIER NATIONAL PARK, WASHINGTON. **Megan K. Walsh**, Department of Geography/Resource Management Program, Central Washington University, 400 E. University Way, Ellensburg, WA 98926; Michael Lukens, Resource Management Program, Central Washington University, 400 E. University Way, Ellensburg, WA 98926; *walshme@cwu.edu*

Fire plays an important role in maintaining the health of many different forest types in the Pacific Northwest, including subalpine forests of Mount Rainier National Park (MORA). However, fire has been actively excluded from the park since the early 20th century so the "natural" fire regime of many areas is unknown. The purpose of this research was to reconstruct the post glacial fire and vegetation history of the Sunrise Ridge region of MORA to determine the extent to which fire activity varied during this time, and to assess the relative influence of vegetation change, climatic variability, and possible human activity on the individual site histories. In summer 2011, lake sediment cores were recovered from Shadow, Sunrise, and Little Sunrise lakes, whose sediments span the last approximate 14,000 years. Chronologies for the sediments were developed using carbon 14 (^{14}C) dating as well as the presence of numerous identifiable tephra layers. Macroscopic charcoal and pollen analysis reveals that fire activity was relatively similar at all three sites during the Holocene. Fire frequency was generally highest during the late Holocene, when the pollen indicates the wettest conditions during the last approximate 14,000 years. Changes in fire frequency seem to be closely linked to the frequency and strength of El Niño Southern Oscillation events, especially during the last approximate 6,000 years. However, increased human ignitions may have also played a role. We hope this information will help land managers determine how fire activity might change at MORA over the next several centuries in light of global warming.

ALBENI FALLS DAM RESTRICTS MOVEMENTS OF BULL TROUT TO NATAL TRIBUTARIES. **Shawna B. Warehime**, Mark Paluch, Allan T. Scholz, Department of Biology Fisheries Research Center, Eastern Washington University, Cheney, WA 99004; Brian Bellgraph, Pacific Northwest National Laboratory, P.O. Box 999, Richland, WA 99354; Jason Connor, Fisheries Management Program Manager, Kalispell Tribe of Indians, P.O. Box 39, Usk, WA 99180; *sbwarehime 'at' eagles.ewu.edu*

We wanted to learn if bull trout (*Salvelinus confluentus*) entrained below Albeni Falls Dam, Idaho would migrate to their natal tributaries to spawn when relocated above the dam. Albeni Falls Dam was completed in 1955 without fish passage which has prevented bull trout that have entrained, or migrated below the dam, from returning to their spawning tributaries. In 2004 and from 2008 to 2013, 18 bull trout (between age class 3 and 6 +) were collected below the dam by electro-fishing and were implanted with radio transmitters before being released above the dam. Fish movements were determined using 11 fixed radio receivers and mobile tracking by truck, boat, and aircraft. Primary and secondary tributaries of probable genetic origin were predicted by comparing genetic samples of bull trout against a genetic database of 37 known bull trout populations throughout the Lake Pend Oreille and Clark Fork River system of northern Idaho and northwestern Montana. Telemetry investigations determined if the selected natal tributaries matched the genetic predictions. Of the 18 fish monitored, 15 returned to Lake Pend Oreille, one returned to the Priest River, and two entrained at Albeni Falls Dam. Of the 15 fish returning to Lake Pend Oreille, six returned to their primary tributary, two to their secondary tributary, two to unpredicted tributaries, and five were undetected after entering the lake. Three tags are still currently active. Initial results indicate that bull trout endeavor to return to their natal tributaries for spawning if transported above the dam.

MANAGING FORESTS IN CONTINUAL TRANSITION: A CHALLENGE CALLING FOR INTERACTIVE MODELS, REMOTE SENSING, AND FIELD VERIFICATION. **Richard Waring**, College of Forestry, Oregon State University, Corvallis, OR 97331; *Richard.Waring 'at' oregonstate.edu*

When I entered the field fifty years ago, we assumed that the future yields and composition of forests could be predicted based on long-term empirical studies. Those assumptions are a lot harder to make today with unparalleled outbreaks of fire, insects, and disease under a changing climate. What underlying changes have occurred to set forests into transition? What changes in growth and composition might we expect across the Pacific Northwest and beyond? My presentation illustrates an approach using process-based models, field surveys, and remote sensing designed to help chart the future of forests in different parts of western North America. The key to recognizing shifts in the productive capacity of forests is to follow trends in the layers of leaves that can be supported. Which species are most vulnerable? Which species are most likely to persist or to migrate? Vulnerability, persistence, and migration can be predicted based on a species' differential response to drought, humidity deficits, and temperature variation throughout the year. The potential exists to decrease the vulnerability of forests to fire, insects, and disease through management, using techniques of selective thinning, shorter rotations, and by increasing biodiversity. The approach will be illustrated with examples.

NUMERIC NUTRIENT CRITERIA FOR 18 MONTANA ECOREGIONS.
Vicki Watson, University of Montana, Environmental Studies**,** Missoula, MT 59812; Mike Suplee, Montana Department of Environmental Quality, 1520 E. 6th Avenue, Helena, MT 59601**;** *Vicki.watson 'at' umontana.edu*

Excess nutrients and associated nuisance algae are among the top 5 causes of impairment of Montana's wadeable streams. In 2008, the state of Montana developed ecoregion-specific numeric criteria for nutrients and nuisance algae, based on stressor-response studies and reference stream data. Harm to beneficial uses was associated with nutrient levels from about the 73rd to 99th percentiles of reference (mean of 86th), hence numeric criteria were set at the 75th and 90th percentiles for the plains and mountains respectively. Based on more recent studies, these criteria were updated in 2012. The new criteria consider ratios of Nitrogen (N) to Phosphorus (P) because some nuisance algae are usually associated with certain ratios of N to P. Background nutrient levels in our western reference streams are usually quite low and have TN:TP mass ratios close to 7:1. The nuisance diatom *Didymosphenia geminata* has produced nuisance growths in low P streams, thriving in waters where N:P ratios are high (34:1 on average). In contrast, nuisance levels of the green alga *Cladophora glomerata* are often found in high P streams with low N:P ratios. Updated ecoregion-specific nutrient criteria for the summer growing season and recommendations for N:P ratios are presented for 18 ecoregions in Montana. The Montana Board of Review has initiated rulemaking to adopt these criteria as standards.

GROUNDWATER DEPENDENT ECOSYSTEMS POLICY AND INVENTORY IN THE US FOREST SERVICE. **Meredith Webster**, US Forest Service 200 E. Broadway, Missoula, MT 59802. *nmwebster 'at' fs.fed.us*

The US Forest Service recognizes the importance of GDEs as significant ecosystems for T&E species, supporting a disproportionately large percent of the total biodiversity relative to their size. The increasing pressure to supply water, minerals and energy, it is critical that the agency identify GDEs so they can be managed. Studying and monitoring the scale, distribution, and vitality of GDEs overtime will allow the Forest Service to understand the dynamic interrelationship of the three (3) elements (recharge, storage /transport, and discharge) of the vital resource known as groundwater. This understanding will then allow the Forest Service to develop a proper management strategy for the sustainability of this vital resource. We would present the Forest Service policy and a field guide to assist forests in inventory and monitoring of GDEs which was developed in the past 2 years. In addition, we would present a case study of a National Forest project.

INTEGRATION OF SHEEP AND CROP PRODUCTION: EFFECTS ON COVER CROP TERMINATION, WHEAT EMERGENCE, AND SHEEP LIVE WEIGHT GAINS.

Jasmine Westbrook, Craig Carr, Patrick Hatfield, Molly Butler, Department of Animal and Range Sciences, Montana State University, P.O. Box 172900, Bozeman, MT 59717-2900, Perry Miller, Fabian Menalled, Department of Land Resources and Environmental Sciences, Montana State University P.O. Box 173120, Bozeman, MT 59717-3120; *jasminekwestbrook 'at' gmail.com*

The integration of sheep grazing into crop rotation systems has been proposed as an alternative to conventional cover crop management techniques. This study assessed the use of sheep grazing to terminate a field pea (*Pisium sativum*) cover crop as part of a rotational winter wheat production system. Rambouillet yearlings grazed the cover crop for 32 days in either a rotational or continuous grazing system. The effects on cover crop termination, sheep live weight gain, and subsequent winter wheat emergence were quantified. Sheep grazing was compared to two conventional termination methods chemical application and mechanical tillage. Sheep grazing was the most effective termination method based on cover (77% dead pea, 1% live pea, 22% bare ground), followed by tilled (60% dead pea, 5% live pea, 35% bare ground) and chemically treated (18% dead pea, 73% live pea, 9% bare ground) plots. Cover comparisons among treatments were significantly different ($p<0.05$) except percent live pea cover between grazing and tillage. Average daily gains did not differ between grazing treatments with sheep exhibiting average daily gains of 0.40 lbs day^{-1} and 0.34 lbs day^{-1}, for rotational and continuous treatments, respectively ($p= 0.117$). Winter wheat seedling emergence post grazing was higher under the continuous grazing treatment ($p = 0.0172$), however, the practical significance of this difference will not be known until the wheat crop has been harvested and yield differences assessed. Results indicate grazing as a viable method of cover crop termination that also minimizes herbicide and fossil fuel inputs.

HOLOCENE BIOTIC SHIFTS IN THE INTERIOR RAINFOREST OF BRITISH COLUMBIA.

Ariana L. White, Daniel G. Gavin, Paleoecology and Biogeography Lab, Department of Geography, 1251 University of Oregon, Eugene, OR 97403-1251; *awhite 'at' uoregon.edu*

Paleoecological studies rarely present opportunities to address questions of homogeneity versus patchiness in forest responses to climate change. We investigated the influence of microclimate and topography on Holocene forest and vegetation successional patterns from paired pollen records from lakes that are 10 kilometers apart. Morkill and West LaSalle lakes are kettle lakes on kame terraces on opposite sides of the Fraser River in east-central British Columbia, Canada. West LaSalle is located in a drier (rainshadow) site and influenced by cold air drainages compared to Morkill. Pollen analysis indicates significant differences in the timing of biotic shifts in the forest composition between the two sites. CONISS analysis reveals that key transitions in pollen assemblages at Morkill lag those at West LaSalle by an average of 325 years. The present interior cedar-hemlock zone becomes visible in the record at 4200 years before present (ybp) at West LaSalle and at 3800 ybp at Morkill. Previous zone changes suggest an earlier time when both forests were a stable conifer mixture preceded by *Betula*-dominated woodland. In addition, the record from West LaSalle Lake shows a post-glacial but pre-forest period of primary succession on glacial silts in which early successional species assemblages are observed. The drier site (West LaSalle) may have had less ecological inertia compared to Morkill due to higher disturbance rates. This comparison sheds light onto controls of Holocene vegetation change over entire landscapes.

EFFECTS OF NATIVE VEGETATION AND AGRICULTURE ON SOIL CARBON OF MONTANA'S GALLATIN VALLEY. **Edward Wierda**, Department of Ecology; Tony Hartshorn, Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT 59717; *edward.wierda 'at' ecat.montana.edu*

Our research aims to quantify soil carbon dynamics in the Gallatin Valley, one of the most heavily cultivated parts of Montana. We compared once-identical, adjacent pairs of soils, where one was dedicated to dryland grain production for nearly a century and the other left as grassland. For four pairs of adjacent soils, we measured both soil organic matter via loss on ignition to estimate volumetric carbon expressed over the upper 30 centimeters of soil, as well as soil respiration converted from micromoles of carbon dioxide per meter squared per second to kilograms of carbon per meter squared per year. The quotient of a soil's volumetric carbon over its corresponding soil respiration rate yields a soil carbon residence time in units of years. We found significant differences in both soil carbon (C) and soil respiration rates. Soil carbon ranged from 5.5 to 8.4 kilograms of carbon per meter (kg C m^{-2}) for cultivated soils and from 7.7 to 10.5 kg C m^{-2} for native grassland soils. Annualized soil respiration from cultivated soil (May 2013) ranged from 0.4 to 1.2 kilograms of carbon per meter per yeat (kg C m^{-2} y^{-1}), considerably lower than from uncultivated soils (1.1 to 4.6 kg C m^{-2} y^{-1}). Soil carbon residence times averaged 10 years for cultivated soils, slightly longer than the average for uncultivated soils. Our paired design suggests that while nearly a century of cultivation has resulted in a 28% decrease of soil organic carbon at a long-term rate of 25 g C m^{-2} y^{-1}, the 65% lower soil respiration rates lead to slightly longer residence times for the carbon remaining in the cultivated soil.

A COMPARISON OF DIATOM ASSEMBLAGES BETWEEN PRESENT AND HISTORIC PRE-MINING WETLAND SEDIMENTS FROM THE BUTTE MINING AREA.
Diane Winter, Algal Analysis, LLC, 5104 23rd Avenue, Missoula MT, 59803; Nicholas J. Tucci, Montana Bureau of Mines and Geology, 1301 West Park Street, Butte, MT, 59701; *diane 'at' algalanalysis.com*

Organic-rich silt samples cored from historic wetland areas in the Blacktail Creek/Silver Bow Creek confluence in the Butte mining district were analyzed for diatom assemblage and environmental information. The record and abundance of the diatoms (siliceous single-celled algae) present offers information regarding the conditions of the pre-mining wetlands ecology in Butte. The organic-rich silt is thought to represent the pre-industrialized extent of groundwater discharge in the Summit valley. Geoscientists have mapped this unit, now often overlain by mine waste, fill, or other anthropogenic material. In some locations the organic-silt layer was not impacted by mine waste (as indicated by lithology, soil pH, and metal's concentrations), while in other areas runoff carried metal-laden acid-generating mine-waste into these wetland areas which decreased their pH. Diatom assemblages from these two types of historic wetland samples (impacted and non-impacted) were compared to assemblages from a modern-day sample in a wetland adjacent to Blacktail Creek. The non-impacted historic organic-silt sediments contained the most diverse diatom assemblages, with many finely-silicified specimens observed. Diatom assemblages and the abundance of chrysophyte cysts in both types of historic sediment samples indicate the pre-mining wetland environment was more oligotrophic than the present-day environment. While metal-tolerant species are more abundant in present-day wetland samples, acid-tolerant species are more abundant in the historic samples. Since organic material from pines and sphagnum mosses can lower pH, the higher abundance of acid-tolerant diatoms is not unexpected. The lower abundance of acid tolerant species in modern-day samples may be due to impacts of industrialization.

THE UNIVERSITY OF MONTANA ALGAE AND DIATOM COLLECTION OF DR. FRED A. BARKLEY. Diane Winter, Algal Analysis, LLC, 5104 23rd Avenue, Missoula MT, 59803; Dennis Vander Meer, Rhithron Associates, Inc., 33 Fort Missoula, MT, 59804; *diane 'at' algalanalysis.com*

Dr. Fred A. Barkley served as the curator of the University Of Montana Herbarium (MONTU) from 1937-1941. His doctoral dissertation in botany from Washington University in St. Louis, titled "A monographic study of *Rhus* and its immediate allies in North and Central America, including the West Indies" was published in the prestigious Annals of the Missouri Botanical Garden (vol. 24, no. 3, 496 pp.). Dr. Barkley collected many plant specimens throughout the western United States which are now housed in the MONTU as well as several other herbaria across the country. While Dr. Barkley mainly focused on higher plants he also discovered a rare red alga in the Bitterroot valley during his tenure as the curator at the MONTU Herbarium. In addition to higher plants Dr. Barkley and several other gentlemen gathered a collection of 54 algae samples from several pond and stream locations in Missoula and Ravalli counties during two intervals: 26 August 1940 and 7-26 October 1940. The excellently preserved dried algae samples are now part of the extensive MONTU botanical collection and provide a useful snapshot of the regional 1940's algae populations. The diatom content of some are analyzed for this study. The most common genera present are *Achnanthes*/*Achnanthidium*, *Cocconeis*, *Gomphonema*, *Navicula*, *Nitzschia*, *Pseudostaurosira*, *Staurosira*, and *Staurosirella* with more rarely observed *Amphora*, *Aulacoseira*, *Caloneis*, *Craticula*, *Cymbella*, *Cymbopleura*, *Diatoma*, *Encyonema*, *Epithemia*, *Eunotia*, *Fragiliaria*, *Frustulia*, *Geissleria*, *Gomphoneis*, *Hannae*, *Hippodonta*, *Melosira*, *Neidium*, *Pinnularia*, *Planothidium*, *Reimeria*, *Rhopolodia*, *Sellophora*, *Stephanocyclus*, *Surirella*, and *Ulnaria* completing the assemblages.

EMERGING RESEARCH IN NATURAL RESOURCE MANAGEMENT THROUGH A CONSORTIUM OF REGIONAL UNIVERSITIES AND FEDERAL AGENCIES.
Pei-Lin Yu, Lisa Gerloff, and Kathy Tonnessen, Rocky Mountains Cooperative Ecosystem Studies Unit, College of Forestry and Conservation, University of Montana, Missoula, MT 59812; *peilin_yu 'at' nps.gov*

A broad array of research through the Rocky Mountains Cooperative Ecosystem Studies Unit (RM-CESU) is tackling key issues that affect the health and integrity of forests of the Rocky Mountains. Federal agencies and academic research partners with expertise ranging from anthropology to zoology are using scientific results to inform best practices for managing forests at local and landscape scales, with an emphasis on use of the RM-CESU to facilitate research in the Great Northern Landscape Conservation Cooperative. This presentation features several examples of research and technical assistance projects featuring cooperation between Federal agencies and Rocky Mountain region universities and colleges (all RM-CESU partners). Research results related to fire and fuels management, restoration ecology, invasive plant and insect disturbance and climate change in Rocky Mountains forests are being used by Federal land managers to develop tactics for ecosystem adaptation and resiliency, such as restoration of sub-alpine plants and management for grizzly bear habitat. The RM-CESU consortium encourages engagement by tribal college faculty and students with Federal agencies in natural and cultural resource stewardship through student internships, field schools and fire information activities. Contacts are Lisa Gerloff, 406-243-5346, lisa.gerloff@cfc.umt.edu, and Pei-Lin Yu, 406-243-2660, pei-lin.yu@cfc.umt.edu.

MISSOULA

MAPS & INFORMATION

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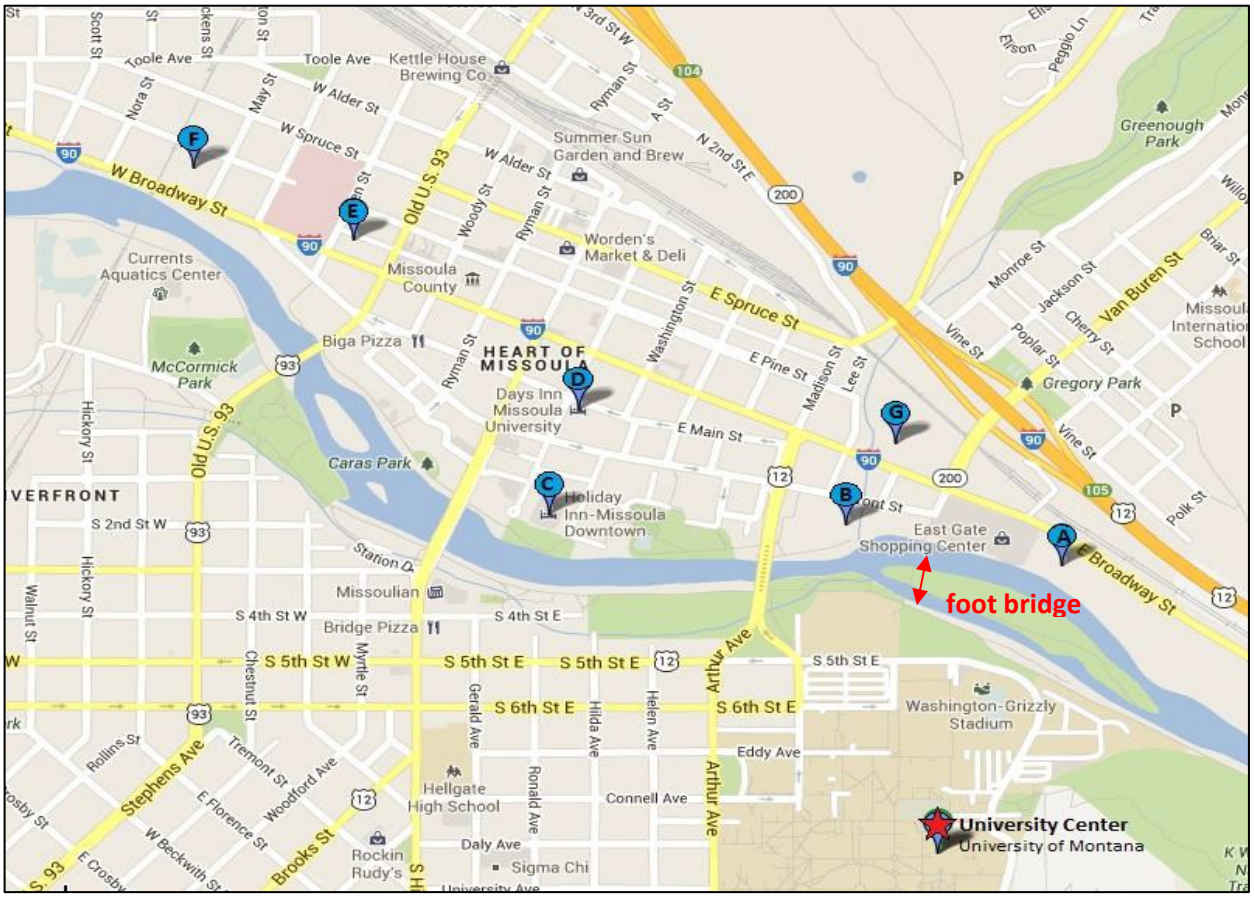
WHERE TO STAY IN MISSOULA



A: Comfort Inn University
1021 East Broadway
406-549-7600
Note: Within walking distance by using the footbridge.

B: DoubleTree by Hilton (Edgewater)
100 Madison Street
406-728-3100
Note 1: Within walking distance by using the Madison St. Bridge.
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Non-River View Rooms	Single Rate	Double Rate	Triple Rate	Quad Rate
Conference Rate	$92.00	$102.00	$112.00	$122.00
Government Rate*	$89.00	$97.00	$107.00	$117.00
Student Rate	$87.00	$87.00	$87.00	$87.00

* Government rate subject to change pending a Per Diem change.

C: Holiday Inn Downtown Missoula
200 South Pattee Street
1-800-939-4249
Note: Shuttle service to/from campus, airport, or bus station is available.

D: Days Inn University
201 East Main Street
406-543-7221

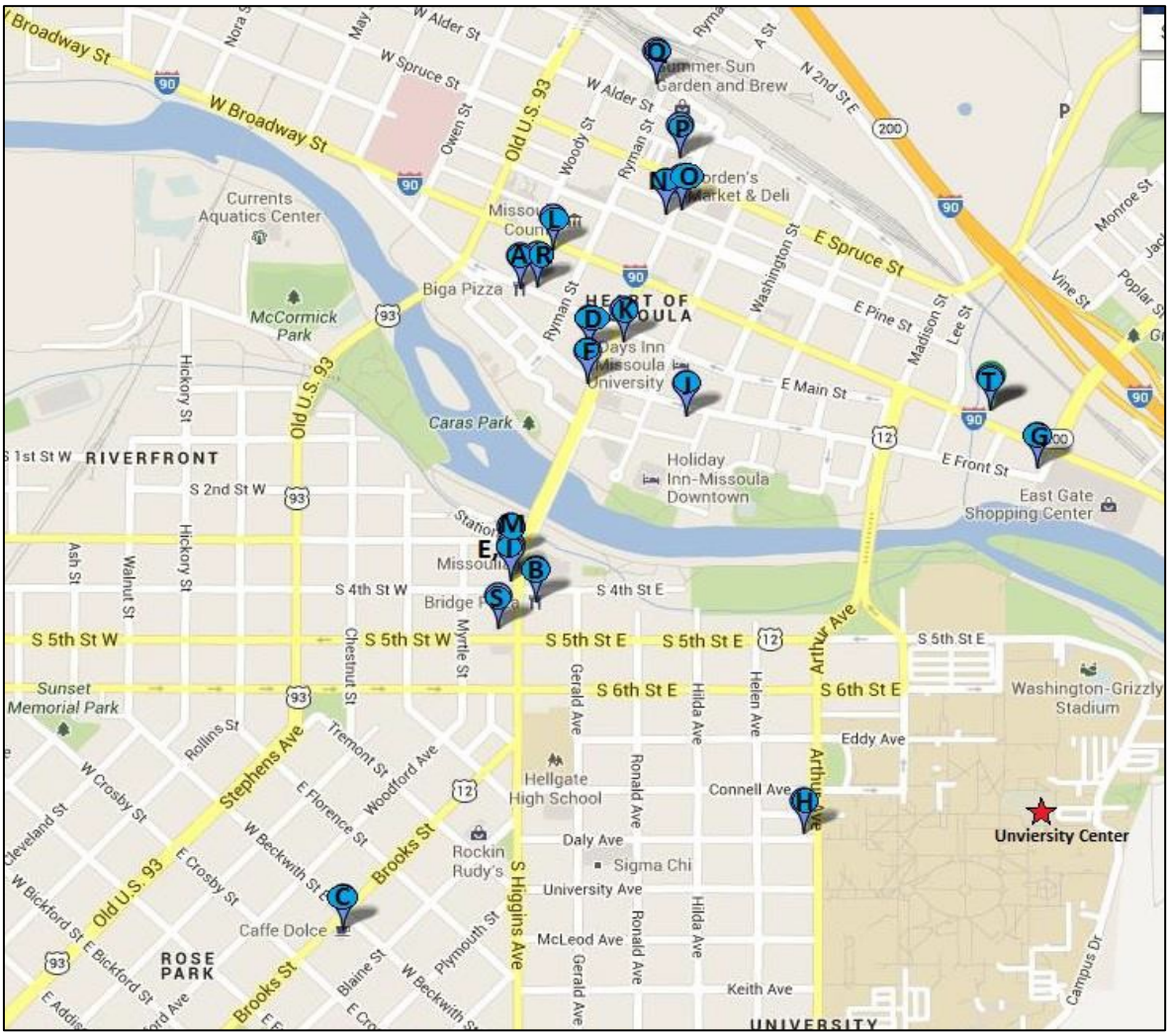
E: Americas Best Value
420 Broadway Street
406-728-4500

F: Red Lion Inn
700 West Broadway Street
406-728-3300

G: Campus Inn Missoula
744 East Broadway Street
406-549-5134
Note: Within walking distance by using the footbridge.

WHERE TO EAT IN MISSOULA

Within walking distance of the University there is a wide variety of restaurants, many of which are not listed below.



A. Biga Pizza
241 W. Main St.
Price: $8-$15

B. Bridge Pizza
600 S. Higgins Ave.
Price: $3-$15

C. Caffe Dolce
500 Brooks St.
Price: $10-$25

D. Catalyst Café and Expresso
111 N. Higgins Ave.
Price: $5-$15

E. Ciao Mambo
541 S. Higgins Ave.
Price: $10-$20

F. El Cazador
101 S. Higgins Ave.
Price: $8-$15

G. Finn and Porter
100 Madison St.
Price: $15-$40

H. Food For Thought
540 Daly Ave.
Price: $5-$12

I. Hob Nob Café
531 S. Higgins Ave.
Price: $5-$15

J. Pearl Café & Bakery
231 E. Front St.
Price: $10-$40

K. Pita Pit
130 N. Higgins Ave.
Price: $5-$10

L. Sa Wa Dee
221 W. Broadway
Price: $10-$20

M. The Silk Road
515 S. Higgins Ave.
Price: $5-$10

N. Sushi Hana
403 N. Higgins Ave.
Price: $10-$25

O. Taco Del Sol
422 N. Higgins Ave.
Price: $3-$8

P. Iron Horse Brew Pub
501 N. Higgins Ave. Price: $7-$15

Q. The Depot
201 Railroad St. W
Price: $10-$30

R. The Shack Café
222 W. Main St.
Price: $10-$30

S. Big Dipper Ice Cream
631 S. Higgins Ave.
$2-$8

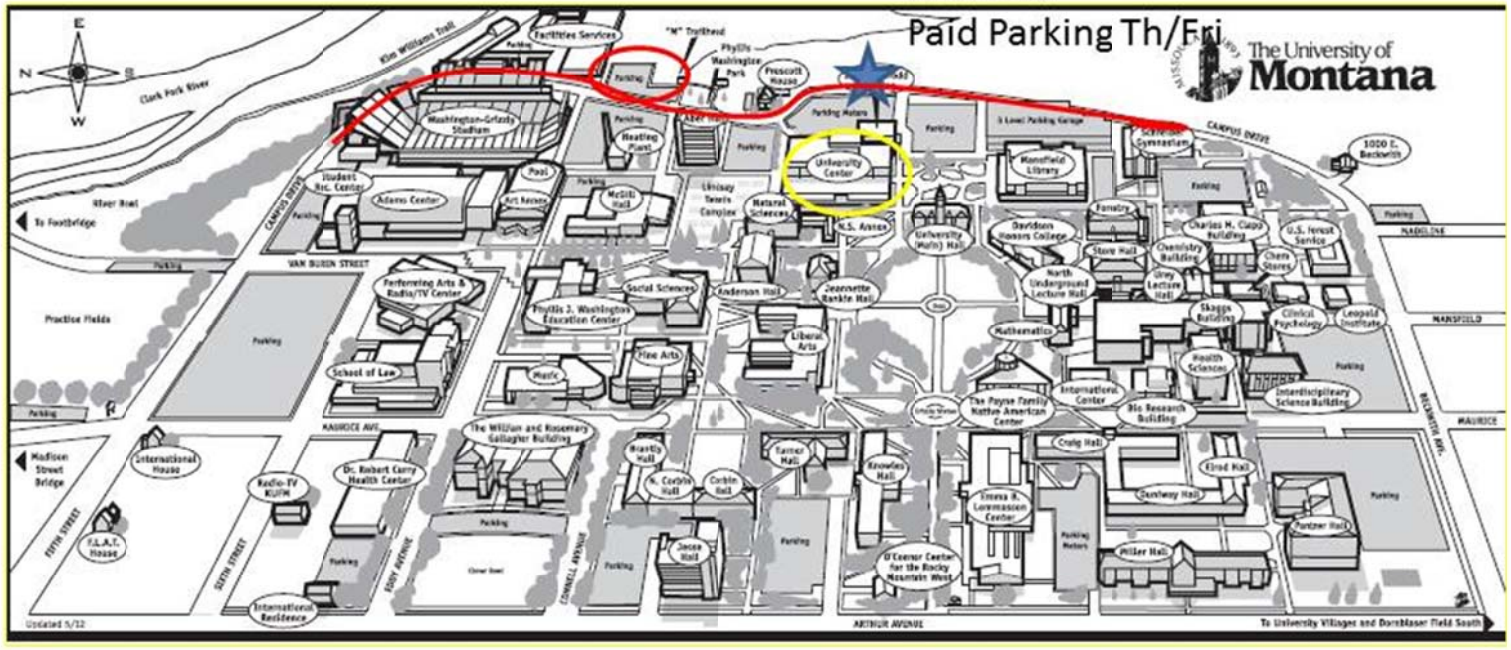
T. Tom Dooley's Hot Dogs
744 E. Broadway St.
Price: $5-$10

Sections in red are where finding parking is more likely before 9 am

Yellow circle marks where the conference is

Blue Star

Paid Parking Th/Fri



NOTE: Blue star is also for those who pre-paid for parking on Wed. March 26th.